CD7171/RC1357

Final
Remedial Investigation Report for Bainbridge Naval Training Center, Port Deposit, Maryland
Volume 2 of 2
Appendices A-P

Contract No. N62477-90-C-0183

February 1999

Prepared for:

UNITED STATES NAVY
Naval Facilities Engineering Command - Chesapeake Division
Washington, DC

Prepared by:

Ecology and Environment, Inc.

Appendices

A Geophysical Survey A-1

B Soil Gas Survey B-1

C Test Pit Logs C-1

D Soil Boring Logs D-1

E Monitoring Wells Installation Logs E-1

F Aquifer Test Data F-1

G Quality Assurance/Quality Control Data Validation Reports G-1

H Results of Domestic Well and Spring Surveys and Sampling 1988, 1992, and 1993 Port Deposit, Maryland H-1

I Screening Analysis of Dermal Contact with Metals in Surface Water I-1

J Exposure Point Concentrations Calculations J-1

K Estimation of Dermal Absorption from Water K-1

L Shower Volatilization Model L-1

M Health Effects Summaries M-1

N Source Papers From the National Center for Environmental Assessment (NCEA) N-1

O Human Health Risk Tables O-1

P Desktop Ecological Risk Assessment P-1

A Geophysical Survey

HAGER-RICHTER
GEOSCIENCE, INC.

GEOPHYSICAL SURVEY
BAINBRIDGE NAVAL TRAINING CENTER
PORT DEPOSIT, MARYLAND

Prepared for:

Ecology and Environment, Inc.
1700 North Moore Street, Suite 1105
Arlington, Virginia 22209

Prepared by:

Hager-Richter Geoscience, Inc.
8 Industrial Way - Unit D10
Salem, New Hampshire 03079

December, 1990
File 90J17

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HAGER-RICHTER
GEOSCIENCE, INC.

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January 3, 1991
File 90J17

Ecology and Environment, Inc.
1700 North Moore Street, Suite 1105
Arlington, Virginia 22209
Attention: Mr. Jeff Tuttle

Re: Geophysical Survey, Bainbridge Naval Training Center,
Port Deposit, Maryland

Dear Mr. Tuttle:

Enclosed are three (3) copies of our report entitled " Geophysical Survey, Bainbridge Naval Training Center, Port Deposit, Maryland."

Please contact us if you have any questions or need further information,

Sincerely yours,
HAGER-RICHTER GEOSCIENCE, INC.

Jutta Hager

Jutta L. Hager
Principal

enc.: 3 copes of report

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0. EXECUTIVE SUMMARY

Hager-Richter Geoscience, Inc. conducted a geophysical survey at the Bainbridge Naval Training Center, Port Deposit, Maryland, for Ecology and Environment, Inc. of Arlington, Virginia in December, 1990. Objective of the survey was to locate possible bedrock fractures southwest of an inactive landfill for siting a bedrock water well.

Geophysical field work was preceded by fracture trace analysis of aerial photographs taken of the area of interest. The field work consisted of VLF (very low frequency) profiling.

One region in the survey area, at the approximate coordinates (N3+60, E8+10), is considered promising as a bedrock well site based on the results of both fracture trace analysis and the VLF survey; therefore, we recommend this area as a possible drilling location.

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TABLE OF CONTENTS

0. Executive Summary 1

Table of Contents 2

1. Introduction 3

2. Equipment and Procedures 3
   2.1 General 3
      2.1.1 Fracture Trace Analysis 4
      2.1.2 VLF Profiling 4
   2.2 Site Specific 4
      2.2.1 Fracture Trace Analysis 5
      2.2.2 VLF Survey 5

3. Results and Discussion 5
   3.1 Fracture Trace Analysis 5
   3.2 VLF Profiles 5

4. Conclusions 6

List of Figures

Figure 1. General location of the Site.

Figure 2. Location of the geophysical survey area.

Figure 3. Plan of the VLF profile lines.

Figure 4. Multi profile plot of VLF profiles.

1. INTRODUCTION

Hager-Richter Geoscience, Inc. was retained by Ecology and Environment, Inc. (E&E) of Arlington, Virginia, to conduct a geophysical survey at the Bainbridge Naval Training Center in Port Deposit, Maryland. This study was part of a larger RI/FS being performed by E&E. Location of the Site is shown in Figure 1.

The geophysical survey consisted of fracture trace analysis and very low frequency (VLF) profiling. Objective of the survey was to determine the presence and location of possible bedrock fractures in an area between two existing monitoring wells at the Site to aid in the siting of an additional bedrock well. The boring logs for these two wells, 1GW-3 and 1GW-5, which were provided to us by E&E, indicate that depth to rock in and immediately to the north of the survey area is between 20 and 23 feet, and that the overburden consists of saprolite.

Hager-Richter geologists Gene Simmons and Jutta Hager performed the fracture trace analysis during the week of November 26th. Jeffrey Reid conducted the VLF field survey on December 5, 1990. All field work was performed at Level D personal protection. The field operations were coordinated with and observed by Mr. Greg Hallford of E&E. The locations of all survey lines were selected by E&E. Data were analyzed in the Hager-Richter office in Salem, New Hampshire. Original data and field notes will be retained in our files for a minimum of three years.

2. EQUIPMENT AND PROCEDURES

2.1 General

In the Northeast, water in the bedrock is stored mainly in fractures, and a successful bedrock water well must intersect one or more of these fractures. In general the productivity of a well depends on the number, size, and geographical extent of the fractures tapped by the well. Some fracture systems can be traced for miles. A well drilled into the intersection of two or more fracture systems, or zones, can produce several hundred gallons of water per minute.

2.1.1 Fracture Trace Analysis. Over the past 10 years, fracture trace analysis has been used with increasing frequency and with excellent success to locate fracture zones in bedrock for siting high yield water wells. Subtle features in aerial photographs, termed photolinears, may indicate the presence and location of these fracture zones. Intersections of several photolinears may be especially promising. Although fracture zones produce photolinears, not all photolinears are caused by fracture zones. Photolinears may also be caused by such features as streams, rock walls, old roads, old paths, edges of formerly tilled fields that are now woodlands, and other cultural features. Verification in the field is therefore essential. Since the fracture zones usually cannot be verified visually, some form of subsurface exploration is required.

2.1.2 VLF Profiling. An ABEM Wadi VLF receiver was used for the VLF profiling survey. The Wadi is a microprocessor controlled instrument that measures the electromagnetic field produced by an existing VLF transmitter, typically located at a large distance from the site. Both the in-phase and the quadrature phase components of the secondary magnetic field are measured as a percentage of the primary magnetic field and automatically recalculated to "current density." The instrument is tuned to the VLF station producing the strongest response in the direction of the survey traverse. The Wadi has a digital memory capable of storing the data for about 6000 stations.

VLF profiling has been used in many areas to locate saturated bedrock fractures. Conductive zones due to saturated, commonly clay-filled fractures affect the direction and strength of the local field generated by distant VLF radio stations. Such effects can be measured with a VLF receiver and are detected as anomalies along profiles made perpendicular to the expected strike of the fracture zone.

2.2 Site Specific

The area selected for survey lies roughly southwest of an inactive sanitary landfill, between two existing monitoring wells, 1GW-3 and 1GW-5. It is located to the east of State Route 276 and northeast of a water tower, in the area indicated in Figure 2. The ground in the area of survey slopes from the northeast to the southwest, with the steepest slope at the northern end. It is covered by trees and thick, brushy vegetation. Portions of the area are marshy.

2.2.1 Fracture Trace Analysis. The fracture trace analysis consisted of examination of aerial photographs of the Site at a scale of 1"=400'. All visible photolinears were noted and marked on a clear overlay. The locations of intersection of several photolinears were also noted. The photolinears are shown in Figure 2; these were used as a guide for the orientation of the VLF survey lines.

2.2.2 VLF Survey. The Annapolis, MD station transmitting at 22.3 kHz was used as the source for the VLF survey. E&E cleared and laid out the survey lines, placing stakes every 100 feet and flags every 20 feet along each line. All locations referred to in this report are based on the conventions established by E&E.

VLF profiles were obtained along 26 lines spaced 20 feet apart, oriented northwest-southeast. This direction was judged to be more nearly perpendicular to the strike of the possible fracture zones based on the orientation of the most prominent photolinears. Stations along each line were 10 feet apart. Because of the limited size of the survey area, the profiles were 150 to 200 feet long. Figure 3 is a plan showing the locations of the VLF profiles.

3. RESULTS AND DISCUSSION

3.1 Fracture Trace Analysis

The fracture trace analysis indicates the presence of several sets of photolinears. The most prominent set is oriented approximately northeast-southwest. It is intersected by photolinears trending approximately east-west and northwest-southeast at the location marked by the open circle in Figure 3.

3.2 VLF Profiles

A multi profile plot of equivalent current density for a depth of 30 feet is displayed in Figure 4. In this plot, the positive, or dark areas, indicate concentrations of relatively higher current density. Where such "highs" can be connected with straight lines, they are interpreted to trace out bedrock fractures. A line connecting such a series of "highs" in Figure 4 may represent a bedrock fracture system. At the approximate coordinates (N3+60, E8+10), marked by an open circle in Figure 4,

the "highs" coincide with the intersection of photolinears shown by the open circle on the plan in Figure 3. Therefore, we recommend this location as the most promising drilling site in the survey area for the proposed bedrock water well.

4. CONCLUSIONS

Based on the results of fracture trace analysis and VLF profiling, one region in the survey area, at the approximate coordinates (N3+60, E8+10), is considered promising as a bedrock well site; therefore, we recommend this area as a possible drilling location.

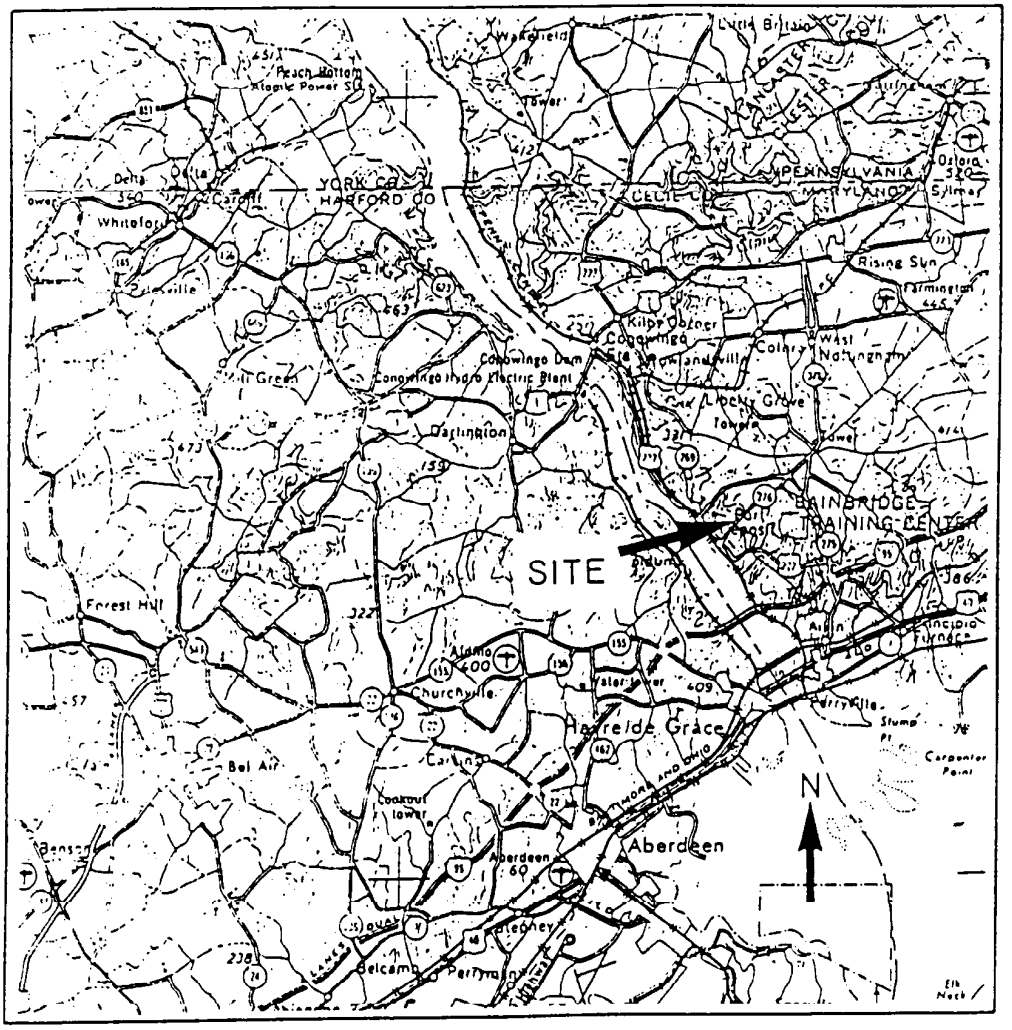

Figure 1. General location of the Site.

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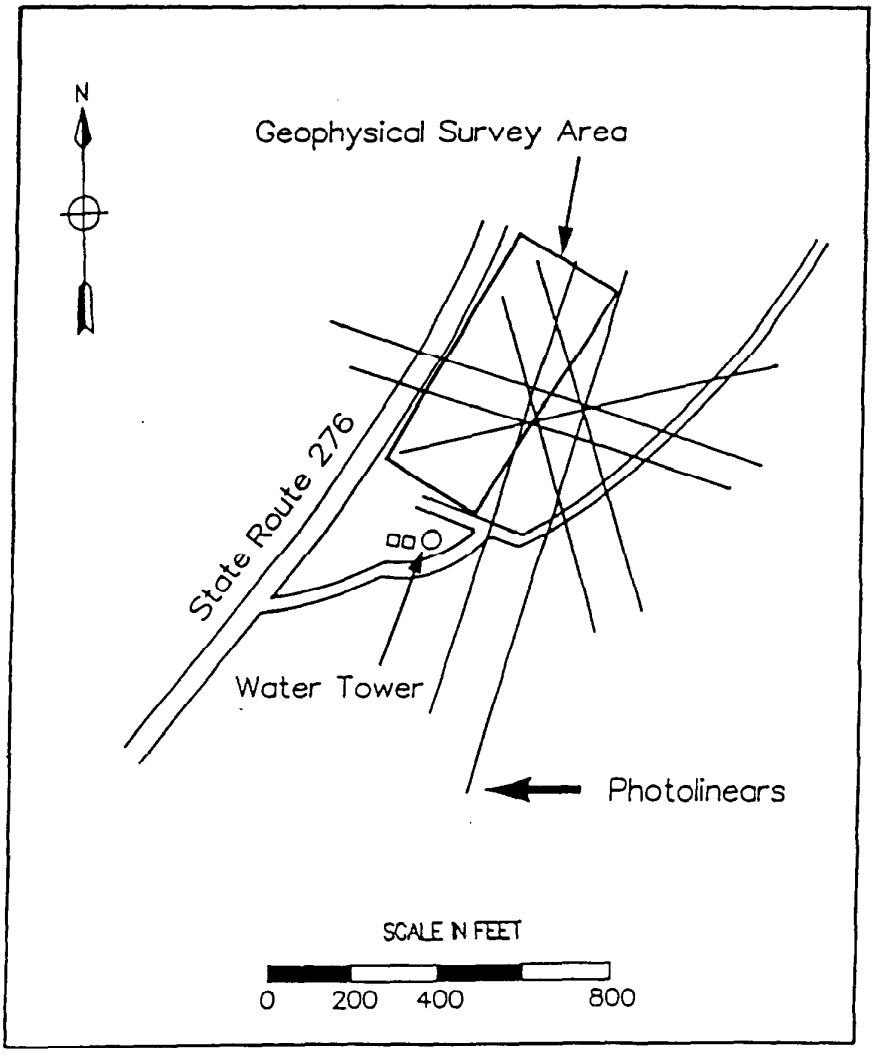

Figure 2. Location of the geophysical survey area, showing approximate location of photolinears. Area boundaries are accurate to approximately 25 feet.

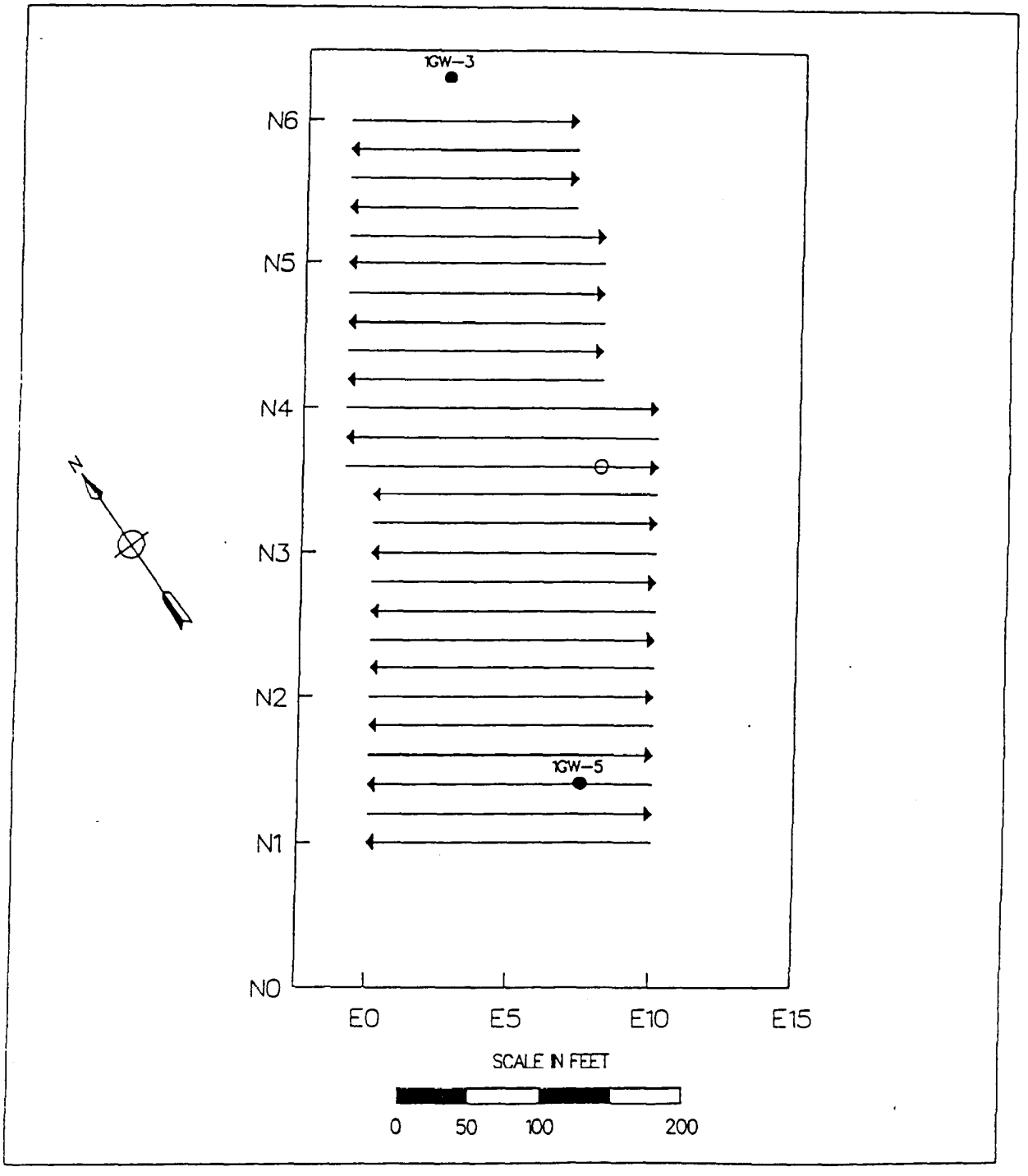

Figure 3. Plan of the VLF profile lines. Coordinate system established by E&E. The filled circles mark existing monitoring wells. The open circle marks the intersection of photolinears.

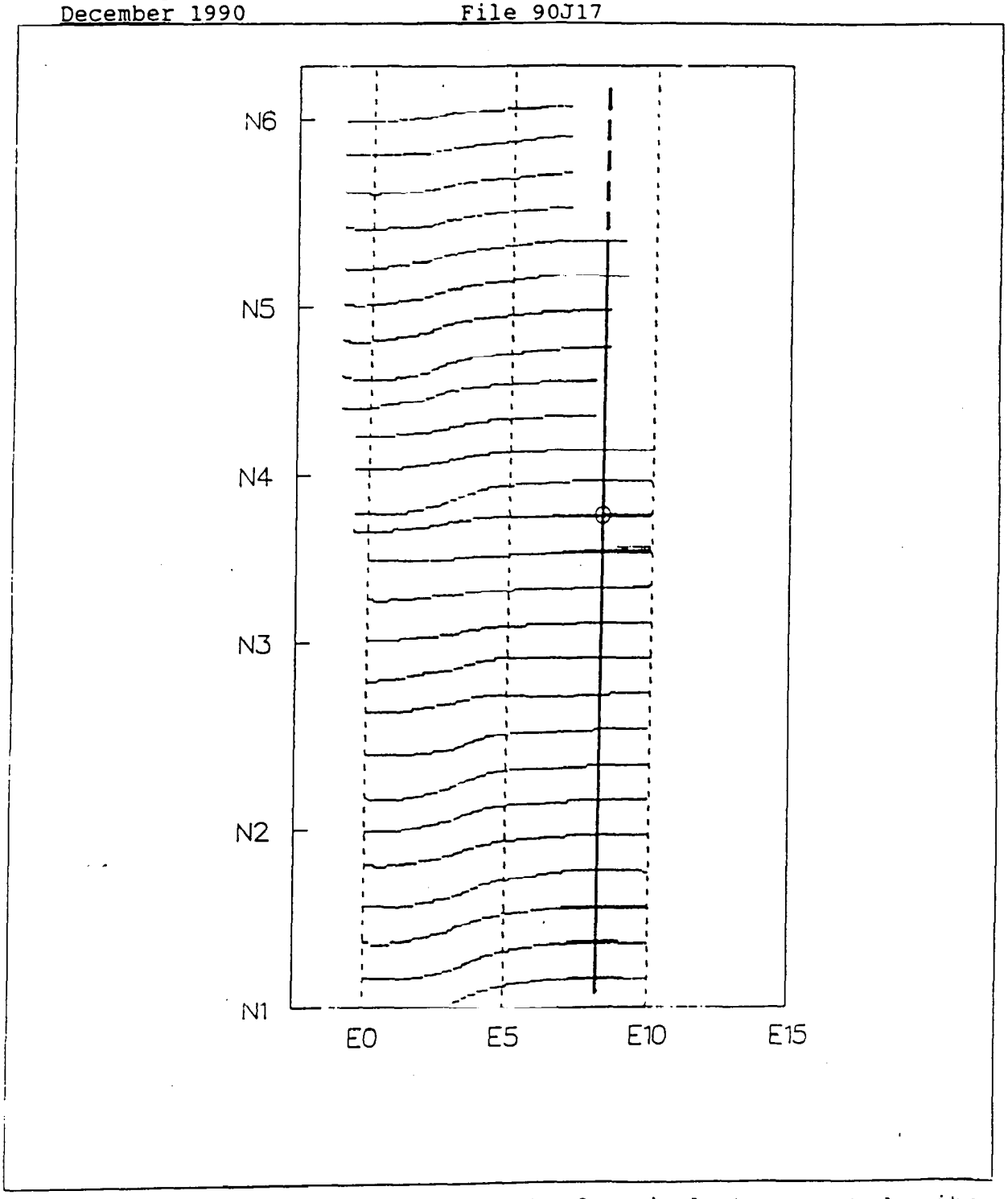

Figure 4. Multi profile plot of equivalent current density at a depth of 30 feet. The line connecting positive areas, or "highs," may trace out a bedrock fracture system. The open circle marks the area where the intersection of photolinears and region of relatively high current density coincide.

Geotechnical Data

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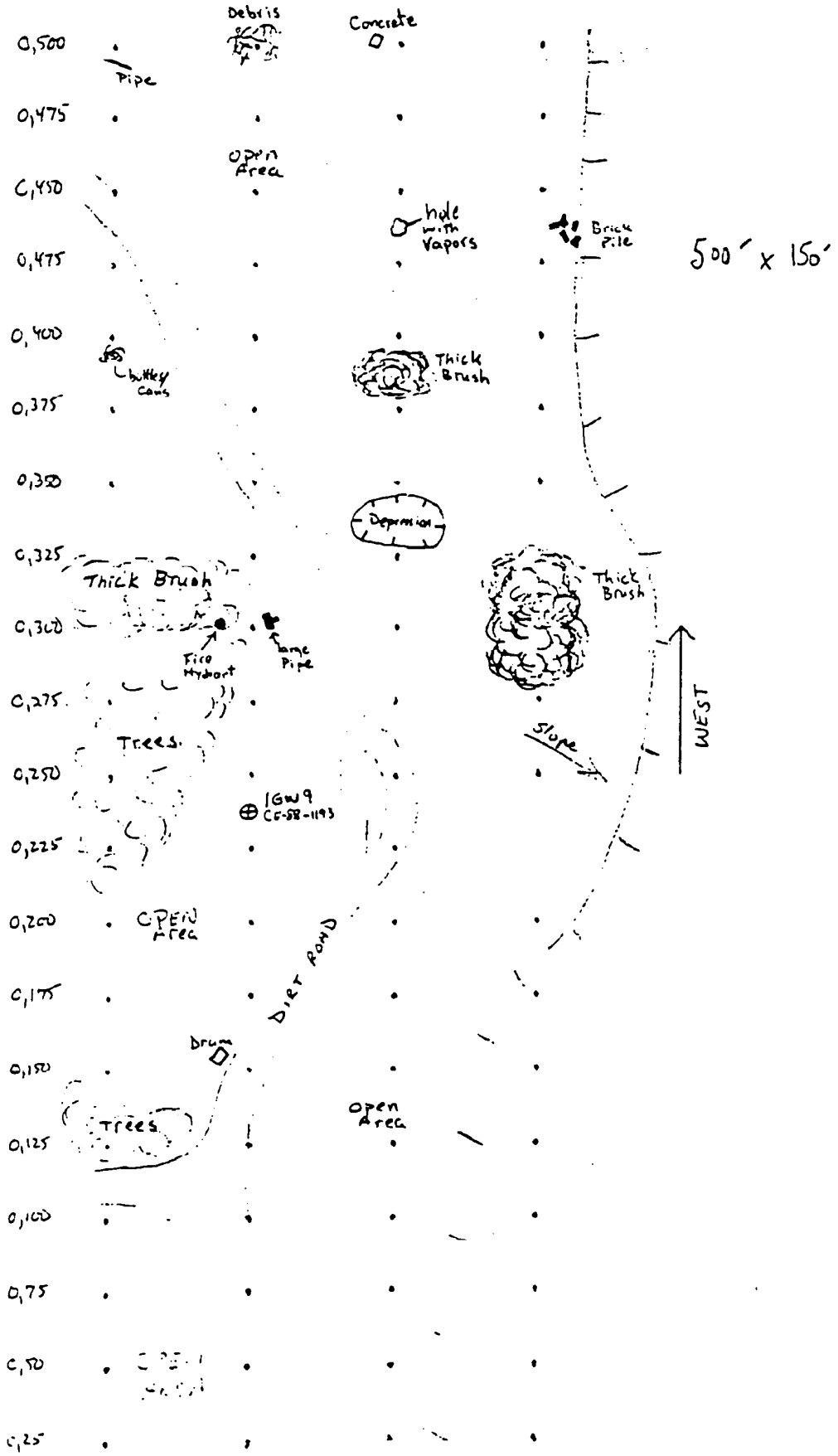

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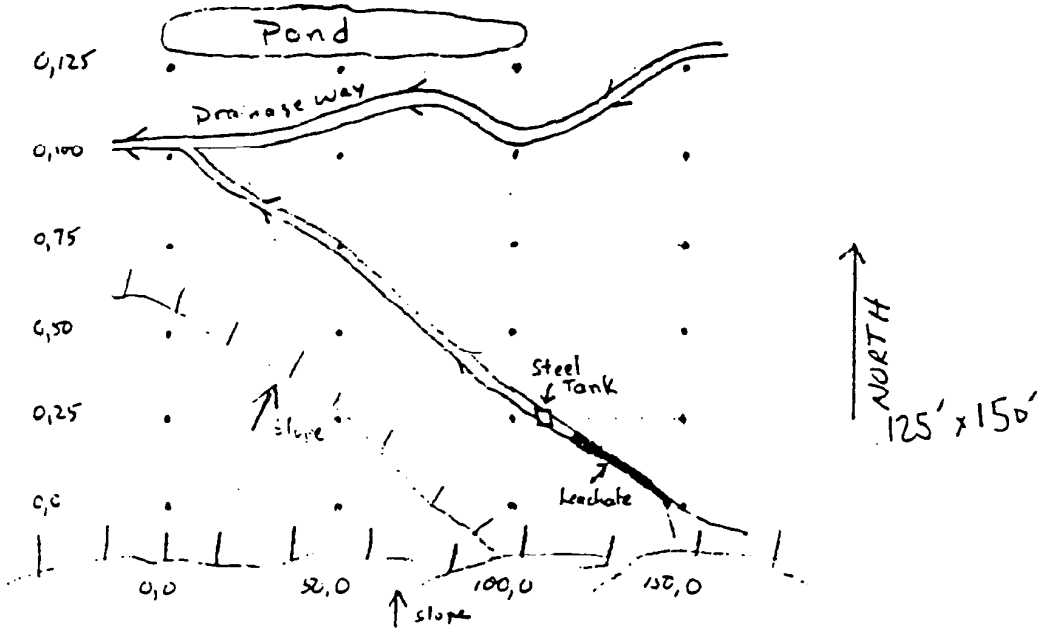

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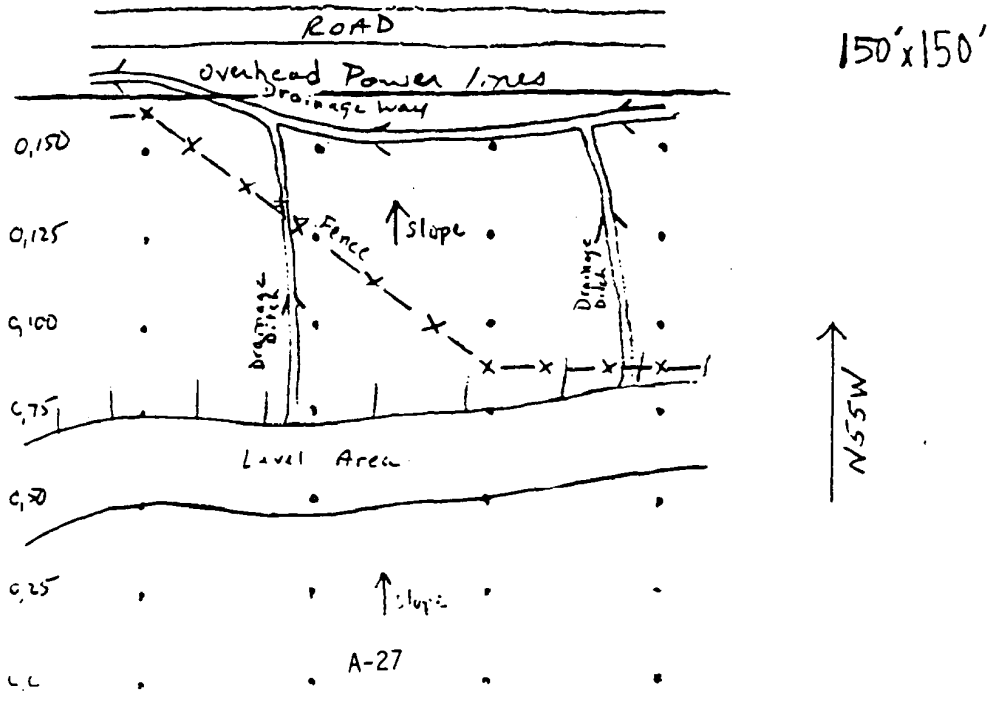

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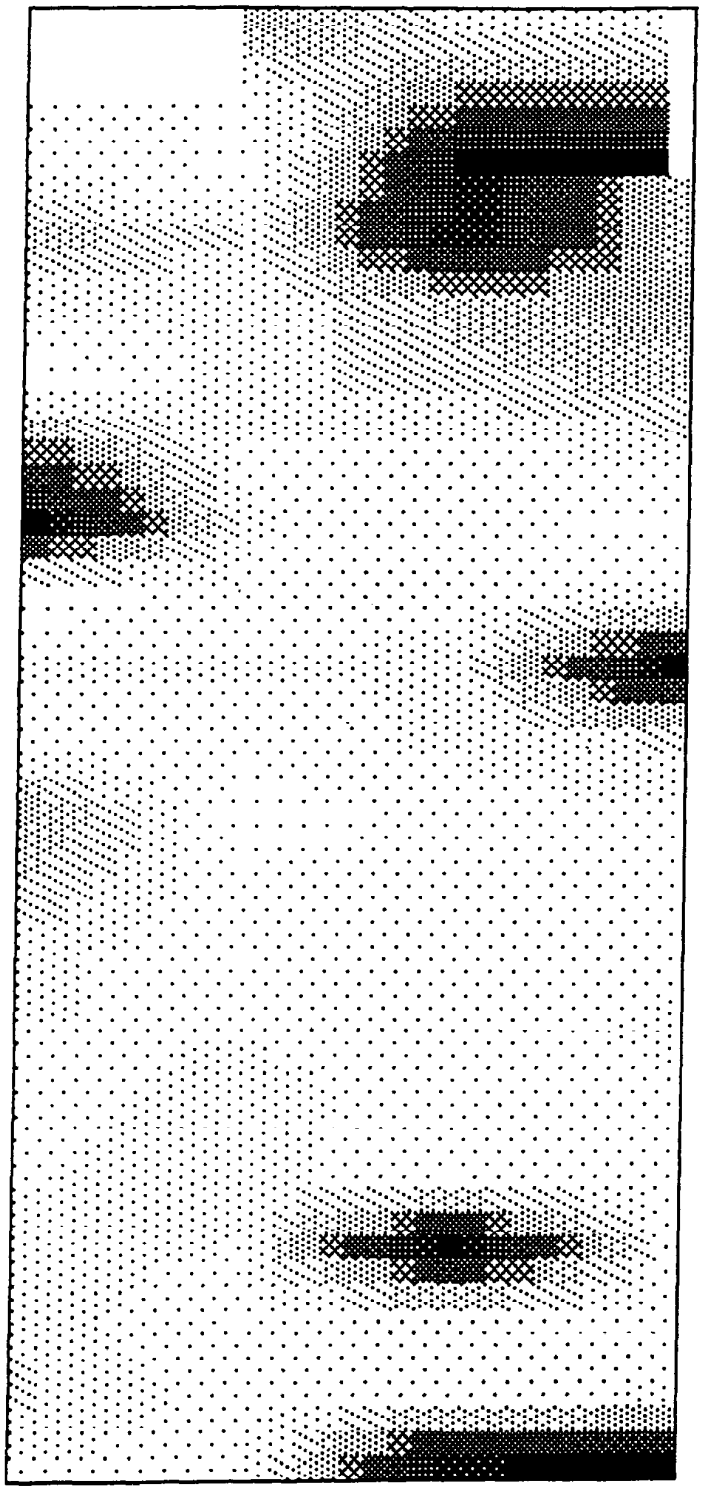

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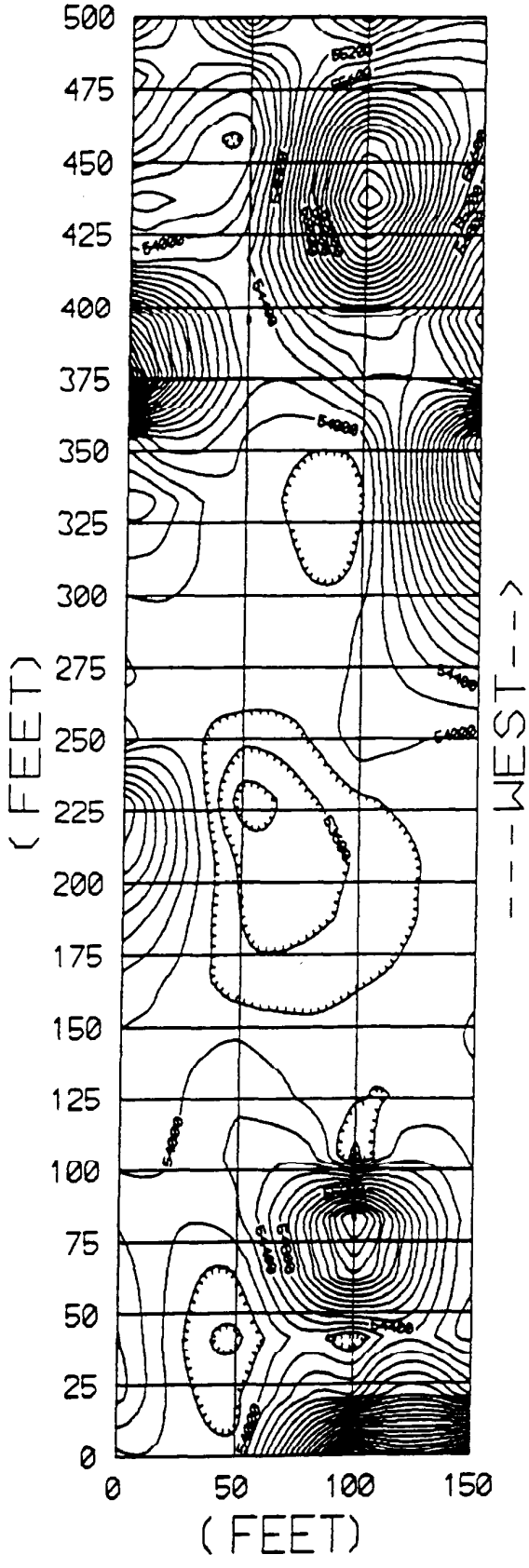

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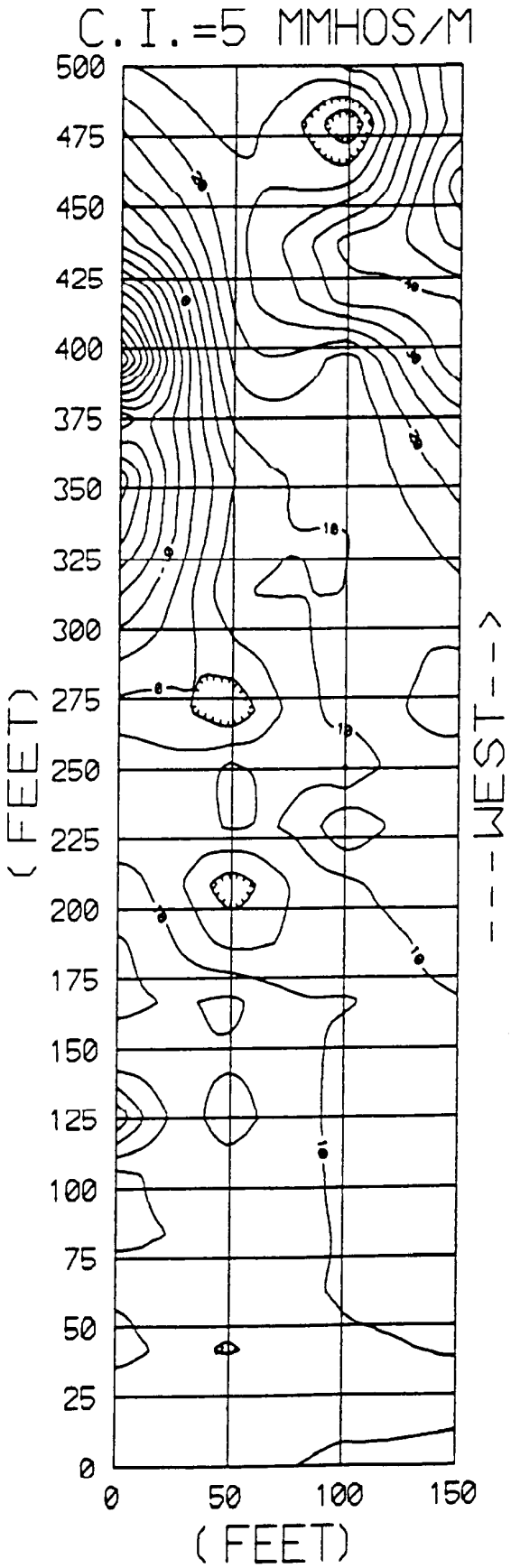

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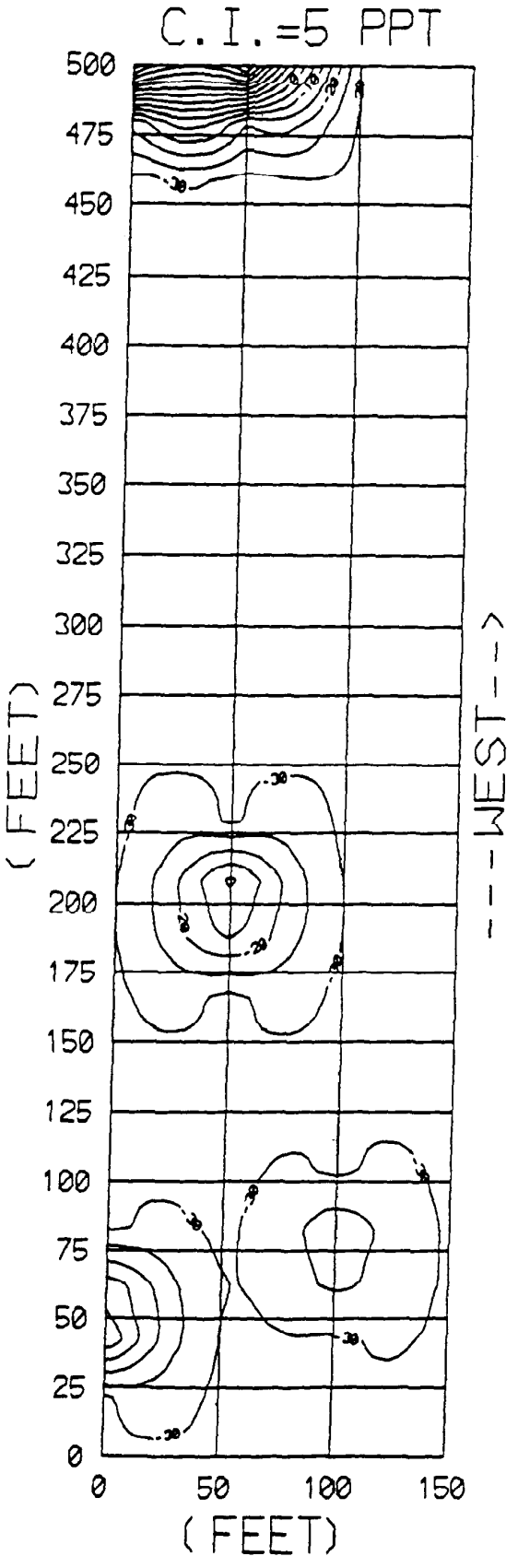

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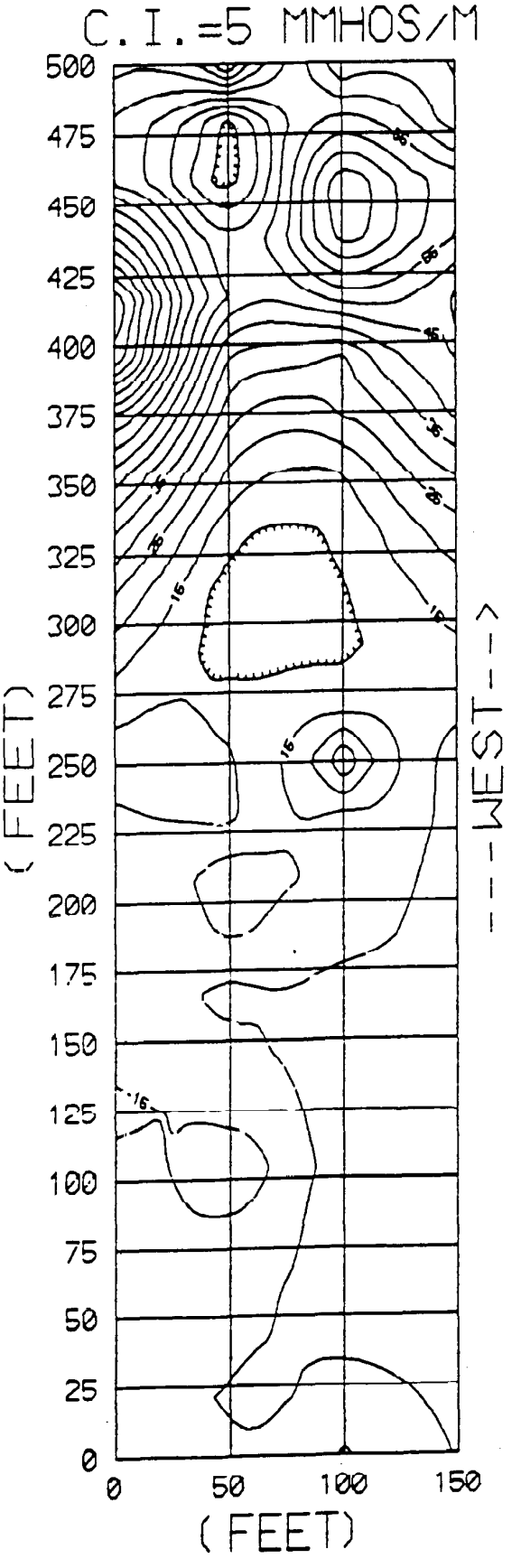

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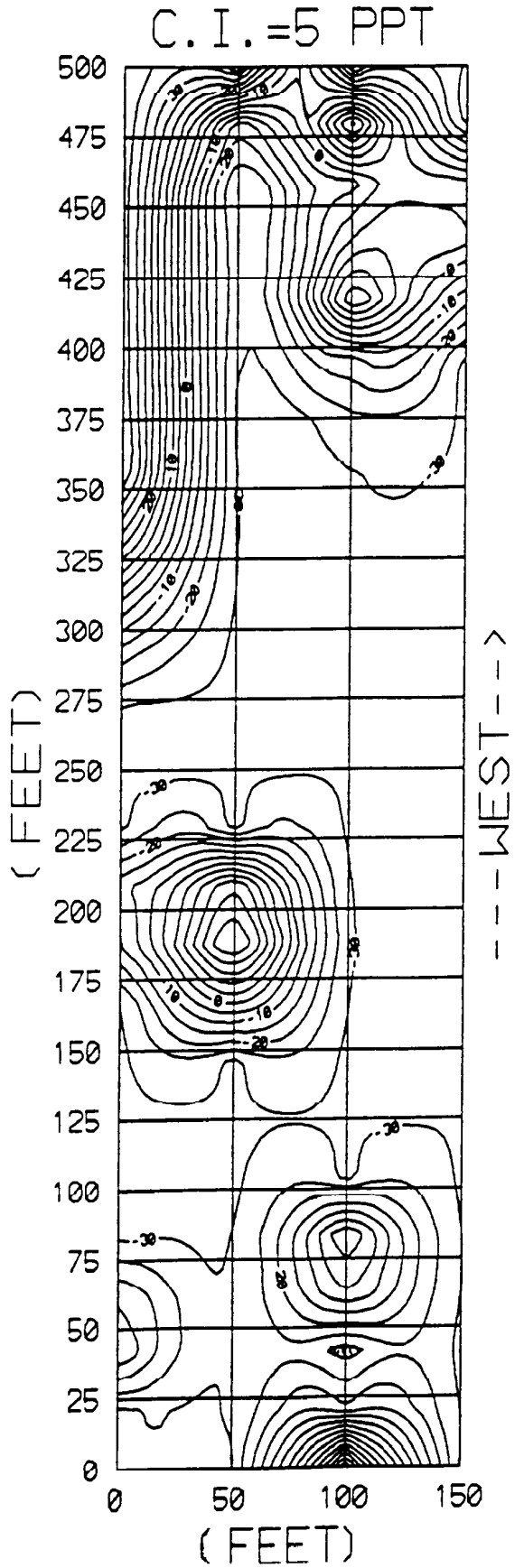

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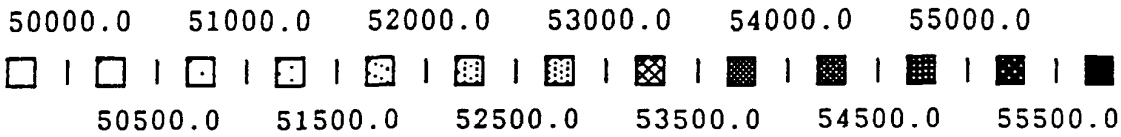

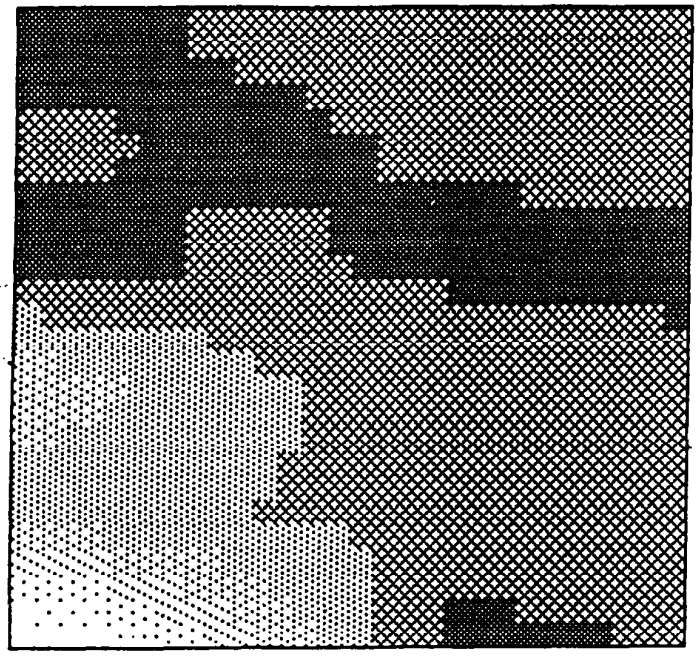

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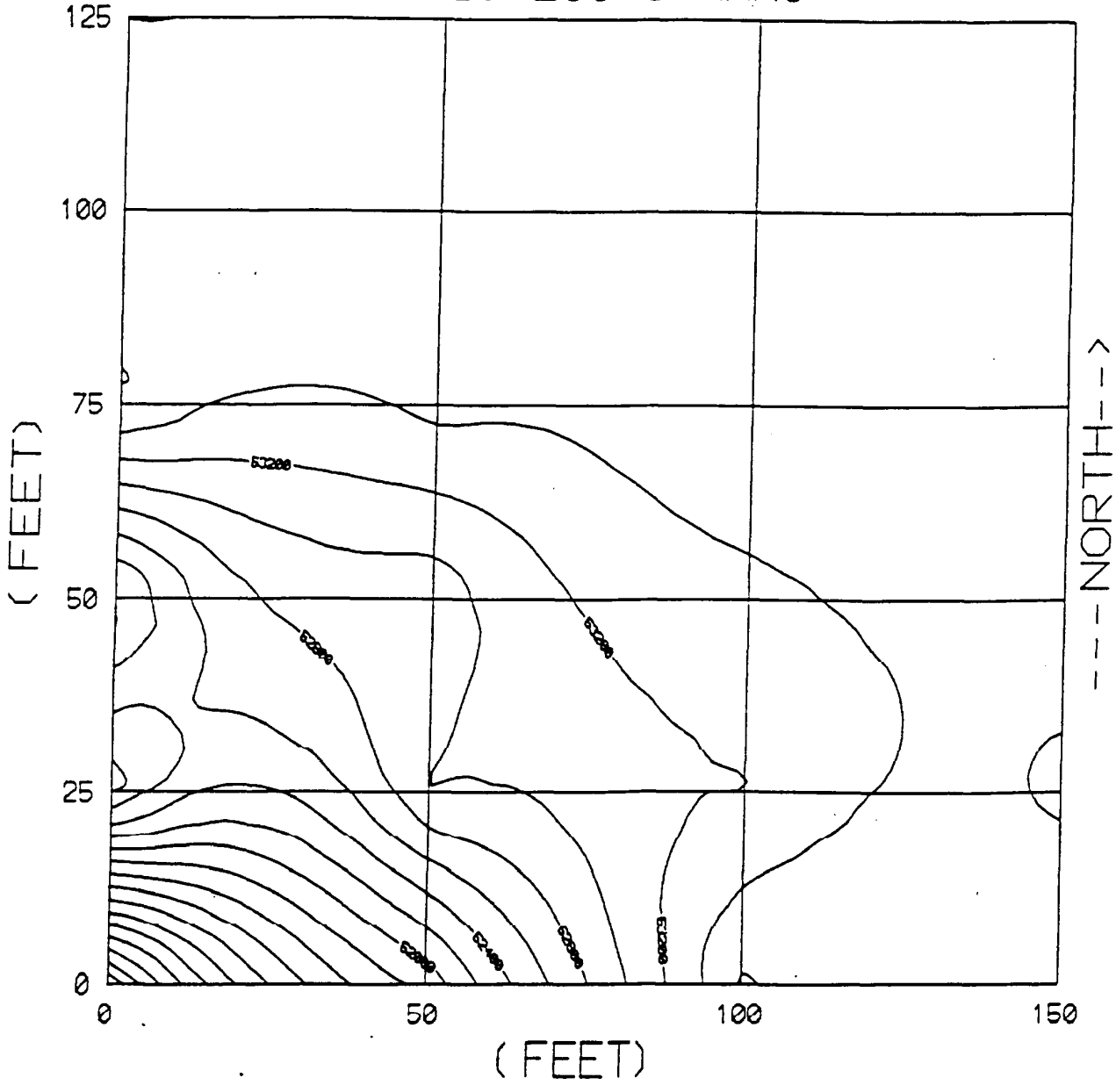

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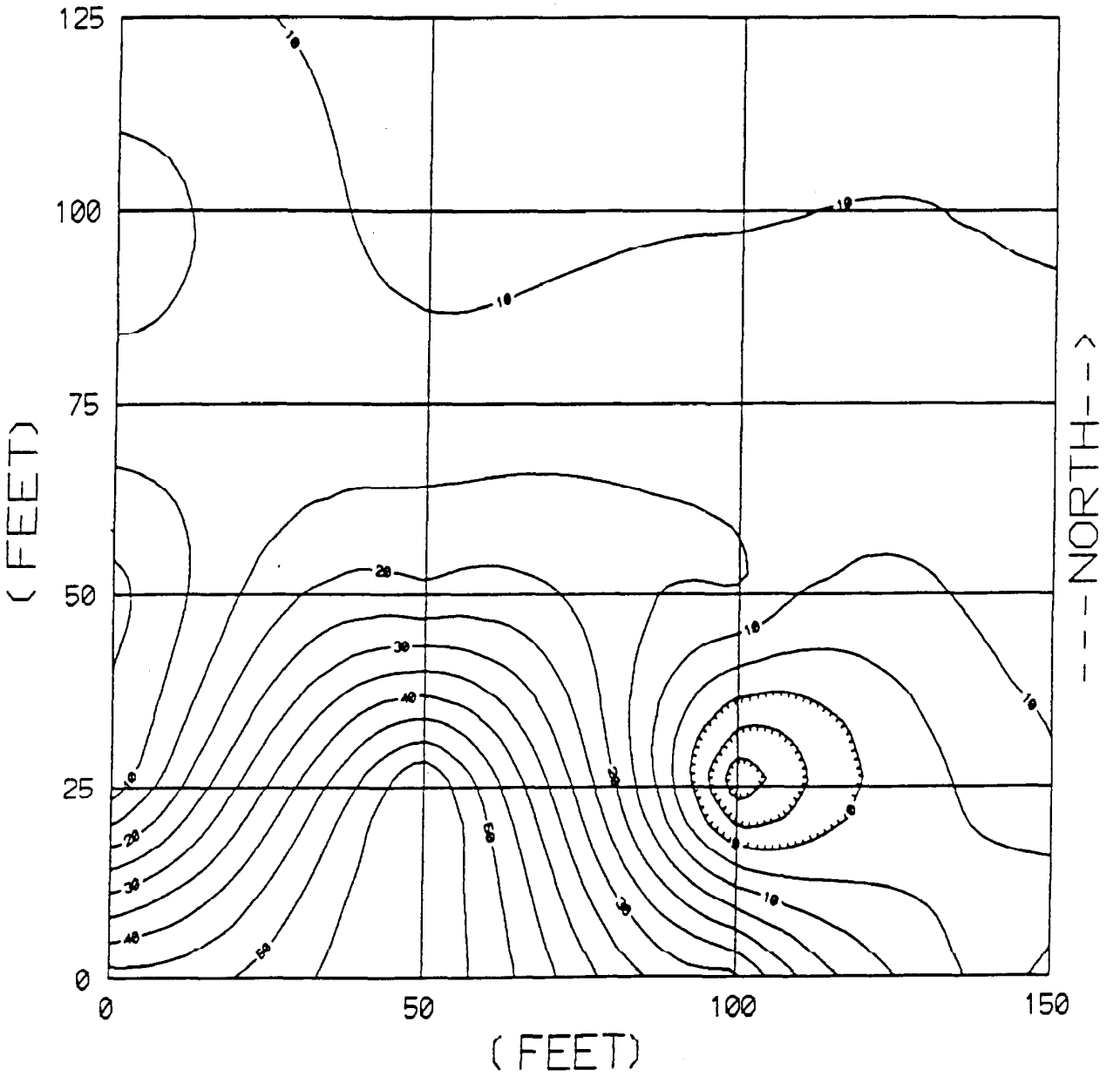

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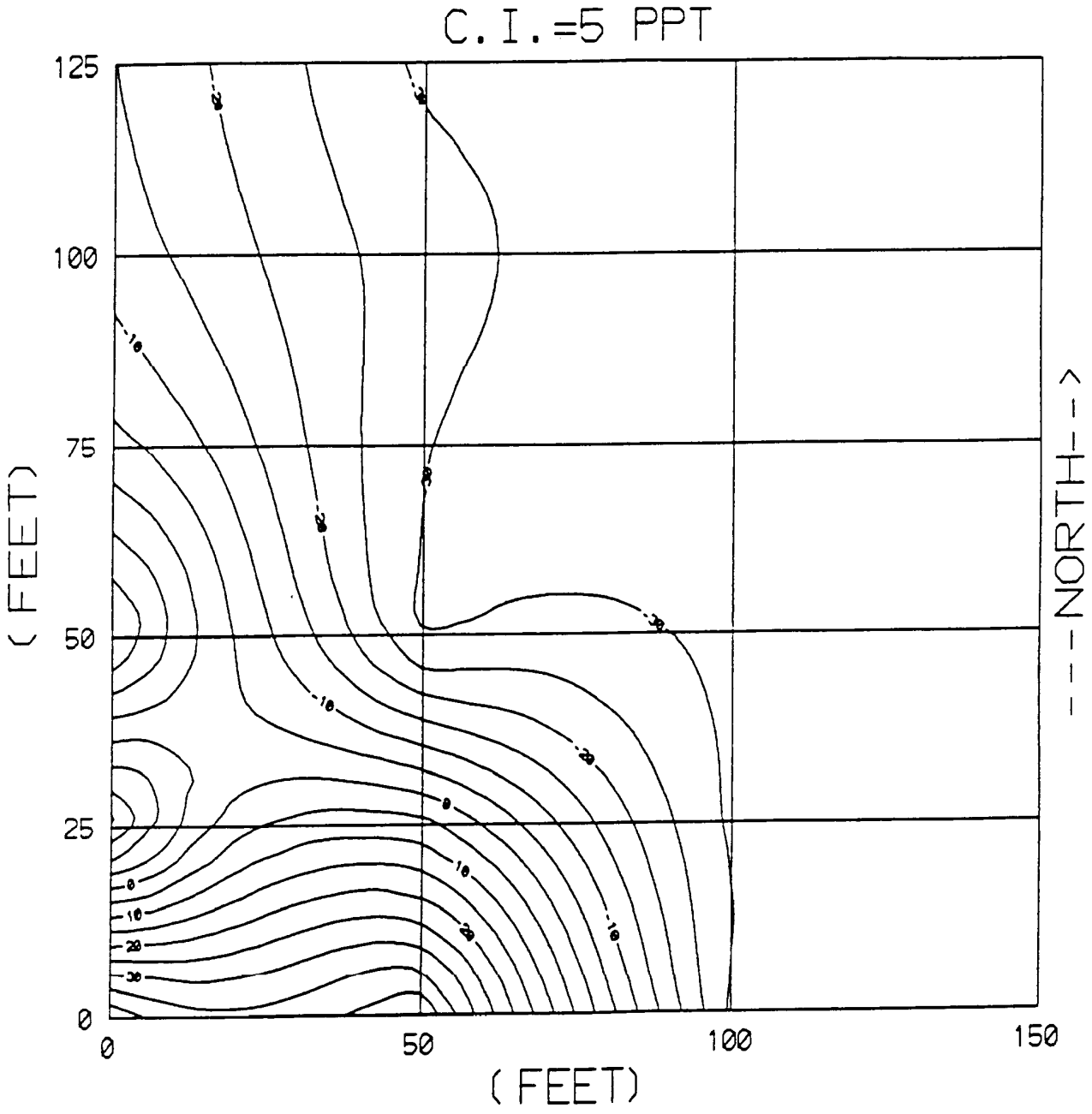

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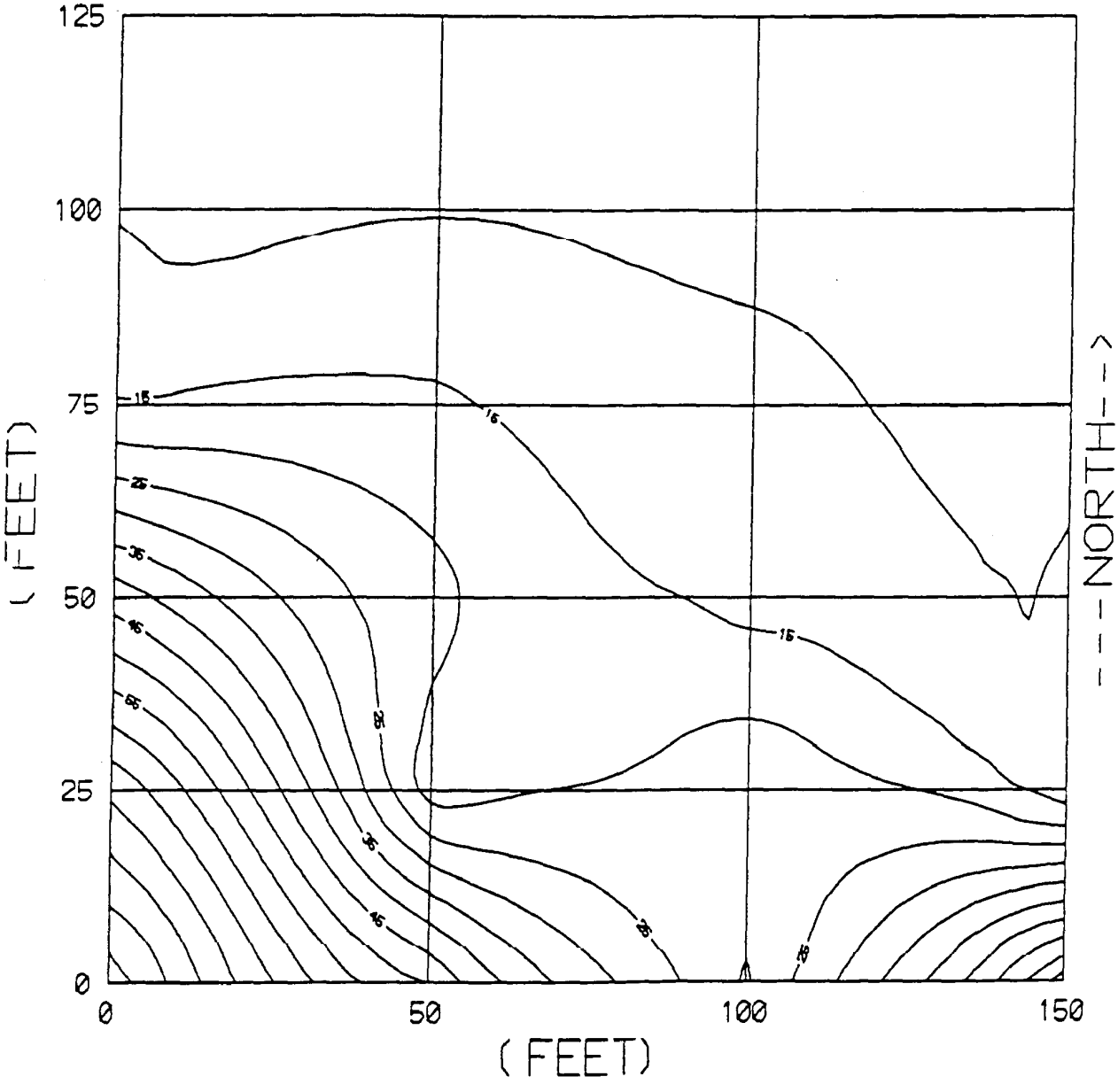

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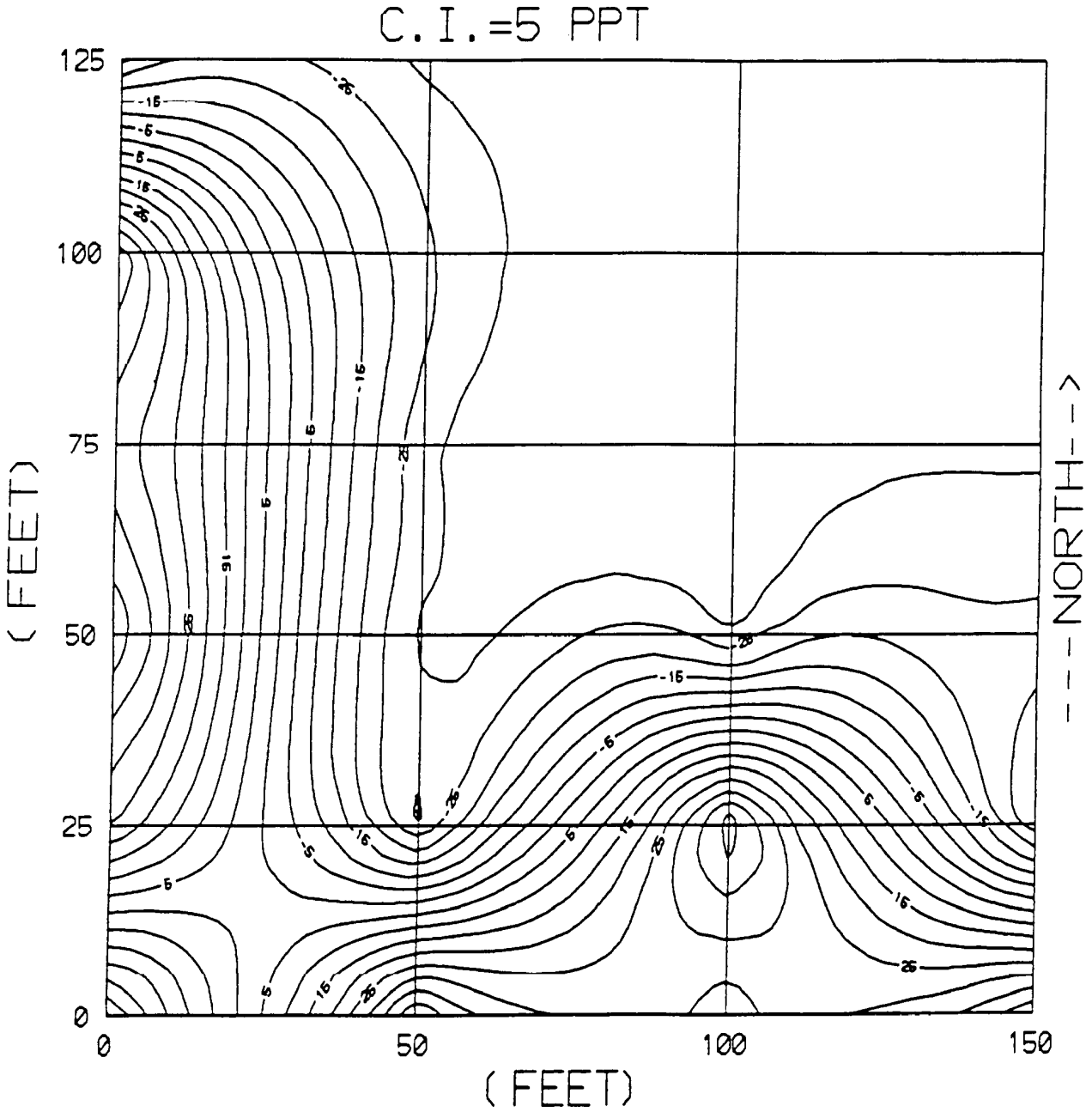

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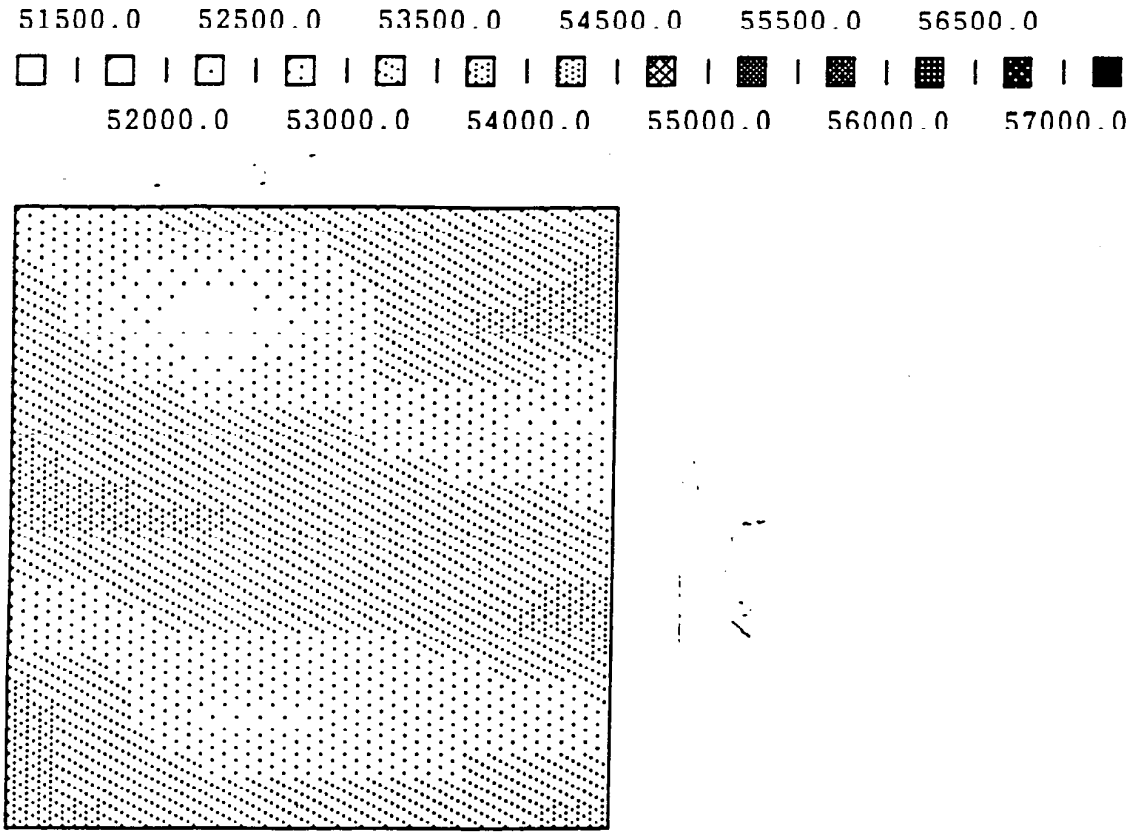

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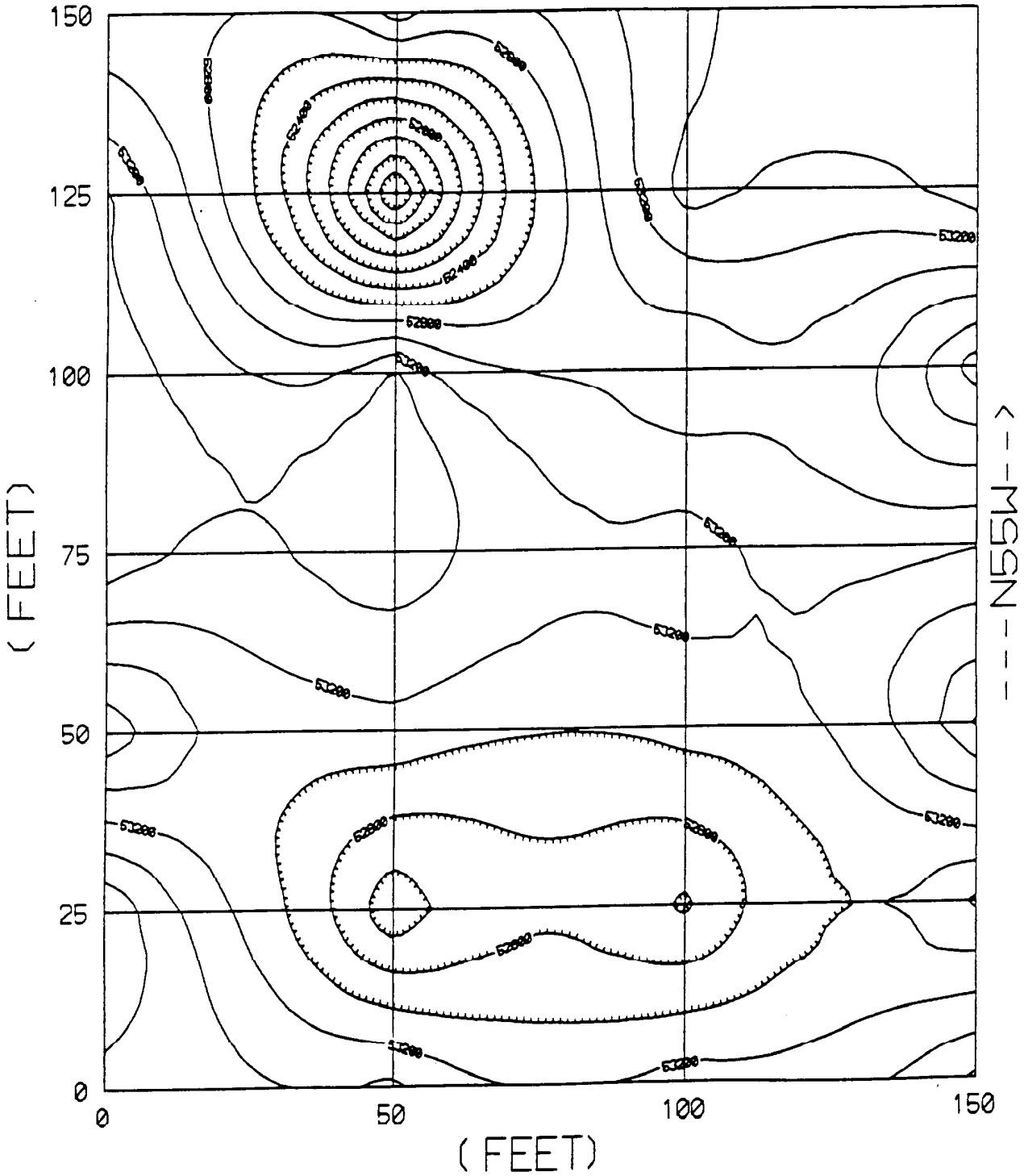

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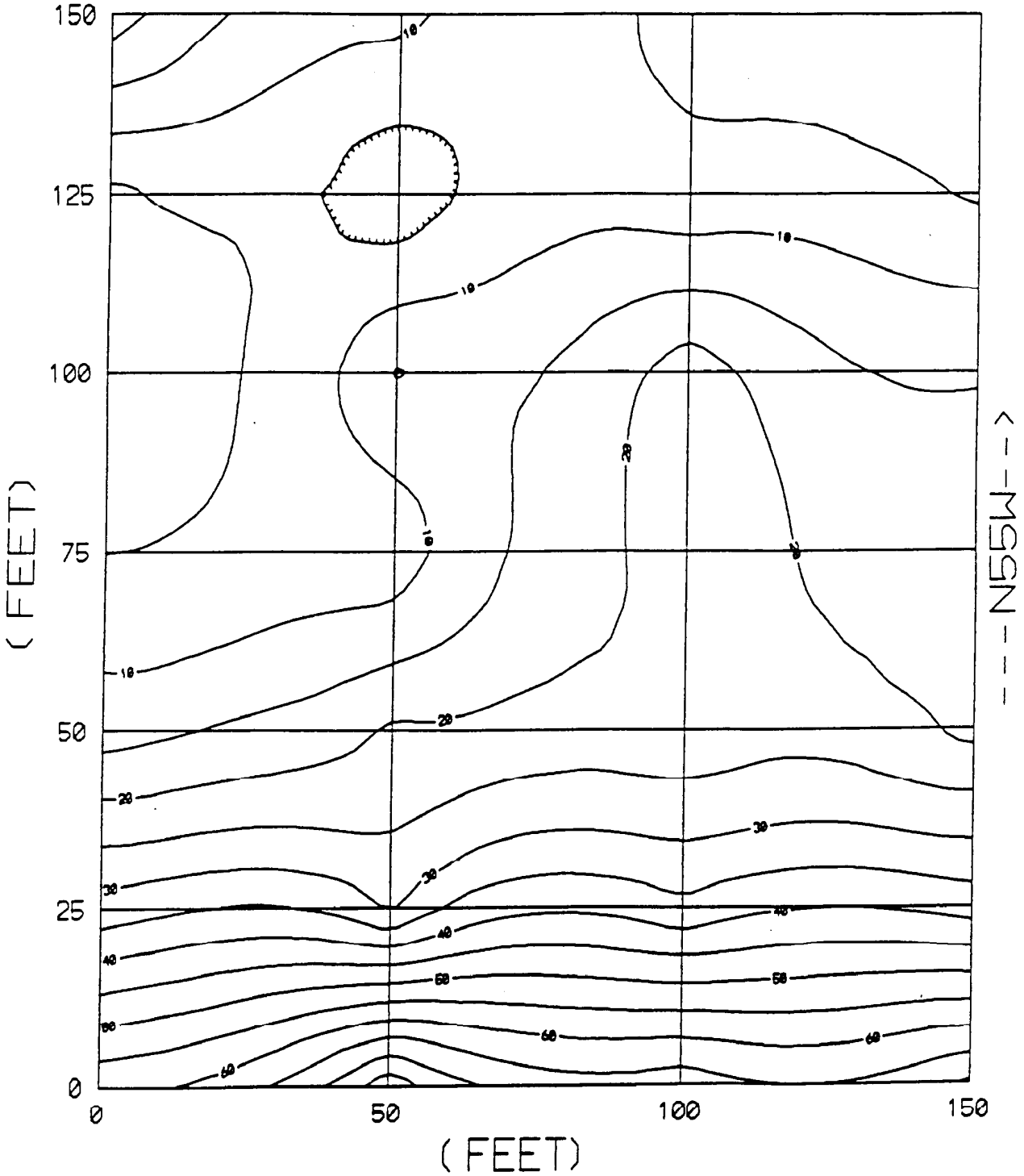

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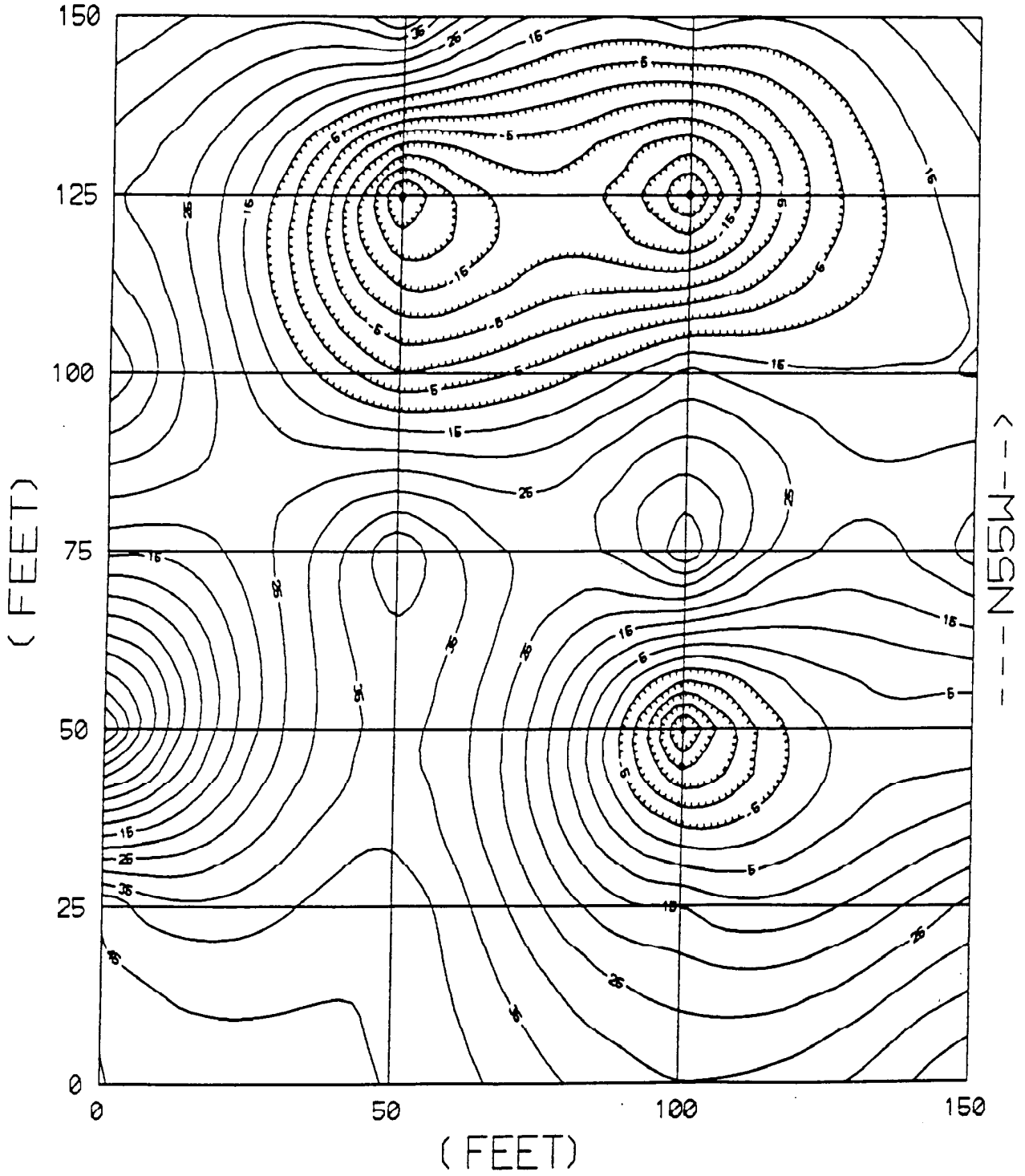

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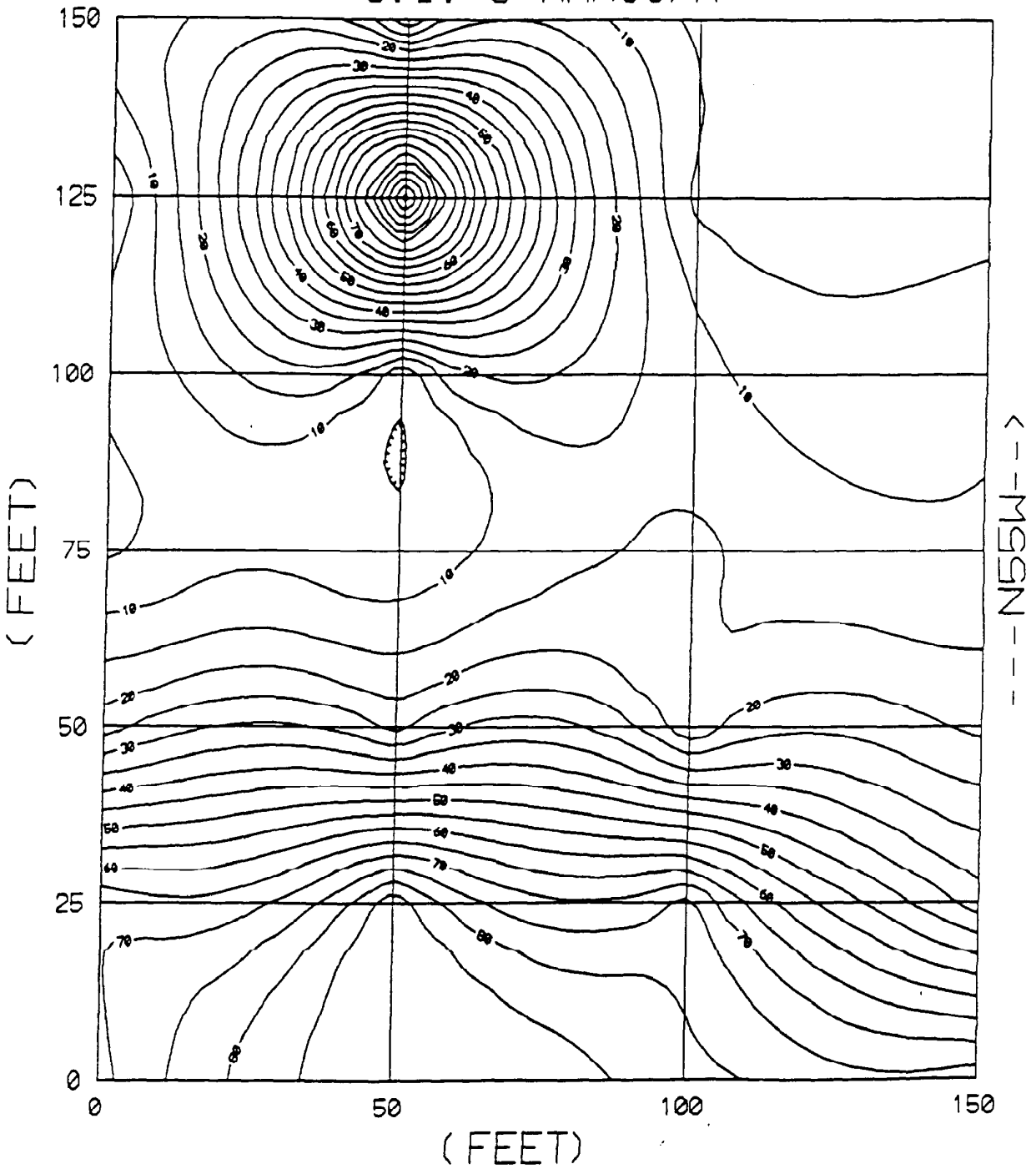

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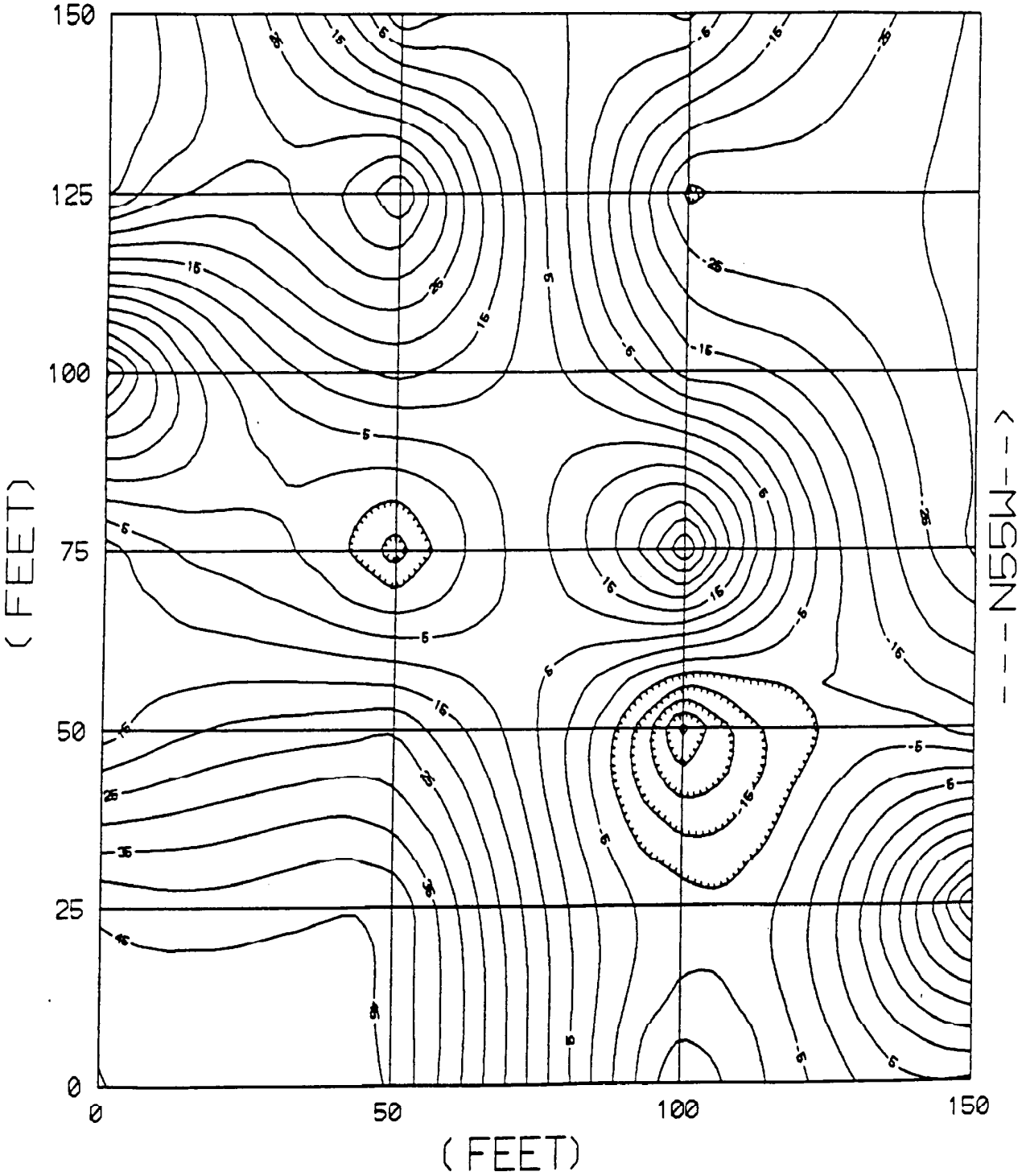

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150.000	16.140	-30.682
175.000	15.540	-30.694
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250.000	9.240	-30.694
275.000	0.720	-30.694
skipped reading		
skipped reading		
skipped reading		
skipped reading		
350.000	-36.960	-30.694
375.000	-11.160	-30.694
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375.000	10.860	-30.682
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300.000	9.300	-30.682
275.000	-7.680	-30.682
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225.000	10.080	-30.682
---> Comment : WELL		
200.000	-9.720	1.902
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225.000	22.620	-30.670
250.000	4.560	-30.670
275.000	14.340	-30.670
300.000	11.160	-30.670
325.000	8.820	-30.670
350.000	11.820	-30.670
375.000	10.440	-30.670
400.000	12.540	-30.670
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500.000	31.740	-30.670

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350.000	21.240	-30.682
skipped reading		
skipped reading		
skipped reading		
skipped reading		
275.000	6.660	-30.682
250.000	12.660	-30.682
skipped reading		
skipped reading		
200.000	12.360	-30.682
175.000	10.800	-30.682
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125.000	8.580	-30.682
100.000	7.560	-30.694
75.000	8.100	-30.694
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Station	Cond.[mS/m]	Inphase [ppt]

```
     skipped reading
  ---> Comment : EAST
     skipped reading
     skipped reading
     skipped reading

LINE: 4        Direction: W
Date: 10-12-92    Time: 12:11
Component: Both   Dipole mode: Horizontal   Instrument Orientation: 1
Start station: 325     Final station: 225
   Station   Cond.[mS/m]  Inphase [ppt]
     skipped reading
     skipped reading
     skipped reading
     skipped reading
     skipped reading
     skipped reading
```

LINE: 1 Direction: N
Date: 11-12-92 Time: 11:36
Component: Both Dipole mode: Horizontal Instrument Orientation: 1
Start station: 0 Final station: 125

Station	Cond.[mS/m]	Inphase [ppt]
0.000	88.320	-31.116
---> Comment : RAIN		
25.000	69.420	25.986
50.000	43.080	44.747
75.000	14.340	32.007
100.000	9.660	44.747
---> Comment : STREAM		
125.000	8.820	-31.080

LINE: 2 Direction: N
Date: 11-12-92 Time: 11:47
Component: Both Dipole mode: Horizontal Instrument Orientation: 1
Start station: 125 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
125.000	7.020	-31.068
skipped reading		
75.000	15.900	-29.105
50.000	21.780	-31.068
25.000	16.740	-31.068
0.000	49.860	44.711

LINE: 3 Direction: N
Date: 11-12-92 Time: 11:55
Component: Both Dipole mode: Horizontal Instrument Orientation: 1
Start station: 0 Final station: 125

Station	Cond.[mS/m]	Inphase [ppt]
0.000	19.380	21.013
25.000	24.780	44.663
---> Comment : TANK		
50.000	13.560	-31.056
75.000	12.960	-31.031
100.000	7.440	-31.043
125.000	7.500	-31.056

LINE: 4 Direction: N
Date: 11-12-92 Time: 12: 3
Component: Both Dipole mode: Horizontal Instrument Orientation: 1
Start station: 125 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
125.000	7.560	-31.056
100.000	6.300	-31.043
75.000	9.480	-31.043
50.000	10.320	-23.373
25.000	10.140	-30.405
0.000	62.460	44.627

LINE: 1 Direction: N
Date: 11-12-92 Time: 11:36
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 125

Station	Cond.[mS/m]	Inphase [ppt]
0.000	47.280	44.675
---> Comment : RAIN		
25.000	6.120	-22.157
50.000	3.060	16.930
75.000	13.440	-3.456

```
    100.000      18.360     -12.282
  ---> Comment : STREAM
    125.000      10.620     -14.895

LINE: 2        Direction: N
Date: 11-12-92    Time: 11:47
Component: Both   Dipole mode: Vertical   Instrument Orientation: 1
Start station: 125     Final station:-25
   Station   Cond.[mS/m]  Inphase [ppt]
    125.000      8.340     -31.080
     skipped reading
     75.000      8.100     -27.106
     50.000     11.880     -29.767
     25.000     20.880     -31.043
      0.000     61.380       6.659
    -25.000     58.680      44.687

LINE: 3        Direction: N
Date: 11-12-92    Time: 11:55
Component: Both   Dipole mode: Vertical   Instrument Orientation: 1
Start station: 0     Final station: 125
   Station   Cond.[mS/m]  Inphase [ppt]
      0.000     30.900     -31.068
     25.000    -15.060     -31.056
  ---> Comment : TANK
     50.000     15.600     -31.056
     75.000     12.660     -31.043
    100.000      9.720     -31.056
    125.000      8.460     -31.056

LINE: 4        Direction: N
Date: 11-12-92    Time: 12: 3
Component: Both   Dipole mode: Vertical   Instrument Orientation: 1
Start station: 125     Final station: 0
   Station   Cond.[mS/m]  Inphase [ppt]
    125.000      9.900     -31.056
    100.000      9.300     -31.056
     75.000     11.580     -31.056
     50.000     13.380     -31.056
     25.000      9.540     -31.056
      0.000     -1.740     -31.056
```

LINE: 1 Direction: N
Date: 11-12-92 Time: 13:34
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 150

Station	Cond.[mS/m]	Inphase [ppt]
0.000	58.800	44.771
25.000	32.000	44.771
50.000	12.800	-31.116
75.000	4.920	16.425
100.000	2.460	44.771
125.000	3.880	30.478
150.000	22.920	44.771

LINE: 2 Direction: S
Date: 11-12-92 Time: 13:43
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 150 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
150.000	11.340	44.771
125.000	1.320	-31.116
100.000	15.300	0.192
75.000	6.700	44.747
50.000	20.760	36.462
25.000	29.400	44.759
0.000	78.200	44.747

LINE: 3 Direction: N
Date: 11-12-92 Time: 13:49
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 150

Station	Cond.[mS/m]	Inphase [ppt]
0.000	68.000	30.116
25.000	36.200	15.112
50.000	21.600	-31.104
75.000	21.800	44.771
100.000	22.800	21.603
125.000	6.480	-31.104
150.000	3.960	18.893

LINE: 4 Direction: S
Date: 11-12-92 Time: 13:52
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 150 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
150.000	1.420	26.757
125.000	4.360	18.436
100.000	14.580	14.703
75.000	18.180	27.431
50.000	18.480	-0.156
25.000	37.600	26.407
0.000	70.600	44.771

LINE: 1 Direction: N
Date: 11-12-92 Time: 13:34
Component: Both Dipole mode: Horizontal Instrument Orientation: 1
Start station: 0 Final station: 150

Station	Cond.[mS/m]	Inphase [ppt]
0.000	68.200	44.771
25.000	69.400	44.771
50.000	22.500	12.499
75.000	4.120	12.764

100.000	5.880	-31.116
125.000	0.939	40.400
150.000	13.800	44.759

LINE: 2 Direction: S
Date: 11-12-92 Time: 13:43
Component: Both Dipole mode: Horizontal Instrument Orientation: 1
Start station: 150 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
150.000	0.960	-4.094
125.000	106.800	44.723
100.000	6.000	16.244
75.000	6.340	-12.427
50.000	23.520	24.565
25.000	88.200	44.759
0.000	88.400	44.747

LINE: 3 Direction: N
Date: 11-12-92 Time: 13:49
Component: Both Dipole mode: Horizontal Instrument Orientation: 1
Start station: 0 Final station: 150

Station	Cond.[mS/m]	Inphase [ppt]
0.000	81.000	-19.760
25.000	76.400	-7.333
50.000	16.200	-31.116
75.000	16.600	39.485
100.000	11.800	-12.318
125.000	3.420	-31.104
150.000	3.780	0.951

LINE: 4 Direction: S
Date: 11-12-92 Time: 13:52
Component: Both Dipole mode: Horizontal Instrument Orientation: 1
Start station: 150 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
150.000	4.280	-31.116
125.000	3.060	-31.116
100.000	9.120	-31.104
75.000	10.980	-31.116
50.000	18.840	-12.993
25.000	37.400	44.795
0.000	78.000	4.202

LINE: 1 Direction: N
Date: 11-12-92 Time: 16: 4
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
0.000	0.000	-1.240

LINE: 1 Direction: N
Date: 11-12-92 Time: 16: 6
Component: Both Dipole mode: Vertical Instrument Orientation: 1
Start station: 0 Final station: 300

Station	Cond.[mS/m]	Inphase [ppt]
0.000	27.000	44.747
25.000	55.800	-13.161
50.000	20.200	-31.140
75.000	9.600	-20.230
100.000	24.200	-14.859
125.000	13.600	2.155
150.000	15.800	44.783
---> Comment : PIT		
175.000	2.940	-21.278
200.000	-10.860	-31.140
---> Comment : HOTEDGE		
225.000	18.900	-31.140
250.000	19.860	44.783
275.000	4.800	7.225
300.000	7.320	3.468

LINE: 1 Direction: N
Date: 11-12-92 Time: 16: 4
Component: Both Dipole mode: Horizontal Instrument Orientation: 1
Start station: 0 Final station: 0

Station	Cond.[mS/m]	Inphase [ppt]
0.000	0.000	-1.216

LINE: 1 Direction: N
Date: 11-12-92 Time: 16: 6
Component: Both Dipole mode: Horizontal Instrument Orientation: 1
Start station: 0 Final station: 300

Station	Cond.[mS/m]	Inphase [ppt]
0.000	27.600	44.747
25.000	45.800	-24.059
50.000	16.800	-31.152
75.000	7.200	-5.346
100.000	17.000	-6.382
125.000	12.200	-10.548
150.000	17.600	-31.128
---> Comment : PIT		
175.000	2.040	3.034
200.000	20.400	31.886
---> Comment : HOTEDGE		
225.000	15.240	-31.140
250.000	49.260	44.747
275.000	3.060	-27.527
300.000	2.880	-18.749

```
C:\SURFER>CD\

C:\>A:

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    0.000      0.000 53222.133
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    0.000      0.000 27944.758

A:\>
```

B Soil Gas Survey

SOIL GAS SURVEY

NAVAL FACILITY

PORT DEPOSIT, MARYLAND

TARGET ENVIRONMENTAL SERVICES, INC.

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SOIL GAS SURVEY

NAVAL FACILITY

BAINBRIDGE

PORT DEPOSIT, MARYLAND

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DECEMBER 1990

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EXECUTIVE SUMMARY

On November 28 and 29, 1990, TARGET Environmental Services, Inc. (TARGET) conducted a soil gas survey of the former fire training area of the Naval Facility, Bainbridge, Port Deposit, Maryland. Samples were analyzed by GC/FID for petroleum hydrocarbons.

A relatively high level of Total Volatiles was present in the eastern portion of the site, with very low levels extending northward to the survey boundary. Low levels were present near the former UST area on the western survey boundary and south of the burned out buildings. An isolated very low level was present in the western corner of the survey area near Davey Jones Road.

The chromatogram signatures of most of the samples in the eastern portion of the survey area and of the sample collected south of the burned out buildings are dominated by early-eluting peaks representing the more mobile and volatile petroleum hydrocarbons. Isolated late-eluting peaks representative of terpenes are evident in the chromatograms of several samples on the survey boundaries. Terpenes are naturally occurring hydrocarbons exuded by plant roots and do not represent a contamination problem.

Map patterns and chromatographic data suggest that petroleum hydrocarbons are present in the subsurface in the eastern portion of the survey area and south of the burned out buildings. The low level of volatile hydrocarbons present south of the burned out building suggests that the occurrence in this area was probably relatively minor.

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Introduction

Ecology and Environment contracted TARGET Environmental Services, Inc. (TARGET) to perform a soil gas survey of the former fire training area at the Naval Facility, Bainbridge, Port Deposit, Maryland. The purpose of the survey was to determine the presence and extent of subsurface petroleum hydrocarbons. The field phase of the soil gas survey was conducted on November 28 and 29, 1990.

Detectability

The soil gas survey data presented in this report are the result of precise sampling and measurement of contaminant concentrations in the vadose zone. Analyte detection at a particular location is representative of vapor, dissolved, and/or liquid phase contamination at that location. The presence of detectable levels of target analytes in the vadose zone is dependent upon several factors, including the presence of vapor-phase hydrocarbons or dissolved or liquid concentrations adequate to facilitate volatilization into the unsaturated zone.

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Terminology

In order to prevent misunderstanding of certain terms used in this report, the following clarifications are offered:

The term "feature" is used in reference to a discernible pattern in the contoured data. It denotes a contour form rather than a definite or separate chemical occurrence.

The term "occurrence" is used to indicate an area where chemical compounds are present in sufficient concentrations to be detected by the analysis of soil vapors. The term is not indicative of any specific mode of occurrence (vapor, dissolved, etc.), and does not necessarily indicate or suggest the presence of "free product" or "phase-separated hydrocarbons."

The term "anomaly" refers to an area where hydrocarbons were measured in excess of what would normally be considered "natural" or "background" levels.

The term "analyte" refers to any of the hydrocarbons standardized for quantification in the chromatographic analysis.

The term "vadose zone" represents the unsaturated zone between the ground water table and the ground surface.

The term "indicates" is used when evidence dictates a unique conclusion. The term "suggests" is used when several explanations of certain evidence are possible, but one in particular seems more likely. As a result, "indicates" carries a higher degree of confidence in a conclusion than does "suggests."

Field Procedures

Soil gas samples were collected at a total of 50 locations at the site, as shown in Figure 1. To collect the samples a 1/2 inch hole was produced to a depth of approximately 4 feet by using a drive rod. Samples 45 and 49 were collected at a depth of 3' due to probe refusal. Samples 46-48 were collected at depths of 2', 2.5' and 2', respectively, due to low soil gas permeability. Where pavement was present, an electric hammer drill was employed for penetration prior to using the drive rod. The entire sampling system was purged with ambient air drawn through an organic vapor filter cartridge, and a stainless steel probe was inserted to the full depth of the hole and sealed off from the atmosphere. A sample of in-situ soil gas was then withdrawn through the probe and used to purge atmospheric air from the sampling system. A second sample of soil gas was withdrawn through the probe and encapsulated in a pre-evacuated glass vial at two atmospheres of pressure (15 psig). The self-sealing vial was detached from the sampling system, packaged, labeled, and stored for laboratory analysis.

Prior to the day's field activities all sampling equipment, slide hammer rods, and probes were decontaminated by washing with soapy water and rinsing thoroughly. Internal surfaces were flushed dry using pre-purified nitrogen or filtered ambient air, and external surfaces were wiped clean using clean paper towels.

Field control samples were collected at the beginning and end of each day's field activities, and after the twenty-third soil gas sample on the second day. Field Control Samples 1, 2, and 3 were obtained by inserting the probe tip into a tube flushed by a 20 psi

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flow of pre-purified nitrogen, while Field Control Samples 4 and 5 were obtained by filtering ambient air through a dust and organic vapor filter cartridge. All Field Control Samples were collected in the same manner as described above.

Laboratory Procedures

All of the samples collected during the field phase of the survey were analyzed according to EPA Method 602 (modified) on a gas chromatograph equipped with a flame ionization detector (GC/FID), but using direct injection instead of purge and trap. Analytes selected for standardization were:

methyl tertiary butyl ether (MTBE)
benzene
toluene
ethylbenzene
meta- and para- xylene
ortho-xylene

These compounds were chosen because of their utility in evaluating the presence of petroleum products such as fuels, lubricating oils, and non-halogenated solvents.

FID Total Volatiles values were generated by summing the areas of all integrated chromatogram peaks and calculated using the instrument response factor for toluene. Injection peaks, which also contain the light hydrocarbon methane, were excluded to avoid the skewing of Total Volatiles values due to injection disturbances and biogenic methane. For samples with low hydrocarbon concentrations, the calculated Total Volatiles concentration is occasionally lower than the sum of the individual analytes. This is because the response factor used for the Total Volatiles calculation is a constant, whereas the individual analyte response factors vary with concentration. It is important to understand that the Total Volatiles levels reported are relative, not absolute, values.

The analytical equipment was calibrated using an instrument-response curve and injection of known concentrations of the above standards. Retention times of the standards were used to identify

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the peaks in the chromatograms of the field samples, and their response factors were used to calculate the analyte concentrations. The tabulated results of the laboratory analysis of the soil gas samples are reported in micrograms per liter (µg/l) in Table 1. Although "micrograms per liter" is equivalent to "parts per billion (v/v)" in water analyses, they are not equivalent in gas analyses, due to the difference in the mass of equal volumes of water and gas matrices.

Map sample points with no data shown indicate that the analyte concentrations in the sample were below the detection limit. Because MTBE and pentane co-elute, they are listed together in the table.

For QA/QC purposes, a duplicate analysis was performed on every tenth field sample. Laboratory syringe blanks of carrier gas were also analyzed after every tenth field sample.

Discussion and Interpretation of Results

In order to provide graphic presentation of the results, individual data sets in Table 1 have been mapped and contoured to produce Figures 2 through 6. Dashed contours are used where patterns are extrapolated into areas of less complete data, or as auxiliary contours.

The FID Total Volatiles map (Figure 2) reveals a relatively high level in the eastern portion of the site (Station 46). Very low levels extend northward to the survey boundary. Low levels are present near the former UST area on the western survey boundary (Station 9) and south of the burned out buildings (Station 43). An isolated very low level is present in the western corner of the survey area near Davey Jones Road (Station 13).

MTBE/pentane (Figure 3) is present in the eastern portion of the site where Total Volatiles were highest. Very low levels are present at two locations in the western portion of the site (Stations 15 and 23) and south of the burned out buildings (Station 43). Benzene (Figure 4) is the most limited of the standardized analytes, being present only where Total Volatiles were highest (Station 46). Ethylbenzene (not mapped) is present south of the burned out buildings (Station 43), as well as at Station 46. Toluene (Figure 5) is highest at Station 46. Isolated very low levels occur south of the former UST area (Station 15), south of the burned out buildings (Station 43) and at Station 35 (near the eastern corner of the survey area). The m- and p-xylene (Figure 6) and o-xylene (not mapped) occurrences are similar. In addition to the occurrence in the eastern portion of the survey area, these

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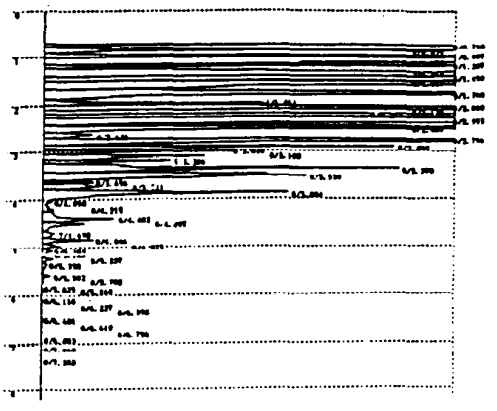
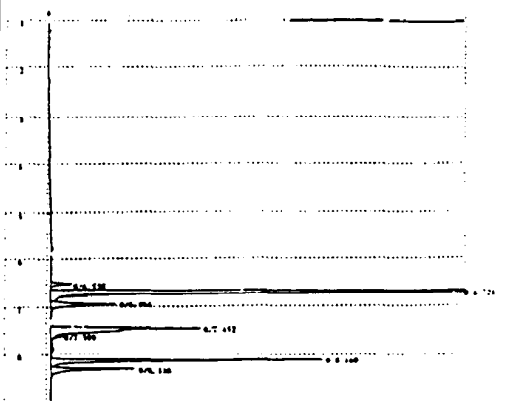
analytes are present south of the burned out buildings (Station 43).



CHROMATOGRAM 1. GC/FID SIGNATURE OF SAMPLE 46



CHROMATOGRAM 2. GC/FID SIGNATURE OF SAMPLE 9

The chromatogram signatures of the samples from the eastern portion of the survey area and of Sample 43 (south of the burned out buildings) are not typical of gasoline or diesel fuel/fuel oil, but reveal early-eluting peaks representative of the more mobile and volatile petroleum hydrocarbons (Chromatogram 1, Sample 46). Isolated late eluting peaks typical of **terpenes** are evident in the chromatograms of several samples on the survey boundaries (Samples 9, 13, 33, and 53), as exemplified by Chromatogram 2 (Sample 9). Terpenes are naturally-occurring hydrocarbons exuded by plant roots and do not represent a contamination problem. Insufficient levels of volatile hydrocarbons are present in the remaining samples to characterize the original contaminant.

The xylenes are less volatile and less soluble than the other analytes, adsorb more readily to the soil particles, and tend to remain nearer to the source. As a result, the xylenes are usually good indicators of source locations. The xylene map patterns

suggest that petroleum hydrocarbons have entered the subsurface in the eastern portion of the survey area and south of the burned out buildings. The low level of volatile hydrocarbons present south of the burned out building suggests that the occurrence in this area was probably relatively minor.

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TABLE 1

LABORATORY RESULTS
FLAME IONIZATION DETECTOR ANALYSIS
CONCENTRATIONS IN MICROGRAMS PER LITER

SAMPLE	PENTANE/ MTBE[1]	BENZENE	TOLUENE	ETHYL-BENZENE	m- & p-XYLENE	o-XYLENE	TOTAL VOLATILES[2]
6	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
7	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
8	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
9	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	200
10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
11	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
12	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
13	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	8.9
14	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15	1.2	<1.0	2.4	<1.0	<1.0	<1.0	11
16	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
17	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.2
18	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
19	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
20	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
21	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
22	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
23	1.2	<1.0	<1.0	<1.0	<1.0	<1.0	7.4
24	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
25	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
26	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
27	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
28	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
29	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
31	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
32	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
33	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	6.0
34	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
35	<1.0	<1.0	1.7	<1.0	<1.0	<1.0	2.7
36	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

[1]CONCENTRATIONS BASED ON RESPONSE FACTOR OF MTBE

[2]CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE INSTRUMENT RESPONSE FACTOR FOR TOLUENE

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TABLE 1 (cont)

LABORATORY RESULTS
FLAME IONIZATION DETECTOR ANALYSIS
CONCENTRATIONS IN MICROGRAMS PER LITER

SAMPLE	PENTANE/ MTBE[1]	BENZENE	TOLUENE	ETHYL-BENZENE	m- & p-XYLENE	o-XYLENE	TOTAL VOLATILES[2]
37	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
38	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
39	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
40	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
41	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
42	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
43	1.1	<1.0	1.9	5.4	5.2	3.0	237
44	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
45	<1.0	<1.0	1.7	<1.0	1.6	<1.0	2.5
46	41,900	442	268	67	175	42	138,900
47	9.9	<1.0	<1.0	<1.0	3.6	1.2	76
48	4.0	<1.0	<1.0	<1.0	<1.0	<1.0	19
49	1.4	<1.0	<1.0	<1.0	<1.0	<1.0	3.3
50	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
51	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
52	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
53	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	4.3
54	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
55	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

[1]CONCENTRATIONS BASED ON RESPONSE FACTOR OF MTBE

[2]CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE INSTRUMENT RESPONSE FACTOR FOR TOLUENE

TABLE 1 (cont)

LABORATORY RESULTS
FLAME IONIZATION DETECTOR ANALYSIS
CONCENTRATIONS IN MICROGRAMS PER LITER

SAMPLE	PENTANE/ MTBE[1]	BENZENE	TOLUENE	ETHYL-BENZENE	m- & p-XYLENE	o-XYLENE	TOTAL VOLATILES[2]
FIELD CONTROL SAMPLES							
1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.7
5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
LABORATORY DUPLICATE ANALYSES							
10	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
10R	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
20	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
20R	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
30R	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
40	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
40R	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
50	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
50R	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
LABORATORY SYRINGE BLANKS							
BMEEM-1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
BMEEM-2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
BMEEM-3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
BMEEM-4	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
BMEEM-5	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

[1]CONCENTRATIONS BASED ON RESPONSE FACTOR OF MTBE

[2]CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE INSTRUMENT RESPONSE FACTOR FOR TOLUENE

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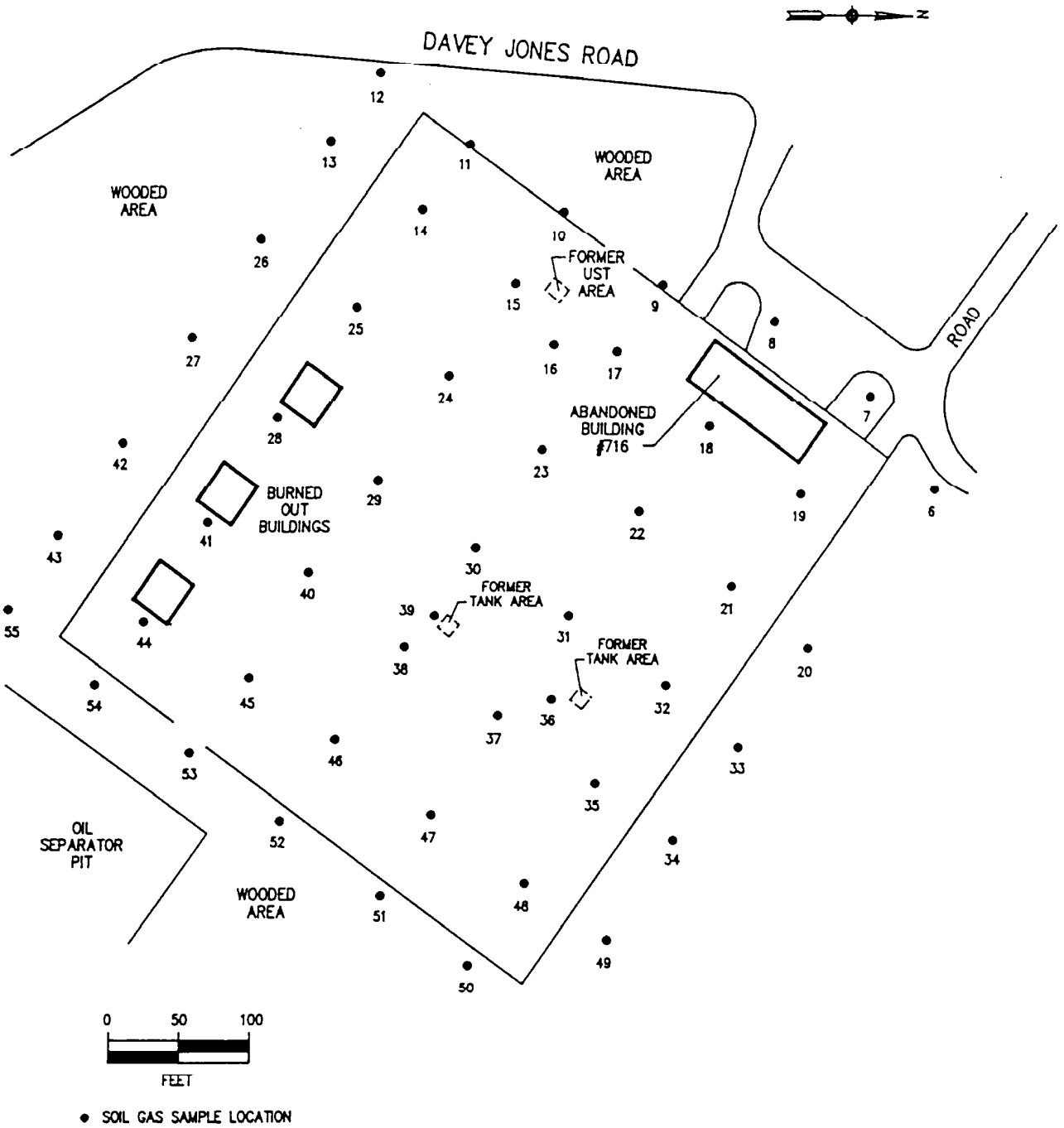

FIGURE 1. Sample Locations

TARGET ENVIRONMENTAL SERVICES, INC.

NAVAL FACILITY
BAINBRIDGE
PORT DEPOSIT, MARYLAND

This map is integral to a written report and should be viewed in that context.

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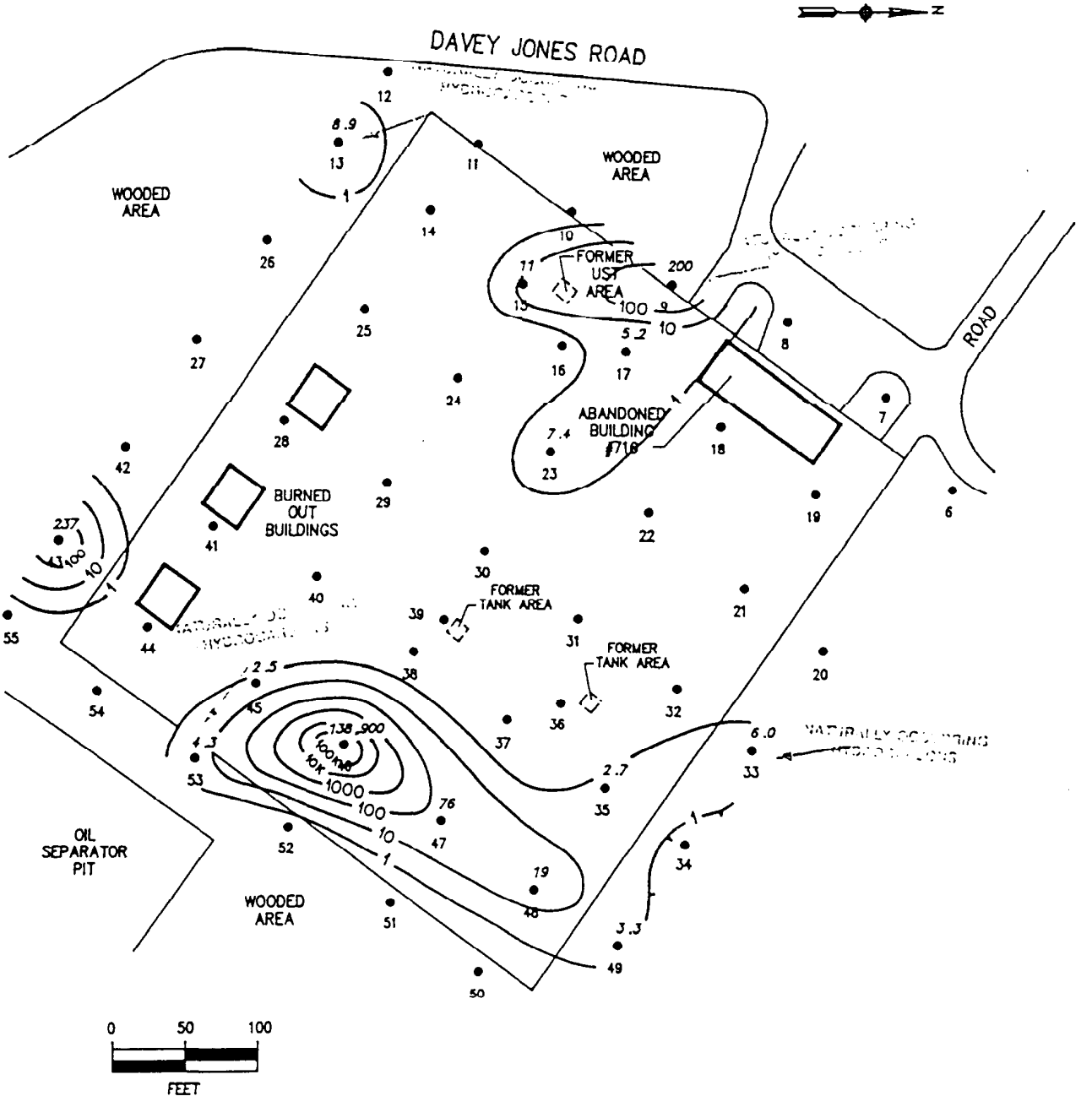

● SOIL GAS SAMPLE LOCATION

FIGURE 2. FID Total Volatiles
(calc'd µg/l)

ENVIRONMENTAL SERVICES, INC.

NAVAL FACILITY
BAINBRIDGE
PORT DEPOSIT, MARYLAND

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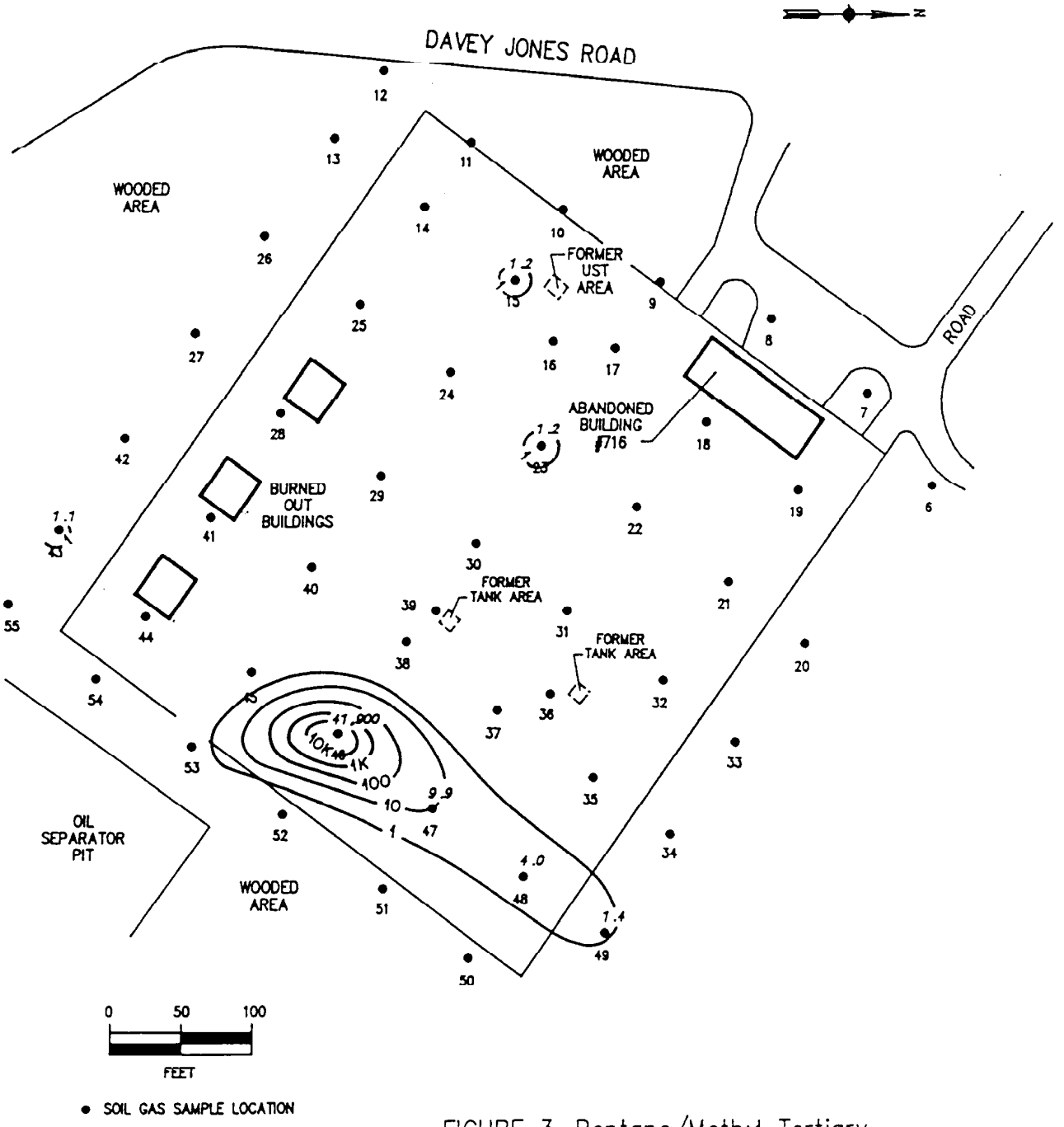

● SOIL GAS SAMPLE LOCATION

FIGURE 3. Pentane/Methyl Tertiary Butyl Ether (MTBE) ($\mu g/l$)

TARGET ENVIRONMENTAL SERVICES, INC.

NAVAL FACILITY
BAINBRIDGE
PORT DEPOSIT, MARYLAND

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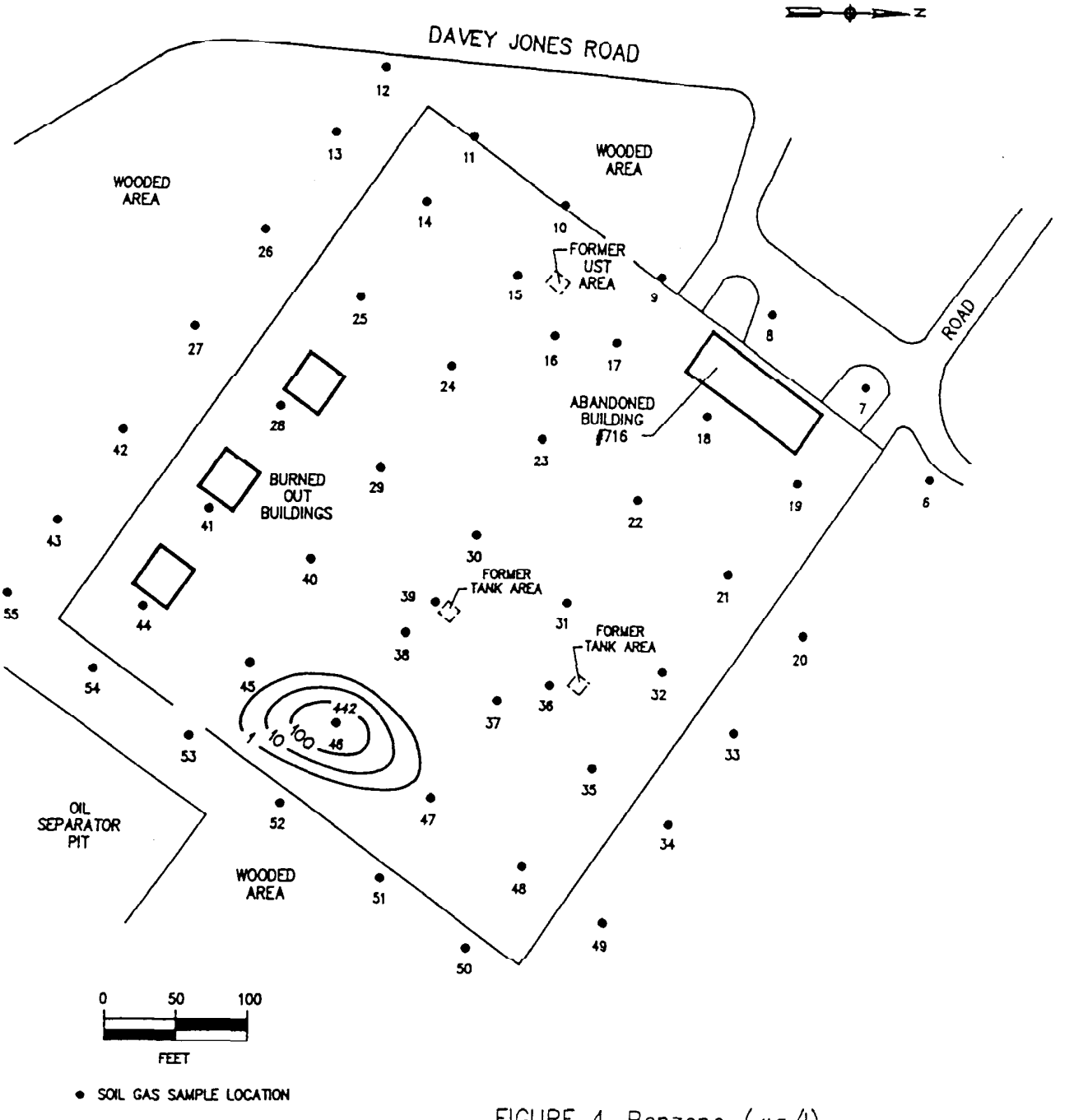

FIGURE 4. Benzene (μg/l)

TARGET ENVIRONMENTAL SERVICES, INC.

NAVAL FACILITY
BAINBRIDGE
PORT DEPOSIT, MARYLAND

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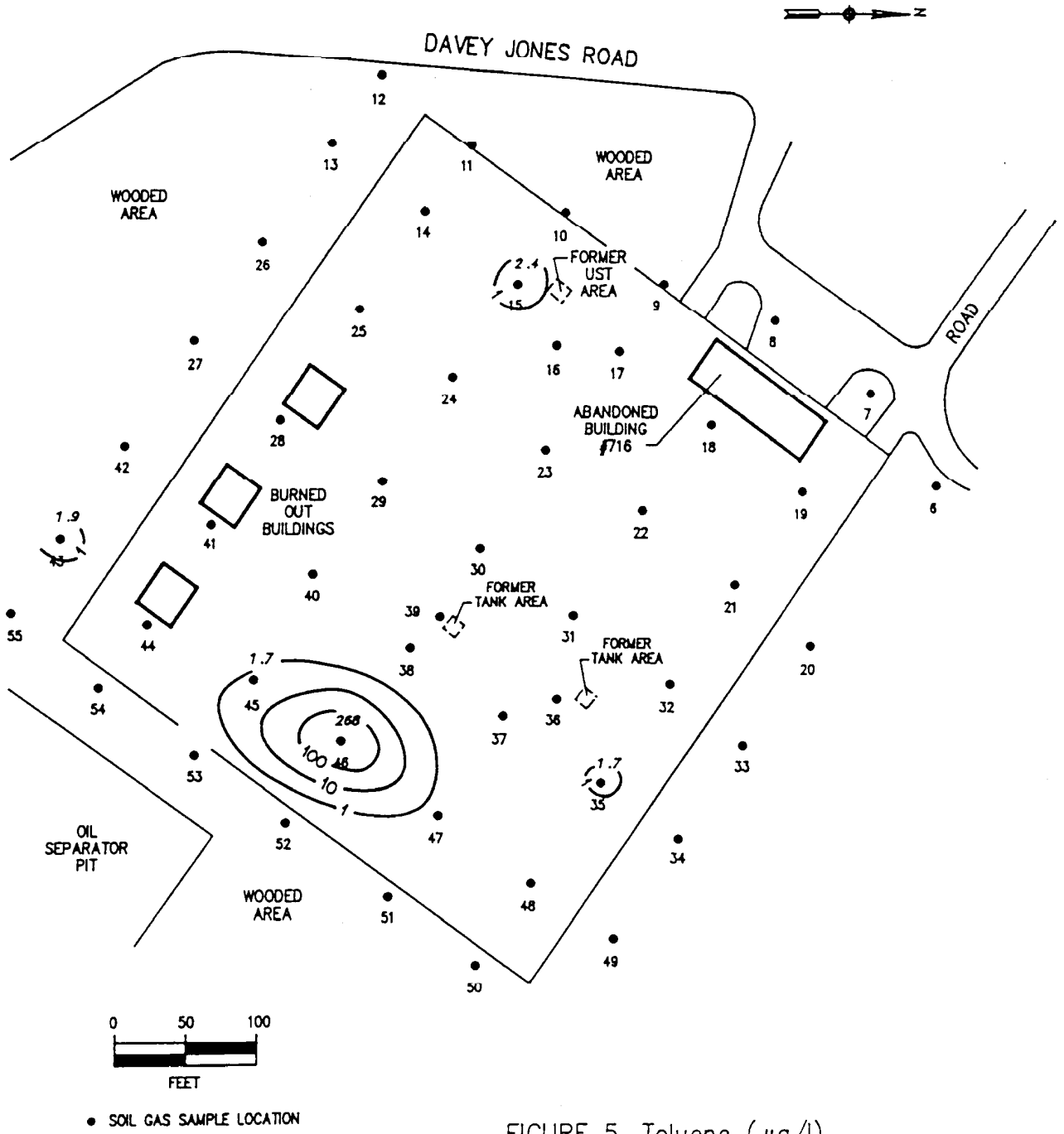

FIGURE 5. Toluene (μg/l)

TARGET ENVIRONMENTAL SERVICES, INC.

NAVAL FACILITY
BAINBRIDGE
PORT DEPOSIT, MARYLAND

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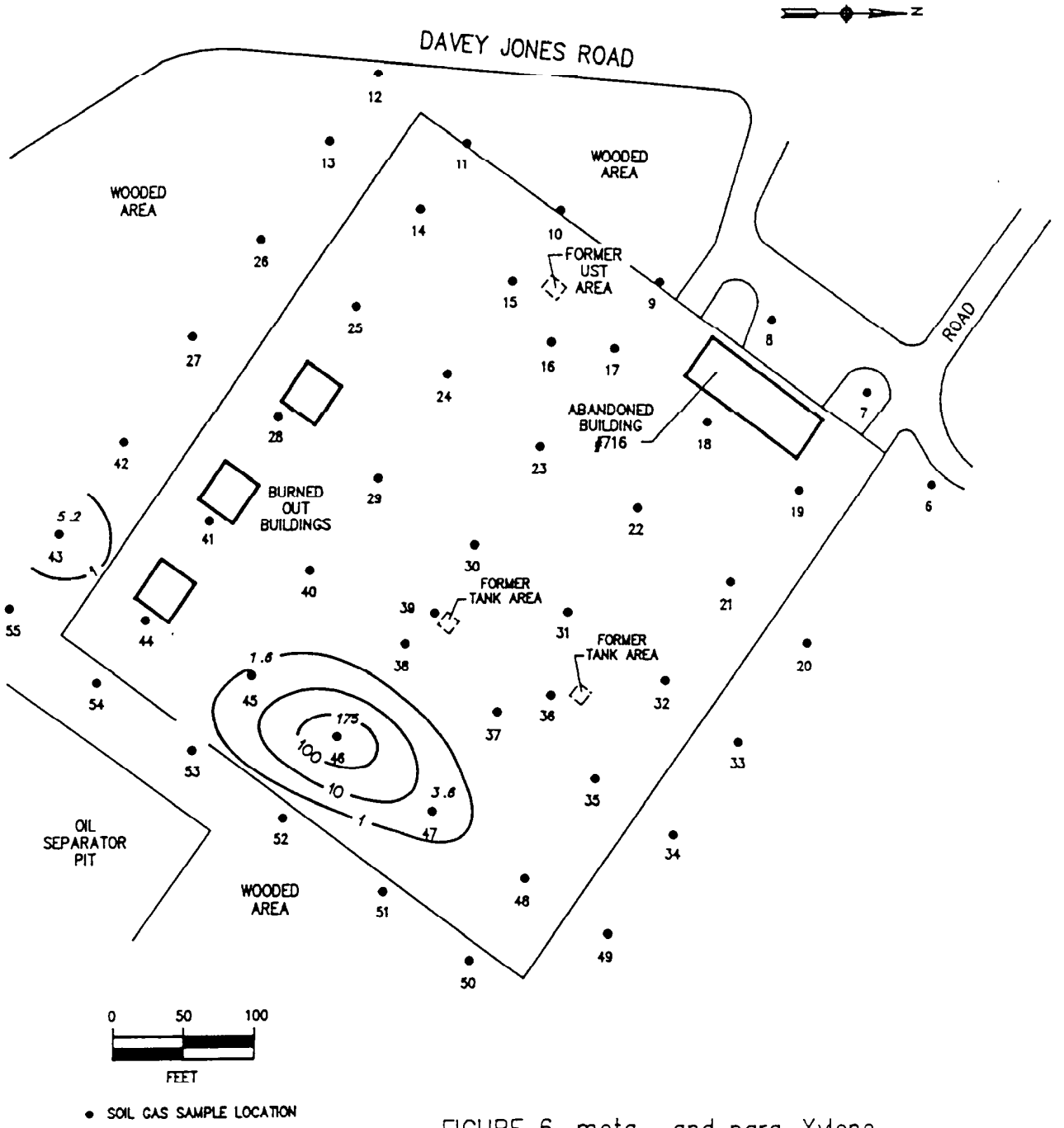

• SOIL GAS SAMPLE LOCATION

FIGURE 6. meta- and para-Xylene ($\mu g/l$)

TARGET ENVIRONMENTAL SERVICES, INC.

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BAINBRIDGE
PORT DEPOSIT, MARYLAND

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C Test Pit Logs

This appendix contains test pit classification log forms describing soil types and materials encountered during test pit excavation as part of the landfill delineation activities.

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP1-1

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/9/93
Pit Dimensions: 10'X 2 X 6' Date Completed: 11/9/93
Groundwater Data Date: _____ Date Backfilled: 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-1 Dark, Brown, humus layer, roots 3pp			OVA = 3 ppm - NO LF Material
2		1-6' Lt brown - ORANGE SANDY SILT NO LF MATERIAL			OVA = 0.0 ppm
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

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TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP1-2N

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/9/93
Pit Dimensions: 10' X 2' X 8' Date Completed: 11/9/93
Groundwater Data Date: _____ Date Backfilled: 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-1 - DARK, BROWN HUMUS LAYER ROOT ZONE			OVA = 0.0 ppm
2		2-3 - ORANGE-BROWN - SILTY CLAY 3-8 SANDY SILT NO LF MATERIAL			OVA = 0.0 ppm
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP1-3N

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4X4 Date Started: 11/9/93
Pit Dimensions: 12 X 9 X 2 Date Completed: 11/9/93
Groundwater Data Date: _____ Date Backfilled: 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
2		0-4 DK BR SILTY HUMUS W/ASH PIECES OF BRICK & CLAY PIPE METAL LF MATERIAL			
4		4-6 ORANGE CLAYEY SILT NO LF MATERIAL			
6		6-9 LT BROWN SILTY SAND			OVA 0.0 ppm
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP2-1

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W GRAF Equipment Used: CASE-590 4x4 Date Started: 11/9/93
Pit Dimensions: 8'X6'X2' Date Completed: 11/9/93
Groundwater Data Date: _____ Date Backfilled: 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
2		0-6' BROWN, SANDY, SILT W/ DEMOLITION DEBRIS, ASPHALT - SOIL STAINED BLACK WITH OILY ODOR OILY DEBRIS			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP2-2N

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4X4 Date Started: 11/9/93
Pit Dimensions: 6'X4'X2' Date Completed: 11/9/93
Groundwater Data Date: _____ Date Backfilled: 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-2 ~~B~~LT BROWN SILT W/BROKEN ROCKS			
2		2-4 GREY SILT/CLAY WITH GRAVEL >. 5 C.M SOME BLACK STAINED MATERIAL AT BOTTOM NOT ASPHALT. OILED ROAD?			OVA 0.0ppm
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE
Test Pit Number: TP3-1

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W GRAF Equipment Used: CASE 590 4X4 Date Started: 11/9/93
Pit Dimensions: 8'X6'X2' Date Completed: 11/9/93
Groundwater Data Date: _____ Date Backfilled: 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-6' DARK BROWN HUMUS w/ METAL, WOOD, ASH, TILE, MSW			
2		WATER AT 5.0'			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP3-2T

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W GRAF Equipment Used: CASE-590 4X4 Date Started: 11/9/93
Pit Dimensions: 8'x7'x2' Date Completed: 11/9/93
Groundwater Data Date: _____ Date Backfilled: 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-2 LT BROWN SILTY SAND, HUMUS ROOTS			
2		2-3 ORANGE CLAY W/ ROUNDED COBBLES			
		3-5 GREY-BROWN SILT/CLAY			
4					
		5-7 BROWN SILT/CLAY			OVA = 0.0PPM
6					
8		NO LANDFILL MATERIAL ENCOUNTERED			
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD 7
Project Name: BAINBRIDGE
Test Pit Number: TP4-1

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W GRAF Equipment Used: CASE 590 AX4 Date Started: 11/9/93
Pit Dimensions: 10'X5'X2' Date Completed: 11/9/93
Groundwater Data Date: _____ Date Backfilled: 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-1 BROWN HUMUS ROOTS			
2		1-5 CLAY FILL W/ MSW (BOTTLES, WOOD, GLASS, etc)			
		H_2O @ 4' - PERCHED (INFILTRATION THROUGH LF ONTO CLAY THAT APPEARS TO BE BENEATH THE AREA)			OVA ≈ 5.0 ppm fluctuating
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP4-2T

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W GRAF Equipment Used: CASE 590 4X4 Date Started: 11/9/93
Pit Dimensions: 12' X 4' X 2' Date Completed: 11/9/93
Groundwater Data Date: _____ Date Backfilled: 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-1 BROWN SILTY SAND, HUMUS W/ ROOT MATERIAL			
		1-2 ORANGE-BROWN CLAY			
2		2-4 GREY-GREEN FINE GRAINED SAND/SILT SAPROLITE			OVA = 20-30 ppm MAX 70 ppm fluctuating
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

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TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP5-1

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W GRAF Equipment Used: CASE 590 4X4 Date Started: 11/9/93
Pit Dimensions: 8' X 7' X 2' Date Completed: 11/9/93
Groundwater Data Date: _____ Date Backfilled: 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
2		0-3 LT BROWN SANDY SILT HUMUS W/ROOTS			
4		3-7 GREY CLAY/SILT W/ MSW-DEBRIS PAPER, GLASS, NEWSPAPER			OVA #95 PPM IN WASTE 10 PPM OVER TEST PIT
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

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TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE
Test Pit Number: TPS-2T

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4X4 Date Started: 11/9/93
Pit Dimensions: 10X3X6 Date Completed: 11/9/93
Groundwater Data Date: _____ Date Backfilled: 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		Humic soil 0-.5' building Fill material, stones debris (not LF)			
2		2'-6' GREY GREEN SAPROLITIC MAT METHANE ODOR (H_2S) NO MSW			OVA 10-45 ppm
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

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TEST PIT CLASSIFICATION LOG

Project Number
Project Name
Test Pit Number TP 6-1

Elevation
Location
Page 1 of 1
Engineer/Geologist W. GRAF
Equipment Used CASE 590 4X4
Date Started 11/9/93
Pit Dimensions 8 x 3 x 3
Date Completed 11/9/93
Groundwater Data Date
Date Backfilled 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-1.5 LT BR HUMIC SANDY SILT W/ ROOTS			
2		1.5-3.0 MSW MATERIAL, PAPER BOTTLES. CANS, ETC OVA 40ppm			INITIAL 100ppm OVA READING
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

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TEST PIT CLASSIFICATION LOG

Project Number
Project Name
Test Pit Number TP 6-2T

Elevation
Location
Page 1 of 1
Engineer/Geologist W. GRAF
Equipment Used CASE 590 4X4
Date Started 11/9/93
Pit Dimensions 8X5X2
Date Completed 11/9/93
Groundwater Data Date
Date Backfilled 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-0.5 DK BROWN HUMIC SILT W/ROOTS			
		1.5-2.0 DK GREY BLACK MATERIAL OILED ROAD SURFACE(?)			
2		2-5.0' BROWN-GREEN SAPROLITIC MAT.			
4		OVA < 1000 ppm			
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

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TEST PIT CLASSIFICATION LOG

Project Number
Project Name
Test Pit Number TP7-1

Elevation
Location
Page 1 of 1
Engineer/Geologist W GRAF
Equipment Used CASE 580 4x4
Date Started 11/9/93
Pit Dimensions 10 X 4 X 2
Date Completed 11/9/93
Groundwater Data Date
Date Backfilled 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-1 BROWN HUMIC SANDY SILT W/ROOTS			
2		1-4 ~~EF~~ MSW MATERIAL W/SILTY CLAY SAPROLITE			
		H2O @ ≈ 4.0'			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

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TEST PIT CLASSIFICATION LOG

Project Number
Project Name
Test Pit Number TP 7-2T

Elevation
Location
Page 1 of 1
Engineer/Geologist W. GRAF
Equipment Used CASE 590 4x4
Date Started 11/9/93
Pit Dimensions X8 x 3 X 2
Date Completed 11/9/93
Groundwater Data Date
Date Backfilled 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-1.5 DK BROWN HUMIC SILTY CLAY w/ ROOTS			
2		1.5-3.0 - GREEN GREY SAPROLITE			
		NO LF MATERIAL			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

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TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP8-~~2~~1

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4X4 Date Started: 11/9/93
Pit Dimensions: 10X5X3 Date Completed: 11/9/93
Groundwater Data Date: _____ Date Backfilled: 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-1 DK BROWN, MOIST HUMIC SILT W/ROOTS			NO LF MAT
2		1-5 MOIST ORANGE BROWN SILT W/CLAY			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP 8-2N

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/9/93
Pit Dimensions: 15 x 8 x 3 Date Completed: 11/9/93
Groundwater Data Date: _____ Date Backfilled: 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-1 DK BROWN HUMIC SILT W/ROOTS, DRY			
		1-7 ORANGE BROWN SILT W/CLAY			NO LF MAT
2					
4					
6					
		7-8 MOIST YELLOW-BROWN FN→MD GR SAND			
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

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TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP8-3N

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/9/93
Pit Dimensions: 10 X 7 X 3 Date Completed: 11/9/93
Groundwater Data Date: _____ Date Backfilled: 11/9/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-2 MOIST DK BROWN HUMIC SILT W/ROOTS			NO LF MAT
2		2-5 MOIST ORANGE BROWN SILT W/CLAY			
4					
		5-7 MOIST GREY GREEN SAPROLITE			
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP8-4N

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/1/93
Pit Dimensions: 12x6x3 Date Completed: 11/1/93
Groundwater Data Date: _____ Date Backfilled: 11/1/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-2 MOIST DK BROWN HUMIC SILT W/ROOTS			NO LF MATERIAL
2		2-6 ORANGE BROWN SILT W/CLAY MOIST			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

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TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP8-SN

Elevation: ____ Location: ____ Page 1 of 1
Engineer/Geologist: DL GRAF Equipment Used: CASE 590 4X4 Date Started: 11/1/93
Pit Dimensions: 9X7X3 Date Completed: 11/1/93
Groundwater Data Date: ____ Date Backfilled: 11/1/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-3 DK BROWN HUMIC SILT W/ROOTS IN 1ST FOOT			NO LF MATERIAL
2					
		3-7 ORANGE BROWN CLAYEY SILT SAPROLITE			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP8-6N

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/10/93
Pit Dimensions: 11x4x3 Date Completed: 11/10/93
Groundwater Data Date: _____ Date Backfilled: 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		OH MOIST DK BROWN HUMIC SILT W/ROOTS			
2		1-4 ORANGE BROWN SILT/SAND/CLAY LF MATERIAL AT BACK OF EXCAVATION			LF MATERIAL ENCOUNTERED
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

recycled paper

ecology and environment

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP9-1

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/ /93
Pit Dimensions: 10x2.5x5 Date Completed: 11/ /93
Groundwater Data Date: _____ Date Backfilled: 11/ /93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-1 DK BROWN HUMIC SILT W/ROOTS & DEBRIS (LF MAT)			DEBRIS (FROM LF?) ENCOUNTERED - 0-1' BGS, NONE BELOW
2		1-2.5 MOIST ORANGE ~~BROWN~~ SILTY SAND NO LF MATERIAL			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number CD7
Project Name BAINBRIDGE NTC
Test Pit Number TP10-1

Elevation _____ Location _____ Page 1 of 1
Engineer/Geologist W. GRAF Equipment Used CASE 590 4x4 Date Started 11/10/93
Pit Dimensions 8X6X3 Date Completed 11/10/93
Groundwater Data Date _____ Date Backfilled 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		~~LT B~~ 0-2 DK HUMIC SILT 0-.25, LT BROWN SANDY SILT W/LF MATERIAL AT REAR OF EXCAVATION (CLOSEST TO LF)			PIT WAS ON A SMALL BERM, ALL LF MATERIAL IN UPPER 2 FEET
2		2-6 BROWN SILT W/ROOTS, NO LF MATERIAL			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

recycled paper
ecology and environment

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP11-1

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF. Equipment Used: CASE 590 4x4 Date Started: 11/10/93
Pit Dimensions: 12x6x4 Date Completed: 11/10/93
Groundwater Data Date: _____ Date Backfilled: 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-2.5 BROWN SANDY SILT W/ROOTS			LF MATERIAL ENCOUNTERED
2		2.5-3 ORANGE BROWN CLAY			
		3-6 LT BROWN SAND W/ROUNDED GRAVEL LF MATERIAL AT THE BASE			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP11-2T

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/10/93
Pit Dimensions: 12 X 6.5 X 3 Date Completed: 11/10/93
Groundwater Data Date: _____ Date Backfilled: 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-2 LT BROWN SILT W/ROOTS			LF MATERIAL AT BASE OF PIT CLOSEST TO LF
2		2-6.5' ORANGE SILT W/CLAY, SAPROLITE AT BOTTOM. LF MATERIAL AT BASE OF THE BACK ~~SECT~~ OF THE PIT CLOSEST TO LF			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

recycled paper
ecology and environment

TEST PIT CLASSIFICATION LOG

Project Number CD7
Project Name BAINBRIDGE NTC
Test Pit Number TP11-3T

Elevation _____ Location _____ Page 1 of 1
Engineer/Geologist DL GRAF. Equipment Used CASE 590 4x4 Date Started 11/10/93
Pit Dimensions 10 X 7 X 3 Date Completed 11/10/93
Groundwater Data Date _____ Date Backfilled 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-2 DK BROWN HUMIC SILT W/ ROOTS ~~0-5~~ (0-.5) ~~THE~~ .5-2 LT BROWN SAND MED GRAINED			NO LF MATERIAL
2		2-7 TAN SANDY SILT, SAPROLITE (GREY GREEN) AT BASE. NO LF MATERIAL			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP12-1

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/10/93
Pit Dimensions: 12x7-4 Date Completed: 11/10/93
Groundwater Data Date: _____ Date Backfilled: 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
2		0-4' LT BROWN SANDY SILT W/ROOTS IN 1ST 2 FEET			LF MATERIAL AT 4-5 FEET BGS
4		4-5 - LF MAT - GLASS, PAPER, ASH, PLASTIC			
6		5-7 BROWN ORANGE SILTY CLAY			
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA - Same as above

recycled paper

ecology and environment

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP 12-2T

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/10/93
Pit Dimensions: 10X 7-3 Date Completed: 11/10/93
Groundwater Date Date: _____ Date Backfilled: 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-1 DK BROWN SILT			
2		1-7 TAN FN GRAINED SAND NO LF MATERIAL			NO LF MATERIAL
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number CD7
Project Name BAINBRIDGE NTC
Test Pit Number TP13-1

Elevation _____ Location _____ Page 1 of 1
Engineer/Geologist DL GRAF Equipment Used CASE 590 4x4 Date Started 11/10/93
Pit Dimensions 15x14x5 Date Completed 11/10/93
Groundwater Data Date _____ Date Backfilled 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-2 DK BROWN SANDY SILT W/ROOTS			NO LF MATERIAL
2		2-3 ORANGE BROWN CLAY			
		3-8 - TAN MD GRAINED SAND, CLEAN			
4					
6					
8		8-14 - MOIST GREY-GREEN SAPROLITE			
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP14-1

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/10/93
Pit Dimensions: 11X8X3 Date Completed: 11/10/93
Groundwater Data Date: _____ Date Backfilled: 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-2 BROWN-ORANGE ~~MATERIAL~~ SILTY CLAY W/TRASH (LF MAT)			LF MATERIAL 0-2' BGS
2		2-8 LT TAN SAND MDGR - CLEAN			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP14-2T

Elevation: ____ Location: ____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/10/93
Pit Dimensions: 15X15X5 Date Completed: 11/10/93
Groundwater Data Date: ____ Date Backfilled: 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-1 LT BROWN SILT W/ROOTS			
2		1-5 ORANGE BROWN SILT W/CLAY			NO LF MATERIAL
4					
6		5-9 LT TAN SAND, CLEAN, MD GRAINED			
8					
10		9-15 ORANGE TAN MOTTLED SAPROLITE - RELICT STRUCTURES PRESENT (ROCK)			
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

recycled paper
ecology and environment

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP 14-[redacted]3N

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/10/93
Pit Dimensions: 8x2.5x3 Date Completed: 11/10/93
Groundwater Data Date: _____ Date Backfilled: 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-.5 ORANGE BROWN SILT W/CLAY			
		.5-2.5 LF MATERIAL W/GREY SILTY CLAY OVA = 90 ppm			LF MATERIAL ENCOUNTERED
2					
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number CD7
Project Name BAINBRIDGE NTC
Test Pit Number TP14-4N

Elevation _____ Location _____ Page 1 of 1
Engineer/Geologist W. GRAF Equipment Used CASE 590 4x4 Date Started 11/10/93
Pit Dimensions 7x3.5x3 Date Completed 11/10/93
Groundwater Data Date _____ Date Backfilled 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-.5 LT BROWN SILT .5-2 CONSTRUCTION RUBBLE W/BROWN SILT			LF MATERIAL ENCOUNTERED
2		2-3.5 DEMOLITION DEBRIS			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

recycled paper
ecology and environment

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP 15-1

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/10/93
Pit Dimensions: 7x3x3 Date Completed: 11/10/93
Groundwater Data Date: _____ Date Backfilled: 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-1 BROWN SILT W/ ROOTS			LF MATERIAL ENCOUNTERED
2		1-3 DEMOLITION DEBRIS & LF MATERIAL			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP15-2T

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/ /93
Pit Dimensions: 6x2.5x3 Date Completed: 11/ /93
Groundwater Data Date: _____ Date Backfilled: 11/ /93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0.-0.5 DK BROWN SILT W/ROOTS			
		.5-2.5 BURNED LF MATERIAL W/SOIL			LF MATERIAL ENCOUNTERED
2					
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

recycled paper
ecology and environment

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP15-35

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/10/93
Pit Dimensions: 10X6X3 Date Completed: 11/10/93
Groundwater Data Date: _____ Date Backfilled: 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0.-2 LT BROWN SANDY SILT W/ROOTS			NO LF MATERIAL
2		2-6 LT TAN MD GRAINED SAND, CLEAN			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number CD7
Project Name BAINBRIDGE NTC
Test Pit Number TP16-1

Elevation _____ Location _____ Page 1 of 1
Engineer/Geologist W. GRAF Equipment Used CASE 590 4x4 Date Started 11/10/93
Pit Dimensions 8X2.5X4 Date Completed 11/10/93
Groundwater Data Date _____ Date Backfilled 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-1 LT BROWN SANDY SILT W/ROOTS			
2		1-2.5 LANDFILL MATERIAL - MSW AND DEMOLITION DEBRIS			LF MATERIAL ENCOUNTERED
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

recycled paper
ecology and environment

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP16-2T

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/10/93
Pit Dimensions: 8X2X3 Date Completed: 11/10/93
Groundwater Data Date: _____ Date Backfilled: 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-0.5 BROWN SANDY SILT W/ ROOTS			
		0.5-2 - MSW & DEMOLITION DEBRIS			LF MATERIAL ENCOUNTERED
2					
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP16-3T

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/10/93
Pit Dimensions: 7x4x3 Date Completed: 11/10/93
Groundwater Data Date: _____ Date Backfilled: 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-2 - BROWN SANDY SILT W/ROOTS			LF MATERIAL ENCOUNTERED
2		2-4 - BROWN SANDY SILT & LF MAT			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

recycled paper
ecology and environment

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NTC
Test Pit Number: TP16-4T

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/10/93
Pit Dimensions: 10X6X3 Date Completed: 11/10/93
Groundwater Data Date: _____ Date Backfilled: 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-1 BROWN SANDY SILT			NO LF MATERIAL
2		1-6 ~~BROWN~~ LT TAN SAND CLEAN NO LF MAT			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

TEST PIT CLASSIFICATION LOG

Project Number: CD7
Project Name: BAINBRIDGE NIC
Test Pit Number: TP17-1

Elevation: _____ Location: _____ Page 1 of 1
Engineer/Geologist: W. GRAF Equipment Used: CASE 590 4x4 Date Started: 11/10/93
Pit Dimensions: 10x6.-3 Date Completed: 11/10/93
Groundwater Data Date: _____ Date Backfilled: 11/10/93

DEPTH (FEET)	SAMPLE NUMBER	DESCRIPTION	USCS SYMBOL	GRAPHIC LOG	REMARKS
		0-1 DK BROWN SILT W/ROOTS			NO LF MATERIAL
2		1-6 DK BROWN SILT W/ROCKS FILL MATERIAL - NO LF MAT			
4					
6					
8					
10					
12					
14					

Notes:

Estimated elevation and location
SAA = Same as above

recycled paper

ecology and environment

D Soil Boring Logs

This appendix contains drilling log forms that describe the subsurface soil types encountered during borehole drilling.

DRILLING LOG OF BORING NO. 2-BH-1

Project: BAINBRIDGE NAVAL TRAINING CENTER
Total Depth of Hole (feet BGS): 15
Location: PORT DEPOSIT, MARYLAND
Ground Elevation (feet above MSL): NA
Boring Location: NW Corner of Oil Separator Pit.
Refusal at (feet BGS): NA
Drilling Company: E & E DRILLING AND TESTING
Date Started / Finished: 1-23-91 / 1-23-91
Driller/Geologist: PAUL BARTH / JEFF TUTTLE
Job#: CD7012

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	LASKEY CORE RUN	COMMENTS
1, 2, 3, 4, 5, 6, 7, 8, 9, 10		0.0-0.1' SAND sandy outwash material.	LASKEY CORE SAMPLE 1	Grab sample for volatiles analysis. Composite sample for BNAs, Pesticides/PCBs, Metals and Cyanide.
		0.1-0.5' TAR/ORGANICS tar/organic layer.		
		0.5-3.5' SAPROLITE tarry/streaked saprolite.		OVA: 40 ppm, diesel odor.
		3.5-5.0' SAPROLITE gneissic laminations.		
		5.0-10.0' SAPROLITE uniform weathered saprolite with pebble layer at 8'. More quartz rich at 9'-10' with granite gneiss bedrock fragments.	LASKEY CORE SAMPLE 2	
10, 11, 12, 13, 14, 15, 16, 17, 18		10.0-15.0' GNEISS bedrock at 12'? 12'-15' layered/banded gneissic bedrock.	LASKEY CORE SAMPLE 3	Difficult drilling.

DRILLING LOG OF BORING NO. 2-BH-2

Project: BAINBRIDGE NAVAL TRAINING CENTER

Location: PORT DEPOSIT, MARYLAND

Boring Location: SW Corner of Oil Separator Pit.

Drilling Company: E & E DRILLING AND TESTING

Driller/Geologist: PAUL BARTH / JEFF TUTTLE

Total Depth of Hole (feet BGS): 10

Ground Elevation (feet above MSL): NA

Refusal at (feet BGS): NA

Date Started / Finished: 1-25-91 / 1-25-91

Job#: CD7012

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	LASKEY CORE RUN	COMMENTS
		0.0-0.3' SILTY SAND silty sand runoff material.	LASKEY CORE SAMPLE 1	Grab sample for volatiles analysis. Composite sample for BNAs, Pesticides/PCBs, Metals and Cyanide.
		0.3-0.7' TAR 4" to 5" tarry, oily, and greasy layer.		
1		0.7-2.7' SILT/TAR 2' mixed silt with tarry streaks.		
2				
3		2.7-4.7' SAPROLITE 2' saprolite with gneissic banding.		
4				
5		5.0-8.0' SAPROLITE banded saprolite with mica predominant; tarry streaks (4" thick).	LASKEY CORE SAMPLE 2	
6				
7				OVA: 8 ppm; minor heaving silts.
8				8' to 10' difficult drilling.
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				

DRILLING LOG OF BORING NO. 2-BH-3

Project: BAINBRIDGE NAVAL TRAINING CENTER
Total Depth of Hole (feet BGS): 10
Location: PORT DEPOSIT, MARYLAND
Ground Elevation (feet above MSL): NA
Boring Location: SE Corner of Oil Separator Pit.
Refusal at (feet BGS): NA
Drilling Company: E & E DRILLING AND TESTING
Date Started / Finished: 1-24-91 / 1-24-91
Driller/Geologist: PAUL BARTH / JEFF TUTTLE
Job#: CD7012

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	LASKEY CORE RUN	COMMENTS
		0.0-0.3' SAND gritty sand runoff layer.	LASKEY CORE SAMPLE 1	Grab sample for volatiles analysis. Composite sample for BNAs, Pesticides/PCBs, Metals and Cyanide.
1		0.3-0.8' TAR 6" to 7" greasy tar layer.		
2		0.8-2.8' GRAVELS AND COBBLES		
3		2.4-4.8' SAPROLITE 2' saprolite with gneissic laminations.		OVA: 3.5 ppm.
4				
5		5.0-7.0' SAPROLITE cobble rich saprolite (2" to 3" size cobbles).	LASKEY CORE SAMPLE 2	
6				
7		7.0-10.0' SCHIST competent schistose bedrock.		
8				
9				
10				Auger refusal at 10'.
11				
12				
13				
14				
15				
16				
17				
18				

DRILLING LOG OF BORING NO. 2-BH-4

Project: BAINBRIDGE NAVAL TRAINING CENTER
Total Depth of Hole (feet BGS): 15
Location: PORT DEPOSIT, MARYLAND
Ground Elevation (feet above MSL): NA
Boring Location: SE Corner of Oil Separator Pit.
Refusal at (feet BGS): NA
Drilling Company: E & E DRILLING AND TESTING
Date Started / Finished: 1-24-91 / 1-24-91
Driller/Geologist: PAUL BARTH / JEFF TUTTLE
Job#: CD7012

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	LASKEY CORE RUN	COMMENTS
		0.0-0.3' HUMUS 4" humus soil layer.	LASKEY CORE SAMPLE 1	Grab sample for volatiles analysis. Composite sample for BNAs, Pesticides/PCBs, Metals and Cyanide.
1		0.3-0.5' ORGANICS streaked organic layer.		
		0.5-3.0' GRAVEL AND SILTY SAND		
2				
3		3.0-5.0' SAND finer, well sorted sand with gravel stringers.		
4				
5		5.0-7.0' SILTY SAND dark brown silty sand with mica and dark mineral laminations.	LASKEY CORE SAMPLE 2	OVA: 20 ppm; diesel odor.
6				
7		7.0-8.0' QUARTZ massive quartz vein (?).		
8		8.0'-10.0' No sample recovery.		
9				
10			LASKEY CORE SAMPLE 3	An additional boring not accounted for in the work plan. Location selected based on drilling of well 2-GW-8 through overburden saturated with diesel (?).
11		11.0'-13.0' SAND green tinted fine sand with heavy fuel/diesel odor.		
12				
13		13.0'-14.0' SILTY SAND coarser silty brown sands also with fuel odor.		
14		14.0'-15.0' No sample recovery.		
15				
16				
17				
18				

DRILLING LOG OF BORING NO. 2-BH-5

Project: BAINBRIDGE NAVAL TRAINING CENTER

Location: PORT DEPOSIT, MARYLAND

Boring Location:

Drilling Company: E & E DRILLING AND TESTING

Driller/Geologist: /

Total Depth of Hole (feet BGS): 4

Ground Elevation (feet above MSL): NA

Refusal at (feet BGS): NA

Date Started / Finished: 4-7-94 / 4-7-94

Job#: CD7012

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	LASKEY CORE RUN	COMMENTS
		0.0-0.5' HUMUS: dark brown, to black, fine to coarse grained, with partially decomposed vegetative material.	2-BH-5	Boring was drilled using a 2-man power auger with 6" outer diameter auger flights.
1		0.5-4.0' CLAYEY SILT: medium brown, high organics, 90% very fine, 10% fine.		
2				
3				
4				Sample 2-BH-5 collected from auger flights at ~4.0' BGS
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				

DRILLING LOG OF BORING NO. 2-BH-6

Page

Project: BAINBRIDGE NAVAL TRAINING CENTER

Location: PORT DEPOSIT, MARYLAND

Boring Location:

Drilling Company: E & E DRILLING AND TESTING

Driller/Geologist: /

Total Depth of Hole (feet BGS): 3

Ground Elevation (feet above MSL): NA

Refusal at (feet BGS): NA

Date Started / Finished: 4-7-94 / 4-7-94

Job#: CD7012

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	LASKEY CORE RUN	COMMENTS
		0.0-0.5' HUMUS: dark brown, to black, fine to coarse grained, with partially decomposed vegetative material.	2-BH-6	Boring was drilled using a 2-man power with 6" outer diameter auger flights.
1		0.5-3.0' CLAYEY SILT: medium brown, high organics, 90% very fine, 10% fine.		
2				Sample 2-BH-6 collected from auger fl at ~3.0' BGS
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
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18				

DRILLING LOG OF BORING NO. 2-BH-7

Project: BAINBRIDGE NAVAL TRAINING CENTER

Location: PORT DEPOSIT, MARYLAND

Boring Location:

Drilling Company: E & E DRILLING AND TESTING

Driller/Geologist: /

Total Depth of Hole (feet BGS): 4

Ground Elevation (feet above MSL): NA

Refusal at (feet BGS): NA

Date Started / Finished: 4-7-94 / 4-7-94

Job#: CD7012

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	LASKEY CORE RUN	COMMENTS
1		0.0-0.5' HUMUS: dark brown, to black, fine to coarse grained, with partially decomposed vegetative material.	2-BH-7	Boring was drilled using a 2-man power auger with 6" outer diameter auger flights.
2		0.5-4.0' CLAYEY SILT: medium brown, high organics, 90% very fine, 10% fine.		
3				
4				Sample 2-BH-7 collected from auger flights at ~4.0' BGS
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6				
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9				
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11				
12				
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14				
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17				
18				

DRILLING LOG OF BORING NO. 2-BH-8

Project: BAINBRIDGE NAVAL TRAINING CENTER

Total Depth of Hole (feet BGS): 2

Location: PORT DEPOSIT, MARYLAND

Ground Elevation (feet above MSL): NA

Boring Location:

Refusal at (feet BGS): NA

Drilling Company: E & E DRILLING AND TESTING

Date Started / Finished: 4-7-94 / 4-7-94

Driller/Geologist: /

Job#: CD7012

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	LASKEY CORE RUN	COMMENTS
1		0.0-0.5' HUMUS: dark brown, to black, fine to coarse grained, with partially decomposed vegetative material.	2-BH-8	Boring was drilled using a 2-man power auger with 6" outer diameter auger flights.
2		0.5-2.0' CLAYEY SILT: medium brown, high organics, 90% very fine, 10% fine.		Sample 2-BH-8 collected from auger flights at ~2.0' BGS
3				
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16				
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DRILLING LOG OF BORING NO. 2-BH-9

Project: BAINBRIDGE NAVAL TRAINING CENTER

Location: PORT DEPOSIT, MARYLAND

Boring Location:

Drilling Company: E & E DRILLING AND TESTING

Driller/Geologist: /

Total Depth of Hole (feet BGS): 3

Ground Elevation (feet above MSL): NA

Refusal at (feet BGS): NA

Date Started / Finished: 4-7-94 / 4-7-94

Job#: CD7012

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	LASKEY CORE RUN	COMMENTS
		0.0-0.25' HUMIC SILT;		Boring was drilled using a 2-man power auger with 6" outer diameter auger flights.
1		0.25-3.0' GRAVELLY SILT; poorly sorted, some clay, high organics throughout, gravels up to ~2" dia.	2-BH-9	
2				Sample 2-BH-9 collected from auger flights at ~3.0' BGS
3				
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10				
11				
12				
13				
14				
15				
16				
17				
18				

DRILLING LOG OF BORING NO. 2-BH-10

Page

Project: BAINBRIDGE NAVAL TRAINING CENTER

Location: PORT DEPOSIT, MARYLAND

Boring Location:

Drilling Company: E & E DRILLING AND TESTING

Driller/Geologist: /

Total Depth of Hole (feet BGS): 3

Ground Elevation (feet above MSL): NA

Refusal at (feet BGS): NA

Date Started / Finished: 4-7-94 / 4-7-94

Job#: CD7012

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	LASKEY CORE RUN	COMMENTS
1		0.0-0.25' HUMUS; dark brown, to black, fine to coarse grained, with partially decomposed vegetative material.	2-BH-10	Boring was drilled using a 2-man power a with 6" outer diameter auger flights.
2		0.25-3.0' CLAYEY SILT; with gravel, high organics, gravels increasing in size with depth, pebbles at 2' and deeper.		
3				Sample 2-BH-10 collected from auger flig at ~2.5-3.0' BGS
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DRILLING LOG OF BORING NO. 2-BH-11

Project: BAINBRIDGE NAVAL TRAINING CENTER

Location: PORT DEPOSIT, MARYLAND

Boring Location:

Drilling Company: C & C DRILLING AND TESTING

Driller/Geologist: /

Total Depth of Hole (feet BGS): 3

Ground Elevation (feet above MSL): NA

Refusal at (feet BGS): NA

Date Started / Finished: 4-7-94 / 4-7-94

Job#: CD7012

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	LASKEY CORE RUN	COMMENTS
		0.0-0.75' CLAYEY SILT: dark brown, to black, high organics, moderate plasticity.	2-BH-11	Boring was drilled using a 2-man power auger with 6" outer diameter auger flights.
1		0.75-3.0' WEATHERED DIORITE/DIORITE SAND: grey to light brown, some iron staining, quartz cobbles present.		
2				
3				Sample 2-BH-11 collected from auger flights at ~3.0' BGS
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DRILLING LOG OF BORING NO. 2-BH-12

Project: BAINBRIDGE NAVAL TRAINING CENTER

Location: PORT DEPOSIT, MARYLAND

Boring Location:

Drilling Company: E & E DRILLING AND TESTING

Driller/Geologist: /

Total Depth of Hole (feet BGS): 2

Ground Elevation (feet above MSL): NA

Refusal at (feet BGS): NA

Date Started / Finished: 4-7-94 / 4-7-94

Job#: CD7012

DEPTH	GRAPHIC LOG	OVERBURDEN DESCRIPTION	LASKEY CORE RUN	COMMENTS
		0.0-0.75' CLAYEY SILT; dark brown, to black, high organics, moderate plasticity.	2-BH-12	Boring was drilled using a 2-man power auger with 6" outer diameter auger flights.
1		0.75-2.0' WEATHERED DIORITE/DIORITE SAND; grey to light brown, some iron staining, quartz cobbles present.		
2				Sample 2-BH-12 collected from auger flights at ~2.0' BGS
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E Monitoring Well Installation Logs

This appendix contains information relevant to the drilling and construction of wells: drilling and sampling logs, monitoring well construction details, and monitoring well installation summaries.

Drilling and Sampling Log

:t Name and Number: Navy Bainbridge / CD7012
ocation: East Side of Old Landfill
g Well Location: SW of 1-6W-8/9
01/21/91
g/Well No.: 1-GW-6
g Contractor: E & E Drilling and Testing Co.
g Equipment: Dietrich D50 Rig
r: Paul Barth
r's Helper(s): Walter Knotts/John Terharr
ogist: Paul Kopsick

Well Casing Size, Type: 4" SCH 40 PVC
Boring Diameter: 8", Quantity
Screen Size and Type: .01" Slot PVC
Screened Interval: 24' to 34'
Well Diameter: 4"
Start Time: 3:00 PM
Completion Time: 5:00 PM (1/22/91)
Total Depth of Hole: 37' *
Groundwater Depth: 27.85' *
Surface Elevation: 235.80' above MSL

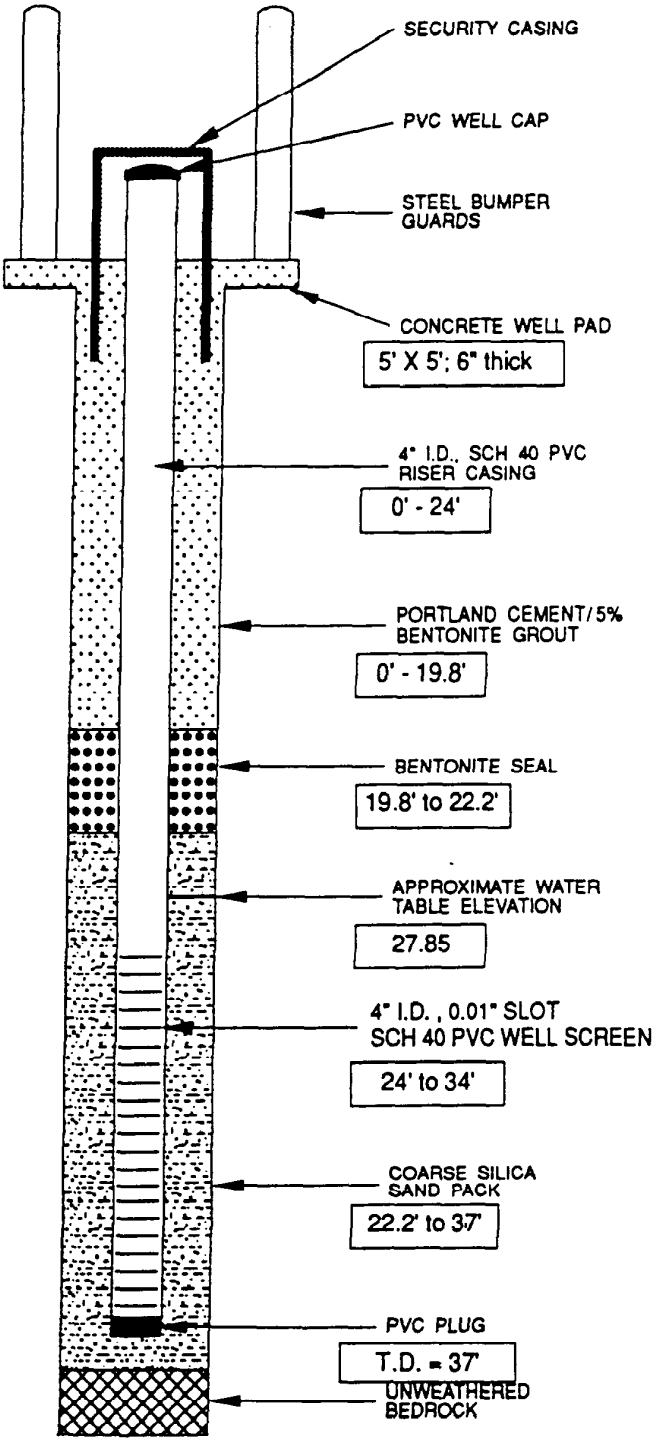
* *Measured from top of protective casing*

ıth	Sample	Graphic Log	Description	Remarks
	N/A		0' to 13' schist / granite saprolite.	
			13' to 37' hard granite saprolite.	
		H_2O Stringer	28' to 29' hard qtz. vein.	
			T.D. = 37'	* No OVA readings above background throughout entire interval * Fine cuttings difficult to log throughout entire interval.

00375.PM3

Monitoring Well Construction Details

Sample No: 1-GW-6



00380.PM3

Monitoring Well Installation Summary

Project: Bainbridge Naval Training Center (NTC)

Well #: 1–GW–6

Date: 01/21/91

Observer: Jeff Tuttle, Hydrogeologist

Well Location:

- East Side of Old Landfill along unnamed creek.
- Access to the location is via the dirt road running down the center of the upper landfill and eastern side of the lower landfill.

Drilling Technique:

- Percussion air hammer drill (8" bit)
- Fine cuttings blown to surface with compressed air.

Generalized Stratigraphy (see accompanying log for details):

- Weathered schist/gneiss saprolite; hard granite saprolite facies; granite bedrock.

Well Construction (see accompanying diagram for details):

- Schedule 40 PVC casing; 24' to 34' screened interval.
- 13.8' thick sand pack; 2.4' bentonite seal; 21' of cement/bentonite grout.
- Concrete well pad with steel bumper guards.

Well Development:

- Total of 165 gallons purged using a stainless steel submersible pump; temperature and conductivity stabilized.

Initial Sampling Date/Depth to Water:

- February 11, 1991; water at 27.85' measured from top of protective casing.
- Total well depth of 37' measured from top of protective casing.
- Purge volume of approximately 20 gallons.

00375A.PM3

Drilling and Sampling Log

Project Name and Number: Navy Bainbridge / CD7012
Site Location: Downgradient of Old Landfill
Boring Well Location: Base of Water Tower Access Rd.
Date: 01/22/91
Boring/Well No.: 1-GW-7
Drilling Contractor: E & E Drilling and Testing Co.
Drilling Equipment: Dietrich D50 Rig
Driller: Paul Barth
Driller's Helper(s): Walter Knotts/John Terharr
Geologist: Jeff Tuttle

Well Casing Size, Type: 4" SCH 40 PVC
Boring Diameter: 8"
Screen Size and Type: .01" Slot PVC
Screened Interval: 16' to 26'
Well Diameter: 4"
Start Time: 11:20 AM
Completion Time: 4:40 PM
Total Depth of Hole: 27.7' *
Groundwater Depth: 11.53' *
Surface Elevation: 138.69' above MSL.

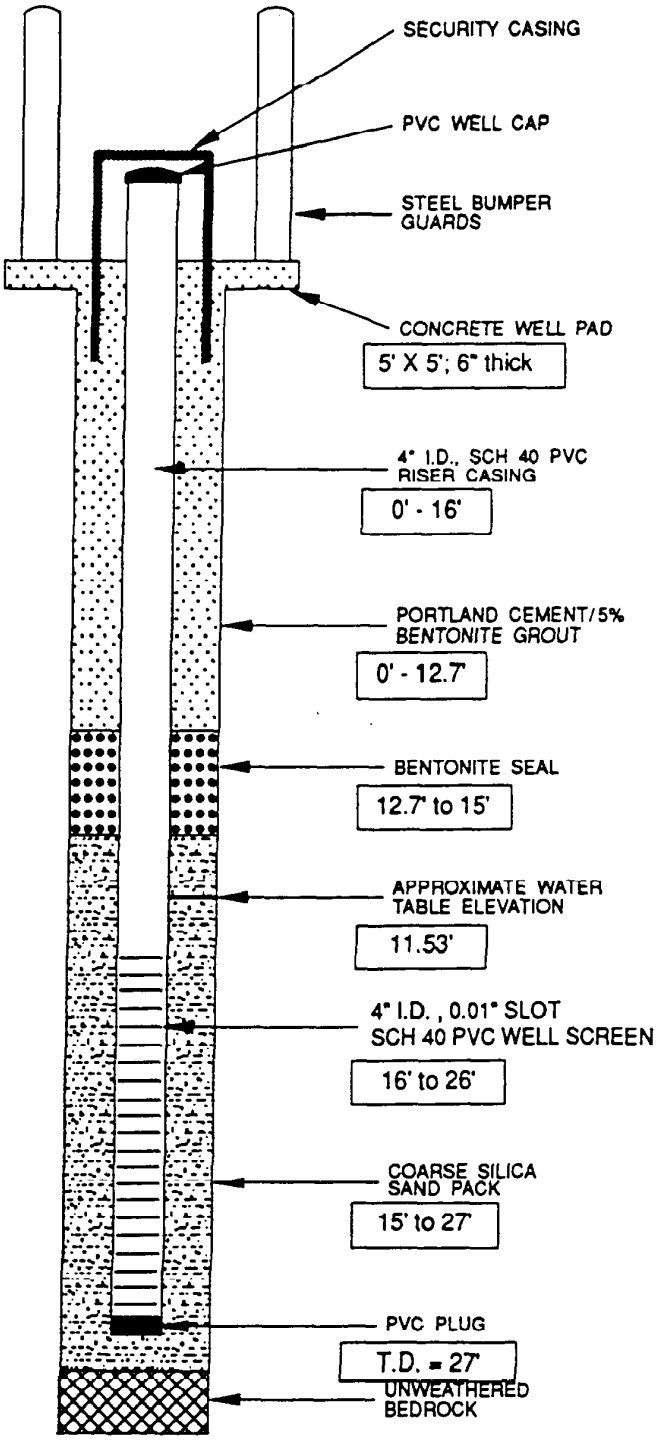
* *Measured from top of protective casing*

Depth	Sample	Graphic Log	Description	Remarks
	N/A		0' to 10' silty sand soil with 1/4" weathered bedrock fragments and 1" qtz cobbles. Some 2" cobbles with black gneissic laminations.	
10'		H_2O Stringers	10' to 13' grey-green chlorite rich saprolite facies with orthoclose feldspar laminations?	
			15' to 18' fine weathered clay layer.	
20'			19' to 20' hard "shelf" slow drilling. Probable top of bedrock?	
			26' to 27' bedrock fracture zone; rapid drilling.	
27'			T.D. = 27	
30'				
				* No significant OVA readings throughout entire interval.
40'				

00375.PM3

Monitoring Well Construction Details

Sample No: 1-GW-7



90380.PM3

Monitoring Well Installation Summary

Project: Bainbridge Naval Training Center (NTC)

Well #: 1–GW–7

Date: 01/22/91

Observer: Jeff Tuttle, Hydrogeologist

Well Location:

- Adjacent creek by entrance road to water tower off Route 276. Downgradient of Old Landfill.
- Topographic elevation 138.69' above MSL.

Drilling Technique:

- Percussion air hammer drill (8" bit).
- Fine cuttings blown to surface with compressed air.

Generalized Stratigraphy (see accompanying log for details):

- Silty sand soil with bedrock fragments; green chlorite rich saprolite facies to top of bedrock at approximately 26'.

Well Construction (see accompanying diagram for details):

- Schedule 40 PVC casing; 16' to 26' screened interval.
- 11' thick sand pack; 2.3' bentonite seal; 12.7' of cement/bentonite grout.
- Concrete well pad with steel bumper guards.

Well Development:

- Total of 45 gallons purged using a stainless steel bailer; temperature and conductivity stabilized (final readings: 31°F and 10.34 µS/cm. respectively).

Initial Sampling Date/Depth to Water:

- February 10, 1991; water at 11.53' measured from top of protective casing.
- Total well depth of 27.7' measured from top of protective casing.
- Purge volume of approximately 35 gallons.

00376A.PM3

Drilling and Sampling Log

Project Name and Number: Navy Bainbridge / CD7012
Site Location: Base of Old Landfill
Boring Well Location: North of 1-GW-5 adjacent 1-GW-9
Date: 1/18/91
Boring/Well No.: 1-GW-8
Drilling Contractor: E & E Drilling and Testing Co.
Drilling Equipment: Dietrich D50 Rig
Driller: Paul Barth
Driller's Helper(s): John Terharr / Walter Knotts
Geologist: Jeff Tuttle / Paul Kopsick

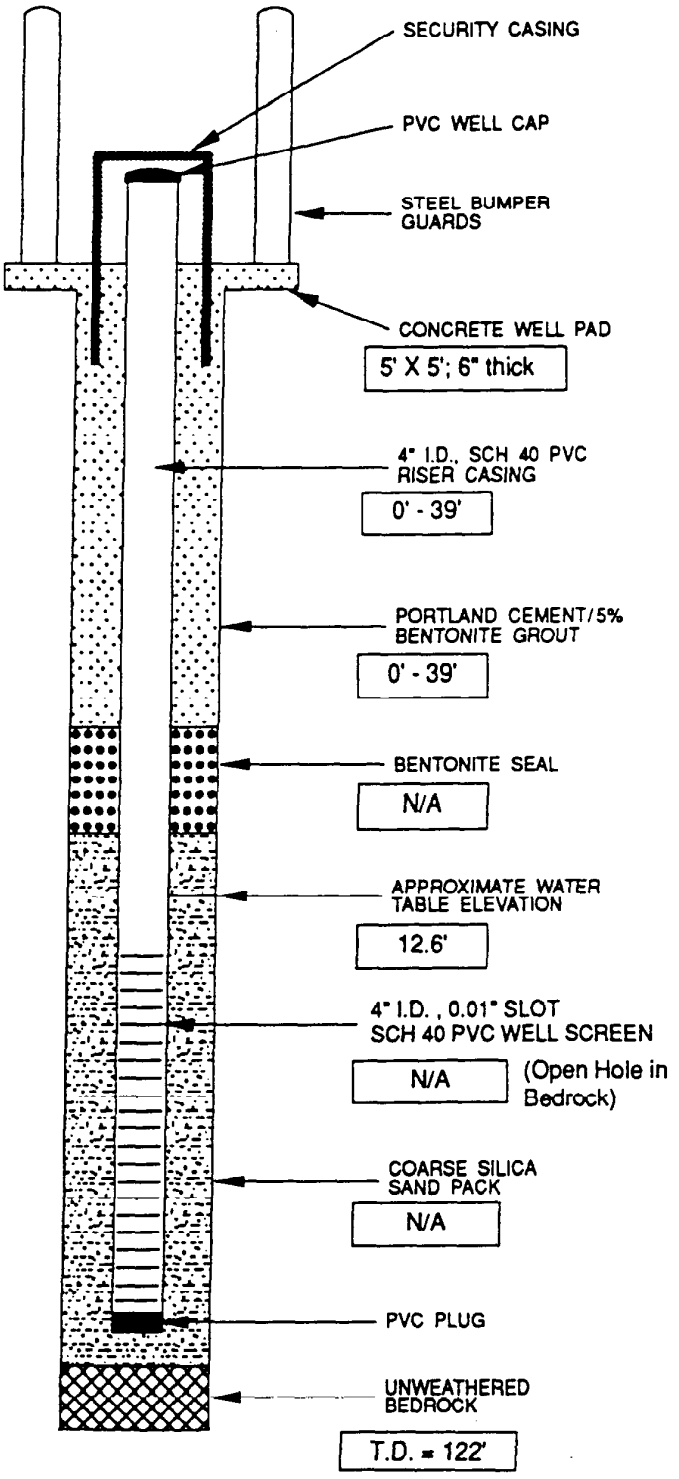
Well Casing Size, Type: 4" SCH 40 PVC
Boring Diameter: 8" to 11'; 6" to 120'
Screen Size and Type: N/A
Screened Interval: Open Hole
Well Diameter: 4"
Start Time: 3:30 PM
Completion Time: 5:45 PM (1/19/91)
Total Depth of Hole: 122'
Groundwater Depth: 12.6'
Surface Elevation: 196.68 above MSL.
* *Measured from top of protective casing*

Depth	Sample	Graphic Log	Description	Remarks
			0' to 4' green phyllite schist facies.	Surface to 10' outer steel casing.
			6' to 9' micaceous granite facies of the Port Deposit gniess.	
			9' to 32' granite saprolite with gneissic laminations alternating mica and feldspar rich layers.	At 9' OVA readings 2 ppm> bkgd.
10'				
20'		H_2O Stringers		At 20' first hint of Perched water in saprolite zone.
			29' to 3' phyllite schist (chlorite rich) layer in saprolite.	
30'			Top of bedrock at 32'.	Made 25' to 35' gpm H_2O once bedrock encountered.
			No cuttings visible - held in suspension in H_2O) slurry (32' to TD).	
40'			52', 60-62', 71-72' } Major Fracture Zones	OVA readings 3ppm > bkgd. at 43', 43' to 48' strong H_2S odor with OVA readings up to 12 ppm > bkgd.
122'			T.D. = 122'	

00376.PM3

Monitoring Well Construction Details

Sample No: 1-GW-8



00380.PM3

Monitoring Well Installation Summary

Project: Bainbridge Naval Training Center (NTC)

Well #: 1–GW–8 (Deep 125' Well)

Date: 01/18/91

Observer: Jeff Tuttle, Hydrogeologist

Well Location:

- North of 1–GW–5 at the base of the Old Landfill.
- Access is via dirt roads to the south and east of the location.
- Well placement based on VLF geophysical survey results.
- Topographic elevation 196.68 ft. above MSL.

Drilling Technique:

- Percussion air hammer drill (8" bit).
- Fine cuttings blown to surface with compressed air.

Generalized Stratigraphy (see accompanying log for details):

- Green phyllite schist saprolite facies; saprolite zone containing gneissic laminations; alternating micaceous rich and feldspathic rich saprolite layers; phyllite schist bedrock with major water producing zones.

Well Construction (see accompanying diagram for details):

- Surface to 10' depth steel casing; schedule 40 PVC riser pipe to 39' through surface casing; No screen, open hole in bedrock.
- *Cement/bentonite grout 39' to surface.*
- Concrete well pad with steel bumper guards.

Well Development:

- Total of 275 gallons purged using a stainless steel submersible pump; temperature and conductivity stabilized (final readings: 30.8°F, 7.74 µs/cm, respectively).

Initial Sampling Date/Depth to Water:

- February 10, 1991; water 12.6' measured from top of protective casing.
- Total well depth of 122' measured from top of protective casing.
- Purge volume of approximately 175 gallons.

00375A.PM3

Drilling and Sampling Log

Project Name and Number: Navy Bainbridge / CD7012
Site Location: Base of Old Landfill
Boring Well Location: 10' NE of 1-GW-8
Date: 01/16/91
Boring/Well No.: 1-GW-9
Drilling Contractor: E & E Drilling and Testing Co
Drilling Equipment: Dietrich D50 Rig
Driller: Paul Barth
Driller's Helper(s): Walter Knotts/John Tarham
Geologist: Paul Kopsick

Well Casing Size, Type: 4" SCH 40 PVC
Boring Diameter: 8"
Screen Size and Type: .01" Slot PVC
Screened Interval: 27.5' to 37.5'
Well Diameter: 4"
Start Time: 11:43 AM
Completion Time: 5:12 PM
Total Depth of Hole: 37' *
Groundwater Depth: 13.8' *
Surface Elevation: 197.09' above MSL

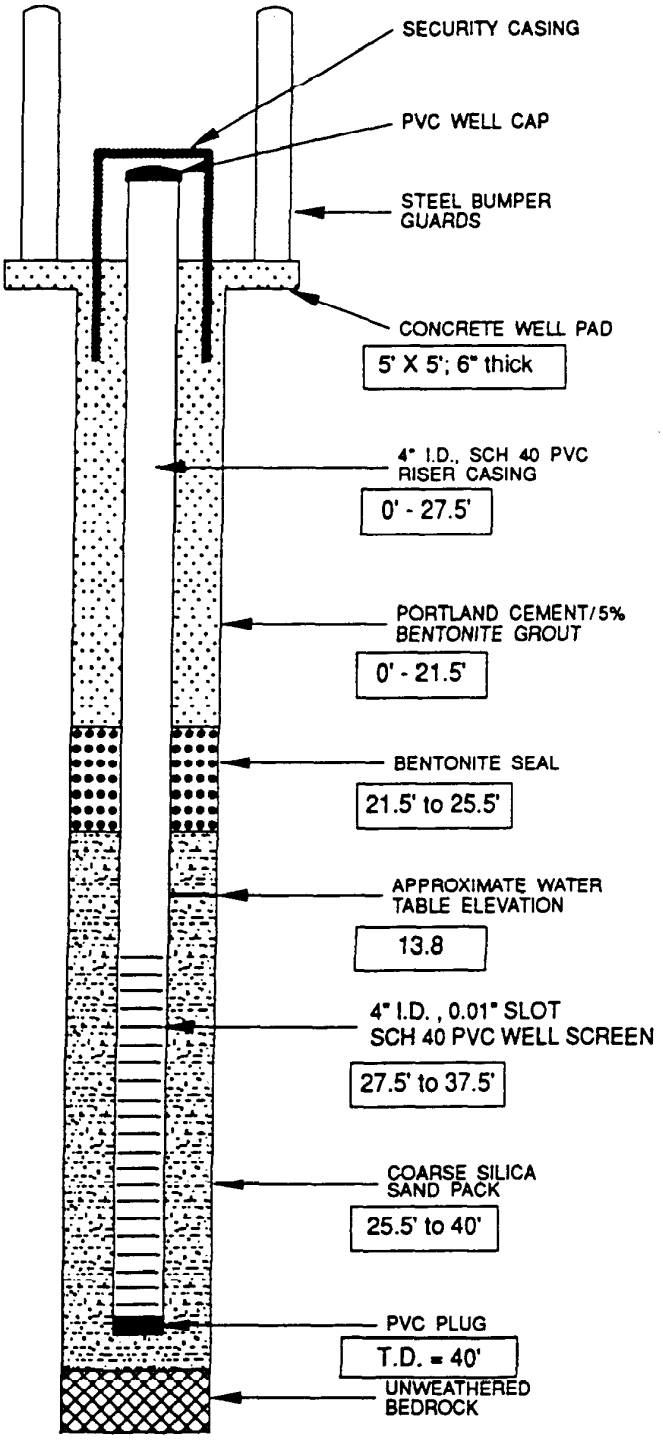
* *Measured from top of protective casing*

Depth	Sample	Graphic Log	Description	Remarks
	N/A		(See log description for 1-GW-8)	
			Phyllite schist and granitic facies of Port Deposit Gneiss.	
10'				
20'				
		H_2O Stringers		
			30' to 31' saprolite fracture zone ("soft" drilling) 34' to 36' fracture zone yielding large volume of water ("soft" drilling) Top of bedrock at 36'?	
30'				
			T.D. = 37'	
40'				

00376.PM3

Monitoring Well Construction Details

Sample No: 1-GW-9



00380.PM3

Monitoring Well Installation Summary

Project: Bainbridge Naval Training Center (NTC)

Well #: 1–GW–9

Date: 01/20/91

Observer: Paul Kopsick, Geologist

Well Location:

- Directly north of 1–GW–8 (10') at the base of the Old Landfill.
- Access is via dirt roads to the south and east of the location.
- Well placement based on VLF geophysical survey results.
- topographic elevation 187.09' above MSL.

Drilling Technique:

- Percussion air hammer drill (8" bit).
- Fine cuttings blown to surface with compressed air; difficult to log.

Generalized Stratigraphy (see accompanying log for details):

(See description for 1–GW–8)

Well Construction (see accompanying diagram for details):

- Schedule 40 PVC casing; 27.5' to 37.5' screened interval.
- 12.5' thick sand pack; 4' bentonite seal; 21.5' of cement/bentonite grout.
- Concrete well pad with steel bumper guards.

Well Development:

- Total of 110 gallons purged using a stainless steel submersible pump; temperature and conductivity stabilized (final readings 31°F, 10.43 µs/cm, respectively).

Initial Sampling Date/Depth to Water:

- February 10, 1991; water 13.8' measured from top of protective casing.
- Total well depth of 30' measured from top of protective casing.
- Purge volume of approximately 52 gallons.

00375A.PM3

Drilling and Sampling Log

Project Name and Number: Navy Bainbridge / CD7012
Site Location: Old Fire Training Area
Boring Well Location: E. Central Portion of Concrete pad
Date: 01/16/91
Boring/Well No.: 2-GW-6
Drilling Contractor: E & E Drilling and Testing Co.
Drilling Equipment: Dietrich D50 Rig
Driller: Paul Barth
Driller's Helper(s): Walter Knotts
Geologist: Jeff Tuttle

Well Casing Size, Type: 4" SCH 40 PVC
Boring Diameter: 8"
Screen Size and Type: .01" Slot PVC
Screened Interval: 9.5' to 19.5'
Well Diameter: 4"
Start Time: 12:30 PM
Completion Time: 2:30 PM
Total Depth of Hole: 19.7' *
Groundwater Depth: 10.25' *
Surface Elevation: 264.50'

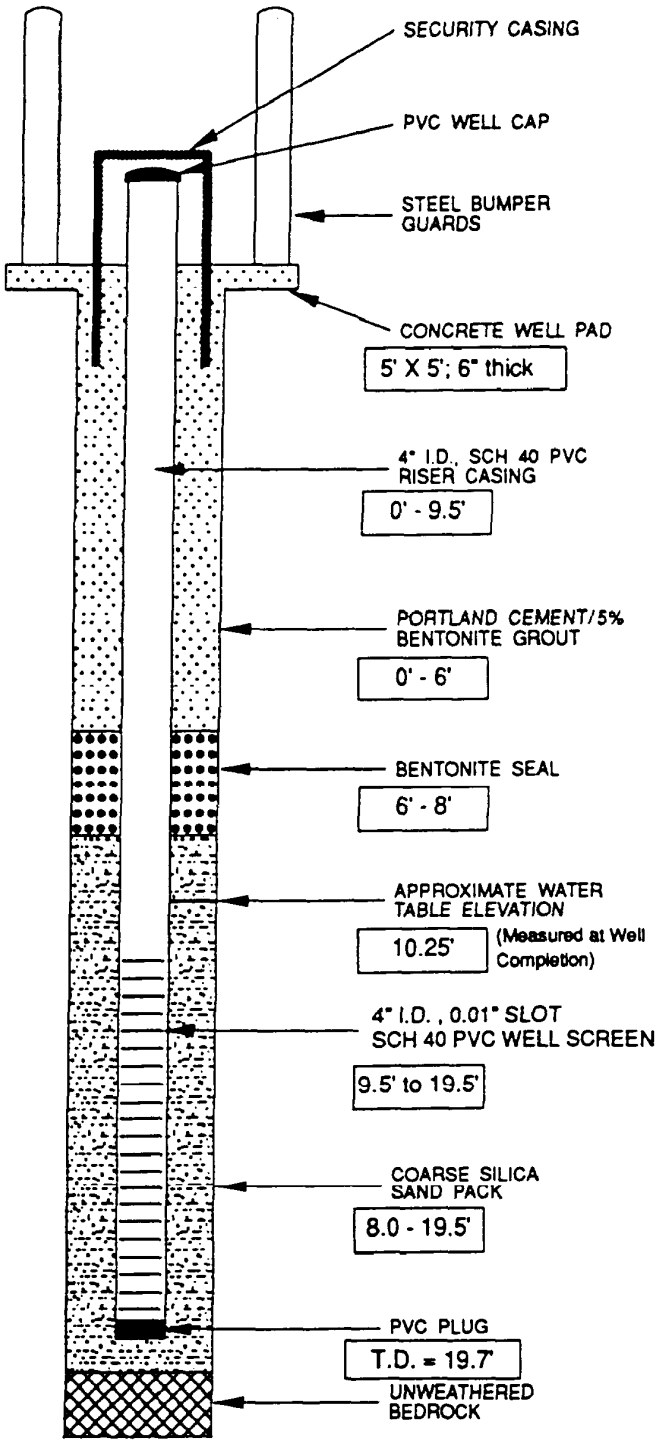
* *Measured from top of protective casing*

Depth	Sample	Graphic Log	Description	Remarks
	N/A	N/A		
			6" concrete slab; 6" to 8" gravel fill beneath concrete.	
5'			1.5' to 5' grey silty sands.	
			5' to 7' cobble zone with 1" to 4" cobbles.	* No OVA readings above background throughout entire interval.
10'			7' to 10' grey–green tinted silty sands.	
			10' to 19.7' coarse reddish sand grading into weathered saprolite with matic, shistose laminations.	
15'				
			T.D.=19.7'.	
20'				

00375.PM3

Monitoring Well Construction Details

Sample No: 2-GW-6



00380.PM3

Monitoring Well Installation Summary

Project: Bainbridge Naval Training Center (NTC)

Well #: 2–GW–6

Date: 01/16/91

Observer: Jeff Tuttle, Hydrogeologist

Well Location:

- Center of eastern side of concrete pad in the Old Fire Training Area.
- Access to the location is via the concrete pad.
- Topographic elevation 264–50 ft. above MSL.

Drilling Technique:

- Hollow stem auger (8").
- Auger advanced through saprolite zone to top of bedrock. Auger refusal at 19.5!

Generalized Stratigraphy (see accompanying log for details):

- Six inches concrete underlain by gravel fill; gray silty sands; cobble layer; fine gray–green sand grading into reddish sand and weathered saprolite.

Well Construction (see accompanying diagram for details):

- Schedule 40 PVC casing; 9.5' to 19.5' screened interval.
- 11.5' thick sand pack; 2' bentonite seal; 6' of cement/bentonite grout.
- Concrete well pad with steel bumper guards.

Well Development:

- Total of 165 gallons purged using a stainless steel submersible pump; temperature, pH and conductivity stabilized.

Initial Sampling Date/Depth to Water:

- February 16, 1991; water 6.2' measured from top of protective casing.
- Total well depth of 22.1' measured from top of protective casing.
- Purge volume of approximately 32 gallons.

00375A.PM3

Drilling and Sampling Log

Project Name and Number: Navy Bainbridge / CD7012
Site Location: Old Fire Training Area
Boring Well Location: Southwest of Bldg. #716
Date: 01/15/91
Boring/Well No.: 2-GW-7
Drilling Contractor: E & E Drilling and Testing Co.
Drilling Equipment: Dietrich D50 Rig
Driller: Paul Barth
Driller's Helper(s): John Terharr / Walter Knotts
Geologist: Jeff Tuttle

Well Casing Size, Type: 4" SCH 40 PVC
Boring Diameter: 8"
Screen Size and Type: .01" Slot PVC
Screened Interval: 16.9' to 36.9'
Well Diameter: 4"
Start Time: 1:45 PM
Completion Time: 5:45 PM (1/17/91)
Total Depth of Hole: 37.2' *
Groundwater Depth: 28.4' *
Surface Elevation: 276.46'

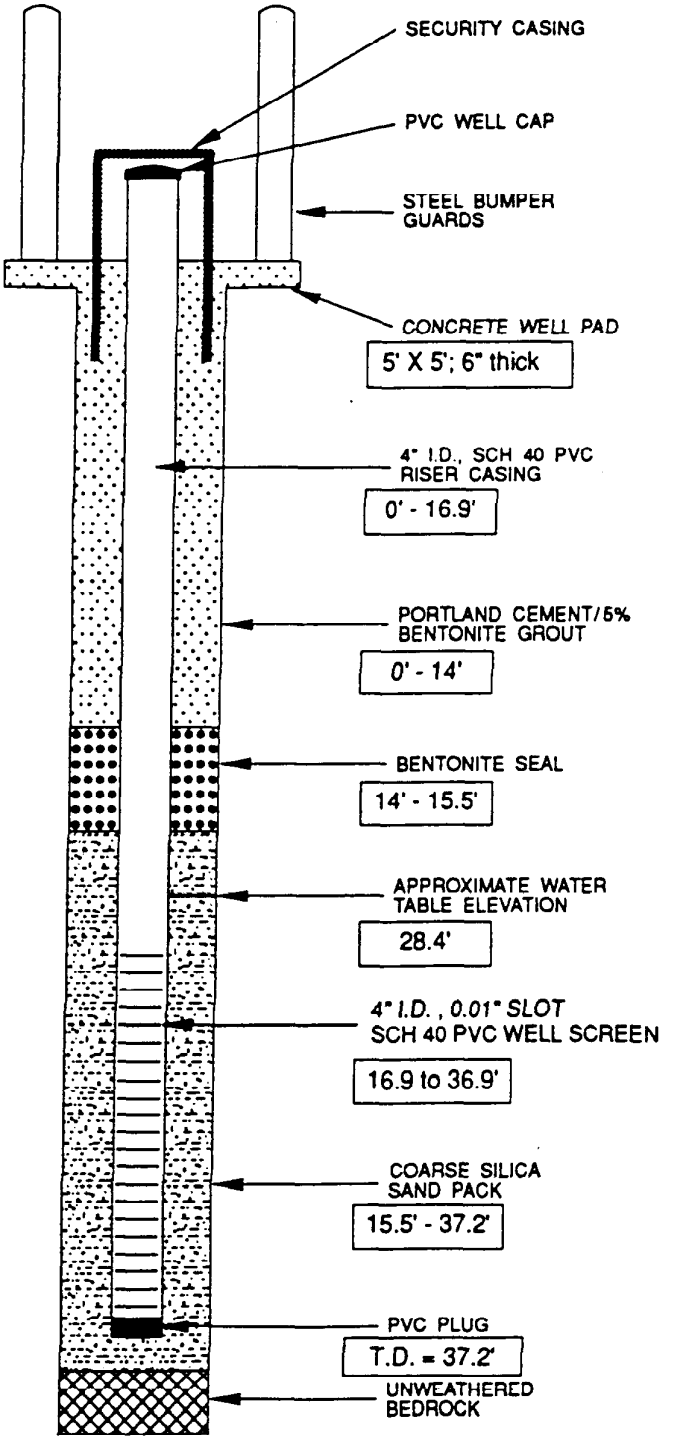
* *Measured from top of protective casing*

Depth	Sample	Graphic Log	Description	Remarks
	N/A	N/A	0'–5' silty, dark brown cohesive clay with quartz pebble fragments.	
			5' to 6' cleaner sand over clay, more friable, less cohesive.	* No OVA readings above background throughout entire interval.
10'			7' to 11' clear, well sorted, light brown sand.	
20'			12' to 17.5' clean, well sorted, light brown sand containing weathered bedrock (quartz) fragments.	* 11' stiff ledge followed by sudden auger drop.
			17.5' suspected top of bedrock. Saprolite grading into competent granite gneiss sequence rich in micc and orthoclase feldspar. First water encountered at 29'.	–used hammer drill beginning at 17.5'.
30'				–Difficult to log fine cuttings from the hammer drill.
			T.D.=37.2'	
40'				

00375.PM3

Monitoring Well Construction Details

Sample No: 2-GW-7



00380.PM3

Monitoring Well Installation Summary

Project: Bainbridge Naval Training Center (NTC)

Well #: 2-GW-7

Date: 01/14/91

Observer: Jeff Tuttle, Hydrogeologist

Well Location:

- "Background" well for Fire Training Area
- Southwest of Building #716 off western edge of concrete pad.
- Access to the location is via entrance road to the fire training area.
- Topographic elevation 276.46 ft. above MSL.

Drilling Technique:

- Hollow stem auger (8") to 17.5'; air hammer drill to 37.2'.
- Auger refusal at 17.5', believed to be the top of granitic bedrock.

Generalized Stratigraphy (see accompanying log for details):

- Surficial dark brown silty clay grading into a clean, well sorted light brown sand; saprolite with weathered granite gneiss fragments rich in quartz; granitic bedrock with a groundmass of vica and orthoclase feldspar.

Well Construction (see accompanying diagram for details):

- Schedule 40 PVC casing; 16.9' to 36.9' screened interval.
- 21.7' thick sand pack; 1.5' bentonite seal; 14' of cement/bentonite grout.
- concrete well pad with steel bumper guards.

Well Development:

- Total of 50 gallons purged using a stainless steel bailer; temperature, pH, and conductivity stabilized (final readings: 30.7°F, 5.74, and 1.63 ms/cm, respectively).

Initial Sampling Date/Depth to Water:

- February 13, 1991; water 28.4' measured from top of protective casing.
- Total well depth of 37.2' measured from top of protective casing.
- Purge volume of approximately 30 gallons.

00375A.PM3

Drilling and Sampling Log

Project Name and Number: Navy Bainbridge / CD7012
Site Location: Old Fire Training Area
Boring Well Location: SE Corner of Concrete Pad
Date: 01/15/91
Boring/Well No.: 2-GW-8
Drilling Contractor: E & E Drilling and Testing Co.
Drilling Equipment: Dietrich D50 Rig
Driller: Paul Barth
Driller's Helper(s): John Terharr / Walter Knotts
Geologist: Jeff Tuttle

Well Casing Size, Type: 4" SCH 40 PVC
Boring Diameter: 8"
Screen Size and Type: .01" Slot PVC
Screened Interval: 10' to 20'
Well Diameter: 4"
Start Time: 10:15 AM
Completion Time: 8:30 AM (1/16/91)
Total Depth of Hole: 22.45' *
Groundwater Depth: 14.4' *
Surface Elevation: 262.48' above MSL

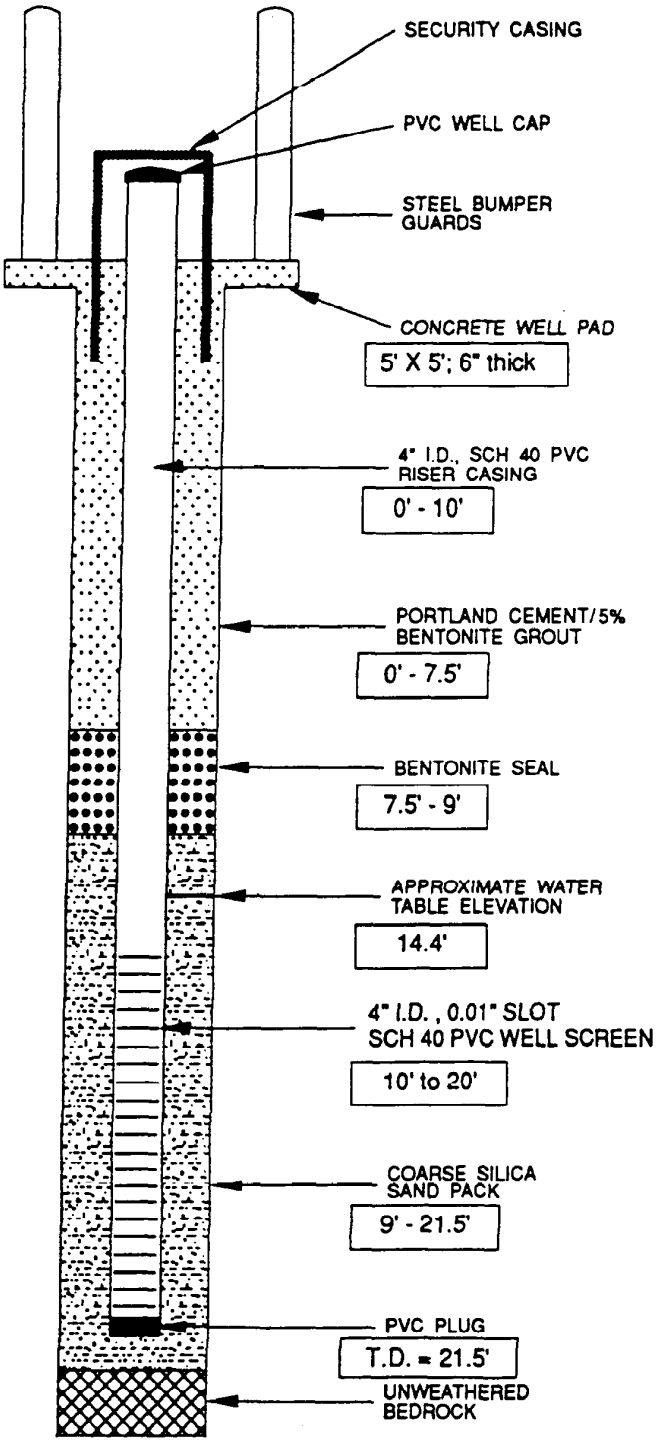
* *Measured from top of protective casing*

Depth	Sample	Graphic Log	Description	Remarks
	N/A	N/A		
				At 2.5' 3-10 ppm OVA readings in the breathing zone.
5'			0' to 6' dark grey, silty, clay; strong diesel odor at 2+ feet. Cutting emit strong fuel oil odor.	
10'			6' to 8' cobble layer with 1" to 4" qtz rich cobbles. Appear to be fluvial in origin (e.g; well sorted). Persistent fuel oil odor.	At 9', 60 ppm OVA reading inside auger.
			8' to 11' cobble transition to light brown sand cuttings still emit fuel odor.	
15'			15' -16' moist silt layer with clay balls.	At 15', 40 ppm OVA reading inside auger.
			' - 20.5' perched water in fine light brown sand with gneissic laminations, grading into competent saprolite.	
20'			20.5' to 21.5' granite gneiss bedrock.	At 20', 22 ppm OVA reading in the borehole.
			T.D. = 21.5'	

00375.PM3

Monitoring Well Construction Details

Sample No: 2-GW-8



00380.PM3

Monitoring Well Installation Summary

Project: Bainbridge Naval Training Center (NTC)

Well #: 2–GW–8

Date: 01/15/91

Observer: Jeff Tuttle, Hydrogeologist

Well Location:

- Off southeast corner of concrete pad in the Old Fire Training Area.
- Access to the location is via the concrete pad.
- Topographic elevation 262.48 ft. above MSL.

Drilling Technique:

- Hollow stem auger (8").
- Auger advanced through saprolite zone to top of bedrock. Auger refusal at 21.5'.

Generalized Stratigraphy (see accompanying log for details):

- Gray silty–clay emitting a strong diesel odor; qtz. rich cobble zone of apparent fluvial origin; transition to fine silty sands green in color; thin silt layer with clay balls; saprolite layer and competent bedrock with gneissic laminations.

Well Construction (see accompanying diagram for details):

- Schedule 40 PVC casing; 10' to 20' screened interval.
- 11' thick sand pack; 1.5' bentonite seal; 7.5' of cement/bentonite grout.
- Concrete well pad with steel bumper guards.

Well Development:

- Total of 35 gallons purged using a stainless steel bailer; temperature and conductivity stabilized (final readings: 23°F, 1.61 us/cm respectively).

Initial Sampling Date/Depth to Water:

- February 13, 1991; water 14.4' measured from top of protective casing.
- Total well depth of 22.45' measured from top of protective casing.
- Purge volume of approximately 16 gallons.

00375A.PM3

Drilling and Sampling Log

Project Name and Number: Navy Bainbridge / CD7012
Site Location: Old Fire Training Area
Boring Well Location: Center of Oil Separator Pit
Date: 01/23/91
Boring/Well No.: 2-GW-9
Drilling Contractor: E & E Drilling and Testing Co.
Drilling Equipment: Dietrich D50 Rig
Driller: Paul Barth
Driller's Helper(s): John Terharr / Walter Knotts
Geologist: Jeff Tuttle

Well Casing Size, Type: 4" SCH 40 PVC
Boring Diameter: 8"
Screen Size and Type: 0.01" Slot PVC
Screened Interval: 6' to 16'
Well Diameter: 4"
Start Time: 9:30 AM
Completion Time: 12:15 PM
Total Depth of Hole: 16' *
Groundwater Depth: 7.15' *
Surface Elevation: 252.06'

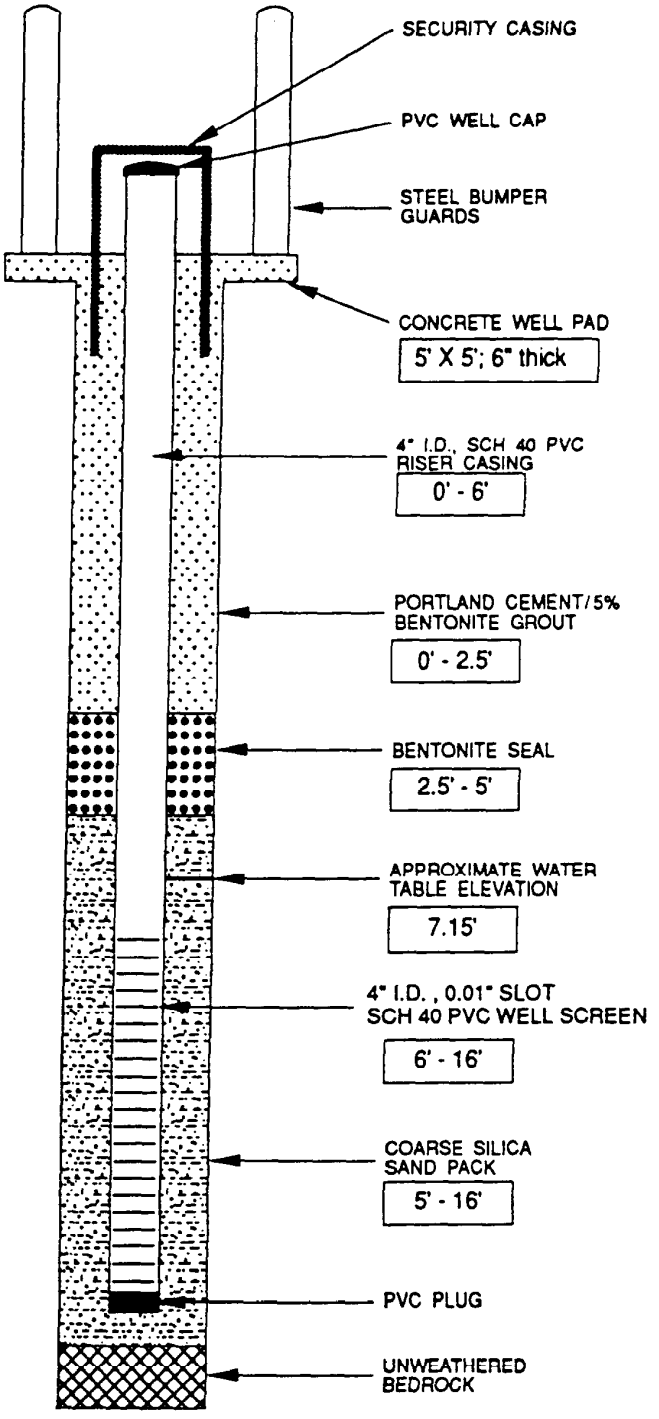
* *Measured from top of protective caseing.*

Depth	Sample	Graphic Log	Description	Remarks
		N /A	0' - 4' gravel fill (access road material).	
5'	4' to 6' composite		4' to 6' organic rich layer; "muck " and oily sludge.	OVA = 100 ppm (50% methane; 50% volatile organics)
10'	8' to 10' composite		6' to 10' gravels and cobbles; sandy saprolite overburden.	
			10'-16' granite gneiss saprolite/bedrock with shistose layers; semilithified.	
15'				
16'			T. D. = 16'	
			* Duplicate soil sample and field blank (of decontaminated Laski samples) taken at this location.	

00376.PM3

Monitoring Well Construction Details

Sample No: 2-GW-9



00360.PM3

Monitoring Well Installation Summary

Project: Bainbridge Naval Training Center (NTC)

Well #: 2-GW-9

Date: 01/23/91

Observer: Jeff Tuttle, Hydrogeologist

Well Location:

- Center of oil separator pit adjacent Old Fire Training Area.
- Access to the location is via "temporary" gravel road extending from the edge of the concrete pad.
- Topographic elevation (from top of protective casing) 254.22' above MSL.

Drilling Technique:

- Hollow steam auger (8").
- Auger advanced through saprolite zone to top of bedrock. Auger refusal at 16'.

Generalized Stratigraphy (see accompanying log for details):

- Gravel fill (from temporary road); sandy runoff material overlying an organic rich soil layer; zone of oily sludge; gravels and cobbles from weathered saprolite; granite gneiss bedrock with shistose layers.

Well Construction (see accompanying diagram for details):

- Schedule 40 PVC casing; 6' to 16' screened interval.
- 11' thick sand pack; 2.5' thick bentonite seal; 2.5' of cement/bentonite grout.
- Concrete well pad with steel bumper guards.

Well Development:

- Total of 45 gallons purged using a stainless steel bailer; temperature, pH and conductivity stabilized.

Initial Sampling Date/Depth to Water:

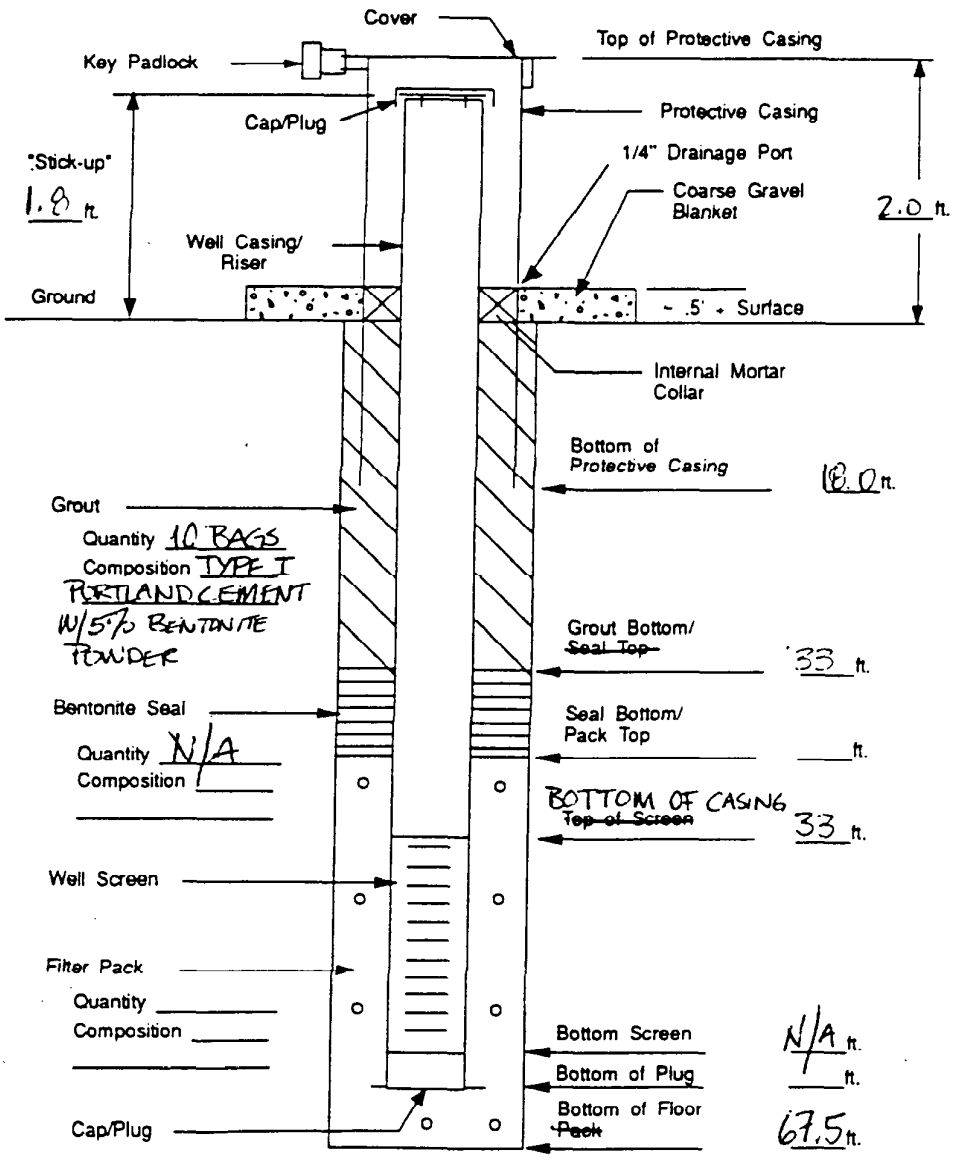
- February 13, 1991; water 7.15' measured from top of protective casing.
- Total well depth of 18.5' measured from top of protective casing.
- Purge volume of 25 gallons.

00375A.PM3

Project: BAINBRIDGE NTC			Boring: 1-GW-10		Page: 1 OF 3
Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	1/5/94 - 1/6/94 Soil/Rock Description START/FINISH-1540, 1/5/94/1/6/94 1658	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		0-5' BR. HUMIC SANDY SILT W/ ROOTS, MINOR ROUNDED GRAVEL			1) 8" AIR HAMMER TO 13.0' 2) 6" AIR HAMMER TO 67.5'
5					
10		10.0' GREEN, CHLORITE-RICH SAPROLITE			
		16.5' BEDROCK - DK, GRANITIC GNEISS			

Well Construction Log:
Site ID Number: MD PERMIT # CE 93-024
Well Number: 1-GW-10
Today's Date:

WELL CONSTRUCTION



ING LOG GENERAL DATA

Boring: 1-GW-10 Page: 3 of 3

H / E&E

W. GRAF / E&E Signature: Walter L Graf

94 Completed: 1/6/94

Drilling Rig: DIETRICH

rface)

5 BGS Date: 1/5/94

5 BGS Date: 1/5/94

6 BGS Date: 1/6/94

	Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End		Start	End	Start	End
3	0	13					
3	18	68					

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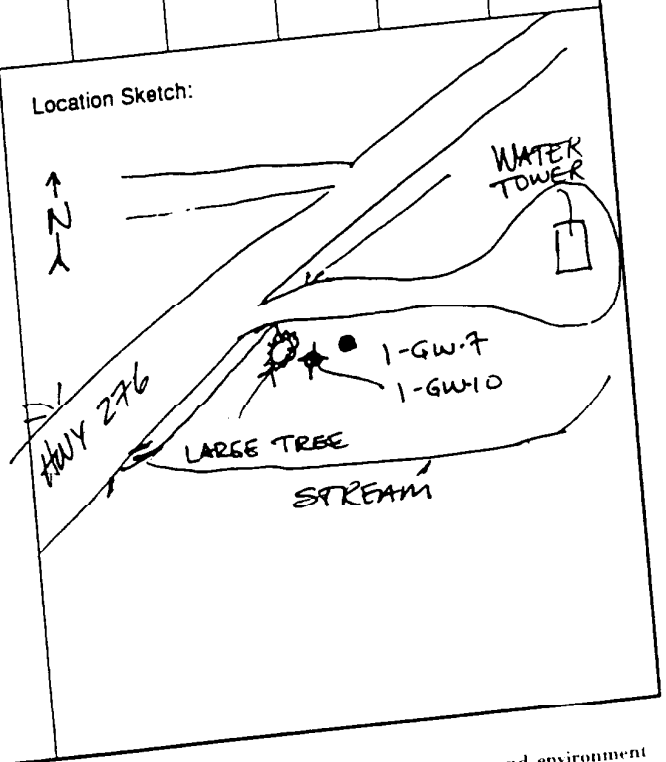
Location Sketch:



ecology and environment

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E-39

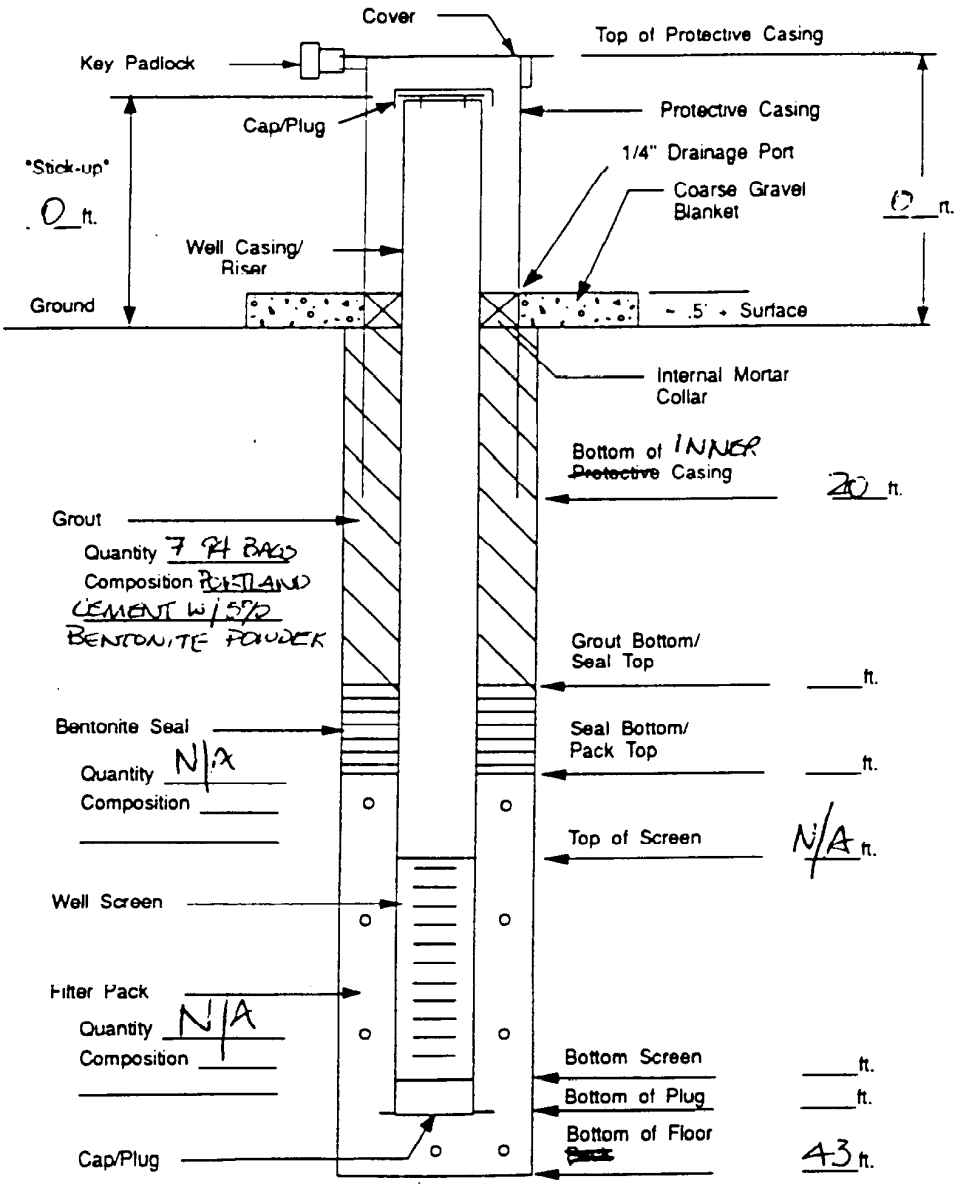
RESCAN PAGE e-39

Project: BAINBRIDGE NTC	Boring: 1-GW-11	Page: 1 OF 3

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	12/19/93- 12/20/93 Soil/Rock Description START/FINISH - 1625/1135 12/20	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		0-1 - FILL MATERIAL			1) 8" AIR HAMMER TO 9' BGS
1		1-3 - GREY SILTY SAND DRY			2) 6" AIR HAMMER TO 43'
					3) TD - 43.0' BGS
3		3-16 - GREY GREEN SAPROLITE, RELICT STRUCTURES PRESENT, ~~WET~~ H2O @ ≈16' BGS ~~16~~			
16		16 - 43.' GRANODIORITIC GNEISS, W/ FRACTURE ZONES.			

Well Construction Log:
Site ID Number: MD PERMIT # CE-93-0215
Well Number: 1GW-11
Today's Date: 12/20/93

WELL CONSTRUCTION



BORING LOG GENERAL DATA

Project: BAINBRIDGE NTC Boring: 1-GW-11 Page: 3 of 3

Driller & Company: P. BARTH / E&E

Geologist/Logger & Company: W. GRAF / E&E Signature: Walter Graf

Date Boring Started: 12/19/93 Completed: 12/20/93

Water Levels (from Ground Surface) Drilling Rig: DIETRICH

First Encountered: 23.0 Date: 12/20/93

While Drilling: 23.0 Date: 12/20/93

At Boring Completion: 14.0 ft Date:

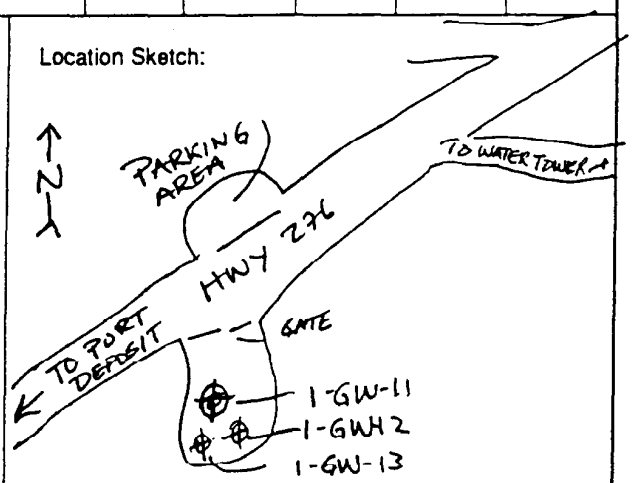
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
12/19/93	1625	1710	0	10					
12/20/93	0823	1139	10	43					

Abbreviations:

Abbr.	Meaning

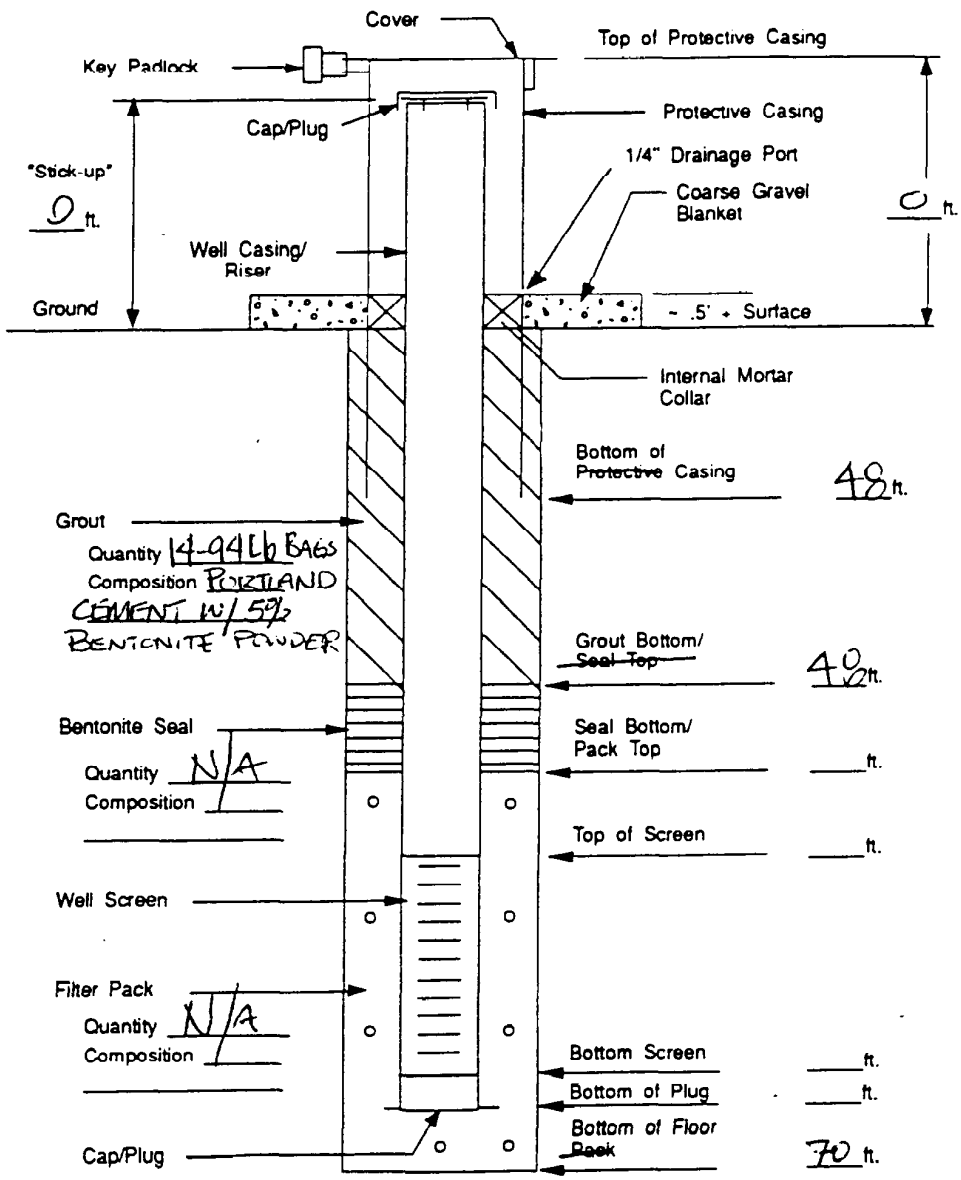
Location Sketch:



Project: BAINBRIDGE NTC			Boring: 1-GW-12		Page: 1 OF 3
Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	12/19/93 Soil/Rock Description START/FINISH 0835-1625	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		0-8 SILTY, SAND, DK BROWN GREY GREEN SAPROLITE @ 5'			1) 8" AIR HAMMER TO 9' 2) 6" AIR HAMMER 9-70' 3) H_2O @ ≈ 16' 4) GOOD WATER-BEARING FRACTURE @ 55' BGS
		8-10' - WEATHERED BEDROCK - GNEISSIC, GRANODIORITIC W/ STAINED QTZITE FRAGMENTS			
		10-70' GRANODIORITIC GNEISS			
		TD-70'			

Well Construction Log:
Site ID Number: MD PERMIT #-A CE-93-0216
Well Number: 1GW12
Today's Date: 12/19/93

WELL CONSTRUCTION



BORING LOG GENERAL DATA

Project: BAINBRIDGE NTC Boring: 1-GW-12 Page: 3 of 3

Driller & Company: P. BARTH / E&E

Geologist/Logger & Company: W. GRAF / E&E Signature: Walter Graf

Date Boring Started: 12/19/93 Completed: 12/19/93

Water Levels (from Ground Surface) Drilling Rig: DIETRICH

First Encountered: 16' Date: 12/19/93

While Drilling: 16' Date: 12/19/93

At Boring Completion: 11.0 Date: 12/20/93

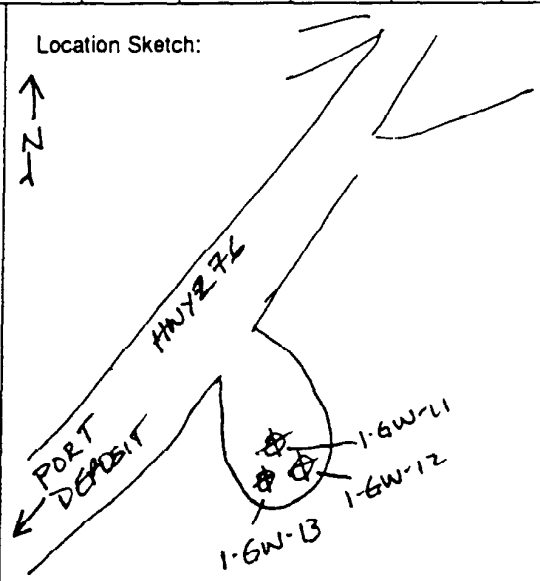
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
12/19/93	0835	1625	0	70					

Abbreviations:

Abbr.	Meaning

Location Sketch:

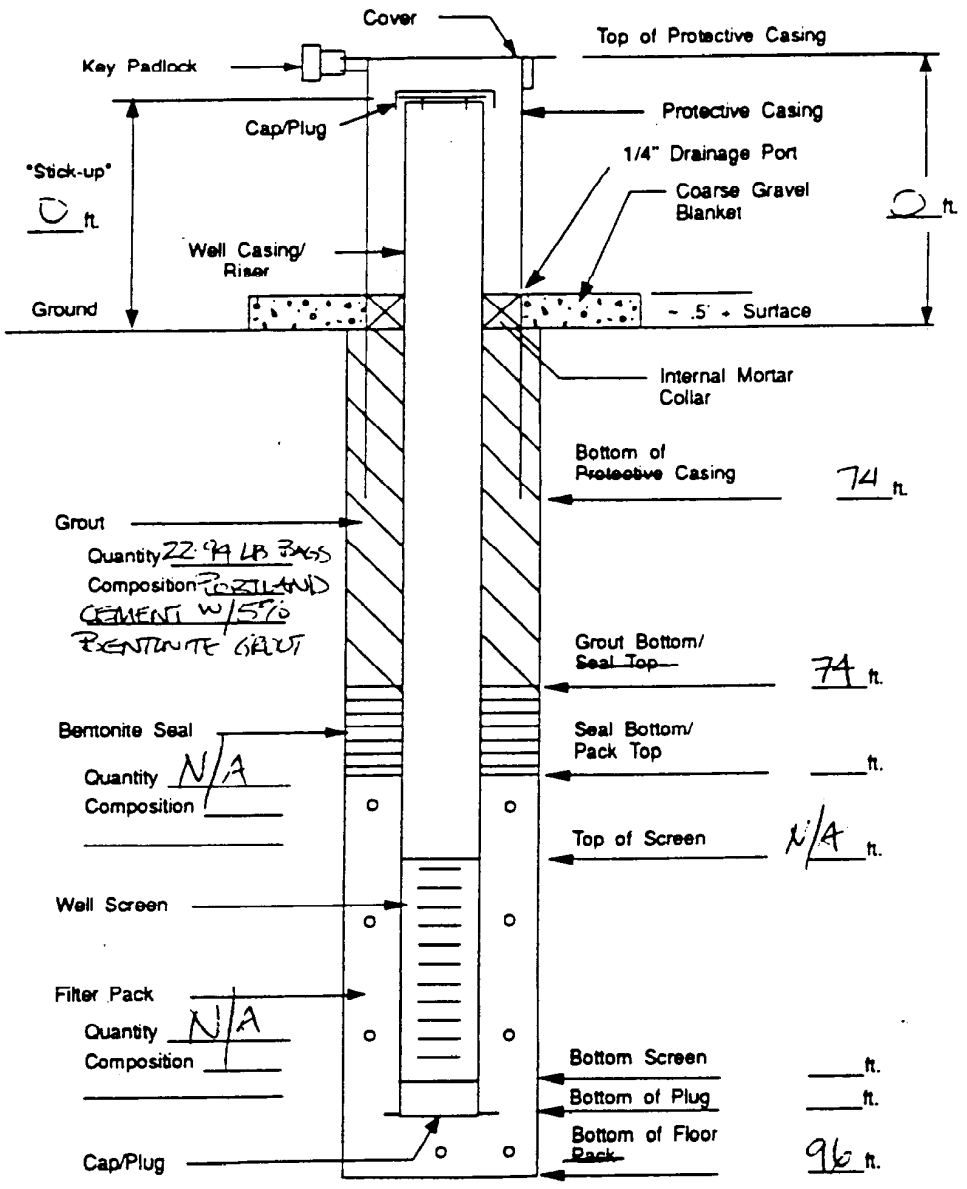


Project: PAINEPRIDGE NTC	Boring: 1-GW-13	Page: 1 OF 3

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	12/17/95 → Soil/Rock Description START/FINISH	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		0-1' DK BROWN HUMUS (SILT) W/ ROOTS DRY → MOIST			1) HOLE ADVANCED TO FT W/AIR HAMMER & 8" BIT
1		1-9 CHLORITE - RICH SAPROLITE DRY			2) HOLE ADVANCED FROM FT TO FT W/6" BIT IN AIR HAMMER
9	▽	H_2O - 9.0'			
		9' - GRANITIC GNEISS			
					DRILLING NOTES 1) AIR HAMMER FROM SURFACE TO 9' 2) SET 6" CARBON STEEL CASING 3) AIR HAMMER 9-96' 4) TD = 96' BGS
		TD = 96'			

Well Construction Log:
Site ID Number: MD PERMIT # CE-93-0217
Well Number: 1GW 13
Today's Date: 12/18/94

WELL CONSTRUCTION



BORING LOG GENERAL DATA

Project: BAINBRIDGE NTC Boring: 1-GW-13 Page: 3 of 3

Driller & Company: P. BARTH / E&E

Geologist/Logger & Company: W. GRAF / E&E Signature: Walter Graf

Date Boring Started: 12/17/93 Completed: 12/18/93

Water Levels (from Ground Surface) Drilling Rig: DIETRICH

First Encountered: ~9' Date: 12/17/93

While Drilling: ~9' Date: 12/17/93

At Boring Completion: 11.7' Date: 12/18/93

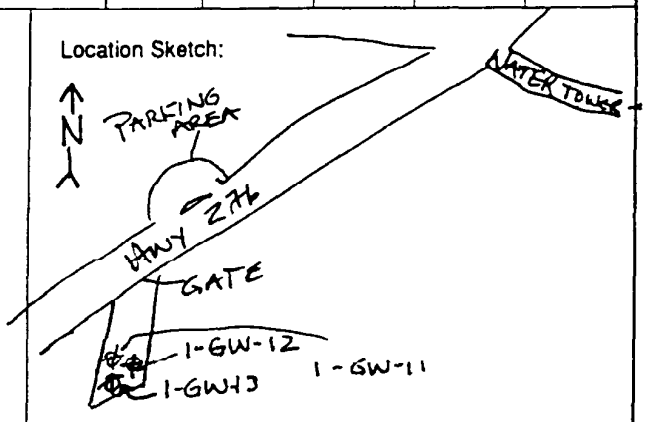
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
12/17/93	1602	1710	0	10'					
12/18/93	0810	1750	10	965					

Abbreviations:

Abbr.	Meaning

Location Sketch:

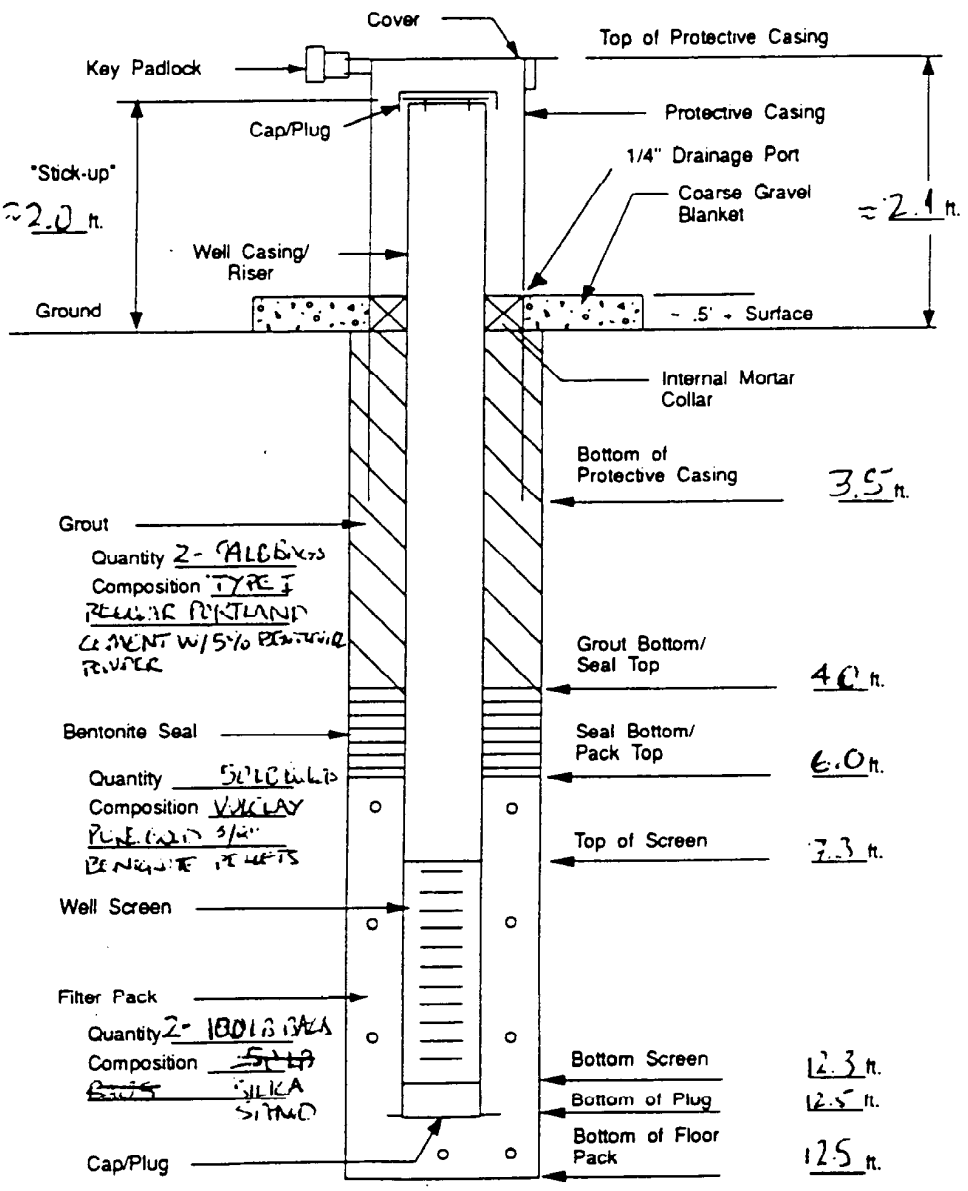


Project: RAINBRIDGE NTC	Boring: 2-GW-10	Page: 1 of 3

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	12/11/93 Soil/Rock Description START/FINISH - 1230/1545	Sample Number & Depth	Blow Count & Recovery	Drilling Data
2		0.2 - DK BR. MOIST HUMIC SILT w/ROOTS 0.2-1.0 DK BR MOIST SILT. C/SAND. TRACE 1.0-2.0 - SAND, TAN MOIST W/ WHITE ROCK. FE STAINING, ROCK GRANITIC GA: 0.0 ppm	1235 R=1.0	6 6 11 8	1) DRIVE SPLIT SPOON w/ 130LB HAMMER W/30" FREEFALL 2) DEPTH & "R" IN FEET 3) HSA
4					4) SPLIT SPOON - 2"x2'
6		BROWN ORANGE SANDY SILT W/ GRAVEL & IMPACTED GRAVEL (REMOVED) BECOMING VERY MOIST AT BOTTOM OF SPOON GA: 0.0 ppm (ROAD FILL)	1247 R=1.6	10 10 22 32	
9	▽	WL ≈ 9.0'			DRILLING DATA 1) DRIVE SPLIT SP 0-2' 2) AUGER TO 4'
		9.10.5 - WET BR ORANGE SAPROLITE & GRAVEL 10.5-11 - SAPROLITE ~~WITH~~ CATTERED GRANITIC MATERIAL	1315 R=1.5	14 18 26 32	3) DR. SPLIT SP 4-6 4) AUGER TO 6' 5) DRIVE SPLIT SP 6-11'
11					6) AUGER REFUSAL @ 12.5' 7) TD 12.5'
		TD=12.5'			

Construction Log:
Site ID Number: PERMIT CE-93-0218
Well Number: 2-GW-1C
Today's Date: 12/11/93

WELL CONSTRUCTION



BORING LOG GENERAL DATA

Project: BAINBRIDGE NTC Boring: 2-GW-10 Page: 3 of 3

Driller & Company: P. BARTH / E&E

Geologist/Logger & Company: W GRAF / E&E Signature: [illegible]

Date Boring Started: 12/11/93 Completed: 12/11/93

Water Levels (from Ground Surface) Drilling Rig: DIETRICH

First Encountered: 9.0' Date: 12/11/93

While Drilling: 9.0' Date: 12/11/93

At Boring Completion: Date:

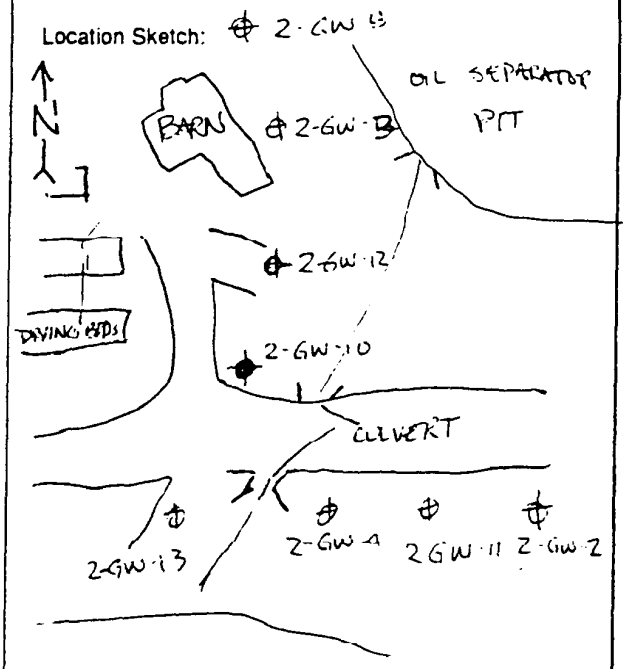
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
12/11/93	1230	1545	0	12.5					

Abbreviations:

Abbr.	Meaning

Location Sketch:



Project: BAINBRIDGE NTC	Boring: 2-GW-11	Page: 1 OF 3

12/8/93 – 12/9/93

START / FINISH – 1050 / 1420

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		0-2 DK BR HUMIC SILT W/ROOTS MOIST 2-2 MOIST LT BROWN SILT W/SAND & BROKEN ROCK GRANITIC OVA = 0	1050 R=1.3		1) SPLIT SPOON DRIVEN W/A 140 LB HAMMER W/ 30" FREE FALL 2) DEPTH IS "0" IN FEET 3) HSA 4) 2" x 2' SPLIT SPOON
2					
4		4-4.3 DK BR MOIST SILT W/MINOR SAND 4.3-6.0 MOIST MOTTLED FINE GR. SAND W/MINOR WEATHERED GRAVEL, LIGHT-GREY-YELLOW W/ RUST (FE STAINS) OVA = 0.0 ppm	1105 R=1.0		
6	▽	H2O @ 9 C'			
9		.2 BROWN WET (ROUNDED SANDY) GRAVEL w. MD GRAINED WET GREY SAND W/GRAVEL SND = COMMON FIN = 20/40/40 0 GRAVEL SUB ANGULAR	1141 R=1.7 OVA=1 ppm	6 7 9 4	
11					
14		14-15 WET SILT W/WEATHERED GRANITE SAPROLITE 15-15.7 SAME AS ABOVE EXCEPT W/GREENISH TINT 15.7-16.0 GRANITE W/MOTTLED RED STREAKS	1202 R=1.0	30 16 16 20	1) DRIVE SPL SP 0-2 2) AUGER TO 4' 3) DRIVE SPLIT SP 4-6' 4) AUGER TO 9' 5) DR SPL SP 9-11' 6) AUGER TO 14' 7) DR SPL SP 14-16' 8) AUGER TO 18' AUGER REFUSAL @ 15'
16					
19					
21			R=		

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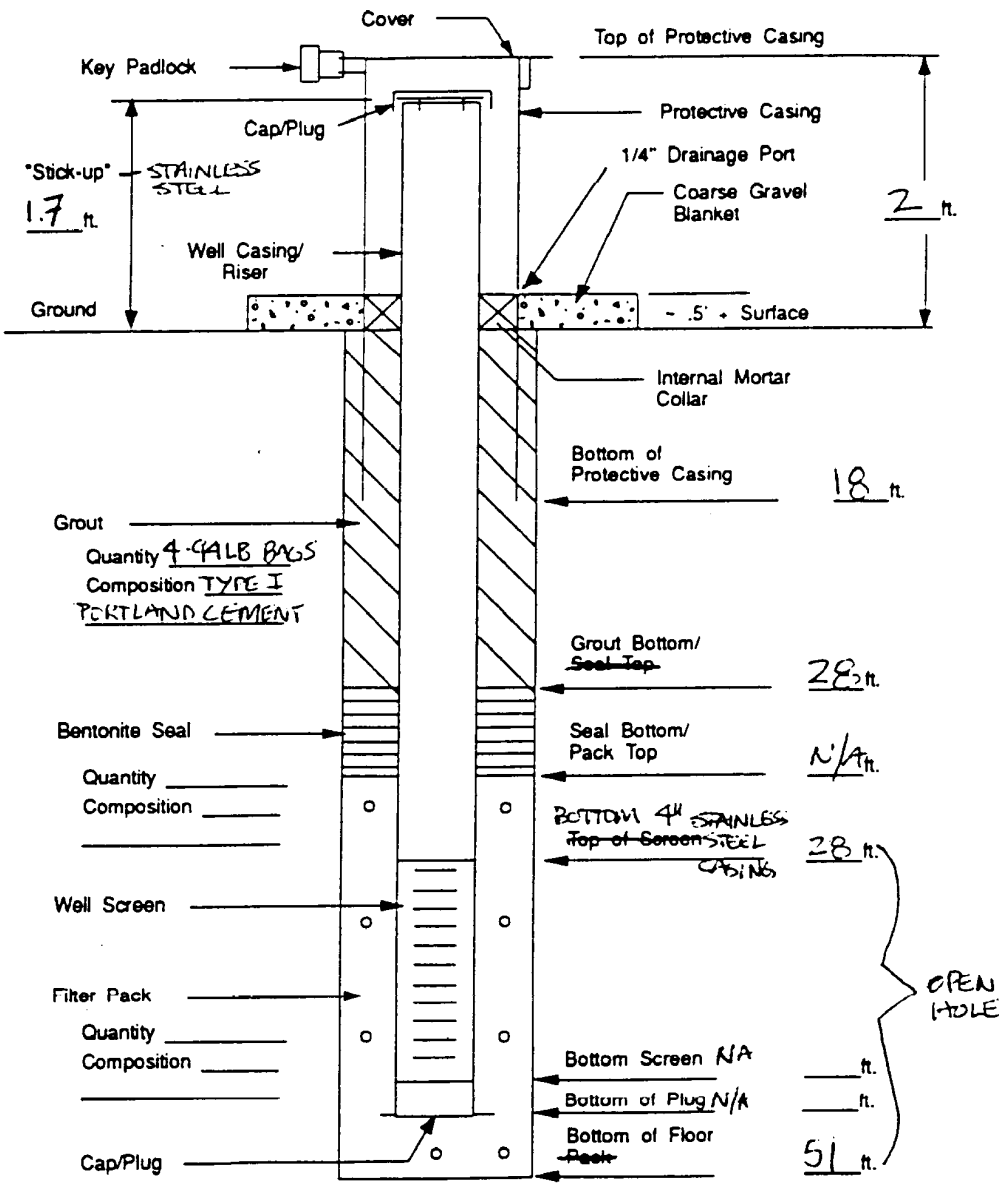
Well Construction Log:
Site ID Number: 2-GW-11 - SITE 2 PERMIT # CE 43-0219
Well Number: 2-GW-11
Today's Date:

WELL CONSTRUCTION



BORING LOG GENERAL DATA

Project: BAINBRIDGE NTC Boring: 2-GW-11 Page: 3 of 3

Driller & Company: P BARTH / E&E

Geologist/Logger & Company: W GRAF / E&E Signature: [illegible]

Date Boring Started: 12/8/93 Completed: 12/9/93

Water Levels (from Ground Surface) Drilling Rig: DETREK

First Encountered: 9.0' Date: 12/8/93

While Drilling: 9.0' Date: 12/8/93

At Boring Completion: Date:

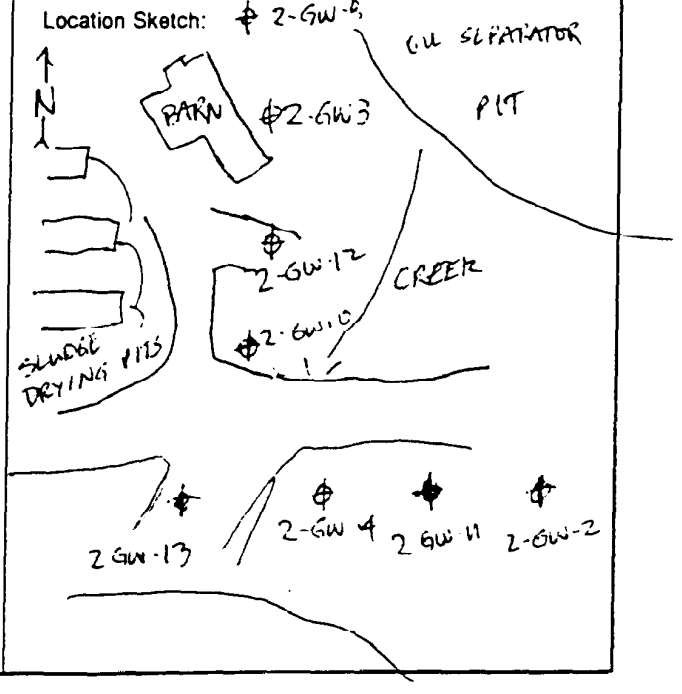
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
12/8/93	1050	1645	0	25					
12/9/93	1235	1420	25'	51'					

Abbreviations:

Abbr.	Meaning

Location Sketch:



Project: BAINBRIDGE NTC	Boring: 2 GW 12	Page: 1 of 3

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	12/12/93 Soil/Rock Description START | FINISH - 1017	Sample Number & Depth	Blow Count & Recovery	Drilling Data
0		0-1 [illegible] SILT & [illegible] 1-2 [illegible] w/ [illegible] GRAVEL [illegible]	1017 R=1.4	7, 13, 14, 16	1) SPLIT SPOON DRIVEN W/ 140LB HAMMER W/ 30" FREE FALL 2) DEPTH #'S IN FEET 3) HSAS 4) 2" x 2' SPLIT SPOONS
2					
4		4-5 [illegible] w/ [illegible] GRAVEL [illegible] SILT [illegible] GRANITIC ROCK TO SATROLITE	1035 R=1.5	[illegible]	
6					DRILLING NOTES 1) DRIVE SPLIT SPOON [illegible] 2) AUGER TO 4' 3) DRIVE SPLIT 4-6 4) AUGER TO 5' REFUSAL 5) SET 8" CASING @ 8' BGS 6) AIR HAMMER TO 28' BGS
9					
11		13' - SATROLITE WEATHERED GRANITE CHIPS - DRY FROM AIR HAMMER - SLIGHT WATER WHEN RECIRCULATED 14' BEDROCK, GRANITIC, GNEISSIC CHIPS W/ SOME QUARTZITE			

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ecology and environment

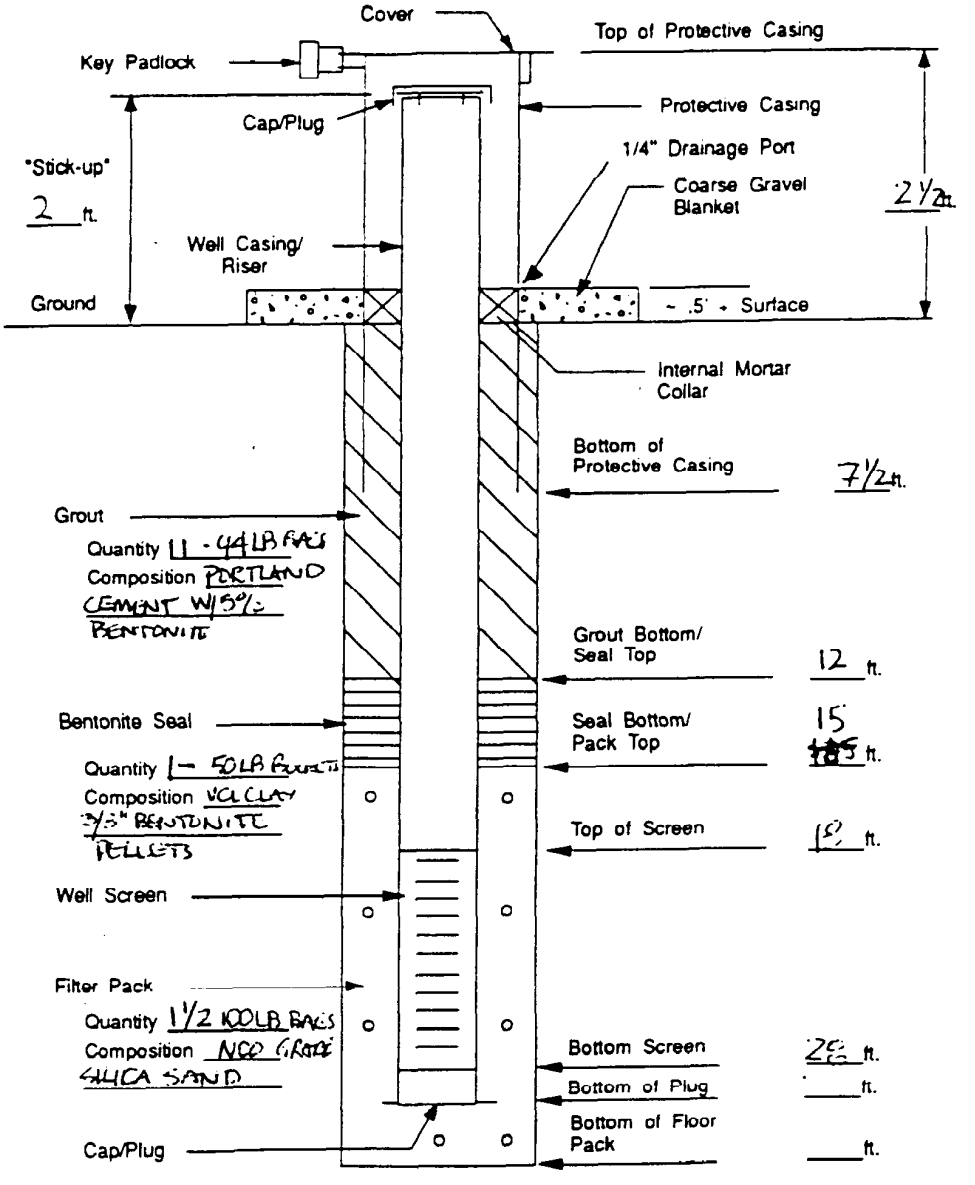
Well Construction Log: _____

Site ID Number: _____

Well Number: 2-GW-12 Permit E-93-0270

Today's Date: 12/13/93

WELL CONSTRUCTION



BORING LOG GENERAL DATA

Project: BAINBRIDGE NTC Boring: 2-GW-12 Page: 3 of 3

Driller & Company: P. BARTH / E&E

Geologist/Logger & Company: W. GRAF / E&E Signature: Walter Graf

Date Boring Started: 12/12/93 Completed: 12/13/93

Water Levels (from Ground Surface) Drilling Rig: DIETRICH

First Encountered: 13' Date: 12/12/93

While Drilling: 13' Date: 12/12/93

At Boring Completion: Date:

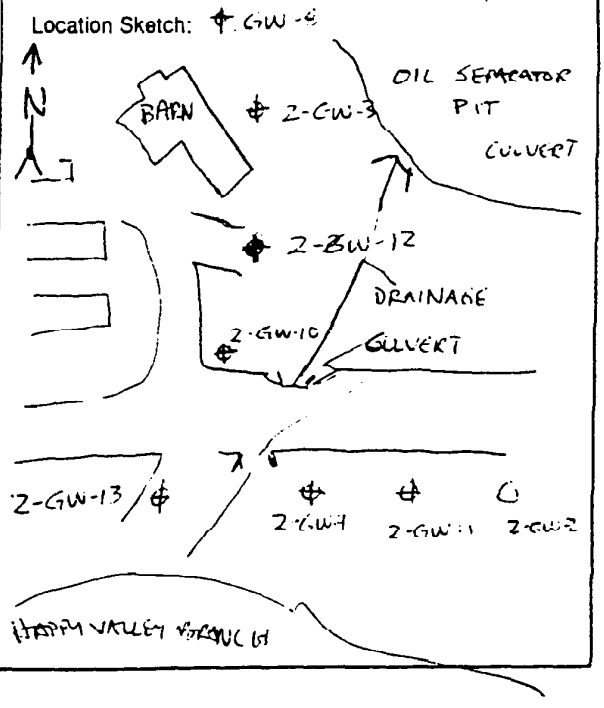
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
12/12	1017	1420	0	27'					
12/13	0922	~~0922~~ 1025	0	28' (reach out hole)					

Abbreviations:

Abbr.	Meaning

Location Sketch:



Project:	Boring: 2-GW-13	Page: 1 of 3

12/10/94 - 12/15/93

12

START/FINISH - 0911/1545 12/10

12/15 1357 1520

Depth/ Elevation (Ft.)	USCS Symbol/ Core Sketch	Soil/Rock Description	Sample Number & Depth	Blow Count & Recovery	Drilling Data
		0-.1 DK BR MOIST SILT w/ROOTS MOIST .1-1 ORANGE BR MOIST SILT w/FINE SAND, ROOTS 1-2 BROWN MOIST SILT w/ROOTS OVA = 0.0 ppm	GW1A R=1.2	8 8 12 10	1) SPLIT SPOONS DRIVEN W/140 LB HAMMER w/30" FREE FALL 2) DEPTH & R IN FEET 3) 6"/4" BAR
	▽	H2O @ 4.0'			
4		4-4.5 WET TAN GREY SAND w/SILT & LARGE ANGULAR GRAVELS 4.5-6 - WET SAND w/GRAVELS TAN w/ ORANGE FE STAINS. WEATHERED DOLOS! GRAVEL SUBANGULAR SIZE GRAVEL OVA = 10 ppm	GW2A R=1.0	24 26 18 17	4) 2" x 2' SPLIT SPOON
6					
9		WET ORANGE BR SANDY SILT w/SUB ROUNDED - ROUNDED GRAVEL w/ MAJ. PORTION TOP GRAVELS OVA = 5 PPM	GW3A R=.6	35 250	} 1 FT
11					DRILLING NOTES 1) DRIVE SPL SP 0-2 2) AUGER TO 4' OVA @ 20 ppm open hole 0 ppm in BREATHING ZONE 3) DRIVE SPL SP 4-6' 4) AUGER TO 9' 20-30 ppm down hole 5) DRIVE SPL SP 9-11 6) REFUSAL @ 11' 7) HAMMER TO 33' 8) SET ST. STEEL CASING 9) HAMMER TO 42' 10) STOP @ 42'. NEED DIFFERENT BIT, WILL MOVE OFF HOLE

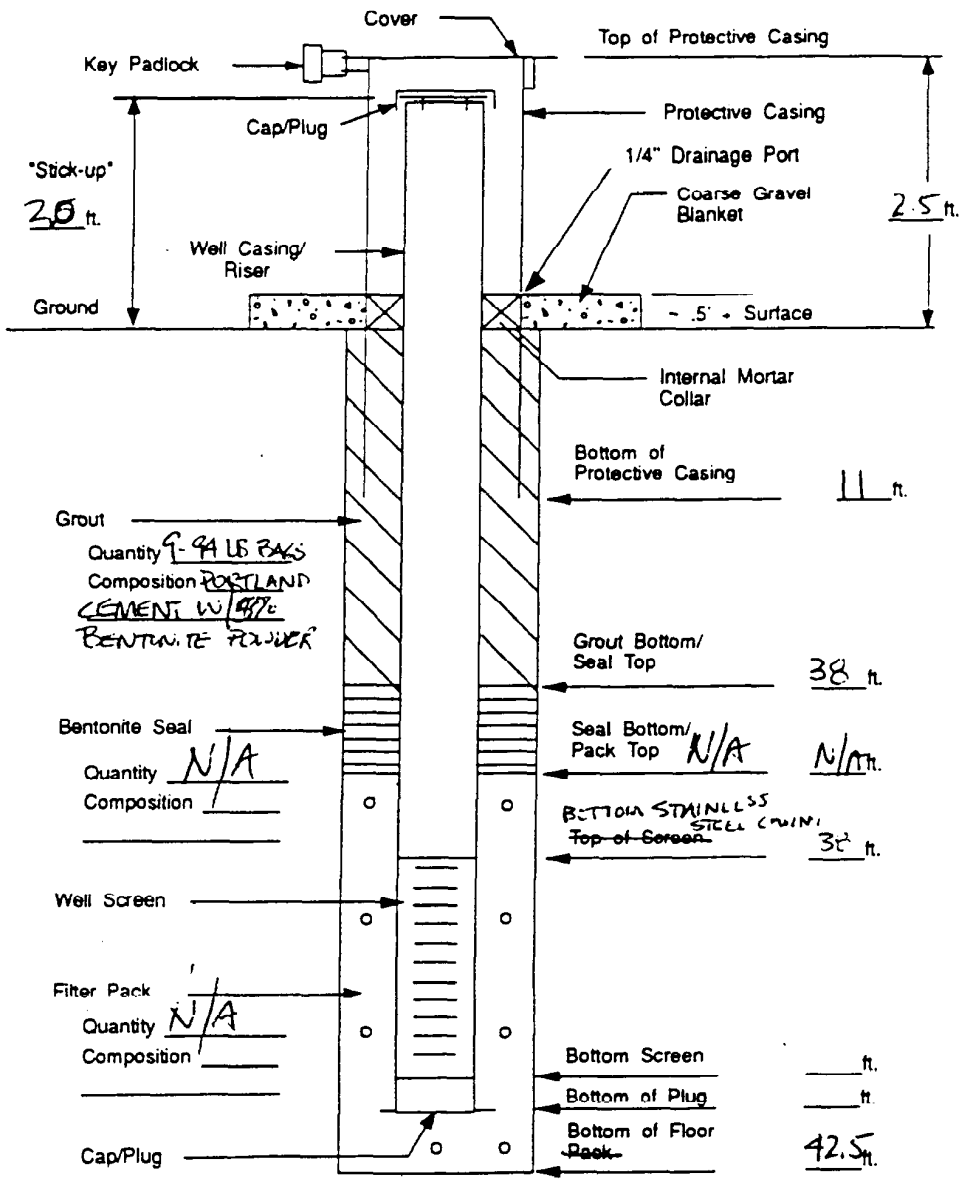
Well Construction Log: _____

Site ID Number: MD PERMIT CE-93-0221

Well Number: 2-GW-13

Today's Date: _____

WELL CONSTRUCTION



BORING LOG GENERAL DATA

Project: BAINBRIDGE NTC Boring: 2-GW-13 Page: 3 of 3

Driller & Company: P. BARTH / E&E

Geologist/Logger & Company: W. GRAF / E&E Signature: Walter Graf

Date Boring Started: Completed:

Water Levels (from Ground Surface) Drilling Rig: DIETRICH

First Encountered: 4.0' Date: 12/10/93

While Drilling: Date:

At Boring Completion: Date:

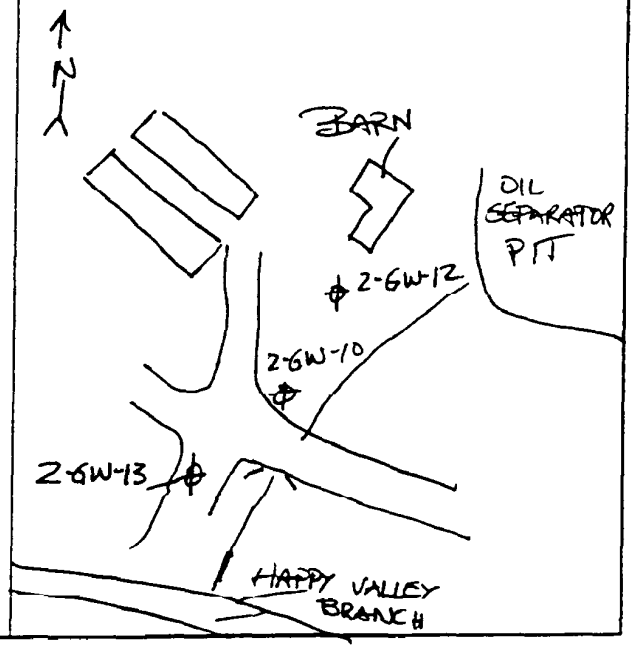
Drilling Shifts:

Date	Time		Depth of Drilling Per Shift		Date	Time		Depth of Drilling Per Shift	
	Start	End	Start	End		Start	End	Start	End
12/10/93	0900	1725	0	38					
12/11/93	0850	1038	38	42.0					
12/15/93	1357	1520	42	42.5					

Abbreviations:

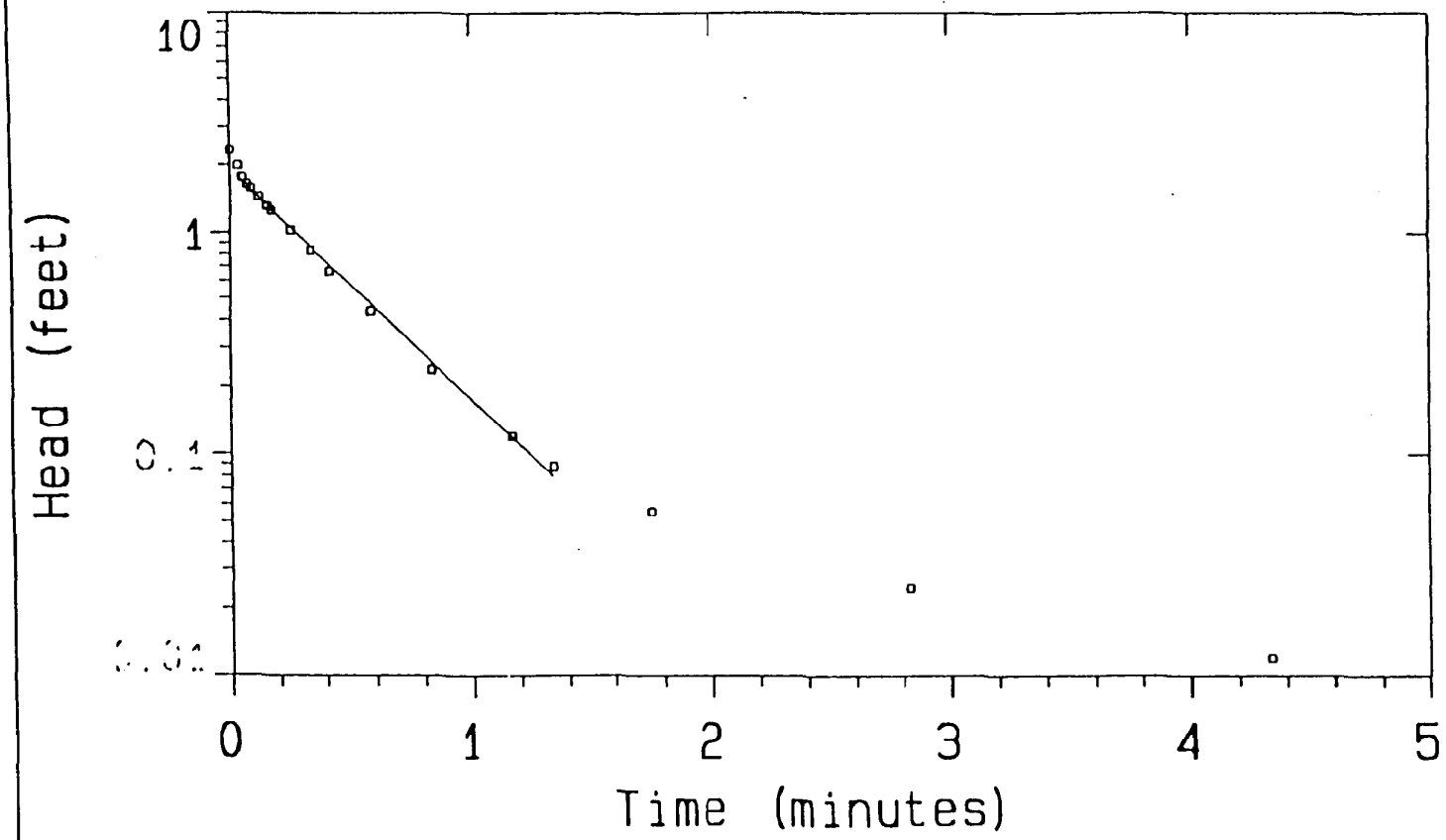
Abbr.	Meaning

Location Sketch:



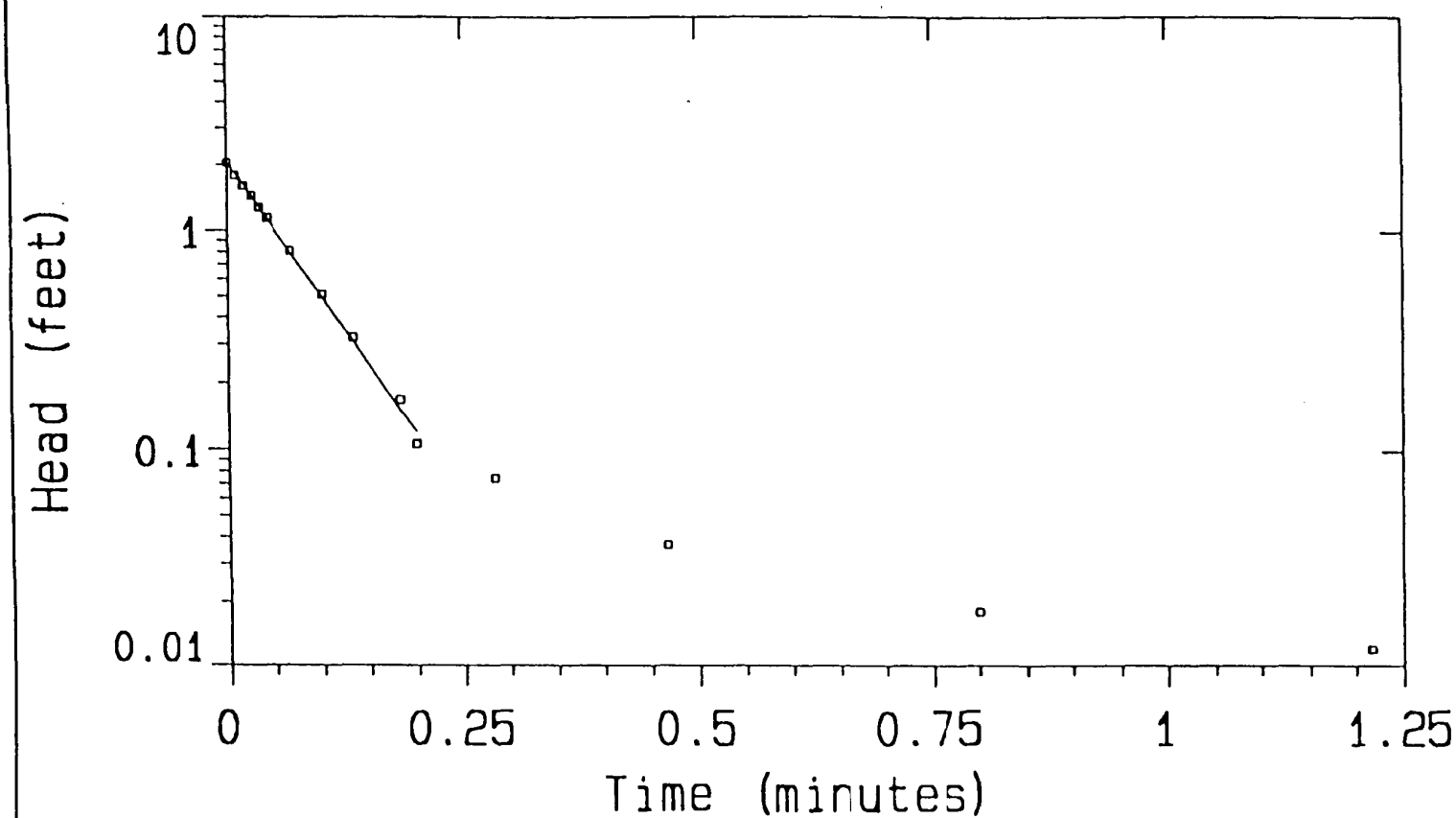
F Aquifer Test Data

This appendix contains slug test data generated from the SLUGIX software program. The data are in numerical and graphical form.

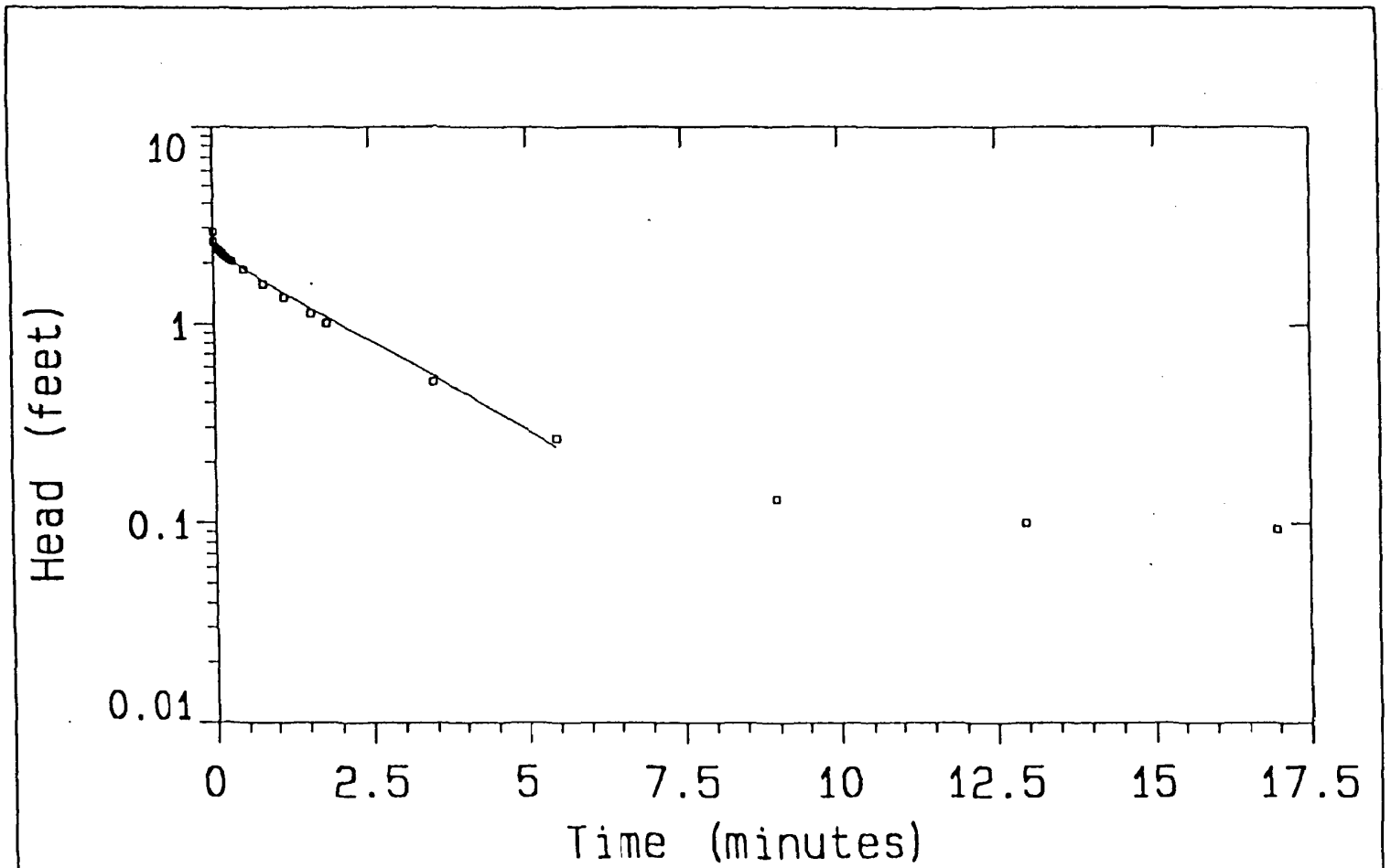


MOD[illegible] BOUWER and RICE	for: BAINBRIDGE NTC	Well Slug Test Data
CONDUC [illegible] .5084 cm/sec	by: Chip Miller	Well: 1GW-1
TRANSM [illegible] .549 sq. cm/sec	WELL DATA: Units: ft	OLD LANDFILL
INITIA [illegible] 2.[illegible]47 ft	AQUIFER: Endless	BAINBRIDGE NTC
Data Set: 1GW-1 / Date: 8-22-91	THICKNESS: 10.00	
	SCREEN: top: 36.50 base: 46.50	
	DIAMETER: casing: .3340 intake: .6360	
	DEPTH: Water Table: 31.92 TD: 48.50	

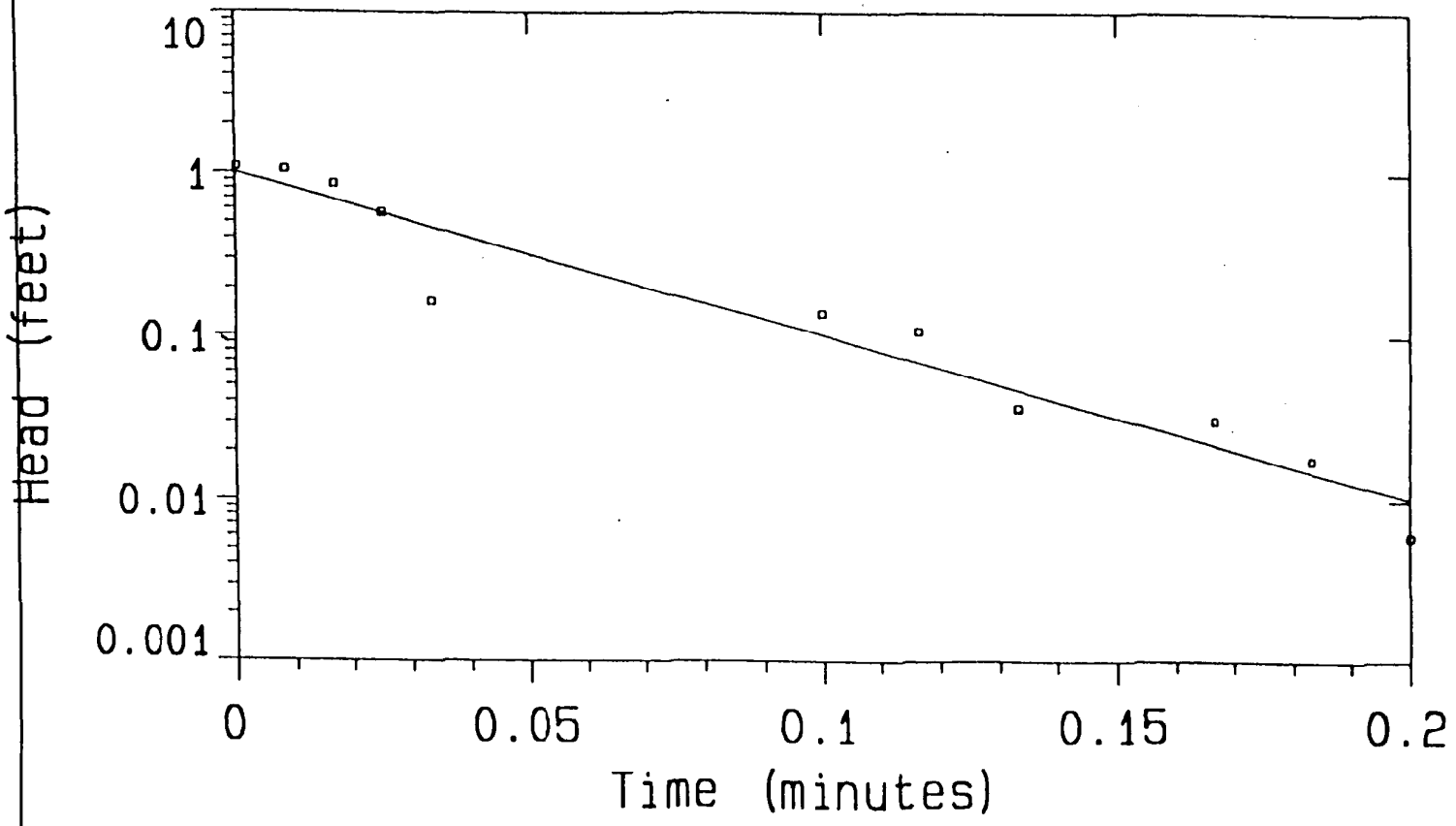
recycled paper
ecology and environment



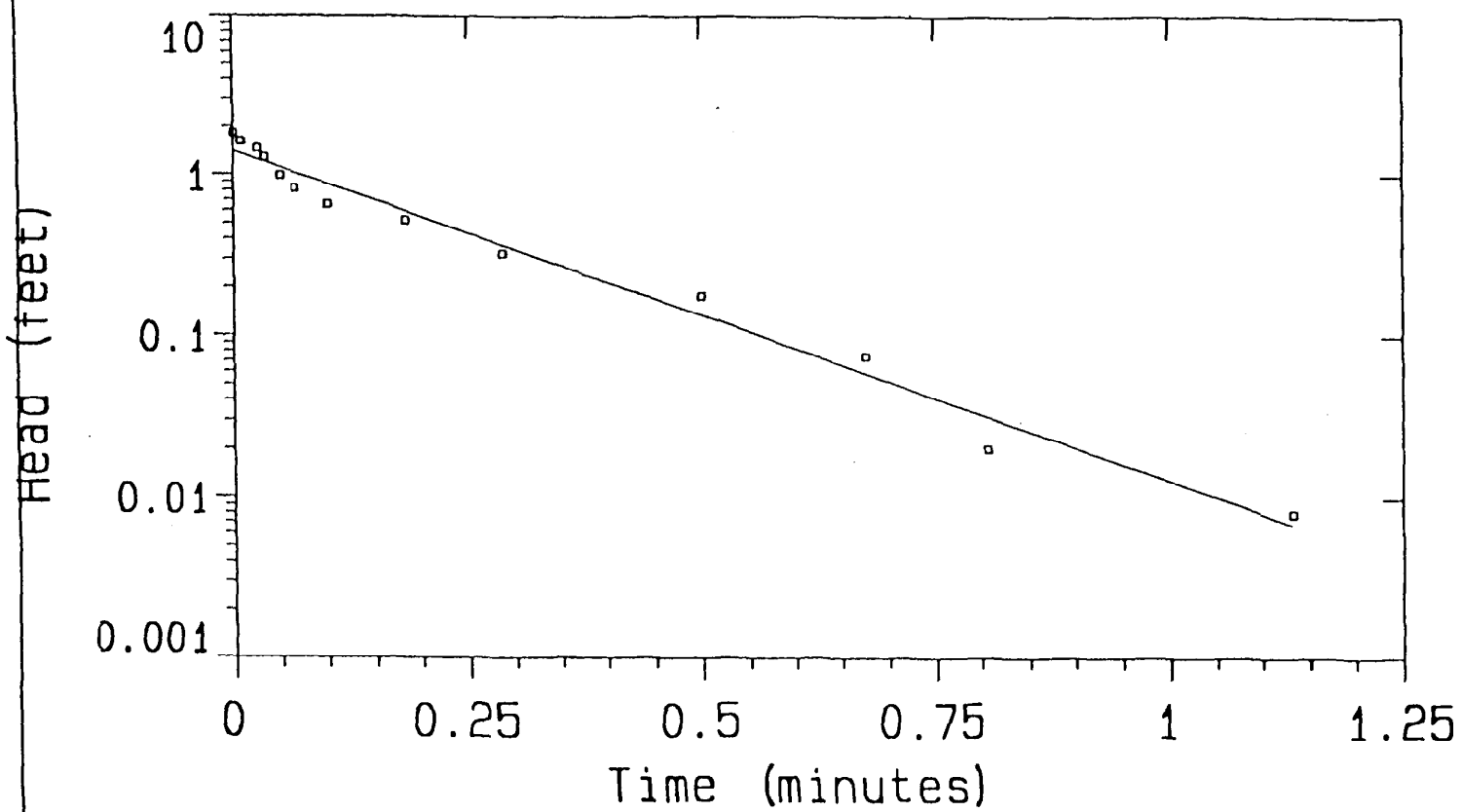
MODEL TYPE: BOUWER and RICE	for: BAINBRIDGE NTC	Well Slug Test Data
CONDUCTIVITY: .02621 cm/sec	by: Chip Miller	Well: 1GW-4
TRANSMISSIVITY: 7.991 sq. cm/sec	WELL DATA: Units: ft	OLD LANDFILL
INITIAL HEAD: 2.044 ft	AQUIFER: Endless	BAINBRIDGE NTC
Data Set: 1GW-4 / Date: 8-22-91	THICKNESS: 10.00	
	SCREEN: top: 25.60 base: 35.60	
	DIAMETER: [illegible] .3340 intake: .6360	
	DEPTH: Wa[illegible] 25.20 TD 36.00	



MODEL TYPE: BOUWER and RICE	for: BAINBRIDGE NTC	Well Slug Test Data
CONDUCTIVITY: .0009171 cm/sec	by: Chip Miller	Well: 1GW-7
TRANSMISSIVITY: .2795 sq. cm/sec	WELL DATA: Units: ft	OLD LANDFILL
INITIAL HEAD: 2.866 ft	AQUIFER: Endless	BAINBRIDGE NTC
Data Set: 1GW-7 / Date: 8-22-91	THICKNESS: 10.00	
	SCREEN: top: 16.00 base: 26.00	
	DIAMETER: casing: .3340 intake: .6660	
	DEPTH: Water Table: 9.470 TD: 27.00	



MODEL TYPE: BOUWER and RICE	for: BAINBRIDGE NTC	Well Slug Test Data
CONDUCTIVITY: .02125 cm/sec	by: Chip Miller	Well: 1GW-8
TRANSMISSIVITY: 53.77 sq. cm/sec	WELL DATA. Units: ft	OLD LANDFILL
INITIAL HEAD: 1.094 ft	AQUIFER Endless	BAINBRIDGE NTC
Data Set: 1GW-8 / Date: 8-22-91	THICKNESS: 83.00	
	SCREEN: top: 39.00 base: 122.0	
	DIAMETER: [illegible]g: .5000 intake: .5000	
	DEPTH: W[illegible]le: 16.20 TD: 122.0	



MODEL TYPE: BOUWER and RICE	for: BAINBRIDGE NTC	Well Slug Test Data
CONDUCTIVITY: .03227 cm/sec	by: Chip Miller	Well: 2GW-1
TRANSMISSIVITY: 7.870 sq. cm/sec	WELL DATA: Units: ft	FIRE TRAINING AREA
INITIAL HEAD: 1.810 ft	AQUIFER: Endless	BAINBRIDGE NTC
Data Set: 2GW-1 / Date: 8-22-91	THICKNESS: 8.000	
	SCREEN: top: 34.30 base: 42.30	
	DIAMETER: casing: .4880 intake: .4880	
	DEPTH: Water Table: 7.950 TD 42.30	

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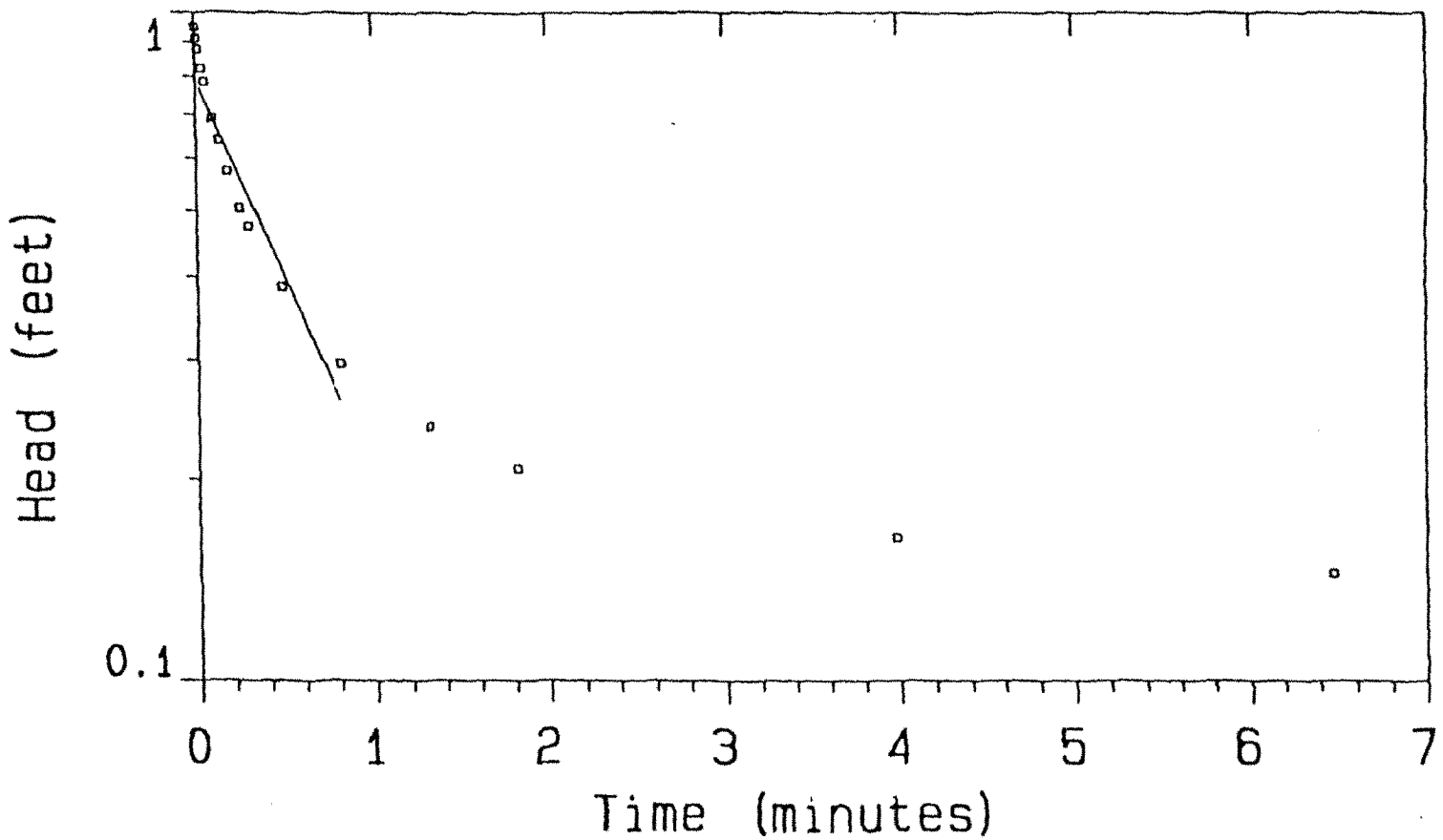
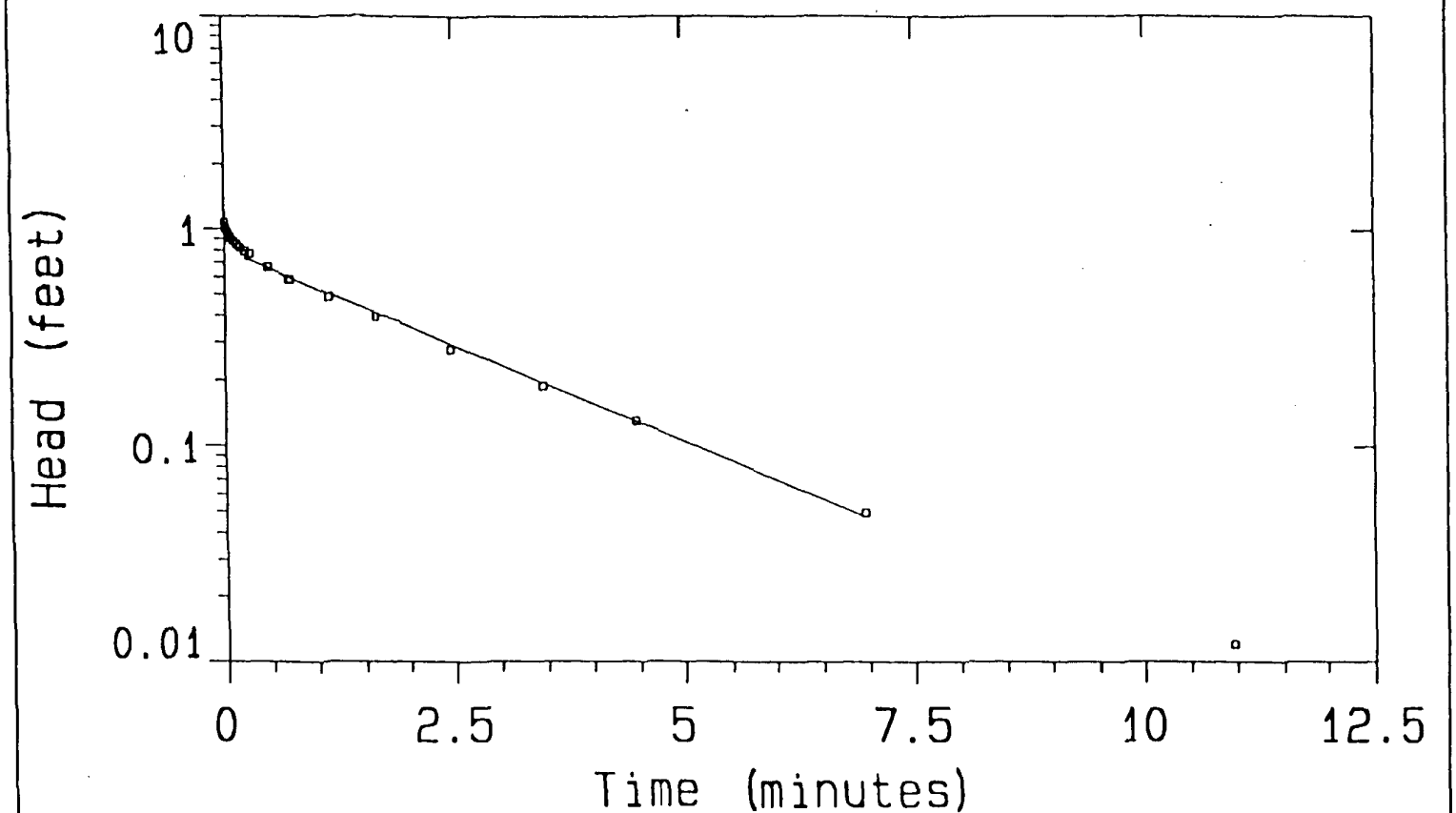
ecology and environment

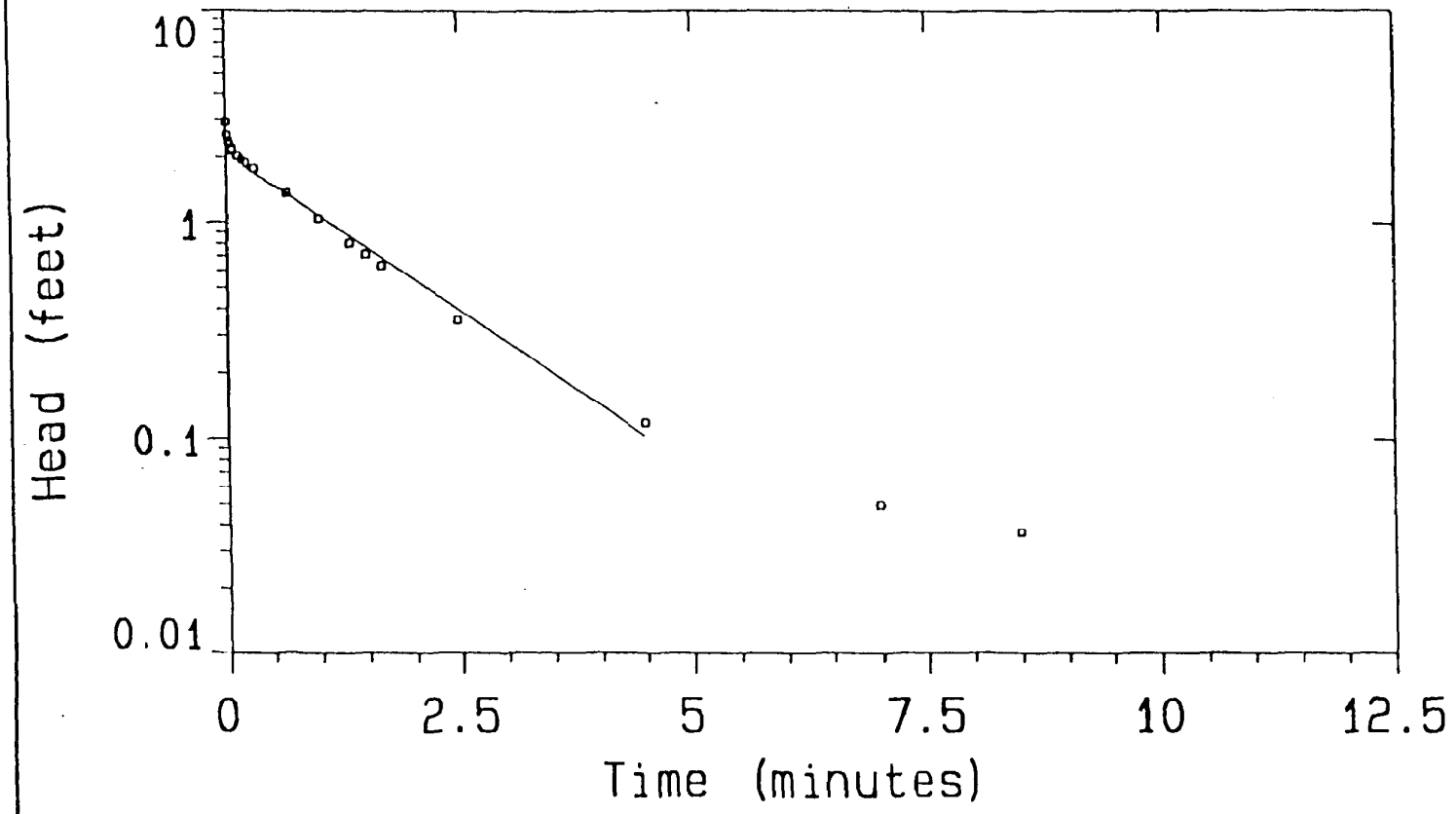


MODEL TYPE: BOUWER and RICE	for: BAINBRIDGE NTC	Well Slug Test Data
CONDUCTIVITY: .01452 cm/sec	by: Chip Miller	Well: 2GW-2
TRANSMISSIVITY: 2.213 sq. cm/sec	WELL DATA: Units: ft	FIRE TRAINING AREA
INITIAL HEAD: .9490 ft	AQUIFER Endless	BAINBRIDGE NTC
Data Set: 2GW-2 / Date: 8-22-91	THICKNESS: 5.000	
	SCREEN: top: 22.40 base: 27.40	
	DIAMETER: casing: .4880 intake: .4880	
	DEPTH: Water Table: 7.380 TD: 27.40	



MODEL TYPE: BOUWER and RICE	for: BAINBRIDGE NTC	Well Slug Test Data
CONDUCTIVITY: .002610 cm/sec	by: Chip Miller	Well: 2GW-5
TRANSMISSIVITY: .6364 sq. cm/sec	WELL DATA: Units: ft	FIRE TRAINING AREA
INITIAL HEAD: 1.075 ft	AQUIFER Endless	BAINBRIDGE NTC
Data Set: 2GW-5 / Date: 8-22-91	THICKNESS: 8.000	
	SCREEN: top: 15.00 base: 23.00	
	DIAMETER: casing: .4880 intake: .4880	
	DEPTH: Water Table: 5.850 TD: 23.00	

recycled paper
ecology and environment



MODEL TYPE: BOUWER and RICE	for BAINBRIDGE NTC	Well Slug Test Data
CONDUCTIVITY: .001251 cm/sec	by Chip Miller	Well: 2GW-6
TRANSMISSIVITY: .3814 sq. cm/sec	WELL DATA. Units: ft	FIRE TRAINING AREA
INITIAL HEAD: 2.948 ft	AQUIFER: Endless	BAINBRIDGE NTC
	THICKNESS: 10.00	
	SCREEN: top: 9.500 base: 19.50	
	DIAMETER: [illegible]a: .3340 intake: .8760	
Data Set: 2GW-6 / Date: 8-22-91	DEPTH: W[illegible]le: 8.850 TD: 19.70	

DATA SET: 1HGW10F

CLIENT:	US NAVY	DATE:	19-OCT-94
LOCATION:	PORT DEPOSIT, MD	WELL NO.:	1-GW-10
COUNTY:	CECIL	WELL DEPTH:	67.50 ft
PROJECT:	BAINBRIDGE NTC	WATER TABLE:	0.000 ft
AQUIFER:	Endless	THICKNESS:	50.07 ft
INTAKE RADIUS:	0.500 ft	CASING RADIUS:	0.500 ft
SCREEN TOP:	35.000 ft	SCREEN BASE:	67.50 ft
INITIAL HEAD:	1.378 ft	TRANS. RATIO:	1.0000

MODEL PARAMETERS:

TRANSMISSIVITY: 11.9 square cm/sec

CONDUCTIVITY: .00780 cm/sec

MODEL TYPE: UNCONFINED PARTIALLY PENETRATED AQUIFER (Bouwer & Rice)

No.	TIME (mins.)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.000E-05	1.37		
2	0.0166	1.32		
3	0.0250	1.11		
4	0.0333	1.53		
5	0.0416	1.75		
6	0.0500	2.84		
7	0.0583	3.46		
8	0.0666	2.82		
9	0.0750	2.76		
10	0.0916	3.45		
11	0.100	3.11		
12	0.116	2.16		
13	0.141	2.17		
14	0.158	2.17		
15	0.183	2.14		
16	0.208	2.02		
17	0.241	1.88		
18	0.275	1.80		
19	0.316	1.98		
20	0.366	1.45		
21	0.416	1.32		
22	0.483	1.17		
23	0.566	1.01		

* Chip Miller

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
24	0.650	0.908		
25	0.750	0.775		
26	0.850	0.667		
27	0.983	0.559		
28	1.20	0.444		
29	1.40	0.374		
30	1.60	0.324		
31	1.80	0.279		
32	2.00	0.247		
33	2.20	0.222		
34	2.60	0.190		
35	3.00	0.158		
36	3.40	0.146		
37	4.00	0.120		
38	4.60	0.108		
39	5.40	0.0950		
40	6.20	0.0760		
41	7.00	0.0630		
42	8.00	0.0630		
43	9.40	0.0500		
44	11.00	0.0440		
45	12.00	0.0380		
46	14.00	0.0310		
47	16.00	0.0310		
48	19.00	0.0250		

CURRENT RESOLUTION MATRIIX NOT AVAILABLE

* Chip Miller

DATA SET: 1HGW10R

CLIENT:	US NAVY	DATE:	19-OCT-94
LOCATION:	PORT DEPOSIT, MD	WELL NO.:	1-GW-10
COUNTY:	CECIL	WELL DEPTH:	67.50 ft
PROJECT:	BAINBRIDGE NTC	WATER TABLE:	0.000 ft
AQUIFER:	Endless	THICKNESS:	57.07 ft
INTAKE RADIUS:	0.500 ft	CASING RADIUS:	0.500 ft
SCREEN TOP:	35.000 ft	SCREEN BASE:	67.50 ft
INITIAL HEAD:	3.437 ft	TRANS. RATIO:	1.0000

MODEL PARAMETERS:

TRANSMISSIVITY: 25.0 square cm/sec

CONDUCTIVITY: .0144 cm/sec

MODEL TYPE: UNCONFINED PARTIALLY PENETRATED AQUIFER (Bouwer & Rice)

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.000E-05	3.43		
2	0.0165	3.30		
3	0.0249	3.24		
4	0.0332	3.17		
5	0.0415	3.08		
6	0.0499	3.00		
7	0.0582	2.92		
8	0.0665	2.84		
9	0.0749	2.77		
10	0.0832	2.69		
11	0.0999	2.56		
12	0.108	2.49		
13	0.124	2.37		
14	0.141	2.26		
15	0.166	2.12		
16	0.183	2.03		
17	0.208	1.90		
18	0.241	1.75		
19	0.274	1.63		
20	0.308	1.51		
21	0.349	1.38		
22	0.399	1.25		
23	0.449	1.13		

* Chip Miller

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
24	0.516	1.01		
25	0.583	0.902		
26	0.666	0.781		
27	0.749	0.692		
28	0.849	0.609		
29	0.966	0.527		
30	1.19	0.412		
31	1.39	0.343		
32	1.59	0.292		
33	1.79	0.260		
34	1.99	0.235		
35	2.39	0.190		
36	2.59	0.171		
37	2.99	0.146		
38	3.39	0.133		
39	3.99	0.108		
40	4.39	0.0950		
41	4.99	0.0880		
42	5.79	0.0690		
43	6.59	0.0570		
44	7.39	0.0500		
45	8.39	0.0440		
46	9.59	0.0380		
47	10.99	0.0310		
48	11.99	0.0250		
49	13.99	0.0190		
50	15.99	0.0190		
51	17.99	0.0190		
52	19.99	0.0120		

CURRENT RESOLUTION MATRIIX NOT AVAILABLE

* Chip Miller

DATA SET: 1HGW11R

CLIENT:	US NAVY	DATE:	19-OCT-94
LOCATION:	PORT DEPOSIT, MD	WELL NO.:	1-GW-11
COUNTY:	CECIL	WELL DEPTH:	43.00 ft
PROJECT:	BAINBRIDGE NTC	WATER TABLE:	11.760 ft
AQUIFER:	Endless	THICKNESS:	31.24 ft
INTAKE RADIUS:	0.500 ft	CASING RADIUS:	0.330 ft
SCREEN TOP:	20.000 ft	SCREEN BASE:	43.00 ft
INITIAL HEAD:	3.373 ft	TRANS. RATIO:	1.0000

MODEL PARAMETERS:

TRANSMISSIVITY: 4.59 square cm/sec

CONDUCTIVITY: .00482 cm/sec

MODEL TYPE: UNCONFINED PARTIALLY PENETRATED AQUIFER (Bouwer & Rice)

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.000E-05	3.37	2.79	17.05
2	0.00829	3.11	2.77	11.11
3	0.0165	3.00	2.74	8.58
4	0.0249	2.91	2.72	6.66
5	0.0332	2.84	2.69	5.04
6	0.0415	2.77	2.67	3.53
7	0.0499	2.71	2.64	2.37
8	0.0582	2.65	2.62	1.19
9	0.0665	2.59	2.59	-0.0518
10	0.0749	2.54	2.57	-1.11
11	0.0832	2.49	2.55	-2.23
12	0.0915	2.46	2.52	-2.57
13	0.108	2.39	2.48	-3.64
14	0.124	2.33	2.43	-4.54
15	0.141	2.25	2.39	-6.10
16	0.158	2.21	2.34	-6.23
17	0.183	2.16	2.28	-5.48
18	0.208	2.10	2.22	-5.68
19	0.233	2.03	2.16	-6.02
20	0.266	1.96	2.08	-6.15
21	0.299	1.88	2.00	-6.42
22	0.333	1.82	1.93	-6.18
23	0.383	1.72	1.83	-5.99

* Chip Miller *

recycled paper ecology and environment

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
24	0.433	1.64	1.73	-5.35
25	0.499	1.54	1.60	-4.34
26	0.566	1.44	1.49	-3.29
27	0.649	1.34	1.36	-1.33
28	0.733	1.25	1.24	1.11
29	0.833	1.16	1.11	4.14
30	0.949	1.05	0.979	7.11
31	0.999	1.01	0.926	8.81
32	1.19	0.876		
33	1.39	0.756		
34	1.59	0.660		
35	1.79	0.578		
36	1.99	0.508		
37	2.39	0.393		
38	2.59	0.349		
39	2.99	0.279		
40	3.39	0.222		
41	3.99	0.165		
42	4.39	0.133		
43	4.99	0.108		
44	5.79	0.0820		
45	6.59	0.0630		
46	7.39	0.0500		
47	8.39	0.0440		
48	9.59	0.0380		
49	10.99	0.0380		
50	11.99	0.0380		
51	13.99	0.0380		
52	15.99	0.0310		

CURRENT RESOLUTION MATRIIX NOT AVAILABLE

* Chip Miller

DATA SET: 1HGW12F

CLIENT:	US NAVY	DATE:	18-OCT-94
LOCATION:	PORT DEPOSIT, MD	WELL NO.:	1-GW12
COUNTY:	CECIL	WELL DEPTH:	70.00 ft
PROJECT:	BAINBRIDGE NTC	WATER TABLE:	0.000 ft
AQUIFER:	Endless	THICKNESS:	58.18 ft
INTAKE RADIUS:	0.500 ft	CASING RADIUS:	0.330 ft
SCREEN TOP:	48.000 ft	SCREEN BASE:	70.00 ft
INITIAL HEAD:	4.364 ft	TRANS. RATIO:	1.0000

MODEL PARAMETERS:

TRANSMISSIVITY: 1.18 square cm/sec

CONDUCTIVITY: .000668 cm/sec

MODEL TYPE: UNCONFINED PARTIALLY PENETRATED AQUIFER (Bouwer & Rice)

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.000E-05	4.36		
2	0.0166	4.46		
3	0.0250	3.64		
4	0.0333	3.42		
5	0.0416	4.33		
6	0.0500	3.79		
7	0.0583	4.00		
8	0.0666	4.18		
9	0.0833	3.81		
10	0.0916	3.58		
11	0.108	2.42		
12	0.125	2.39		
13	0.150	3.80		
14	0.166	2.86		
15	0.200	3.15		
16	0.233	3.74		
17	0.266	2.76		
18	0.308	3.15		
19	0.366	2.98		
20	0.416	2.87		
21	0.483	2.73		
22	0.566	3.04		
23	0.666	2.67		

* Chip Miller

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
24	0.766	2.61		
25	0.900	3.58		
26	1.00	3.53		
27	1.20	3.46		
28	1.40	3.37		
29	1.60	3.29		
30	1.80	3.20		
31	2.20	3.05		
32	2.60	2.93		
33	3.00	2.79		
34	3.40	2.68		
35	4.00	2.53		
36	4.60	2.40		
37	5.40	2.24		
38	6.40	2.07		
39	7.40	1.93		
40	8.60	1.79		
41	10.00	1.66		
42	12.00	1.52		
43	13.00	1.46		
44	16.00	1.35		
45	18.00	1.31		
46	21.00	1.26		
47	25.00	1.23		

CURRENT RESOLUTION MATRIIX NOT AVAILABLE

* Chip Miller

DATA SET: 1HGW12R

CLIENT:	US NAVY	DATE:	18-OCT-94
LOCATION:	PORT DEPOSIT, MD	WELL NO.:	1-GW12
COUNTY:	CECIL	WELL DEPTH:	70.00 ft
PROJECT:	BAINBRIDGE NTC	WATER TABLE:	0.000 ft
AQUIFER:	Endless	THICKNESS:	58.18 ft
INTAKE RADIUS:	0.500 ft	CASING RADIUS:	0.330 ft
SCREEN TOP:	48.000 ft	SCREEN BASE:	70.00 ft
INITIAL HEAD:	3.890 ft	TRANS. RATIO:	1.0000

MODEL PARAMETERS:

TRANSMISSIVITY: 3.22 square cm/sec

CONDUCTIVITY: .00181 cm/sec

MODEL TYPE: UNCONFINED PARTIALLY PENETRATED AQUIFER (Bouwer & Rice)

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.000E-05	3.89		
2	0.0499	3.87		
3	0.0582	3.65		
4	0.0665	3.65		
5	0.0749	3.59		
6	0.0832	3.58		
7	0.0999	3.53		
8	0.116	3.51		
9	0.133	3.45		
10	0.158	3.41		
11	0.183	3.36		
12	0.208	3.31		
13	0.241	3.27		
14	0.274	3.24		
15	0.324	3.18		
16	0.366	3.15		
17	0.433	3.09		
18	0.499	3.03		
19	0.583	2.96		
20	0.666	2.90		
21	0.783	2.82		
22	0.899	2.75		
23	0.999	2.69		

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No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
24	1.19	2.59		
25	1.39	2.49		
26	1.59	2.39		
27	1.79	2.31		
28	2.19	2.14		
29	2.59	2.00		
30	2.99	1.86		
31	3.39	1.74		
32	3.79	1.63		
33	4.59	1.42		
34	5.19	1.29		
35	5.99	1.14		
36	6.99	0.978		
37	8.19	0.813		
38	9.39	0.679		
39	10.99	0.533		
40	12.99	0.400		
41	14.99	0.304		
42	16.99	0.235		
43	19.99	0.171		

CURRENT RESOLUTION MATRIIX NOT AVAILABLE

* Chip Miller

DATA SET: 1HGW13F

CLIENT:	US NAVY	DATE:	19-OCT-94
LOCATION:	PORT DEPOSIT, MD	WELL NO.:	1-GW13
COUNTY:	CECIL	WELL DEPTH:	95.50 ft
PROJECT:	BAINBRIDGE NTC	WATER TABLE:	13.760 ft
AQUIFER:	Endless	THICKNESS:	81.74 ft
INTAKE RADIUS:	0.500 ft	CASING RADIUS:	0.330 ft
SCREEN TOP:	74.000 ft	SCREEN BASE:	95.50 ft
INITIAL HEAD:	3.500 ft	TRANS. RATIO:	1.0000

MODEL PARAMETERS:

TRANSMISSIVITY: 2.71 square cm/sec

CONDUCTIVITY: .00109 cm/sec

MODEL TYPE: UNCONFINED PARTIALLY PENETRATED AQUIFER (Bouwer & Rice)

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.000E-05	3.50	3.44	1.60
2	0.141	3.24	3.34	-2.90
3	0.166	3.34	3.32	0.769
4	0.191	3.48	3.30	5.07
5	0.225	3.28	3.28	0.103
6	0.266	3.31	3.25	1.77
7	0.308	3.19	3.22	-0.848
8	0.366	3.18	3.18	0.225
9	0.433	2.98	3.13	-5.03
10	0.500	3.03	3.09	-2.02
11	0.583	2.95	3.03	-2.78
12	0.683	2.95	2.97	-0.592
13	0.800	2.90	2.89	0.187
14	0.933	2.86	2.81	1.73
15	1.00	2.84	2.77	2.28
16	1.20	2.79		
17	1.40	2.75		
18	1.80	2.66		
19	2.00	2.63		
20	2.40	2.55		
21	2.80	2.49		
22	3.20	2.42		
23	3.80	2.33		

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No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
24	4.60	2.21		
25	5.20	2.13		
26	6.20	2.01		
27	7.20	1.90		
28	8.40	1.77		
29	10.00	1.63		
30	12.00	1.46		
31	14.00	1.33		
32	16.00	1.21		
33	19.00	1.06		
34	22.00	0.940		
35	26.00	0.806		
36	30.00	0.705		

CURRENT RESOLUTION MATRIIX NOT AVAILABLE

* Chip Miller

DATA SET: 2HGW10F

CLIENT:	US NAVY	DATE:	19-OCT-94
LOCATION:	PORT DEPOSIT, MD	WELL NO.:	2-GW10
COUNTY:	CECIL	WELL DEPTH:	12.30 ft
PROJECT:	BAINBRIDGE NTC	WATER TABLE:	8.600 ft
AQUIFER:	Endless	THICKNESS:	3.70 ft
INTAKE RADIUS:	0.330 ft	CASING RADIUS:	0.330 ft
SCREEN TOP:	7.300 ft	SCREEN BASE:	12.30 ft
INITIAL HEAD:	1.251 ft	TRANS. RATIO:	1.0000

MODEL PARAMETERS:

TRANSMISSIVITY: .552 square cm/sec

CONDUCTIVITY: .00489 cm/sec

MODEL TYPE: UNCONFINED PARTIALLY PENETRATED AQUIFER (Bouwer & Rice)

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.000E-04	1.70		
2	0.0166	1.65		
3	0.0250	1.62		
4	0.0333	1.45		
5	0.0416	1.46		
6	0.0500	1.42		
7	0.0583	1.42		
8	0.0666	1.46		
9	0.0750	1.46		
10	0.0833	1.46		
11	0.0916	1.44		
12	0.108	1.42		
13	0.125	1.60		
14	0.141	1.34		
15	0.166	1.35		
16	0.191	1.35		
17	0.216	1.34		
18	0.250	1.41		
19	0.283	1.28		
20	0.325	1.15		
21	0.366	1.37		
22	0.433	1.16		
23	0.483	1.13		

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No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
24	0.566	1.07		
25	0.633	1.02		
26	0.733	0.978		
27	0.833	0.927		
28	0.966	0.857		
29	1.20	0.749		
30	1.40	0.673		
31	1.60	0.609		
32	1.80	0.552		
33	2.20	0.451		
34	2.40	0.406		
35	2.80	0.336		
36	3.20	0.279		
37	3.80	0.216		
38	4.20	0.184		
39	5.00	0.139		
40	5.60	0.114		
41	6.40	0.0880		
42	7.40	0.0690		
43	8.40	0.0630		
44	9.60	0.0570		
45	11.00	0.0500		
46	13.00	0.0440		

CURRENT RESOLUTION MATRIIX NOT AVAILABLE

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DATA SET: 2HGW10R

CLIENT:	US NAVY	DATE:	19-OCT-94
LOCATION:	PORT DEPOSIT, MD	WELL NO.:	2-GW10
COUNTY:	CECIL	WELL DEPTH:	12.30 ft
PROJECT:	BAINBRIDGE NTC	WATER TABLE:	8.600 ft
AQUIFER:	Endless	THICKNESS:	3.70 ft
INTAKE RADIUS:	0.330 ft	CASING RADIUS:	0.330 ft
SCREEN TOP:	7.300 ft	SCREEN BASE:	12.30 ft
INITIAL HEAD:	1.607 ft	TRANS. RATIO:	1.0000

MODEL PARAMETERS:

TRANSMISSIVITY: .721 square cm/sec

CONDUCTIVITY: .00640 cm/sec

MODEL TYPE: UNCONFINED PARTIALLY PENETRATED AQUIFER (Bouwer & Rice)

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.000E-05	1.60		
2	0.00830	1.54		
3	0.0166	1.53		
4	0.0250	1.53		
5	0.0333	1.51		
6	0.0416	1.51		
7	0.0500	1.49		
8	0.0583	1.49		
9	0.0666	1.48		
10	0.0750	1.46		
11	0.0916	1.43		
12	0.100	1.42		
13	0.116	1.41		
14	0.133	1.39		
15	0.150	1.37		
16	0.175	1.34		
17	0.200	1.32		
18	0.225	1.29		
19	0.258	1.27		
20	0.291	1.23		
21	0.333	1.20		
22	0.383	1.16		
23	0.433	1.12		

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No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
24	0.500	1.08		
25	0.566	1.04		
26	0.650	0.997		
27	0.733	0.940		
28	0.850	0.883		
29	0.966	0.864		
30	1.00	0.781		
31	1.20	0.705		
32	1.40	0.635		
33	1.60	0.578		
34	1.80	0.476		
35	2.20	0.432		
36	2.40	0.355		
37	2.80	0.298		
38	3.20	0.254		
39	3.60	0.196		
40	4.20	0.171		
41	4.60	0.133		
42	5.40	0.108		
43	6.00	0.0820		
44	7.00	0.0690		
45	8.00	0.0570		
46	9.00	0.0500		
47	10.00	0.0440		
48	12.00	0.0380		
49	13.00	0.0380		
50	15.00	0.0380		
51	18.00	0.0310		

CURRENT RESOLUTION MATRIIX NOT AVAILABLE

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No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
24	0.500	1.08		
25	0.566	1.04		
26	0.650	0.997		
27	0.733	0.940		
28	0.850	0.883		
29	0.966	0.864		
30	1.00	0.781		
31	1.20	0.705		
32	1.40	0.635		
33	1.60	0.578		
34	1.80	0.476		
35	2.20	0.432		
36	2.40	0.355		
37	2.80	0.298		
38	3.20	0.254		
39	3.60	0.196		
40	4.20	0.171		
41	4.60	0.133		
42	5.40	0.108		
43	6.00	0.0820		
44	7.00	0.0690		
45	8.00	0.0570		
46	9.00	0.0500		
47	10.00	0.0440		
48	12.00	0.0380		
49	13.00	0.0380		
50	15.00	0.0380		
51	18.00	0.0310		

CURRENT RESOLUTION MATRIIX NOT AVAILABLE

* Chip Miller

DATA SET: 2HGW11F

CLIENT:	US NAVY	DATE:	20-OCT-94
LOCATION:	PORT DEPOSIT, MD	WELL NO.:	2-GW-11
COUNTY:	CECIL	WELL DEPTH:	51.00 ft
PROJECT:	BAINBRIDGE NTC	WATER TABLE:	0.000 ft
AQUIFER:	Endless	THICKNESS:	50.32 ft
INTAKE RADIUS:	0.330 ft	CASING RADIUS:	0.330 ft
SCREEN TOP:	28.000 ft	SCREEN BASE:	51.00 ft
INITIAL HEAD:	3.551 ft	TRANS. RATIO:	1.0000

MODEL PARAMETERS:

TRANSMISSIVITY: 4.77 square cm/sec

CONDUCTIVITY: .00311 cm/sec

MODEL TYPE: UNCONFINED PARTIALLY PENETRATED AQUIFER (Bouwer & Rice)

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.000E-05	3.55		
2	0.00830	3.26		
3	0.0166	3.38		
4	0.0250	3.36		
5	0.0333	3.33		
6	0.0416	3.03		
7	0.0500	3.31		
8	0.0583	3.13		
9	0.0750	2.88		
10	0.0833	3.32		
11	0.0916	3.30		
12	0.108	3.22		
13	0.125	2.87		
14	0.150	2.94		
15	0.166	3.01		
16	0.200	2.13		
17	0.225	2.71		
18	0.258	2.81		
19	0.300	2.77		
20	0.350	2.71		
21	0.400	2.65		
22	0.466	2.57		
23	0.533	2.52		

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No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
24	0.616	2.45		
25	0.716	2.35		
26	0.833	2.27		
27	0.950	2.17		
28	1.20	2.00		
29	1.40	1.87		
30	1.60	1.75		
31	2.00	1.54		
32	2.20	1.44		
33	2.60	1.26		
34	3.00	1.10		
35	3.40	0.965		
36	4.00	0.794		
37	4.60	0.660		
38	5.40	0.533		
39	6.20	0.432		
40	7.20	0.336		
41	8.20	0.266		
42	9.60	0.196		
43	11.00	0.146		
44	13.00	0.108		

CURRENT RESOLUTION MATRIIX NOT AVAILABLE

* Chip Miller

DATA SET: 2HGW12F

CLIENT:	US NAVY	DATE:	20-OCT-94
LOCATION:	PORT DEPOSIT, MD	WELL NO.:	2-GW-12
COUNTY:	CECIL	WELL DEPTH:	28.00 ft
PROJECT:	BAINBRIDGE NTC	WATER TABLE:	14.490 ft
AQUIFER:	Endless	THICKNESS:	13.51 ft
INTAKE RADIUS:	0.330 ft	CASING RADIUS:	0.330 ft
SCREEN TOP:	18.000 ft	SCREEN BASE:	28.00 ft
INITIAL HEAD:	2.865 ft	TRANS. RATIO:	1.0000

MODEL PARAMETERS:

TRANSMISSIVITY: 40.0 square cm/sec

CONDUCTIVITY: .0973 cm/sec

MODEL TYPE: UNCONFINED PARTIALLY PENETRATED AQUIFER (Bouwer & Rice)

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
1	0.00830	2.86	3.86	-34.74
2	0.0166	3.48	3.44	1.29
3	0.0250	3.74	3.06	18.18
4	0.0333	3.29	2.73	17.05
5	0.0416	3.08	2.43	20.83
6	0.0500	2.25	2.17	3.66
7	0.0583	2.16	1.93	10.55
8	0.0666	2.50	1.72	31.13
9	0.0833	1.35	1.37	-1.44
10	0.0916	0.717	1.22	-70.72
11	0.100	1.07	1.09	-1.60
12	0.116	1.53	0.867	43.35
13	0.125	0.876	0.772	11.83
14	0.150	0.565	0.547	3.16
15	0.166	0.438	0.435	0.639
16	0.200	0.0820	0.274	-234.8
17	0.216	0.177	0.218	-23.39
18	0.250	0.127	0.137	-8.50
19	0.283	0.0760	0.0870	-14.56
20	0.316	0.0500	0.0550	-10.02
21	0.366	0.0310	0.0276	10.94
22	0.416	0.0250	0.0138	44.57
23	0.466	0.0250		

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No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
24	0.533	0.0190		
25	0.600	0.0190		
26	0.683	0.0190		
27	0.766	0.0880		
28	0.883	0.0380		
29	0.983	0.146		
30	1.20	0.0440		
31	1.40	0.0440		
32	1.60	0.0440		
33	1.80	0.0440		
34	2.20	0.0440		
35	2.40	0.0440		
36	2.80	0.0500		
37	3.00	0.0500		

CURRENT RESOLUTION MATRIIX NOT AVAILABLE

* Chip Miller

DATA SET: 2HGW12R

CLIENT:	US NAVY	DATE:	20-OCT-94
LOCATION:	PORT DEPOSIT, MD	WELL NO.:	2-GW-12
COUNTY:	CECIL	WELL DEPTH:	28.00 ft
PROJECT:	BAINBRIDGE NTC	WATER TABLE:	14.490 ft
AQUIFER:	Endless	THICKNESS:	13.51 ft
INTAKE RADIUS:	0.330 ft	CASING RADIUS:	0.330 ft
SCREEN TOP:	18.000 ft	SCREEN BASE:	28.00 ft
INITIAL HEAD:	1.124 ft	TRANS. RATIO:	1.0000

MODEL PARAMETERS:

TRANSMISSIVITY: 31.0 square cm/sec

CONDUCTIVITY: .0754 cm/sec

MODEL TYPE: UNCONFINED PARTIALLY PENETRATED AQUIFER (Bouwer & Rice)

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.000E-04	4.50	4.40	2.00
2	0.0333	2.67	2.83	-5.91
3	0.0416	2.43	2.53	-3.95
4	0.0500	2.19	2.26	-3.12
5	0.0583	2.00	2.02	-1.41
6	0.0666	1.81	1.81	-0.363
7	0.0750	1.65	1.62	1.63
8	0.0833	1.48	1.45	2.16
9	0.100	1.21	1.16	4.07
10	0.108	1.08	1.04	3.55
11	0.125	0.883	0.833	5.58
12	0.141	0.698	0.668	4.28
13	0.158	0.552	0.534	3.13
14	0.183	0.393	0.383	2.51
15	0.208	0.266	0.274	-3.18
16	0.241	0.165	0.176	-6.69
17	0.275	0.114	0.112	1.08
18	0.308	0.0630	0.0723	-14.80
19	0.350	0.0380	0.0414	-9.13
20	0.400	0.0250	0.0212	14.84
21	0.450	0.0190		
22	0.516	0.0190		
23	0.583	0.0120		

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No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
24	0.666	0.0190		
25	0.766	0.0120		
26	0.866	0.0120		
27	0.983	0.0120		
28	1.20	0.0120		
29	1.40	0.00600		

CURRENT RESOLUTION MATRIIX NOT AVAILABLE

* Chip Miller

DATA SET: 2HGW12R

CLIENT:	US NAVY	DATE:	20-OCT-94
LOCATION:	PORT DEPOSIT, MD	WELL NO.:	2-GW-12
COUNTY:	CECIL	WELL DEPTH:	28.00 ft
PROJECT:	BAINBRIDGE NTC	WATER TABLE:	14.490 ft
AQUIFER:	Endless	THICKNESS:	13.51 ft
INTAKE RADIUS:	0.330 ft	CASING RADIUS:	0.330 ft
SCREEN TOP:	18.000 ft	SCREEN BASE:	28.00 ft
INITIAL HEAD:	1.124 ft	TRANS. RATIO:	1.0000

MODEL PARAMETERS:

TRANSMISSIVITY: 31.0 square cm/sec

CONDUCTIVITY: .0754 cm/sec

MODEL TYPE: UNCONFINED PARTIALLY PENETRATED AQUIFER (Bouwer & Rice)

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.000E-04	4.50	4.40	2.00
2	0.0333	2.67	2.83	-5.91
3	0.0416	2.43	2.53	-3.95
4	0.0500	2.19	2.26	-3.12
5	0.0583	2.00	2.02	-1.41
6	0.0666	1.81	1.81	-0.363
7	0.0750	1.65	1.62	1.63
8	0.0833	1.48	1.45	2.16
9	0.100	1.21	1.16	4.07
10	0.108	1.08	1.04	3.55
11	0.125	0.883	0.833	5.58
12	0.141	0.698	0.668	4.28
13	0.158	0.552	0.534	3.13
14	0.183	0.393	0.383	2.51
15	0.208	0.266	0.274	-3.18
16	0.241	0.165	0.176	-6.69
17	0.275	0.114	0.112	1.08
18	0.308	0.0630	0.0723	-14.80
19	0.350	0.0380	0.0414	-9.13
20	0.400	0.0250	0.0212	14.84
21	0.450	0.0190		
22	0.516	0.0190		
23	0.583	0.0120		

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DATA SET: 2HGW13F

CLIENT:	US NAVY	DATE:	19-OCT-94
LOCATION:	PORT DEPOSIT, MD	WELL NO.:	2-GW-13
COUNTY:	CECIL	WELL DEPTH:	42.50 ft
PROJECT:	BAINBRIDGE NTC	WATER TABLE:	6.550 ft
AQUIFER:	Endless	THICKNESS:	35.95 ft
INTAKE RADIUS:	0.330 ft	CASING RADIUS:	0.330 ft
SCREEN TOP:	38.000 ft	SCREEN BASE:	42.50 ft
INITIAL HEAD:	3.500 ft	TRANS. RATIO:	1.0000

MODEL PARAMETERS:

TRANSMISSIVITY: 29.5 square cm/sec

CONDUCTIVITY: .0269 cm/sec

MODEL TYPE: UNCONFINED PARTIALLY PENETRATED AQUIFER (Bouwer & Rice)

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.000E-04	3.50	2.92	16.33
2	0.00830	2.35	2.89	-23.33
3	0.0166	2.65	2.86	-8.04
4	0.0250	3.02	2.83	6.13
5	0.0333	3.05	2.80	8.07
6	0.0416	2.80	2.78	0.746
7	0.0583	2.43	2.72	-11.62
8	0.0666	2.83	2.69	4.89
9	0.0833	2.72	2.63	3.16
10	0.0916	2.68	2.61	2.59
11	0.108	2.71	2.55	5.70
12	0.125	2.56	2.50	2.39
13	0.141	2.47	2.45	0.971
14	0.191	2.19	2.30	-5.16
15	0.225	2.18	2.20	-1.13
16	0.258	2.09	2.11	-1.41
17	0.291	2.00	2.03	-1.29
18	0.333	2.10	1.92	8.24
19	0.400	1.58	1.77	-11.77
20	0.450	1.58	1.66	-5.38
21	0.516	1.32	1.53	-16.11
22	0.600	1.49	1.38	7.45
23	0.700	1.28	1.21	4.97

* Chip Miller

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No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
24	0.800	1.13	1.07	4.80
25	0.933	1.11		
26	1.00	0.972		
27	1.20	0.864		
28	1.40	0.781		
29	1.60	0.711		
30	1.80	0.603		
31	2.20	0.527		
32	2.60	0.470		
33	3.00	0.425		
34	3.40	0.393		
35	3.80	0.336		
36	4.40	0.298		
37	5.20	0.260		
38	6.00	0.228		
39	6.80	0.203		
40	7.80	0.171		

CURRENT RESOLUTION MATRIIX NOT AVAILABLE

* Chip Miller

DATA SET: 2HGW13R

CLIENT:	US NAVY	DATE:	19-OCT-94
LOCATION:	PORT DEPOSIT, MD	WELL NO.:	2-GW-13
COUNTY:	CECIL	WELL DEPTH:	42.50 ft
PROJECT:	BAINBRIDGE NTC	WATER TABLE:	6.550 ft
AQUIFER:	Endless	THICKNESS:	35.95 ft
INTAKE RADIUS:	0.330 ft	CASING RADIUS:	0.330 ft
SCREEN TOP:	38.000 ft	SCREEN BASE:	42.50 ft
INITIAL HEAD:	1.664 ft	TRANS. RATIO:	1.0000

MODEL PARAMETERS:

TRANSMISSIVITY: 12.2 square cm/sec

CONDUCTIVITY: .0111 cm/sec

MODEL TYPE: UNCONFINED PARTIALLY PENETRATED AQUIFER (Bouwer & Rice)

No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
1	1.000E-04	3.00	2.77	7.39
2	0.0416	2.59	2.66	-2.41
3	0.0500	2.62	2.63	-0.524
4	0.0666	2.72	2.59	4.85
5	0.0750	2.68	2.57	4.34
6	0.0833	2.61	2.54	2.63
7	0.100	2.62	2.50	4.56
8	0.108	2.50	2.48	1.04
9	0.125	2.46	2.44	1.00
10	0.150	2.38	2.37	0.183
11	0.175	2.25	2.31	-2.73
12	0.200	2.17	2.25	-3.93
13	0.225	2.14	2.19	-2.73
14	0.266	2.06	2.10	-2.06
15	0.308	1.95	2.01	-3.45
16	0.350	1.86	1.93	-3.47
17	0.400	1.76	1.83	-3.85
18	0.466	1.65	1.71	-3.66
19	0.550	1.51	1.56	-3.40
20	0.633	1.39	1.43	-3.04
21	0.716	1.29	1.32	-1.87
22	0.833	1.16	1.16	-0.0558
23	0.966	1.04	1.01	2.16

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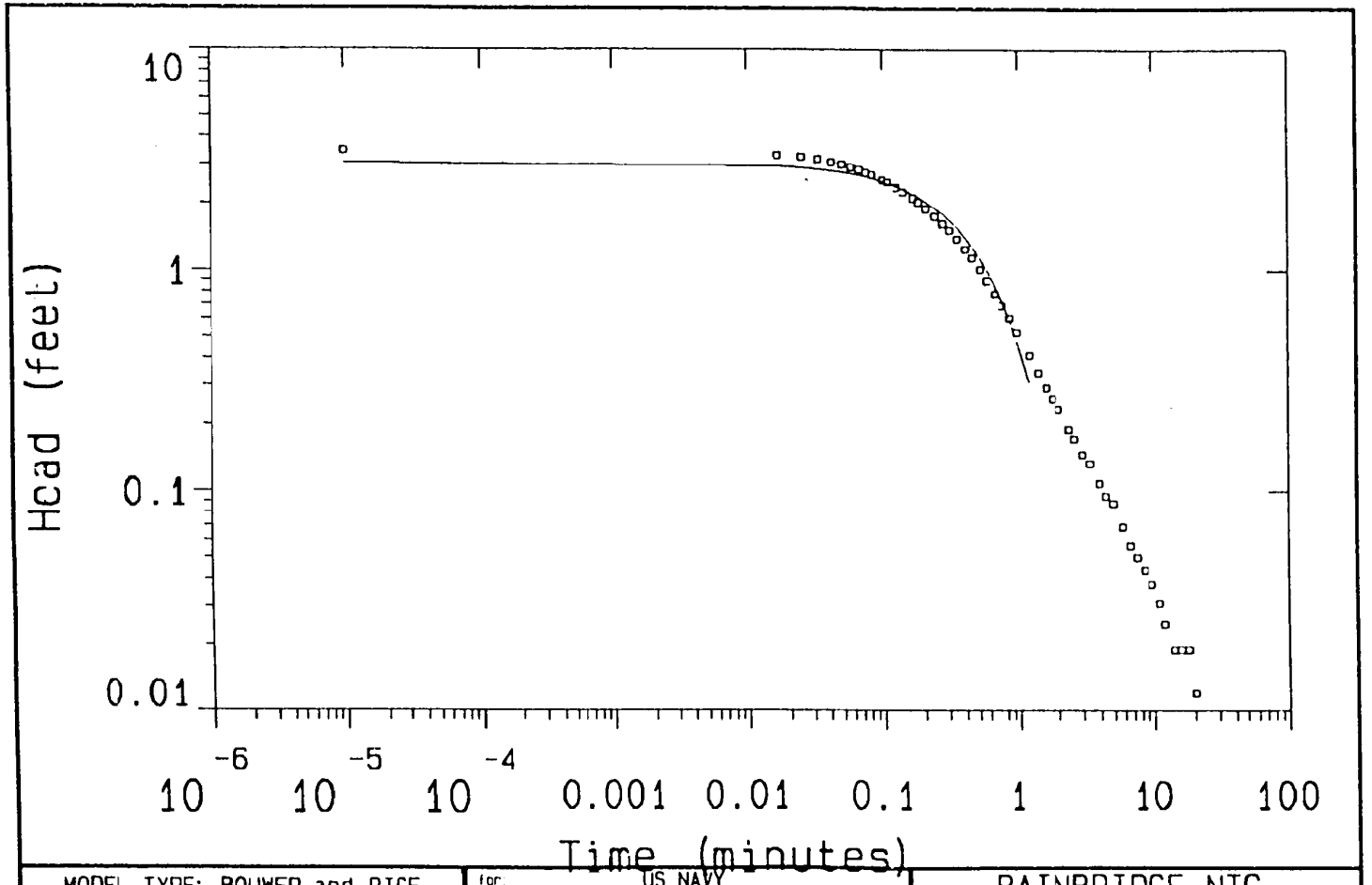
No.	TIME (mins)	Head, H (ft) DATA	SYNTHETIC	DIFFERENCE (percent)
24	1.20	0.864	0.799	7.48
25	1.40	0.743		
26	1.80	0.571		
27	2.00	0.508		
28	2.20	0.451		
29	2.60	0.362		
30	3.00	0.298		
31	3.60	0.228		
32	4.00	0.196		
33	4.80	0.133		
34	5.40	0.0950		
35	6.20	0.0630		
36	7.20	0.0250		
37	7.80	0.00600		

CURRENT RESOLUTION MATRIIX NOT AVAILABLE

* Chip Miller



MODEL TYPE: BOUWER and RICE	for: US NAVY	BAINBRIDGE NTC
CONDUCTIVITY: .01440 cm/sec	by: ECOLOGY AND ENVIRONMENT INC	Well: 1-GW-10
TRANSMISSIVITY: 25 06 sq. cm/sec	WELL DATA: Units: ft	PORT DEPOSIT, MD
INITIAL HEAD: 3.437 ft	AQUIFER: Endless	CECIL
Data Set: 1HGW10R / Date: 19-OCT-94	THICKNESS: 57.07	
	SCREEN: top: 35.00 base: 67.50	
	DIAMETER: casing: 1.000 intake: 1.000	
	DEPTH: Water Table: 5.000 TD: 67.50	

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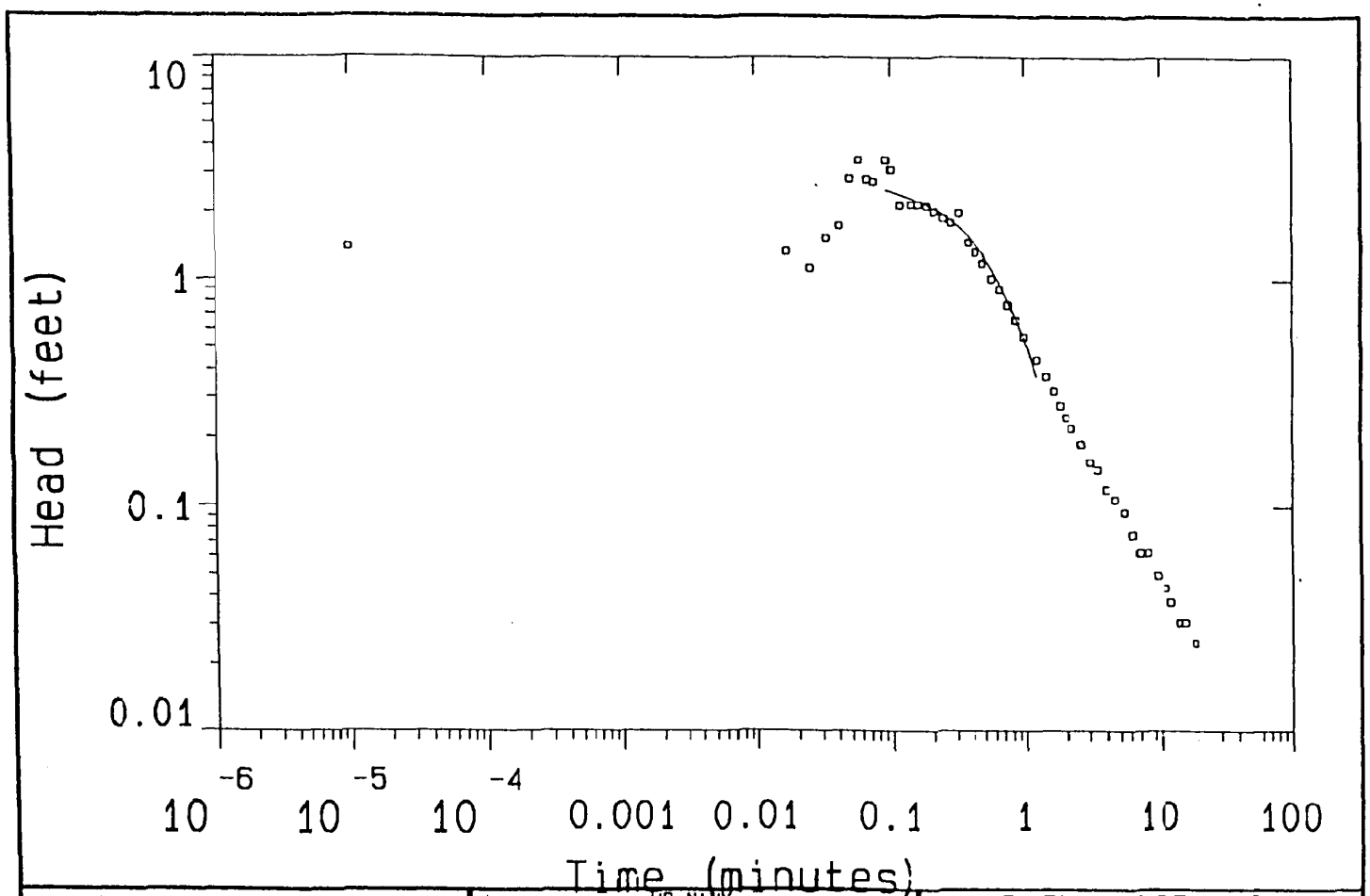


MODEL TYPE: BOUWER and RICE

CONDUCTIVITY: .007800 cm/sec

TRANSMISSIVITY: 11.90 sq. cm/sec

INITIAL HEAD: 1.378 ft

Data Set: 1HGW10F | Date: 19-OCT-94

for: US NAVY

by: ECOLOGY AND ENVIRONMENT INC.

WELL DATA: Units: ft

AQUIFER: Endless

THICKNESS: 50.07

SCREEN: top: 35.00 base: 67.50

DIAMETER: casing: 1.000 intake: 1.000

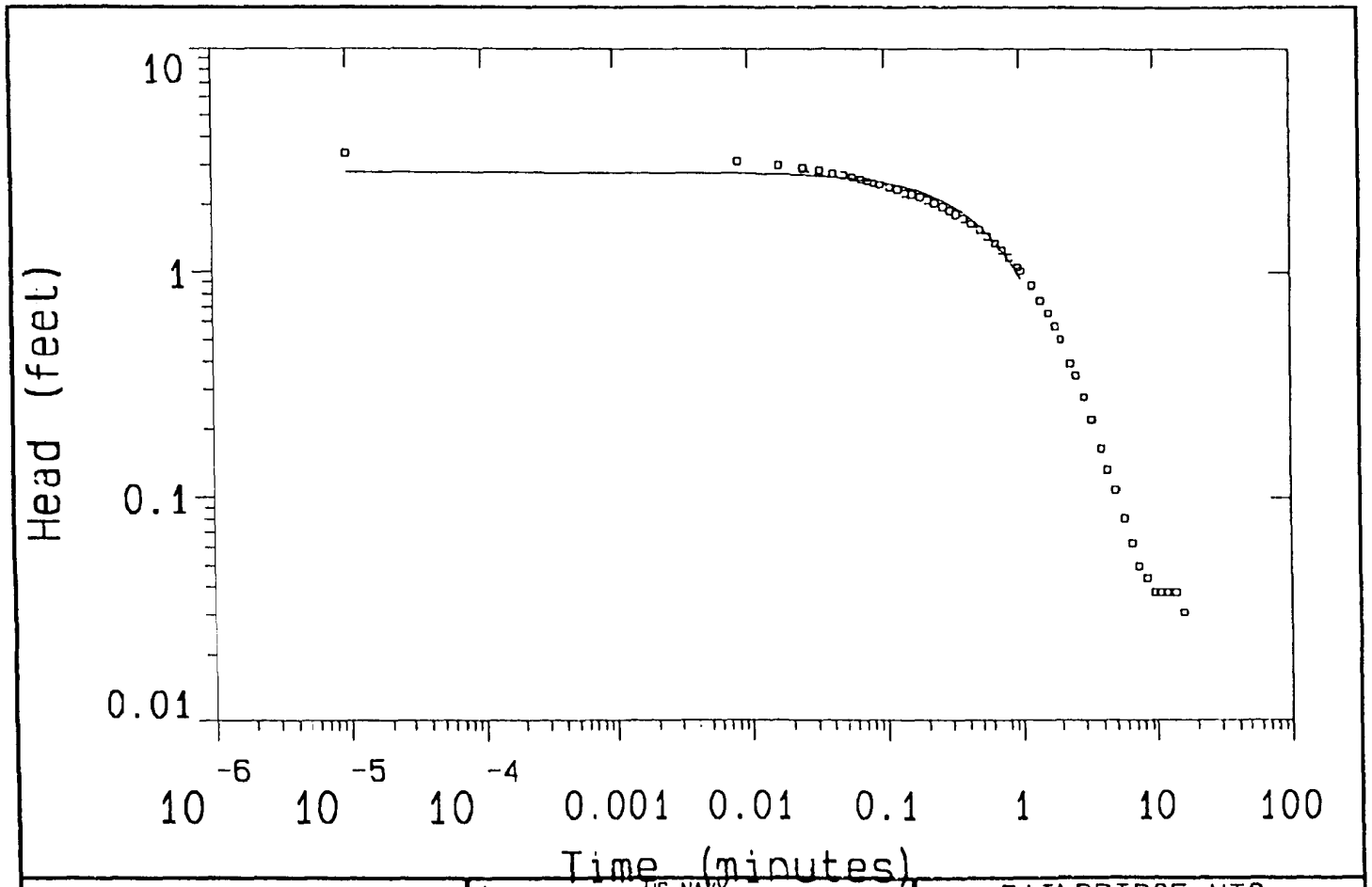
DEPTH: Water Table: 0.000 TD: 67.50

BAINBRIDGE NTC

Well: 1-GW-10

PORT DEPOSIT, MD

CECIL



MODEL TYPE: BOUWER and RICE	for: US NAVY	BAINBRIDGE NTC
CONDUCTIVITY: .004819 cm/sec	by: ECOLOGY AND ENVIRONMENT INC.	Well: 1-GW-11
TRANSMISSIVITY: 4.589 sq. cm/sec	WELL DATA: Units: ft	PORT DEPOSIT, MD
INITIAL HEAD: 3.373 ft	AQUIFER: Encless	CECIL
Data Set 1HGW119 / Date: 19-OCT-94	THICKNESS: 31.24	
	SCREEN: top: 20.00 base: 43.00	
	DIAMETER: casing: .6600 intake: 1.000	
	DEPTH: Water Table: 11.75 TD: 43.00	

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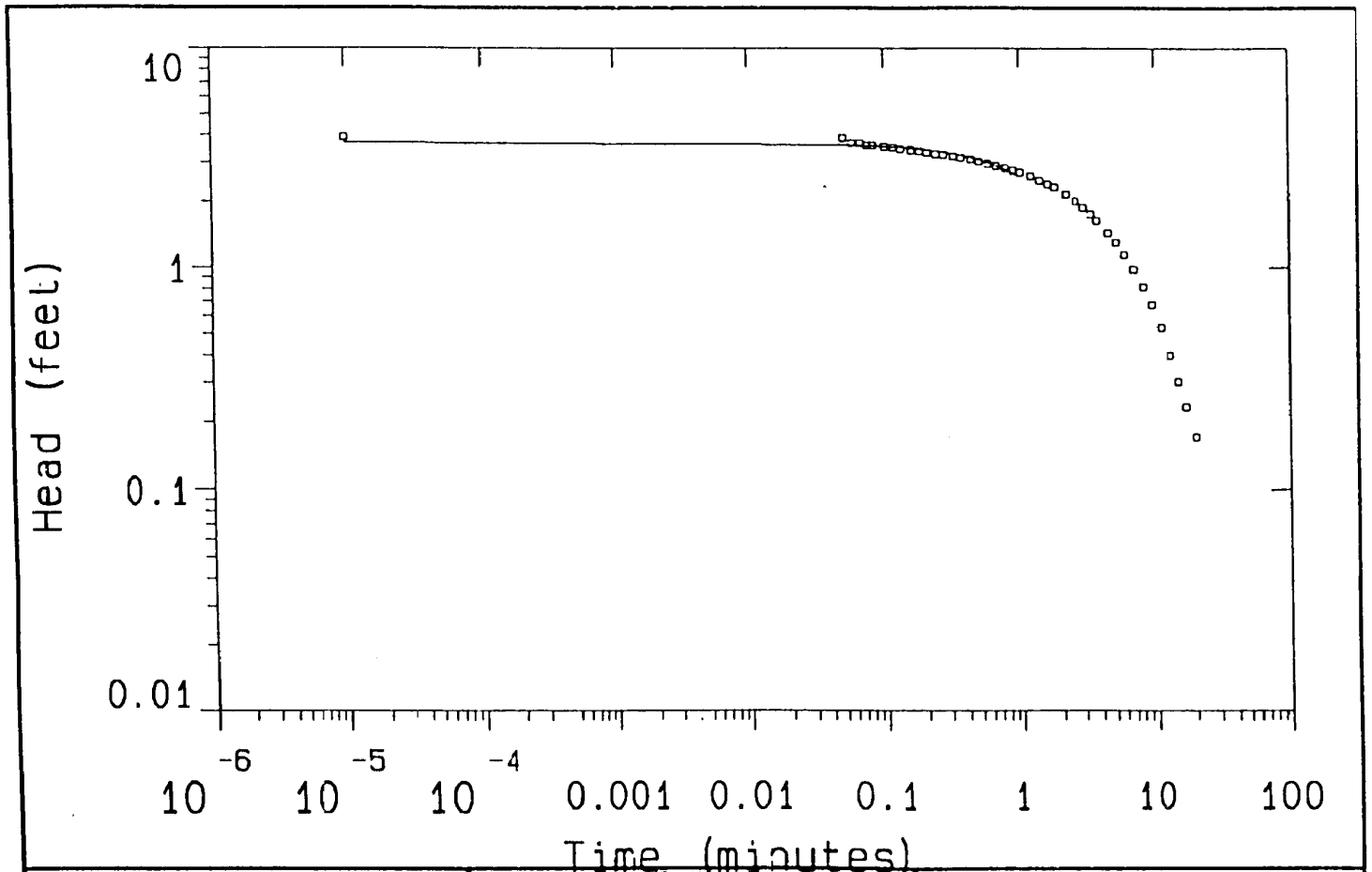
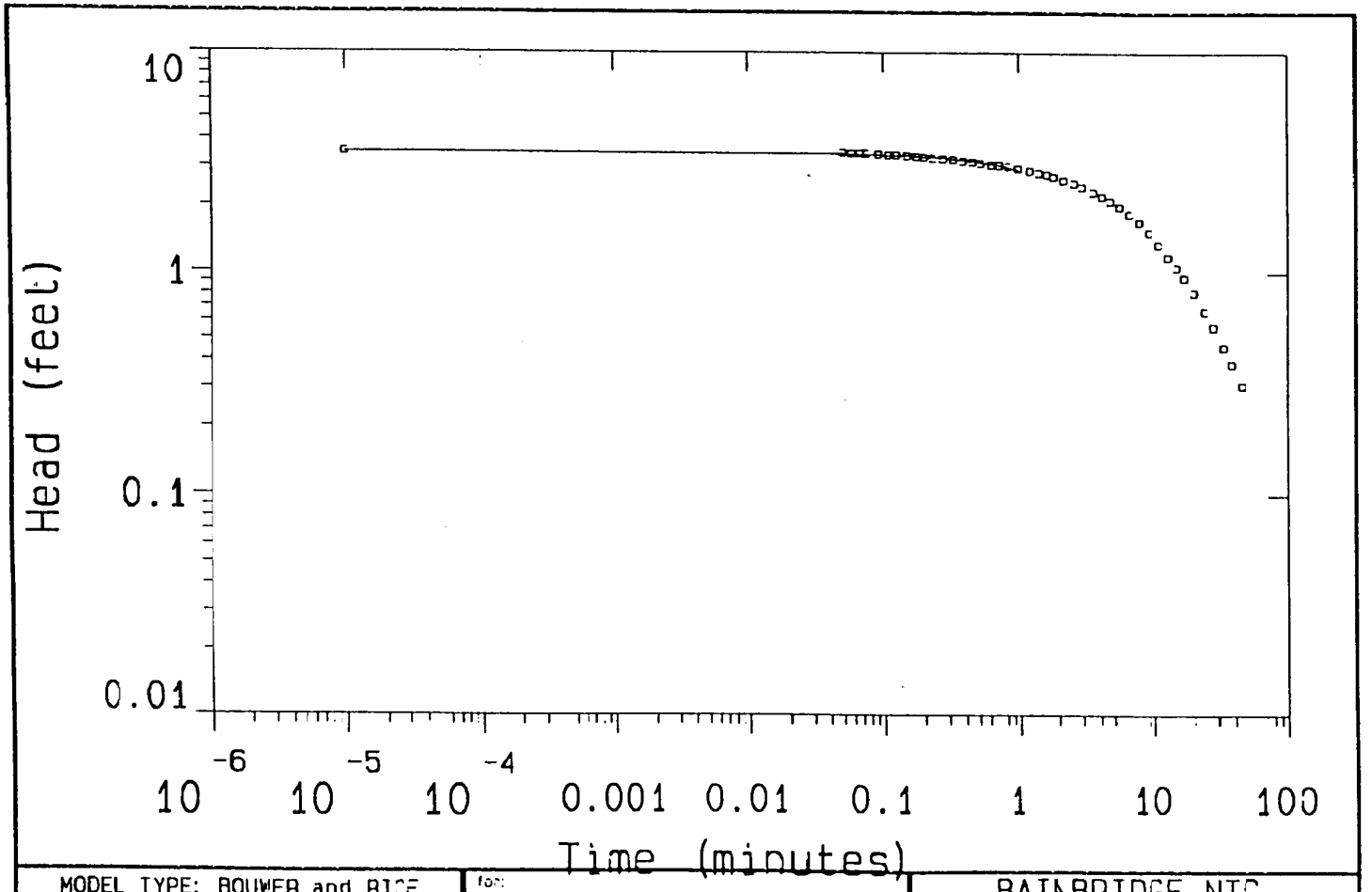


MODEL TYPE: BOUWER and RICE	for: US NAVY	BAINBRIDGE NTC
CONDUCTIVITY: .001817 cm/sec	by: ECOLOGY AND ENVIRONMENT INC.	Well: 1-GW12
TRANSMISSIVITY: 3.223 sq. cm/sec	WELL DATA: Units: ft	PORT DEPOSIT, MD
INITIAL HEAD: 3.890 ft	AQUIFER: Endless	CECIL
Data Set: 14GW129 / Date: 18-OCT-94	THICKNESS: 53.18	
	SCREEN: top 48.00 base: 70.00	
	DIAMETER: casing: .6600 intake: 1.000	
	DEPTH: Water Table: 0.000 TD: 70.00	



MODEL TYPE: BOUWER and RICE

CONDUCTIVITY: .0008488 cm/sec

TRANSMISSIVITY: 2.114 sq. cm/sec

INITIAL HEAD: 3.469 ft

Data Set: 1HGW139 | Date: 19-OCT-94

for:

by ECOLOGY AND ENVIRONMENT INC.

WELL DATA: Units: ft

AQUIFER: Endless

THICKNESS: 31.74

SCREEN: top: 74.00 base: 95.50

DIAMETER: casing: .6600 intake: 1.000

DEPTH: Water Table: 0.000 TD: 95.50

BAINBRIDGE NTC

Well: 1-GW-13

PORT DEPOSIT, MD

CECIL

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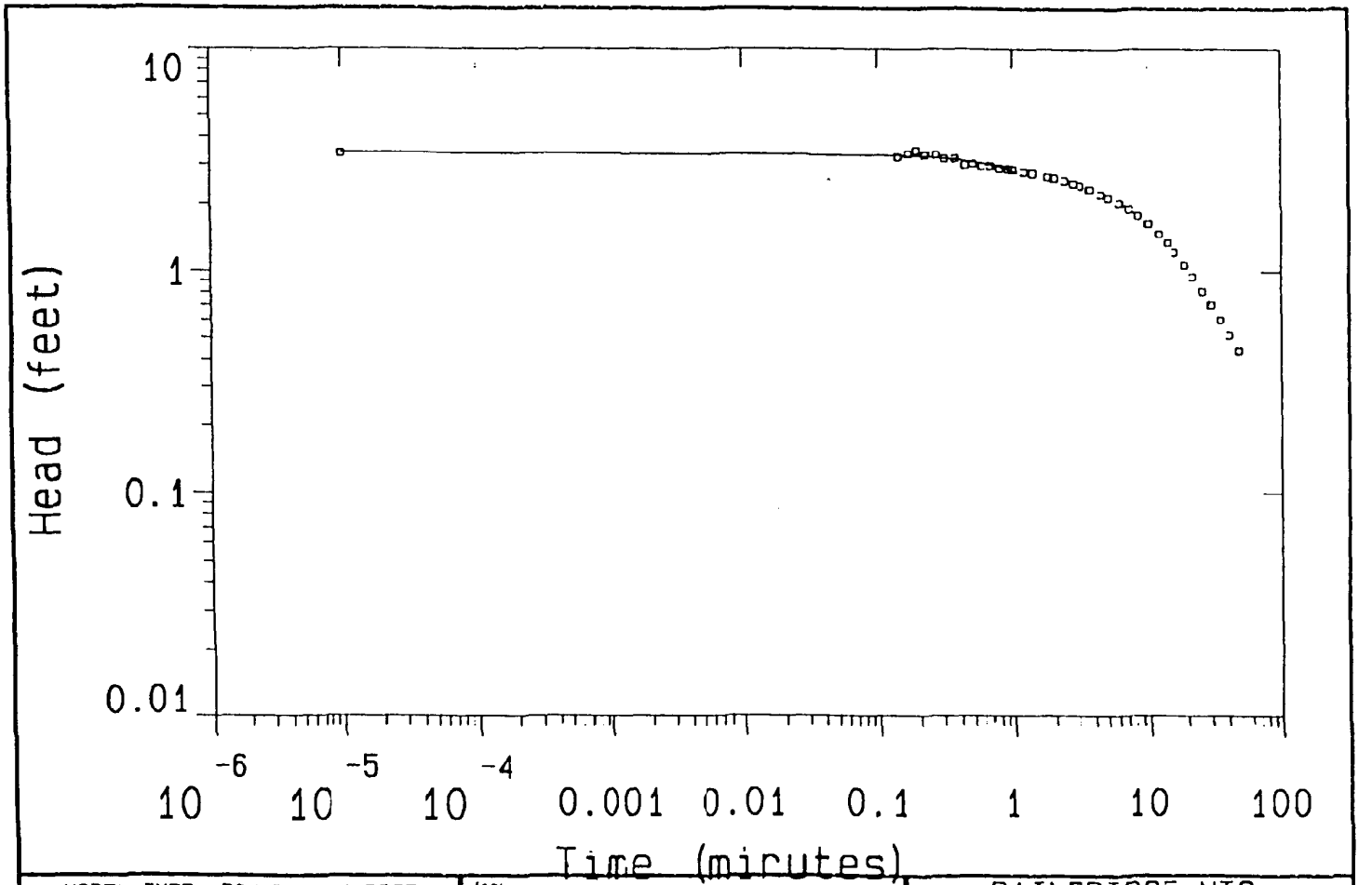
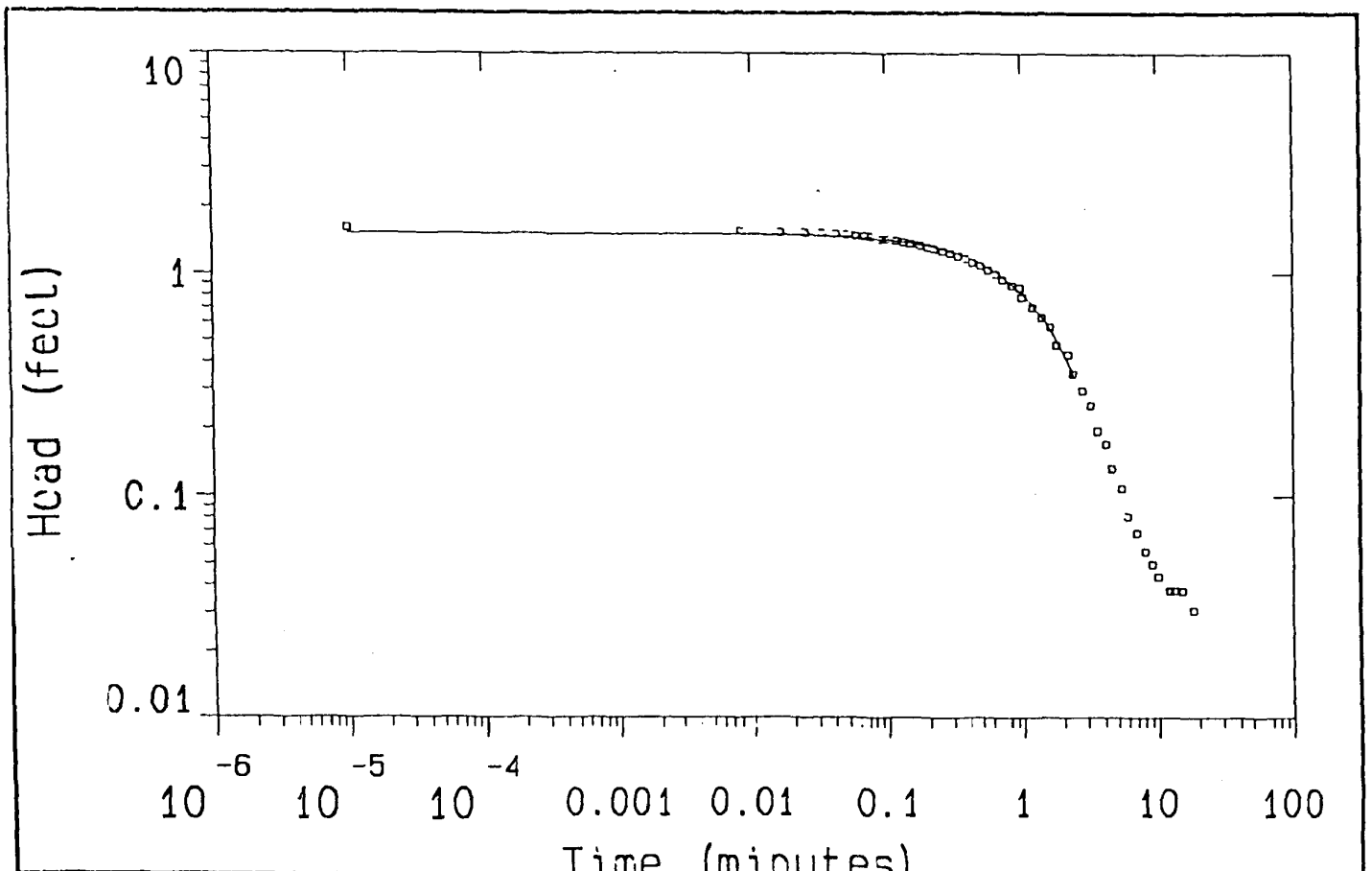


MODEL TYPE: BOUWER and RICE	for:	BAINBRIDGE NTC
CONDUCTIVITY: .0008363 cm/sec	by: ECOLOGY AND ENVIRONMENT INC.	Well: 1-GW-13
TRANSMISSIVITY: 2.083 sq. cm/sec	WELL DATA: Units: ft	PORT DEPOSIT, MD
INITIAL HEAD: 3.350 ft	AQUIFER: Endless	CECIL
Data Set: 1HGW13F / Date: 19-OCT-94	THICKNESS: 81.74	
	SCREEN: top: 74.00 base: 95.50	
	DIAMETER: casing: .6600 intake: 1.000	
	DEPTH: Water Table: 0.000 TD: 95.50	



MODEL TYPE: BOUWER and RICE CONDUCTIVITY: .006398 cm/sec TRANSMISSIVITY: .7216 sq cm/sec INITIAL HEAD: 1.607 ft	for: US NAVY by: ECOLOGY AND ENVIRONMENT INC WELL DATA: Units: ft AQUIFER: Endless THICKNESS: 3.700 SCREEN: top: 7.300 base: 12.30 DIAMETER: casing: .5600 intake: .6600 DEPTH: Water Table: 8.600 TD: 12.30	BAINBRIDGE NTC Well: 2-GW10 PORT DEPOSIT, MD CECIL
Data Set: 2WGW10	Date: 19-OCT-94	

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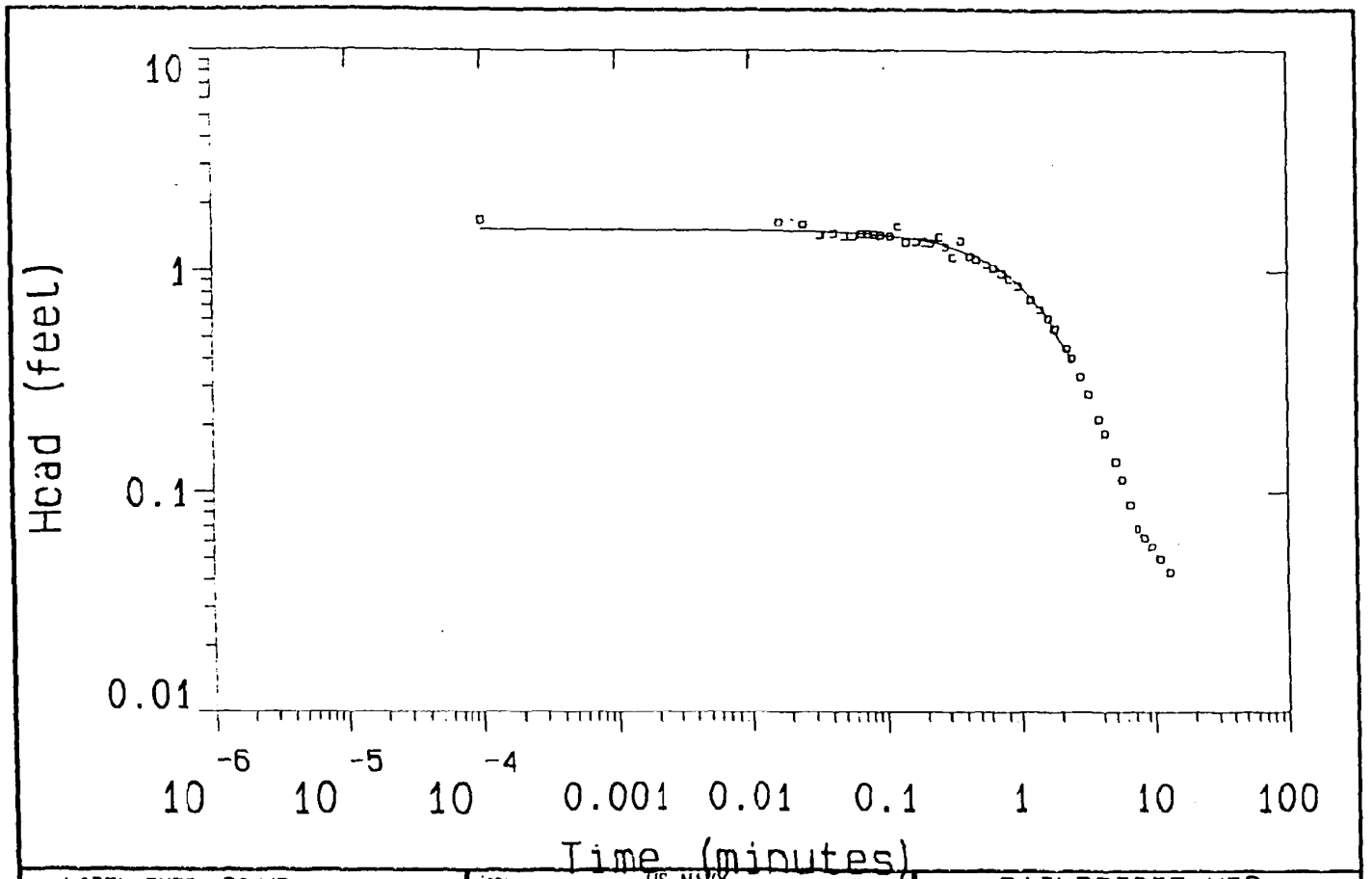
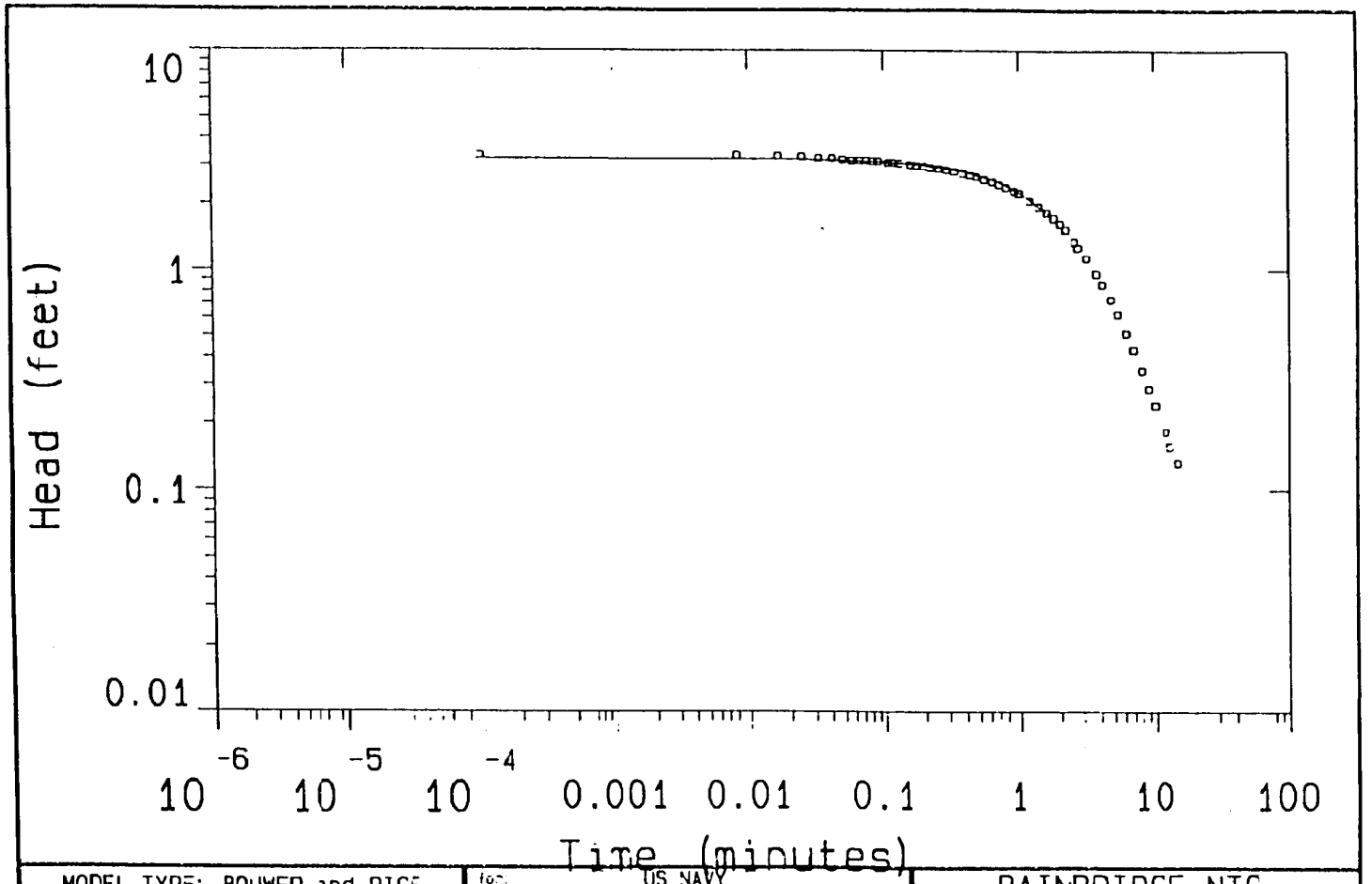


MODEL TYPE: BOUWER and RICE	for: US NAVY	BAINBRIDGE NTC
CONDUCTIVITY: .004894 cm/sec	by: ECOLOGY AND ENVIRONMENT INC.	Well: 2-GW10
TRANSMISSIVITY: .5519 sq. cm/sec	WELL DATA: Units: ft	PORT DEPOSIT, MD
INITIAL HEAD: 1.251 ft	AQUIFER: Endless	CECIL
Data Set: 2-GW10F / Date: 19-OCT-94	THICKNESS: 3.700	
	SCREEN: top: 7.300 base: 12.30	
	DIAMETER: casing: 6600 intake: .6600	
	DEPTH: water table: 8.600 TD: 12.30	



MODEL TYPE: BOUWER and RICE CONDUCTIVITY: .001667 cm/sec TRANSMISSIVITY: 2.558 sq. cm/sec INITIAL HEAD: 3.310 ft	for: US NAVY by: ECOLOGY AND ENVIRONMENT INC. WELL DATA: Units: ft AQUIFER: Endless THICKNESS: 50.32 SCREEN: top: 28.00 base: 51.00 DIAMETER: casing: .6600 intake: .6600 DEPTH: Water Table: 3.000 TD: 51.00	BAINBRIDGE NTC Well: 2-GW-11 PORT DEPOSIT, MD CECIL
Data Set: 2HGW119 Date: 20-OCT-94		

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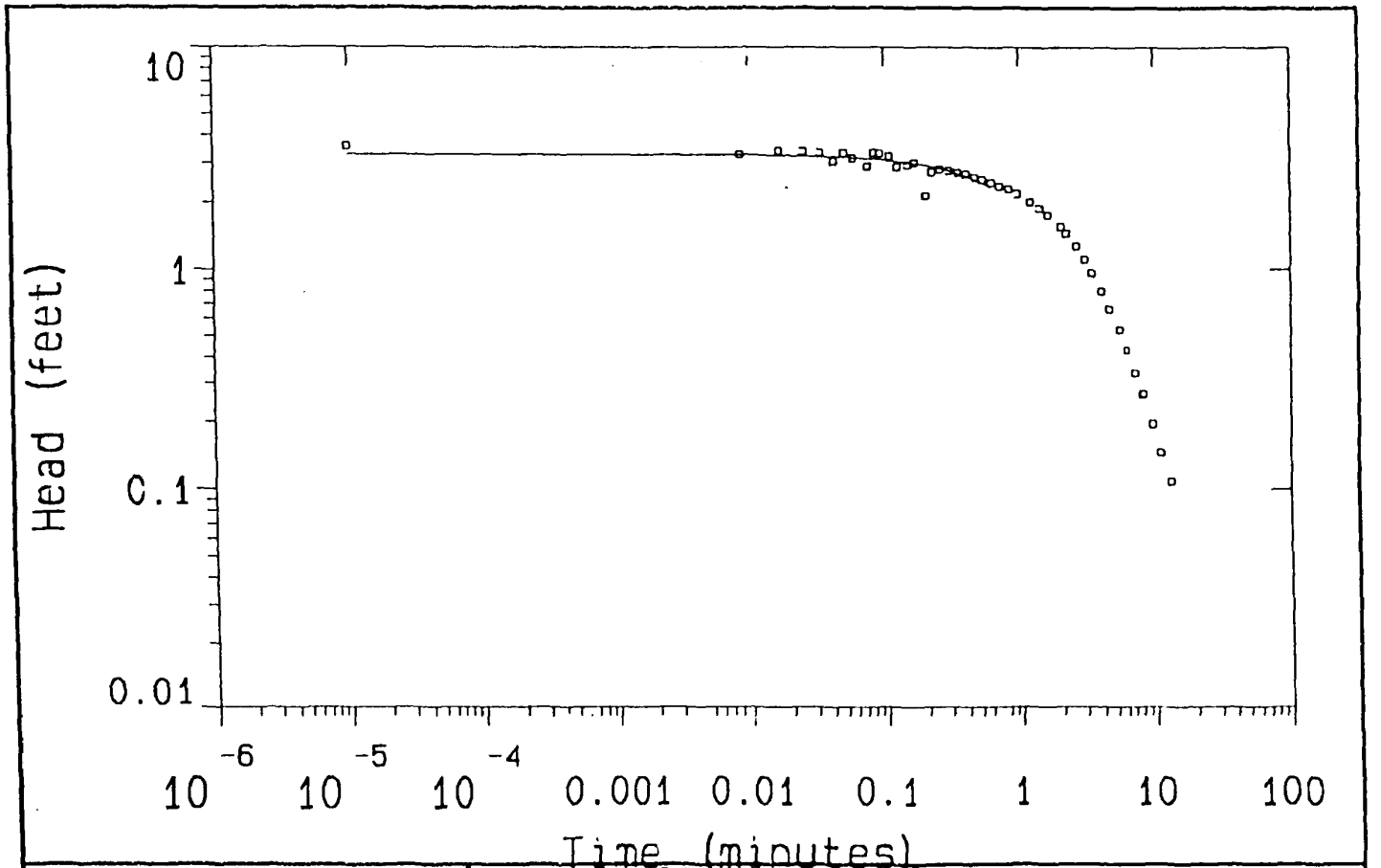
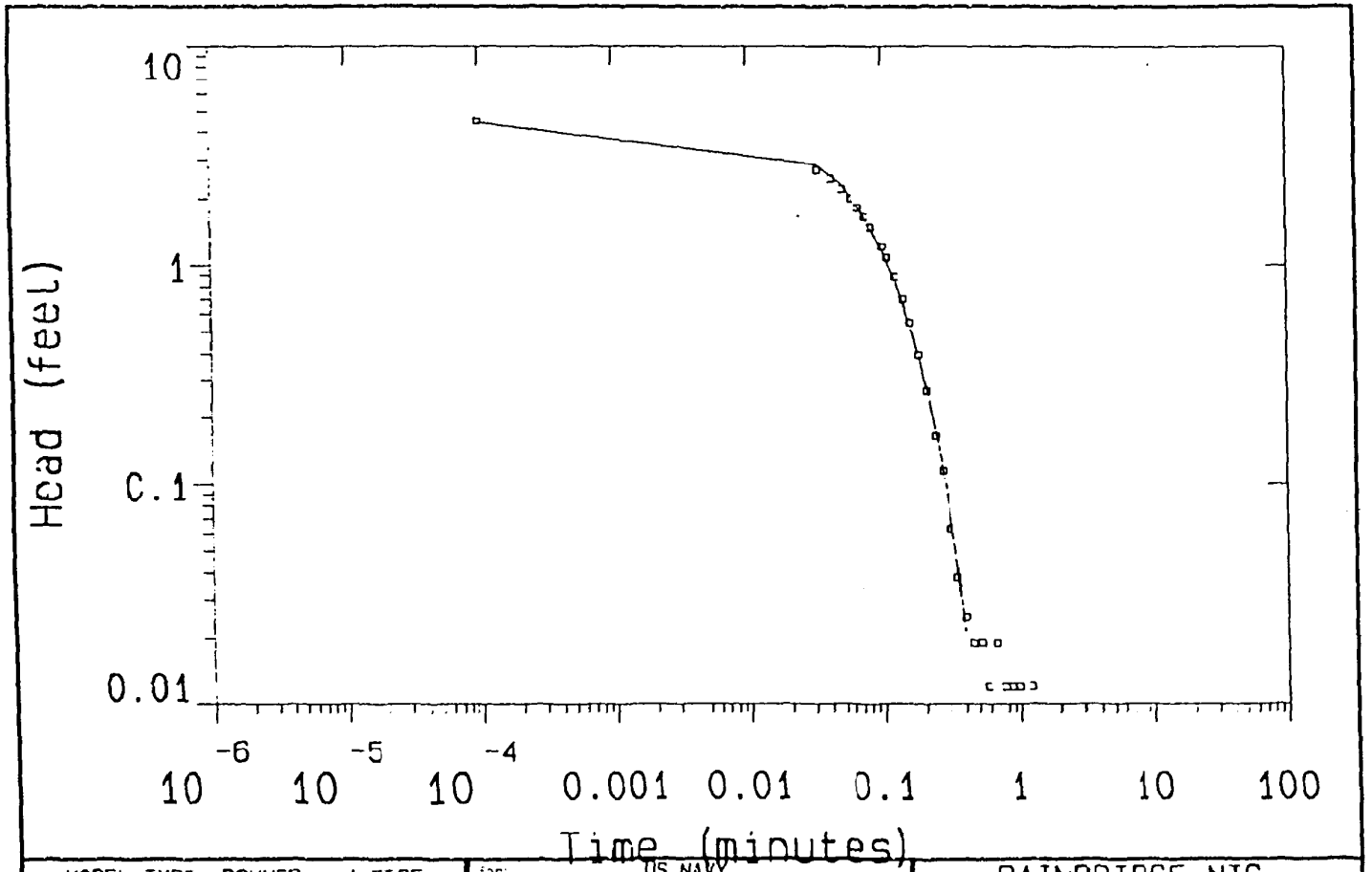


MODEL TYPE: BOUWER and RICE	for: US NAVY	BAINBRIDGE NTC
CONDUCTIVITY: .003114 cm/sec	by: ECOLOGY AND ENVIRONMENT INC	Well: 2-GW-11
TRANSMISSIVITY: 4.777 sq. cm/sec	WELL DATA: Units: ft	PORT DEPOSIT, MD
INITIAL HEAD: 3.551 ft	AQUIFER: Endless	CECIL
Data Set: 2GW11F / Date: 20-OCT-94	THICKNESS: 50.32	
	SCREEN: top: 28.00 base: 51.00	
	DIAMETER: casing: 6600 intake: .5600	
	DEPTH: Water Table: 0.000 TD: 51.00	



MODEL TYPE: BOUWER and RICE	for: US NAVY	BAINBRIDGE NTC
CONDUCTIVITY: .07540 cm/sec	by: ECOLOGY AND ENVIRONMENT INC.	Well: 2-GW-12
TRANSMISSIVITY: 31.04 sq. cm/sec	WELL DATA: Units: ft	PORT DEPOSIT, MD
INITIAL HEAD: 1.124 ft	AQUIFER: Endless	CECIL
Data Set: 2-GW12B / Date: 20-OCT-94	THICKNESS: 13.51	
	SCREEN: top: 18.00 base: 28.00	
	DIAMETER: casing: .6600 intake: .6600	
	DEPTH: Water Table: 14.49 TD: 28.00	

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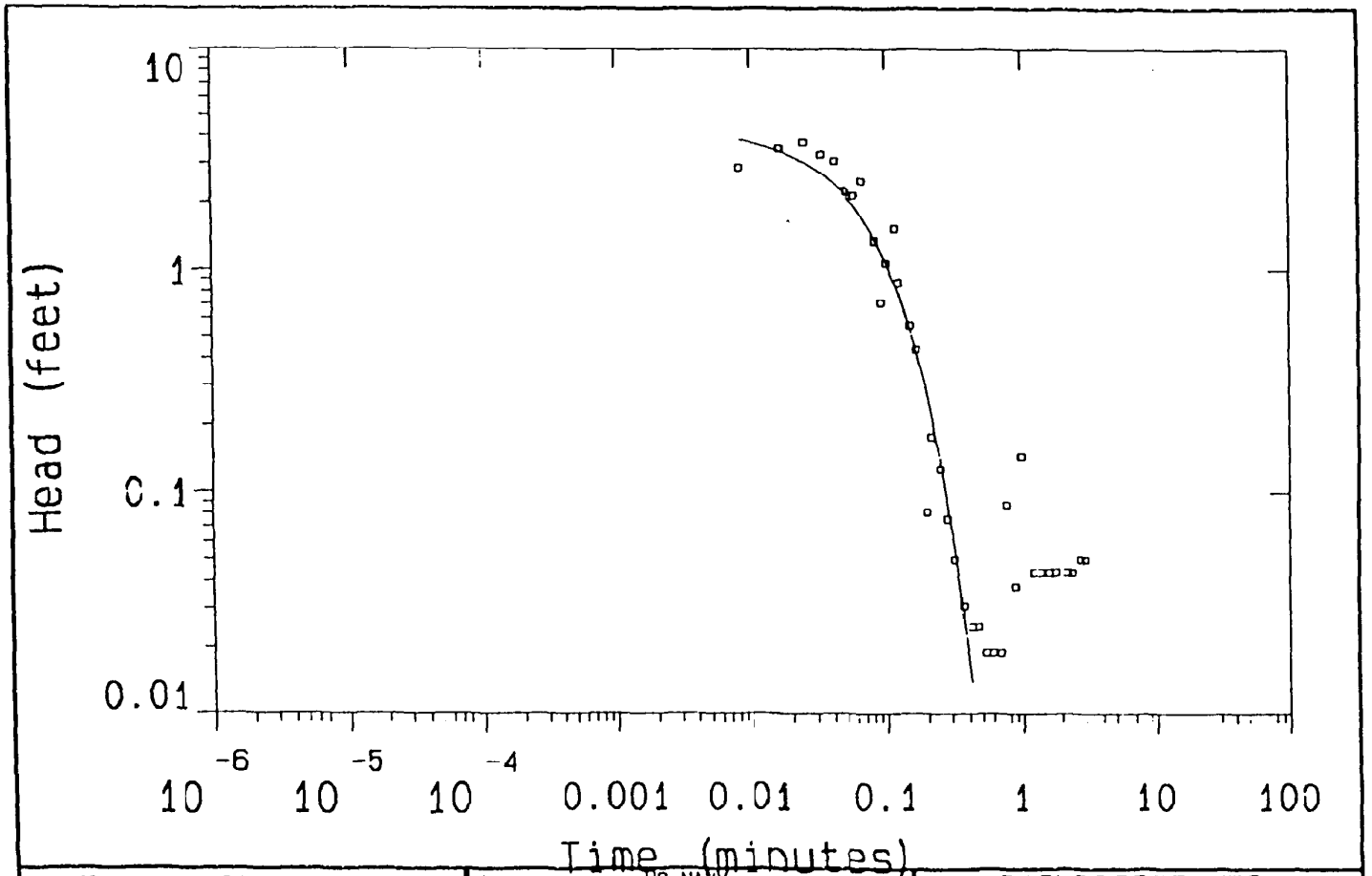


MODEL TYPE: BOUWER and RICE

CONDUCTIVITY: .09731 cm/sec

TRANSMISSIVITY: 40.07 sq. cm/sec

INITIAL HEAD: 2.865 ft

Data Set: 2HGW12F | Date: 20-OCT-94

for: US NAVY

by: ECOLOGY AND ENVIRONMENT INC.

WELL DATA: Units: ft

AQUIFER: Endless

THICKNESS: 13.51

SCREEN: top: 18.00 base: 28.00

DIAMETER: casing: .6600 intake: .6600

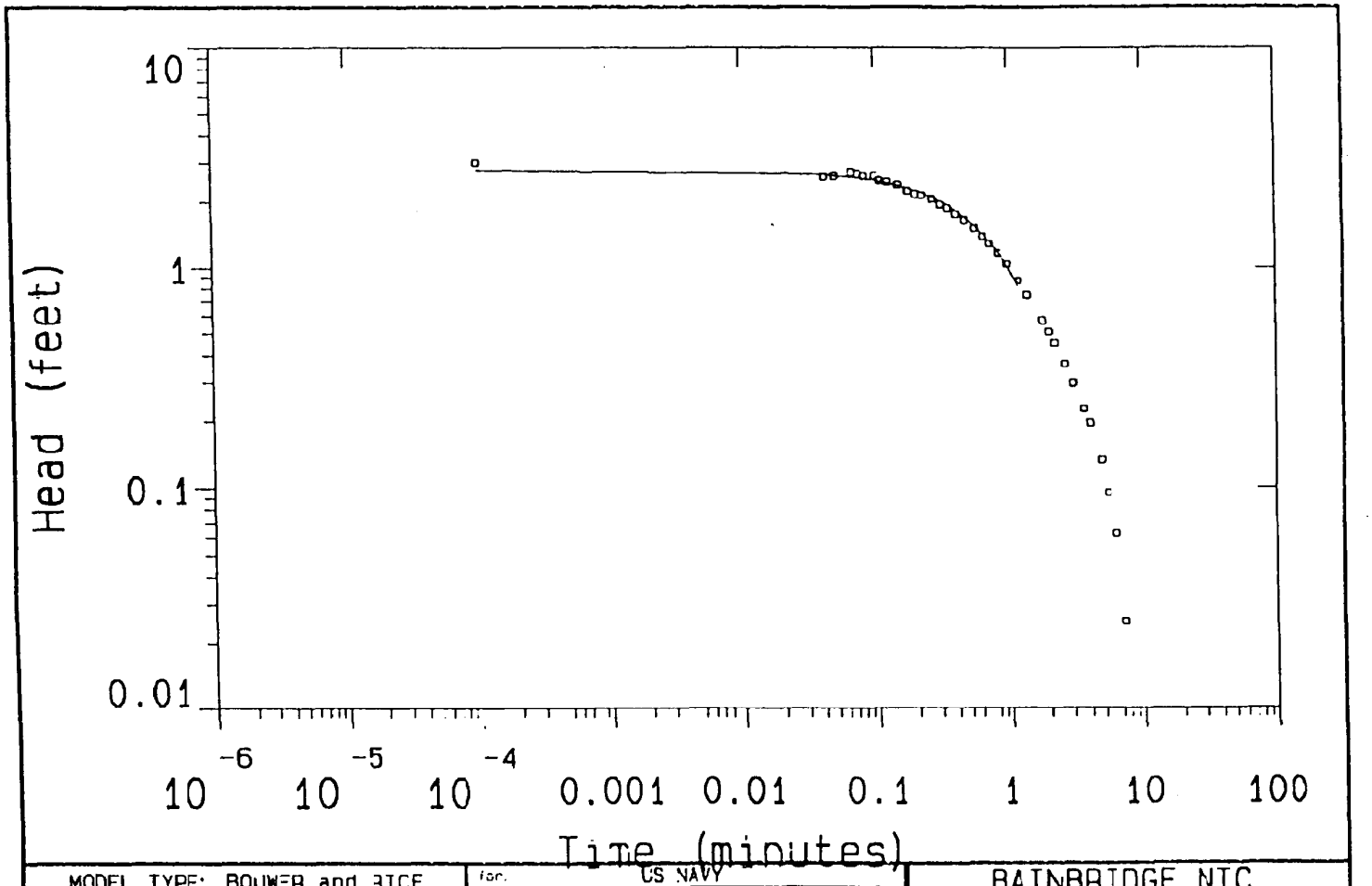
DEPTH: Water Table: 14.49 TD: 28.00

BAINBRIDGE NTC

Well: 2-GW-12

PORT DEPOSIT, MD

CECIL



MODEL TYPE: BOUWER and RICE	for: US NAVY	BAINBRIDGE NTC
CONDUCTIVITY: .01116 cm/sec	by: ECOLOGY AND ENVIRONMENT INC.	Well: 2-GW-13
TRANSMISSIVITY: 12.22 sq. cm/sec	WELL DATA: Units: ft	PORT DEPOSIT, MD
INITIAL HEAD: 1.664 ft	AQUIFER: Endless	CECIL
Data Set: 2HGW13A / Date: 19-OCT-94	THICKNESS: 35.95	
	SCREEN: top: 38.00 base: 42.50	
	DIAMETER casing: .6600 intake: .6600	
	DEPTH: Water Table: 6.550 TD: 42.50	

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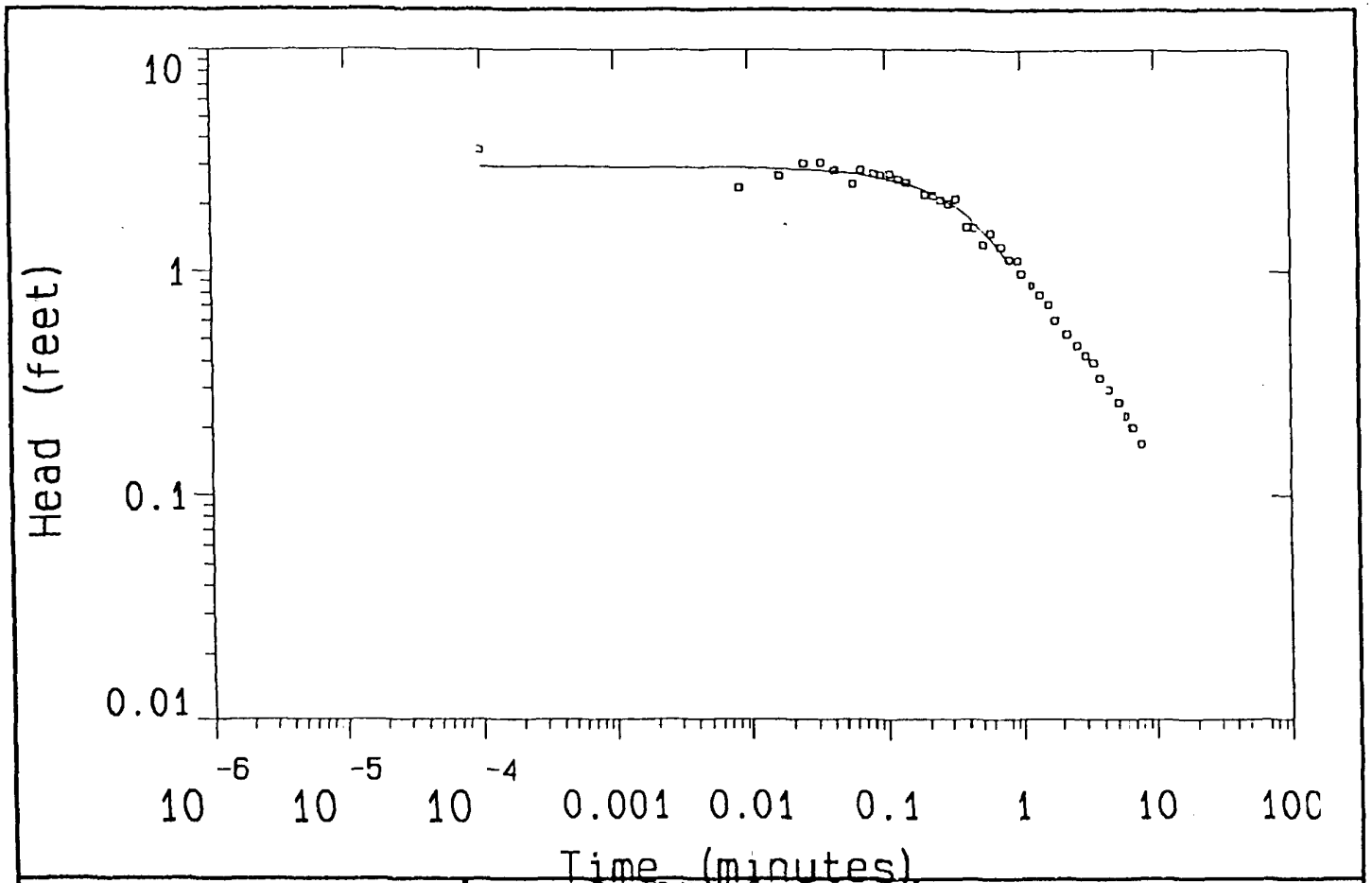

MODEL TYPE: BOUWER and RICE

CONDUCTIVITY: .02693 cm/sec

TRANSMISSIVITY: 29.51 sq. cm/sec

INITIAL HEAD: 3.500 ft

Data Set: 2HGW13F | Date: 19-OCT-94

for: US NAVY

by: ECOLOGY AND ENVIRONMENT INC

WELL DATA: Units: ft

AQUIFER: Endless

THICKNESS: 35.95

SCREEN: top: 38.00 base: 42.50

DIAMETER: casing: .6600 intake: .6600

DEPTH: Water Table: 6.550 TD: 42.50

BAINBRIDGE NTC

Well: 2-GW-13

PORT DEPOSIT, MD

CECIL

G Quality Assurance/Quality Control Data Validation Reports

This appendix contains letters concerning reports on the validation of all samples collected by E & E at the NTC during the 1991 and 1994 sampling events. The appendix is divided into several sections that are organized by sampling event.

January 1991 Sampling Event

DATA VALIDATION SUMMARY

Bainbridge Navy Remedial Investigation
E & E Data Package 9100.194
Sampling Dates January 23-25, 1991

INTRODUCTION

This Data Validation Summary report was generated for Work Order #1 for soil and water analyses for the Bainbridge Navy Remedial Investigation. The analytical laboratory work was performed by Ecology and Environment, Inc. (E & E's) Analytical Services Center.

The data package includes 14 soil and 5 water samples. Analytical testing consisted of volatile organic analyses by Gas Chromatography/Mass Spectroscopy (GC/MS); Benzene, Ethyl Benzene, Toluene and Xylene (BETX) by GC; Base/Neutral and Acid Extractable Organics by GC/MS; Pesticides and PCB's by GC; Total Petroleum Hydrocarbons by Infrared Spectrophotometry; Inorganics by Atomic Absorption (AA)and Inductively Coupled Argon Plasma (ICP); Mercury by Cold Vapor; and Cyanides by Spectrophotometry.

The following report provides a summary of data acceptability and deviations in accordance with the Naval Energy and Environmental Support Activity (NEESA) Level C Data Validation Requirements. The site-specific Work Plan and Quality Assurance Project Plan (QAPP) were reviewed. These documents detailed the project background and requirements for the investigation.

VOLATILE ORGANICS BY GC/MS

OVERALL ASSESSMENT OF DATA

All volatile organic data generated by GC/MS are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms. The data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

All Holding times were met within the acceptable time frame of 7 days for unpreserved and 14 days for preserved water samples. The soil holding time of 14 days was also met.

II. GC/MS Tuning

All tuning was generated within the acceptable limits for Bromofluorobenzene (BFB).

III. Calibration

All initial and continuing calibration was performed within acceptable limits for average Relative Response Factors (RRF), Percent Relative Standard Deviation (%RSD), Relative Response Factors (RRF), and Percent Difference (%D).

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IV. Blanks

a.) Field Blanks: The following compounds were detected in the 5 field blanks: chloromethane, methylene chloride, acetone, carbon disulfide, chloroform, 1,2-dichloroethane, bromodichloromethane and toluene. A public water supply was utilized for collection of the field blank on 1/23/91. This water was used for steam cleaning followed by a deionized water rinse. This field blank cannot be used to qualify the analytical data because of the trihalomethane contamination present. The field blanks which were used to determine contamination included Rinsates 1 and 2 and Trip blanks 1 and 2.

The highest concentrations of the compounds detected in the field blanks are listed as follows: chloromethane in Rinsate #2 at 11 ug/l, methylene chloride in both trip blanks at 12 ug/l, acetone in Rinsate #1 at 14 ug/l and toluene in Trip blank #2 at 3 ug/l. Chloromethane was not found in any of the asociated samples. The samples were qualified for acetone and methylene chloride through the laboratory blanks. The exceptions to this are noted within the text as appropriate. The limit used for the review of toluene contamination was 30 ug/l. Results found to be below the 30ug/l were qualified as 'U', not detected. Carbon disulfide was detected in Rinsate #2 and Trip Blank #2 at 2 ug/l, estimated. The limit for carbon disulfide review is 10 ug/l. Sample 2GW-9-SB1 was found to contain 37 ug/kg of carbon disulfide. No other carbon disulfide contamination was noted within the samples. Carbon disulfide was not detected in any of the method blanks. The summary of the laboratory blanks is detailed in the following paragraphs.

b.) Laboratory (Method) Blanks: The following compounds were detected in the 6 method blanks: methylene chloride, acetone, 2-butanone and toluene. The laboratory method blank VBLKW1 for water is associated with the following samples: Field blank, Rinsates 1and 2, Trip blanks 1 and 2, the Field blank MS and MSD. Laboratory blank VBLKW1 was found to contain methylene chloride and acetone at 9 and 14 ug/l, respectively. The limits utilized to assess the associated samples are 90 ug/l for methylene chloride and 140 ug/l for acetone. The associated samples were qualified with 'U', not detected.

Laboratory method blank VBLKM1 for soil is associated with sample 2BH-1A at the medium level. Laboratory blank VBLKM1 was found to contain 1700 ug/kg of methylene chloride and 500 ug/kg as an estimated value for toluene. The limits used to assess sample 2BH-1A included: 17,000 ug/kg for methylene chloride and 5,000 ug/kg for toluene. Toluene was not detected in sample 2BH-1A. The sample was qualified as 'U' for methylene chloride. Acetone was not present in the method blank. A limit of 140 ug/l for acetone from Rinsate #1 was utilized to determine if qualification was necessary. The 1,100 ug/kg of acetone detected in the sample exceeds this limit, therefore, no qualification is necessary.

Laboratory method blank VBLKM2 for soil is associated with 2BH-3A1 at the medium level. Laboratory blank VBLKM2 was found to contain 790 ug/kg of methylene chloride and 140 ug/kg as an estimated value of toluene. The limits used to assess the sample 2BH-3A1 includes 7,900 ug/kg for methylene chloride and 1,400 ug/kg for toluene. The sample was qualified with 'U' for these compounds. Acetone was not present in the method blank. The limit of 140 ug/l for acetone from Rinsate #1 was utilized for review. The sample exceeds this limit, therefore, no qualification is necessary.

Laboratory method blank VBLKS1 for low level soil is associated with the following: 2BH-1B, 2BH-1C, 2BH-2A, 2BH-2B, 2BH-3B, 2BH-4B, 2GW-9-SB2 and 2GW-9-SB2A. Laboratory blank VBLKS1 was found to contain methylene chloride at 7 ug/kg and 23 ug/kg of acetone. The associated limits for review of the samples included 70 ug/kg for methylene chloride and 230 ug/kg for acetone. The associated samples were qualified with 'U'.

Laboratory method blank VBLKS2 for low level soil is associated with the following samples: 2BH-4A, 2GW-9-SB1, 2GW-9-SB1MS and MSD. Laboratory blank VBLKS2 was found to contain methylene chloride at 13 ug/kg, 9 ug/kg estimated, for acetone and 3 ug/kg estimated, for 2-Butanone. The associated limits for review are 130 ug/kg for methylene chloride, 90 ug/kg for acetone and 30 ug/kg for 2-Butanone. The samples which were found to contain levels of the contaminant lower than the limit were qualified with 'U'. The values which exceeded the limit are considered to contain the compound of interest at the level indicated.

Laboratory method blank VBLKS3 for low level soil is associated with samples 2BH-3A and 2BH-4C. The laboratory blank VBLKS3 was found to contain methylene chloride at 5 ug/kg and acetone at 5 ug/kg, estimated. The limits used to assess the samples are 50 ug/kg for both methylene chloride and acetone. The methylene chloride found in the samples were qualified as 'U'. The acetone exceeded the limit of both 50 ug/kg in the method blank and 140 ug/l in Rinsate #1, therefore, needed no qualification.

V. Surrogate Recovery

BFB surrogate recovery was reported low and out of specification at 68% and 70% for soil samples 2GW-9-SB1MS and 2GW-9-SB1MSD, respectively. The QC limit for BFB Surrogate Recovery is (74-121%). The analytical data was qualified appropriately with 'J' or 'UJ'. The positive results are qualified as 'J' and the nondetectable compounds 'UJ' as estimated, for the volatiles in this MS/MSD only.

VI. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

All MS/MSD's were generated within acceptable limits for Relative Percent Difference (RPD) and Percent Recovery (%R).

VII. Internal Standards Performance

All internal standards were generated within acceptable specifications for area counts and retention time variation.

SEMI-VOLATILE ORGANICS BY GC/MS
(Base/Neutral and Acid Extractable Organics)

OVERALL ASSESSMENT OF DATA

All base/neutral and acid extractable organic data generated by GC/MS are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms. The data has been generated in accordance with the site-specific QAPP and project requirements.

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I. Holding Times

Soil sample 2BH-1A was re-extracted and re-analyzed due to unacceptable surrogate recoveries generated from the initial analytical run. The second run was performed after the 14 day holding time for soil extraction. Acceptable recoveries were generated for the second run. The data was appropriately qualified with 'J' or 'UJ'. The positive results are qualified as 'J' and the nondetectable compounds 'UJ' as estimated, for all semi-volatiles in sample 2BH-1A.

Two water samples (Field Blank and Rinsate #1) collected on 1/23/91, were extracted on 1/31/91. This exceeded the 7 day extraction holding time for water samples by one day. The positive results in these two samples which were not already qualified as 'U' based on the blank results are qualified 'J'. The nondetectable compounds are qualified 'UJ' as estimated.

II. GC/MS Tuning

All tuning was generated within acceptable limits for Decafluorotriphenylphosphine (DFTPP).

III. Calibration

All initial and continuing calibration was performed within acceptable limits for RRF, %RSD, RRF, and %D.

IV. Blanks

a.) Field Blanks: Bis(2ethylhexyl)phthalate was detected in the 3 field blanks. These samples included Field Blank, Rinsate #1 and Rinsate #2. The highest level of bis(2ethylhexyl) phthalate among the field blanks was 4 ug/kg, estimated in Rinsate #1. All samples were qualified for bis(2ethylhexyl) phthalate through the corresponding method blanks. These are detailed below.

b.) Laboratory (Method) Blanks: Bis(2ethylhexyl)phthalate was detected in the 3 method blanks. These samples included SBLKW1, SBLKS1 and SBLKS2. The samples associated with the water method blank SBLKW1 included the Field blank and Rinsates 1 and 2. Laboratory method blank SBLKS2 for soil was associated with sample 2BH-1A only. Laboratory method blank SBLKS1 for soil was associated with the rest of the soil samples.

Laboratory method blank SBLKW1 was found to contain bis(2ethylhexyl) phthalate at 4 ug/l, estimated. The limit utilized for review was 40 ug/l. The corresonding samples were qualified with 'U'.

Laboratory method blank SBLKS1 was found to contain 65 ug/kg, estimated of bis(2ethylhexyl) phthalate. A limit of 650 ug/kg was utilized for review of the samples. The associated samples were all qualified with 'U'.

Laboratory method blank SBLKS2 was found to contain 150 ug/kg, estimated of bis(2ethylhexyl) phthalate. A limit of 1,500 ug/kg was utilized to determine the effect on soil sample 2BH-1A. The sample was qualified with 'U'.

V. Surrogate Recovery

All surrogate recovery was found to be generated within acceptable limits for the 6 surrogate compounds.

VI. MS/MSD

All MS/MSD's were generated within acceptable limits for RPD and %R.

VII. Internal Standards Performance

All internal standards were generated within acceptable specifications for area counts and retention time variation.

PESTICIDES/PCB's BY GC

OVERALL ASSESSMENT OF DATA

All pesticide and PCB data generated by GC are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms and within the following text. The data has been generated in accordance with the site-specific QAPP and project requirements.

The MS/MSD's generated for the pesticides/PCB's may not be used to determine long term precision and accuracy of the analytical method on the matrix due to poor RPD and %R.

I. Holding Times

Two water samples (Field Blank and Rinsate # 1) collected on 1/23/91, were extracted on 1/31/91. This exceeded the 7 day extraction holding time for water samples by one day. Both water field blanks were appropriately qualified with 'UJ' as estimated. Positive results were not detected in any pesticide/PCB samples.

II. GC Instrument Performance

Adequate chromatographic resolution and instrument sensitivity were achieved through the generation of data within acceptable limits. These included DDT retention time, retention time windows/standards, DDT/Endrin degredation check, and retention time check for dibutylchlorendate (DBC). The following deviations are noted for the data set.

Retention time criterion was not met in the INDB standard analyzed at 18:28 on 2/7/91. The following EVALB standard met the appropriate criterion. All samples falling inbetween these two standards were reanalyzed.

Percent Difference (%D) criterion was not met in the final standards of the 2/7/91 pesticide analytical sequence. The laboratory took no action since these were the closing standards.

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III. Calibration

All initial and continuing calibration was performed within acceptable limits for calibration factors (CF), percent relative standard deviation (%RSD), and %D with the following notation.

As reported previously in Section II, the %D criterion was not met in the final standards of the 2/7/91 pesticide analytical sequence. No action was taken by the laboratory since these were closing standards.

IV. Blanks

a). Field Blanks: Pesticides/PCB's were not detected in any of the 3 field blanks. These samples included the Field Blank and Rinsate #1 and #2.

b.) Laboratory (Method) Blanks: Pesticides/PCB's were not detected in any of the 4 method blanks.

V. DBC Retention Time

Retention time shift for the samples were all generated within appropriate specifications with the exception of sample 2BH-1A. Retention time shift for DBC could not be reported for the sample due to the dilution required for the analysis. No qualification is required.

VI. MS/MSD

Both sets of MS/MSD's were not generated within acceptable limits for RPD and %R. These samples included 2BH-3BMS, 2BH-3BMSD, 2GW-9-SB2AMS and 2GW-9-SB2AMSD. The laboratory reported the presence of interferences and the possible concentrating of the spiking solution utilized. This data is qualified as 'UJ', however, this data may not be used to determine long term precision and accuracy of the analytical method on the matrix. The remaining data set is considered to be valid and acceptable because of consistent adherence to acceptable specifications.

BENZENE, ETHYL BENZENE, TOLUENE and XYLENE (BETX) BY GC

OVERALL ASSESSMENT OF DATA

All BETX data generated by GC analysis are valid and acceptable with the appropriate qualifiers, as noted on the data summary forms. Data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

The 7 day water holding time was exceeded for the 3 field blanks analyzed. Samples Rinsate # and Field Blank were collected on 1/23/91 and analyzed on 2/4/91 (5 days over). Rinsate #2 was collected on 1/25/91 and analyzed on2/4/91 (3 days over). The data was appropriately

qualified with 'J' or 'UJ'. Positive results for these samples were qualified with 'J' and nondetectable compounds with 'UJ' as estimated.

II. Calibration

All initial and continuing calibration was performed within acceptable limits for %RSD and %D.

III. Blanks

a.) Field Blanks: Three field blanks were analyzed for BETX. These included Rinsate samples #1 and #2 and the traditional Field Blank. Rinsate #2 was found to contain 0.31 ug/l (ppb) of toluene, while Rinsate #1 exhibited no contamination by BETX. The Field Blank was found to contain 0.89 ug/l of toluene. These field blanks are associated with the 14 soil samples for which the BETX was cancelled.

b.) Laboratory (Method) Blanks: One method blank was analyzed with the data set. BETX was not detected.

IV. Surrogates

All surrogate recovery was found to be generated within acceptable limits for trifluorotoluene (TFT) %R.

V. MS/MSD

An MS/MSD was not performed because BETX analysis was cancelled for the soil samples.

VI. Blank Spike

The blank spike was generated within acceptable limits for %R.

TOTAL PETROLEUM HYDROCARBONS (TPH)

OVERALL ASSESSMENT OF DATA

The TPH data generated by spectrophotometric analysis are valid and acceptable, as noted on the data summary forms. Data has been generated in accordance with the site-specific QAPP and project requirements. The field blanks should have been analyzed for TPH, rather than BETX. The level of BETX detected within the field blanks at the ppb level will not affect the sample TPH results at the ppm level.

I. Holding Times

No holding times are cited for soils for TPH analysis.

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II. Calibration

The 3 to 5 point curve for daily calibration was generated within specifications for the method.

III. Blank Spike

One blank spike was analyzed for the data set. The %R was generated within acceptable limits

INORGANIC ANALYSES BY AA AND ICP
(Mercury by Cold Vapor; Cyanides by Spectrophotometry)

OVERALL ASSESSMENT OF DATA

All inorganic data generated by AA, ICP, Cold Vapor and Spectrophotometric methods are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms with the following exceptions. The lead values for the samples run by furance are qualified as estimated 'J', due to low spike recovery. The antimony and selenium detection limits are qualified as 'R' unusable, due to 0% matrix spike recovery. The data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

All holding times were met within the acceptable time frame for metals (6 months), mercury (28 days), and cyanide (14 days). Rinsate sample #1 was received by the laboratory unpreserved for metals and cyanide. The positive results are qualified as 'J' and the nondetectable inorganics as 'UJ', estimated.

II. Calibration

All initial and continuing calibration was performed within acceptable limits for %R, correlation coefficients, and mid-range standards.

III. Blanks

a.) Field Blanks: Three water field blanks were analyzed for metals and cyanide. The sample labeled Field Blank was found to contain the following metals: aluminum, barium, calcium, iron, lead, magnesium, manganese, potassium, sodium and zinc. This sample originated from a public water supply and cannot be used to qualify the inorganic data. Deionized water is the preferable field blank supply. Rinsate #1 was found to contain iron and manganese at levels below the Contract Required Detection Limits (CRDL). These levels included 89.1 ug/l for iron and 2.9 ug/l for manganese. Rinsate #2 was found to contain iron at 53.6 ug/l. This was less than the CRDL.

The limit utilized for review of the iron data was 445.5 ug/l, while the limit for manganese was 14.5 ug/l. The asociated samples were all above these limits, therefore, no qualification was necessary.

b.) Laboratory (Method) Blanks: All initial calibration, continuing calibration and preparation blanks were generated in accordance within acceptable limits.

IV. ICP Interference Check Sample (ICS)

The ICP ICS was generated within acceptable limits for %R and frequency.

V. Laboratory Control Sample (LCS)

The LCS for the analyses generated acceptable %R for all the analytes except arsenic (71%) and selenium (56.1%) for soils. The data was qualified as estimated with 'J' for positive results or 'UJ' for nondetectable inorganics. All soil samples were qualified with either the 'J' or 'UJ' for selenium and arsenic. Selenium, however, is later qualified as unusable 'R' due to poor matrix spike recovery.

VI. Duplicate Sample Analysis

Sample 2BH-4B was run in duplicate by the laboratory to determine precision. All analytes were within specifications for RPD withthe exception of nickel, sodium and zinc. The nickel and sodium values were <5 times the CRDL and were not qualified. The zinc values were qualified with 'J' as estimated. This qualifier applies to all soil samples.

VII. Matrix Spike Sample Analysis

Sample 2BH-4B was used as the spiked sample. The %R was generated within acceptable specifications with the exception of the following: arsenic (63.6%), iron (2158.4%), managanese (146%), antimony (0%), selenium (0%) and lead (5%). The %R limits for iron are not applicable in this case due to the fact that the sample result for iron exceeds four times the spike added. Arsenic and manganese are considered estimated for all soil samples and qualified as 'J' for positive values and 'UJ' for nondetectable values. Antimony and selenium were not detected in any of the samples. The antimony and selenium detection limits in all the soil samples are qualified as unusable 'R'. The %R for the lead matrix spike analyzed by ICP yielded an acceptable recovery of 99%. The furnace method, however, yielded spike recovery at 5%. The lead values from the samples run by furnace are qualified as estimated 'J'. All samples were qualified 'J' for lead except 2GW-9-SB2, 2BH-1A and 2BH-2A.

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Rec'd ChemWorld
Reg Mail on 7 May 17

ecology and environment, inc.
BUFFALO CORPORATE CENTER
368 PLEASANTVIEW DRIVE, LANCASTER, NEW YORK 14086, TEL. 716/684-8060
International Specialists in the Environment

May 13, 1991

Ms. Andrea P. Schuessler, CHMM
ChemWorld Environmental, Inc.
4500 Avamere Street
Bethesda, MD 20814

Dear Andrea:

Ecology and Environment, Inc. (E & E), is pleased to approve ChemWorld Environmental, Inc.'s (CW's) Data Validation Summary Report dated April 24, 1991 for Bainbridge Naval Training Center (BNTC), E & E Job 9100.194. The following comments are being made to facilitate future CW data validation reports.

1. Section IV. Volatiles, Blanks - For clarity, please specify that the upper limit for qualifying data for blank contamination is 10 times the highest associated blank level for common laboratory contaminants, such as methylene chloride and acetone, and 5 times the highest associated blank level for other contaminants.

2. Section IV. Volatiles, Blanks - In some instances, you stated that the associated samples were qualified "U" as not detected. Please state that the parameter (methylene chloride, etc.) was qualified in associated samples and specify those samples in a general way, such as, all soil samples analyzed by low level protocol for this job number.

3. Section IV. Volatiles, Blanks - The two soil samples analyzed by medium level protocol should be assessed together. Use the highest medium level protocol method blank levels for any laboratory contamination. The soil samples analyzed by low level protocol should be assessed together, using the highest low level protocol method blank levels for any contamination. Read the EPA Functional Guidelines for further discussion of blank contamination assessment.

4. Section V. Inorganics, LCS - the second sentence states that nondetectable inorganics are qualified "UJ". Please specify that nondetects for arsenic and selenium, in this case, are qualified "UJ".

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5. Section VII. Inorganics, Spikes - For clarity, divide the discussion of poor spike recoveries into more readable segments. Paragraph when necessary for better understanding.

Attached to this letter please find a copy of page XII-25 of the NEESA document "Quality Assurance in Environmental Analysis" in response to your request for inorganic qualifiers for laboratory CLP data.

If you have any questions or require additional clarification, please contact me at 716-684-8060, ext. 2606.

Sincerely,

Joanne M. McMullan

Joanne M. McMullan, QA Chemist

Enclosure

cc: B. Walter, E & E Project Manager
M. Meredith, E & E QA Officer
CD-7013 Central File

J. McMullan

MEMORANDUM

TO: Buff Walter, E & E Project Manager

FROM: Joanne McMullan, E & E QA Chemist JMM

DATE: June 28, 1991

SUBJECT: Comments on Bainbridge Naval Training Center Sampling Results - Overall Evaluation

ChemWorld Environmental, Inc. (CW) has performed data validation for three sampling events performed at the Bainbridge Naval Training Center (BNTC) site. These sampling events occurred on January 23-25, 1991, February 10-14, 1991, and April 15-20, 1991. and are considered as Work Orders 1, 2, and 3, respectively. Work Orders 2 and 3 correspond to the first and second groundwater and surface water sampling rounds.

The following comments present further explanation/clarification of CW's comments and overall evaluation of data usability, considering the sampling events as a whole.

Comment 1:

In the first sampling round (Work Order 2), surrogates were inadvertently omitted from BNA analysis of the following samples; 1-GW-1, 1-GW-2BN, 1-GW-3, 2-SW-5BW, 2-SW-6, 2-SW-7, 2-SW-8 Dup, and the accompanying method blank and blank spike samples. There was insufficient sample volume to reanalyze the samples. In the second sampling round (Work Order 3), BNA analysis was accomplished successfully on samples from the same locations.

There was good correlation between the results obtained in the two sampling events. In the first round, sample 1-GW-3 contained 1,4-dichlorobenzene at 34 ug/L. In the second round, the corresponding sample 1-GW-3A contained 1-4-dichlorobenzene at 26 ug/L, 2-chlorophenol at 6 ug/L, and 2,4-dichlorophenol at 7 ug/L. Sample 2-SW-6R contained diethylphthalate at 430 ug/L in the second round, which did not appear on the first round. It is likely that the diethlyphthalate is due to field contamination from the gloves used while sampling. All other samples indicated no detectable BNA compounds in either round of sampling.

In accordance with data validation guidelines, CW rejected the first round BNA results as unusable. In our opinion, the first round BNA results are valid and can be used for all purposes, based on the correlation between the first and second round results.

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Comment 2:

Comparison of BNA analyses in the first and second rounds indicate matrix interferences in certain samples. In the first round, samples 1-GW-8, 1-GW-8 Dup, and 2-GW-4 gave acid phenol surrogate recoveries of less than 10% and 2-GW-9 gave two low base neutral recoveries. In the second round, sample 1-GW-8A gave low base neutral recoveries and sample 1-GW-8A RE gave acid phenol recoveries of less than 10%. Samples 2-GW-4A and 2-GW-4ARE gave acid phenol recoveries below 10% and 2-GW-4A gave low base neutral recoveries. Samples 2-GW-9 and 2-GW-9 Dup each gave one low acid phenol recovery.

Surrogate recovery problems in both sampling rounds substantiates matrix interferences with BNA analysis of samples from locations 1-GW-8, 2-GW-4, and 2-GW-9.

Comment 3:

In the first sampling round (Work Order 2) cyanide results for samples 1-GW-4, 1-GW-5, 1-GW-6, 1-GW-8 Dup, 1-SW-3, and 1-SW-10 were rejected by CW as unusable, due to lack of preservation at pH>12. In the second sampling round (Work Order 3), samples from the same locations were analyzed successfully for cyanide. No cyanide was detected in any of the samples in either round. In our opinion, both the first and second round results of no detectable cyanide are valid and usable.

Comment 4:

In the first round (Work Order 2), cyanide results also were rejected by CW as unusable for samples 2-GW-1, 2-GW-2, 2-GW-3, 2-GW-6, 2-GW-7, 2-GW-8 Dup, and 2-GW-9. No cyanide was detected, but recovery of the continuing calibration standard outside the QC limits was noted. Actually, the recovery was above the QC limit at 115%, which means that cyanide would have been detected, if present. In the second round (Work Order 3), samples from the same locations were analyzed successfully for cyanide with no cyanide being detected. In our opinion, both the first and second round results of no detectable cyanide are valid and usable for all purposes.

djr/CD7013

February 1991 Sampling Event

DATA VALIDATION REPORT

BAINBRIDGE NAVY REMEDIAL INVESTIGATION

SAMPLING DATES OF FEBRUARY 10 - 14, 1991

PREPARED FOR:

Ecology and Environment, Inc.
368 Pleasantview Drive
Lancaster, New York 14086

May 1991

PREPARED BY:

ChemWorld Environmental, Inc.
4500 Avamere Street
Bethesda, Maryland 20814

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DATA VALIDATION SUMMARY

Bainbridge Navy Remedial Investigation
E & E Data Packages 9100.299, 9100.300, 9100.308
9100.309, 9100.331, 9100.332 and 9100.338
Sampling Dates February 10-14, 1991

INTRODUCTION

This Data Validation Summary report was generated for Work Order #2 for water and sediment analyses for the Bainbridge Navy Remedial Investigation. The analytical laboratory work was performed by Ecology and Environment, Inc. (E & E's) Analytical Services Center.

The seven data report packages referenced above include 35 water and 15 sediment samples. Analytical testing consisted of volatile organic analyses by Gas Chromatography/Mass Spectroscopy (GC/MS); Benzene, Ethyl Benzene, Toluene and Xylene (BETX) by GC; Base/Neutral and Acid Extractable Organics by GC/MS; Pesticides and PCB's by GC; Total Petroleum Hydrocarbons by Infrared Spectrophotometry; Inorganics by Atomic Absorption (AA)and Inductively Coupled Argon Plasma (ICP); Mercury by Cold Vapor; and Cyanides by Spectrophotometry.

The following report provides a summary of data acceptability and deviations in accordance with the Naval Energy and Environmental Support Activity (NEESA) Level C Data Validation Requirements. The site-specific Work Plan and Quality Assurance Project Plan (QAPP) were reviewed. These documents detailed the project background and requirements for the investigation.

VOLATILE ORGANICS BY GC/MS

OVERALL ASSESSMENT OF DATA

All volatile organic data generated by GC/MS are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms and within the following text. Due to a scheduling error, sample TB-4 was not analyzed for volatile organics by GC/MS. The following data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

All holding times were met within the acceptable time frame of 7 days for unpreserved water samples and 14 days for sediment samples with the exception of the following.

Groundwater samples 2-GW-8-DUP, 2-GW-9 and Trip Blank #7 collected on 2/13/91 exceeded the holding time by one day. Positive results were qualified with 'J' and nondetectable compounds with 'UJ', as estimated.

II. GC/MS Tuning

All tuning was generated within the acceptable limits for Bromofluorobenzene (BFB).

III. Calibration

All initial and continuing calibration was performed within acceptable limits for average Relative Response Factors (RRF), Percent Relative Standard Deviation (%RSD), Relative Response Factors (RRF), and Percent Difference (%D) with the exception of the continuing calibration check of C5695 analyzed on 2/15/91 for sediments. The %D for 1,1-dichloroethene was 43.5%. The maximum allowable %D is 25%. The compound 1,1-dichloroethene was not detected in any of the samples, therefore, no qualification was necessary.

IV. Blanks

Laboratory (Method) Blanks: Five water method blanks were analyzed for the samples from package 9100.300. Methylene chloride was found within the blanks at the following levels: VBLK-W1 at 15 ug/l, VBLK-W2 at 10 ug/l, VBLK-W3 at 6 ug/l, VBLKW4 at 8 ug/l, and VBLK-W5 at 6 ug/l. The samples associated with the blanks include: VBLK-W1 (1-GW-7, 1-SW-4, 1-SW-7); VBLK-W2 (1-GW-9, 1-SW-11, 1-SW-11DUP, 1-SW-5, 1-SW-6, 1-SW-8, 1-SW-11MS and MSD); VBLK-W3 (1-GW-4 and 1-GW-5); VBLK-W4 (1-GW-8, 1-GW-8DUP, 1-SW-9, 1-TR-3, 1-TR-3MS and MSD) and VBLK-W5 (1-GW-6, 1-SW-10 and 1-SW-3). The limit used to qualify the data set was 10 times the highest methylene chloride value (150 ug/l). All samples were qualified with 'U', not detected.

VBLK-W5 was also found to contain 7 ug/l estimated, of acetone. A limit of 70 ug/l was used to qualify the acetone values for the samples. All positive values for acetone were qualified as 'U', not detected.

An additional four water method blanks were analyzed for volatiles from package 9100.332. Laboratory method blank VBLK-W1 was found to contain methylene chloride at 6 ug/l and acetone at 7 ug/l estimated, and 1,2-dichloroethane at 4 ug/l, estimated. The compound 1,2-dichloroethane was not found in any of the samples. The samples associated with this method blank include: 1-GW-1, 1-GW-2, 1-GW-3, 2-SW-5, 2-SW-7, 2-SW-8, 2-SW-8DUP, 2-TB-6, 2-TB-6MS and MSD. Laboratory method blanks VBLK-W2 and VBLK-W3 were found to contain methylene chloride at 10 ug/l and 12 ug/l, respectively. Samples associated with these two blanks include: VBLK-W2 (1-GW-3DL, 2-GW-1, 2-GW-2, 2-GW-6, 2-SW-6, 2-GW-8MS) and VBLK-W3 (2-GW-3, 2-GW-4, 2-GW-7, 2-GW-8, Trip blank #8 and 2-GW-8MSD). Method blank VBLK-W4 contained methylene chloride at 9 ug/l and acetone at 5 ug/l, estimated. The samples associated with this blank include: 2-GW-5, 2-GW 8DUP, 2-GW-9, Trip blank #7 and Trip blank #9. A limit of 10 times the highest blank value was used for review of the samples. These included 120 ug/l for methylene chloride and 70 ug/l for acetone. All samples were qualified with 'U', not detected with the exception of samples 2-GW-8, 2-GW-8MS/MSD.

Five method blanks for sediments were analyzed for volatiles (data package 9100.299). VBLKS-1 was found to contain methylene chloride at 9 ug/kg and acetone at 6 ug/kg. The samples associated with this method blank are 1-SED-11, 1-SED-11DUP, 1-SED-3, 1-SED-4, 1-SED-5, 1-SED-6, 1-SED-7, 1-SED-8, 1-SED-9, 1-SED-9MS and MSD. VBLK-S2 was found to contain methylene chloride at 7 ug/kg and acetone at 7 ug/kg, estimated. VBLK-S3 exhibited contamination by methylene chloride at 6 ug/kg, acetone at 8 ug/kg estimated, and total xylenes at 1 ug/kg, estimated. VBLK-S4 exhibited contamination

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by methylene chloride and acetone at 12 ug/kg and 48 ug/kg, respectively. The samples associated with this method blank included: 2-SED-5, 2-SED-6, 2-SED-7, 2-SED-8, 2-SED-8DUP, 2-SED-8DUPMS and MSD. VBLK-S5 was found to contain methylene chloride and acetone at 8 and 13 ug/kg, respectively. Sample 2-SED-7RE was associated with this blank. All samples found to be under the 10 times limit for the highest blank values for methylene chloride (120 ug/kg), acetone (480 ug/kg) and xylene (5 ug/kg) were qualified as 'U', not detected.

VBLKW-1 exhibited contamination by methylene chloride at 10 ug/l. The trip blank 2-TB-5 was qualified with 'U' for methylene chloride.

Field Blanks: One trip blank (1-TR-3) was analyzed for volatiles for data package 9100.300. Methylene chloride was detected at 7 ug/l. The corresponding samples were qualified for methylene chloride through the method blanks.

One trip blank (2-TB-5) for the sediment samples was analyzed for volatiles for data package 9100.299. The trip blank was found to contain methylene chloride at 6 ug/l, acetone at 8 ug/l estimated, and chloroform at 9 ug/l. All samples were qualified for methylene chloride through the method blanks. Chloroform was not found in any of the samples. The trip blank qualified 1-SED-9MS for acetone as 'U', not detected.

Four additional trip blanks for water samples were analyzed for volatiles for data package 9100.332. These included: 2-TB-6, Trip blank #7, #8 and #9. The trip blanks were qualified as 'U' not detected for methylene chloride and acetone.

V. Surrogate Recovery

Toluene d-8 and 1,2-dichloroethane d-4 surrogate recovery were reported high and out of specification at 111% and 117% for water samples 1-SW-11MSD and 1-SW-9, respectively. The QC limit for toluene Surrogate Recovery is 88-110%; and the %Recovery limit for 1,2-dichloroethane is 76-114%. The analytical data was qualified appropriately with 'J' or 'UJ'. The positive results are qualified as 'J' and the nondetectable compounds 'UJ' as estimated.

Toluene d-8 surrogate recovery was reported high and out of specification for sediment samples 1-SED-10 (128%), 1-SED-10DL (131%) and2-SED-7RE (119%). The limit for toluene surrogate recovery is 81-117%. The positive values were qualified with 'J', estimated and the nondetectable compounds were qualified as 'UJ'.

BFB surrogate recovery was reported low at 73% for sediment sample 2-SED-7. The limit for BFB recovery is 74-121%. The positive results are qualified as 'J' and the nondetectable compounds as 'UJ', estimated.

The surrogate recovery for 1,2-dichloroethane d-4 for groundwater sample 2-GW-8-MSD was found to be out of specification at 118%. The limit for the surrogate recovery is 76-114%. The sample was qualified with 'J' for the positive results and 'UJ' for the nondetectable compounds.

VI. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

All MS/MSD's were generated within acceptable limits for Relative Percent Difference (RPD) and Percent Recovery (%R) with the exception of the RPD's for 2 of the 5 compounds for 2-SED-8-DUP. The compounds included toluene and chlorobenzene. The surrogate spike recovery for the method blanks were all generated within acceptable limits. The deviation noted for precision is possibly due to the nonhomogeneity of the sample, therefore, no qualification was determined to be necessary. All %R were found to be generated within acceptable limits for 2-SED-8-DUP.

VII. Internal Standards Performance

All internal standards were generated within acceptable specifications for area counts and retention time variation with the exception of the following.

Sediment sample 1-SED-10 analyzed on 2/15/91 did not meet the lower limit criteria for area counts for bromochloromethane (23700), 1,4-difluorobenzene (69800) and chlorobenzene (29700). The limits were 28200, 132000 and 110500, respectively.

Sediment sample 1-SED-10DL analyzed on 2/18/91 also did not meet the lower limit criteria for area counts for 1,4-difluorobenzene (85800) and chlorobenzene (48800). The limits were 112500 and 94500, respectively. Both sediment samples 1-SED-10 and 1-SED-10DL were previously qualified with 'J' for positive results and 'UJ' for nondetectable compounds through poor surrogate recoveries; further qualification is not necessary.

SEMI-VOLATILE ORGANICS BY GC/MS
(Base/Neutral and Acid Extractable Organics)

OVERALL ASSESSMENT OF DATA

All base/neutral and acid extractable organic data generated by GC/MS are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms and within the following text. The MS/MSD was performed on a method blank because insufficient sample volume was delivered to the laboratory.

The acid phenol fraction for the semi-volatile analysis for samples 1-GW-2 and 2-SW-5 were lost in a laboratory accident. Insufficient sample volume precluded reextraction and analysis of the phenols. These samples were analyzed for the base/neutral fraction only. The acid phenol compounds affected by this are qualified as 'Q' on the data summary forms and 'X' within the analytical data pack.

The acid phenol compounds were qualified as 'R', unusable, for samples 1-GW-8 and 1-GW-8DUP due to surrogate recovery of less than 10%. Sample 2-GW-4 was qualified as 'R', unusable, due to surrogate recovery of less than 10% for both the base/neutral and acid extractable compounds. The following samples were qualified as 'R', unusable due to 0% surrogate recoveries: 1-GW-1, 1-GW-2-BN, 1-GW-3, 2-SW-5-BN, 2-SW-6, 2-SW-7, 2-SW-8, 2-SW-8DUP, SBLK-W1, SBLK-W1MS and SBLK-1MSD. All other data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

All holding times were met within the acceptable time frame for water samples (extracted within 7 days and analyzed within 40 days) and sediment samples (extracted within 14 days and analyzed within 40 days).

II. GC/MS Tuning

All tuning was generated within acceptable limits for Decafluorotriphenylphosphine (DFTPP).

III. Calibration

All initial and continuing calibration was performed within acceptable limits for RRF, %RSD, RRF, and %D.

IV. Blanks

Laboratory (Method) Blanks: Two method blanks were analyzed for the sediment samples. These included SBLK-S1 and SBLK-S2. Bis(2-ethylhexyl)phthalate was detected in the samples at 43 ug/kg and 63 ug/kg estimated, respectively. A limit of 10 times the highest bis(2-ethylhexyl)phthalate value for the blanks was utilized for review of the samples. All the samples were qualified as 'U'.

Three laboratory method blanks were analyzed for the water samples of data set 9100.332. These included SBLK-W1, SBLK-W2 and SBLK-S3. Bis(2ethylhexyl)phthalate was detected in all three method blanks at 4 ug/l, estimated. A limit of 40 ug/l was utilized to evaluate the samples. All samples associated with the three method blanks were qualified as 'U' not detected.

Two laboratory method blanks were analyzed for the water samples of data set 9100.300. Both SBLK-W1 and SBLK-W2 were found to contain 4 ug/l estimated, of bis(2ethylhexyl)phthalate. A limit of 40 ug/l was utilized to evaluate the samples. All samples asociated with the method blanks were qualified as 'U' not detected.

V. Surrogate Recovery

All surrogate recovery was found to be generated within acceptable limits for the 6 surrogate compounds with the exception of sample 1-SED-10 for data set 9100.299. The surrogates were not generated within specification due to the dilution required for the analysis. Qualification of the sample was not required.

The surrogate compounds were not added to the water samples extracted on 2/19/91, therefore, 0% recovery was detailed within the laboratory report (9100.332) for the following samples: 1-GW-1, 1-GW-2-BN, 1-GW-3, 2-SW-5BN, 2-SW-6, 2-SW-7, 2-SW-8, 2-SW-8DUP, SBLK-W1, SBLK-W1MS and SBLK-W1MSD. Reanalysis could not be performed because additional sample was not available. The base/neutral and acid extractable compounds for the samples noted above are qualified as 'R', unusable due to the 0% surrogate recovery.

In addition to this deviation, sample 2-GW-8DUP was out of specification for2 of the 6 surrogate compounds. The compounds nitrobenzene-d5 (115%) and 2-Fluorobiphenyl (132%) were found to be reported higher than their respective limit. The limits include 35-114% for

nitrobenzene and 43-116% for 2-Fluorobiphenyl. The positive values were qualified with 'J' and the nondetected values as 'UJ', as estimated.

Three of six surrogate compounds were out of specifications for percent recovery of sample 2-GW-4. Phenol-d5 and 2-Fluorophenyl were reported at 0% recovery. Their limits are 10-94% and 21-100%, respectively. The compound 2,4,6-Tribromophenol was found out of specification at 6%. The limit is 10-123%. The non-detectable values were qualified as 'R', unusable, due to the possibility of false negatives. Positive results were not detected for sample 2-GW-4.

Sample 2-GW-9 was found out of specification for 2 of the 6 surrogate compounds. The compound 2-Fluorobiphenyl was found at 40%; the limit is 43-116%. Terphenyl recovery was found at 24%; its limit being 33-141%. The positive values were qualified 'J' and the nondetectable compounds as 'UJ', estimated.

All surrogate recoveries for water samples (Data set 9100.300) 1-GW-8, 1-GW-8DUP and 1-SW-10 did not meet %R criteria. For sample 1-GW-8, Phenol d-5 (6%) and 2-Fluorophenyl (10%) did not meet the %R limits of 10-94% for phenol and 21-100% for 2-fluorophenyl. Phenol d-5 (0%), 2-Fluorophenyl (1%) and 2,4,6-Tribromophenol (9%) were found to be out of specification for the sample 1-GW-8DUP. The %R for 2,4,6-Tribromophenol is 10-123%. The 14 acid phenol compounds were qualified as 'R', unusable, for sample 1-GW-8 and the duplicate. Positive results were not detected for the acid phenol compounds, but the possibility of false negatives exist. Due to limited sample volume, reextraction could not be performed. Since samples 1-GW-8/DUP are field duplicates, a matrix effect appears to be substantiated by the similar recoveries generated.

The compound 2,4,6-Tribromophenol (166%) for 1-SW-10 was also found out of specification. Qualification of the data was not found to be necessary.

VI. MS/MSD

All MS/MSD's were generated within acceptable limits for RPD and %R with the exception of the following.

One spike recovery for 2,4-dinitrotoluene in sample 2-SED-8. The limit for 2,4-dinitrotoluene recovery is 28-89%. Qualification of the data is not required.

Spike recovery and RPD were found to be out of specification for sample SBLK-W3 -MS and MSD (data set 9100.332). The compounds 1,4-dichlorobenzene (35%) and 1,2,4-trichlorobenzene (37%) were found to be generated low and out of specification. The spike recovery limits are 36-97% for 1,4-dichlorobenzene and 39-98% for 1,2,4-trichlorobenzene. RPD was out of specification for 1,4-dichlorobenzene. RPD was generated at 29%. The limit is 28%. Qualification of the MS/MSD data was not found to be necessary.

The MS/MSD water method blank sample SBLK-W1 was found to be outside limits for precision for 2-chlorophenol at 47%. The RPD limit is 40%. Qualification of the data was not found to be necessary. Surrogate recovery generated for SBLK-W1 was reported at 0% because of the omission of the surrogate spike compounds as detailed in Section V.

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The MS/MSD sample SBLK-W2 was found to be out of specification for both %R and RPD for 1,4-dichlorobenzene. The %R generated was 31% (limit 36-97%) and the RPD generated was 65% (limit 28%). The compound 1,2,4-trichlorobenzene had an RPD out of specification at 41%. The limit is 28%. The surrogate recovery for SBLK-W2 was found to be generated within acceptable limits. Qualification of the data was not found to be necessary.

VII. Internal Standards Performance

All internal standards were generated within acceptable specifications for area counts and retention time variation with the following exception.

The internal standard area count for perylene-d12 was generated low (48000) for sample SBLK-W1-MS from data set 9100.300. The acceptable lower limit is 55500. The compounds quantitated using the internal standard were qualified as 'UJ', estimated.

PESTICIDES/PCB's BY GC

OVERALL ASSESSMENT OF DATA

All pesticide and PCB data generated by GC are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms and within the following text. The MS/MSD was performed on a method blank because insufficient sample volume was delivered to the laboratory. The data has been generated in accordance with the site-specific QAPP and project requirements.

The presence of several pesticide compounds were confirmed by GC/MS for the sediment samples (Case 9100.299) using the original semi-volatile analysis. A pesticide reference standard was analyzed by GC/MS on 2/5/91.

I. Holding Times

All holding times were met within the acceptable time frame for water samples (extracted within 7 days and analyzed within 40 days) and sediment samples (extracted within 14 days and analyzed within 40 days).

II. GC Instrument Performance

Adequate chromatographic resolution and instrument sensitivity were achieved through the generation of data within acceptable limits. These included DDT retention time , retention time windows/standards, DDT/Endrin degredation check, and retention time shift for dibutylchlorendate (DBC). The following deviations are noted for the data sets.

(Case 9100.300)
The INDA standards for 2/21/91 (04:07) and 3/6/91 (21:25) were found to have a retention time shift of >2%. Qualification of the data was not found to be necessary.

Retention time criterion was not met for the INDA standard analyzed at 02:32 on 2/28/91. All affected samples were reanalyzed.

DDT degredation was found to exceed 20% for EVAL MIX B (23%) analyzed on 2/28/91 at 11:36. Positive results were not detected in the associated samples. Qualification of the data was not found to be necessary.

Aldrin fell outside of the established retention time window in the INDA standard analyzed on 3/5/91 at 11:11. The laboratory did not take corrective action since all other compounds were within retention time windows and the following standards were acceptable.

(Case 9100.332)
Retention time shift for DBC was not generated at <2% for sample 2-SW-6 on 2/26/91 at 19:03 and 3/4/91 at 21:14. The data is qualified as 'J', estimated.

Retention time criterion was not met for the INDA standard analyzed at 02:32 on 2/28/91. Sample 2-GW-8 was reanalyzed with the other associated samples from Case 9100.300.

As noted above, aldrin fell outside the established RT window on 3/5/91 at 11:11. Action was not taken by the laboratory. The sample associated with this standard is 2-GW-8DUP.

As noted above, the RT criteria was not met for the INDA standard analyzed at 02:32 on 2/28/91. The samples were reanalyzed.

As noted above, DDT degredation was found to exceed 20% for EVAL MIX B analyzed on 2/28/91 at 11:36. Qualification of the data was not found to be necessary.

(Case 9100.299)
As noted above, DDT degredation was found to exceed 20% for the EVAL MIX B analyzed on 2/28/91 at 11:36. The sediment samples from Case 9100.299 were not affected by this deviation.

DBC retention time shifts exceeded the <2% %D criteria for several standards and samples. These included the following: INDA (2/21/91 at 4:07); 2-SED-6 (2/27/91 at 1:47); 2-SED-7 (2/27/91 at 3:07); 1-SED-10 (2/27/91 at 23:48); EVALB (3/1/91 at 22:06); 2-SED-6 (3/6/91 at 11:36); 2-SED-7 (3/6/91 at 12:31); INDA (3/6/91 at 21:25); 1-SED-10 (3/8/91 at 3:04); INDA (3/21/91 at 19:22); 1-SED-9 (3/22/91 at 10:55); 1-SED-10 (3/22/91 at 13:23) and Hexane (3/22/91 at 18:32). The samples 2-SED-6, 2-SED-7 and 1-SED-7 were confirmed by GC/MS. The data remains qualified as noted by the laboratory. Pesticides/PCB's were not detected in samples 1-SED-9 and 1-SED-10.

An autosampler misinjection occurred at 22:06 on 3/1/91 during an EVALB injection. The standard was immediately reanalyzed.

Aldrin was found to be outside the retention time window in the INDA standard analyzed at 11:11 on 3/5/91. Aldrin was within the window for the following standard sequence. Qualification of the data was not necessary.

The INDB standard analyzed at 2:06 on 3/6/91 and the samples immediately following were reanalyzed starting at 9:23 due to an autosampler malfunction.

The INDA standard at 21:25 on 3/6/91 was analyzed at an incorrect temperature. The standard was immediately reanalyzed.

The INDA standard analyzed at 20:40 on 3/21/91 reveals that heptachlor is outside of the retention time window and %D criterion was not met for gamma-BHC. Qualification of the data was not found to be necesssary.

The %D criterion was not met for several compounds in the INDB standard analyzed at 20:41 on 3/22/91. The samples were not quantitated from this column. Qualification of the data was not found to be necessary.

The INDA standard at 19:22 on 3/21/91 was analyzed at the incorrect temperature. The standard was immediately reanalyzed.

I. Calibration

All initial and continuing calibration was performed within acceptable limits for calibration factors (CF), percent relative standard deviation (%RSD) for linearity, and %D with the following notations.

(Case 9100.300)
Inadvertently, the 72 hour limit was exceeded in the 2/20/91 and 2/25/91 pesticide analytical sequences. However, all analyses pertinent to this case from these sequences were performed within the 72 hour limit.

Percent Difference (%D) criterion was not met for several of the pesticide individual standards. The affected samples were reanalyzed.

The %D for the INDA standard of 2/28/91 at 12:47 was found to exceed the %D limit of 20% for 4,4'-DDT (27%). Pestcides/PCB's were not detected in any of the samples. Qualification of the data was not found to be necessary.

The %D for 4,4'-DDT and Methoxychlor for the INDA standard analyzed on 3/6/91 at 22:04 were found to exceed the 20% limit at 49.6% and 36.1%, respectively. Positive results were not found for these compounds. Qualification of the data was not found to be necessary.

(Case 9100.332)
The %D criterion was not met in the closing INDA and INDB standards of the 2/25/91 and 3/4/91 pesticide analytical sequences. Corrective action was not taken since these were the final standards of the sequence.

As noted above, the %D for the INDA standard on 2/28/91 at 12:47 was found to exceed the limit of 20%. Qualification of the data was found not to be necessary.

(Case 9100.299)
The 2/20/91 and 2/25/91 pesticide analytical sequences exceeded the 72 hour limit. All analyses to be utilized for the sediment sample data were injected within the time limit.

The linearity criterion of 10% was exceeded for 4,4'-DDT at 23% and Aldrin at 13% for the analyses of 2/20/91 to 2/22/91 for column OV-1. The sediment samples were not quantified from this column. Qualification was not found to be necessary.

The INDB standard analyzed at 00:20 on 2/22/91 did not meet specifications. All samples injected after this standard, except 1-SED-5 and 1-SED-9, were reanalyzed.

Several compounds in the INDA standard analyzed at 2:32 on 2/28/91 fell outside of the established retention time windows. Several %D values were also found to be out of specification for standards on 2/23/91 and 2/28/91. The sediment samples from Case 9100.299 were not affected by these particular standards, therefore, qualification was not found to be necessary.

The %D for 4,4'-DDT was 50% in the INDA standard analyzed at 22:04 on 3/6/91. The analytical sequence was terminated.

IV. Blanks

a). Field Blanks: Field blanks were not analyzed for pesticides/PCB's.

b.) Laboratory (Method) Blanks: Pesticides/PCB's were not detected in any of the 7 method blanks.

V. MS/MSD

In general, the MS/MSD's were found to be acceptable for the water and sediment sample analyses for pesticides/PCB's. Slight deviations were reported for the %R of endrin and 4,4'-DDT in 1 of 4 MS/MSD's for the water samples(9100.332). Only the MS was reported for 1 of the 2 MS/MSD's for Case 9100.300 because the MSD was not extracted with the MS. High %R's for one of the MS/MSD's for the sediment samples (9100.299) was noted. The heptachlor and aldrin %R's were elevated due to matrix interferences. A high RPD was reported for aldrin in the same MS/MSD (182%). The RPD limit was 43%.

BENZENE, ETHYL BENZENE, TOLUENE and XYLENE (BETX) BY GC

OVERALL ASSESSMENT OF DATA

All BETX data generated by GC analysis are valid and acceptable with the appropriate qualifiers, as noted on the data summary forms. Data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

The 7 day water holding time was exceeded for by one day for trip blank 2-TB-6 collected on 2/12/91. The sample was qualified as 'UJ', estimated.

II. Calibration

All initial and continuing calibration was performed within acceptable limits for %RSD and %D with the following exceptions. The continuing calibration %D was out of specification for MTBE at 18%. The limit was 15%. For the initial calibration on 2/19/91, MTBE was out of specification for %RSD at 40% (Limit 20%). Qualification of the data was not found to be necessary.

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III. Blanks

a.) Field Blanks: Four field blanks were analyzed for BETX. These included 2-TB-6 and Trip blanks #7,#8 and #9. BETX was not detected in any of the trip blanks.

b.) Laboratory (Method) Blanks: Three method blanks were analyzed with the data set. BETX was not detected.

IV. Surrogates

All surrogate recovery was found to be generated within acceptable limits for trifluorotoluene (TFT) %R.

V. MS/MSD

The MS/MSD was found to be generated within acceptable limits for %R and RPD.

VI. Blank Spike

The blank spike was generated within acceptable limits for %R.

TOTAL PETROLEUM HYDROCARBONS (TPH)

OVERALL ASSESSMENT OF DATA

The TPH data generated by spectrophotometric analysis for sediment samples 2-SED-5, 2-SED-6, 2-SED-7, 2-SED-8, *and 2-SED-8DUP are qualified as unusable, 'R', due to two* violations of method protocol; blank subtraction and the omission of the blank spike analysis.

I. Holding Times

No holding times are cited for soils for TPH analysis.

II. Calibration

The 3 to 5 point curve for daily calibration was generated within specifications for the method.

III. Blank Spike

A blank spike was not assigned by the laboratory for the TPH analysis. The TPH results were blank subtracted by the laboratory.

INORGANIC ANALYSES BY AA AND ICP
(Mercury by Cold Vapor; Cyanides by Spectrophotometry)

OVERALL ASSESSMENT OF DATA

All inorganic data generated by AA, ICP, Cold Vapor and Spectrophotometric methods are considered

to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

The cyanide results for water samples 1-GW-4, 1-GW-5, 1-GW-6, 1-GW-8, 1-GW-8DUP, 1-SW-3 and 1-SW-10 are qualified as 'R', unusable, due to the omission of sodium hydroxide preservative. Due to continuing calibration verification recoveries outside quality control limits, samples 2-GW-1, 2-GW-2, 2-GW-3, 2-GW-6, 2-GW-7, 2-GW-8DUP, and 2-GW-9 are qualified as 'R', unusable. The remaining data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

All holding times were met within the acceptable time frame for metals (6 months), mercury (28 days), and cyanide (14 days). Samples 1-GW-4, 1-GW-5, 1-GW-6, 1-GW-8, 1-GW-8DUP, 1-SW-3 and 1-SW-10 were received by the laboratory unpreserved for cyanide. Cyanide was not detected in any of the associated samples. These samples are qualified as 'R', unusable, due to the absence of sodium hydroxide preservation and the possibility of false negatives.

II. Calibration

All initial and continuing calibration was performed within acceptable limits for %R, correlation coefficients, and mid-range standards with the exception of the following.

Recovery of the cyanide initial verification standard on 2/20/91 fell below the acceptable limit. An old working standard was used, probably resulting in the low recovery. Results were accepted on the recoveries of the continuing verification standards which were all within CLP limits.

Cyanide continuing calibration verification (CCV) recoveries from 2/23/91 are outside of the CLP limit. Reanalysis was not performed because no sample volume remained. Cyanide was not detected in any of the samples. Samples asociated with this run include: 2-GW-1, 2-GW-2, 2-GW-3, 2-GW-6, 2-GW-7, 2-GW-8DUP, and 2-GW-9. The cyanide values for these samples are qualified 'R', unusable, due to CCV recoveries outside QC limits.

Recovery of the lead CCV standard analyzed at 15:01 on 3/1/91 exceeded the CLP limit. The laboratory did not take action since the recoveries of all other verification standards analyzed in the sequence were acceptable. Positive lead values analyzed by furnace were qualified as 'J', estimated.

III. Blanks

a.) Field Blanks: The field blank labeled GW-Rinsate collected for data set 9100.300 was found to contain 1.8 ug/l of lead and 11.0 ug/l of zinc. The values are both reported under the Contract Required Detection Limit (CRDL). Lead and zinc sample results greater than the Instrument Detection Limit (IDL) but less than 5 times the amount of the blank value were qualified as 'U'.

The field blank labeled 2GW-Rinsate collected for the data set 9100.332 was found to contain calcium at 407 ug/l, lead at 1.2 ug/l and sodium at 379 ug/l. The values are all

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reported under the CRDL. Lead values >IDL but <5 times the amount of the blank value were qualified as 'U'.

b.) Laboratory (Method) Blanks: All initial calibration, continuing calibration and preparation blanks were generated in accordance within acceptable limits with the following exceptions.

For data set 9100.332, thallium was detected in the continuing calibration blank at 2.8 ug/l and lead at 2.2 ug/l in the preparation blank. Thallium and lead values >IDL but <5 times the amount of the blank value were qualified with 'U'.

For data set 9100.299, iron was detected at 4.206 mg/kg. Qualification was not found to be necessary.

IV. ICP Interference Check Sample (ICS)

The ICP ICS was generated within acceptable limits for %R and frequency.

V. Laboratory Control Sample (LCS)

The LCS for the analyses generated acceptable %R for all the analytes except for sodium at 153% (9100 299). The positive results were qualified as 'J', estimated

VI. Duplicate Sample Analysis

Sample 1-GW-9 was run in duplicate by the laboratory to determine precision. All analytes were within specifications for RPD withthe exception of cobalt and zinc. The cobalt values were <5 times the CRDL and were not qualified. The zinc values >100 ug/l were qualified with 'J' as estimated.

Sample 2-GW-8D was run in duplicate by the laboratory. Analytes were within specification except zinc. The zinc values <5 times the CRDL were not qualified. The zinc values >100 ug/l were qualified as 'J', estimated.

Sample 1-SED-5 was run in duplicate for data set 9100.299. Analytes were within specification except for chromium (41.6%); cobalt (51.7%); copper (39.1%) and zinc (72.7%). The cobalt and copper values were all under 5 times the CRDL and were not qualified. The chromium and zinc values which were over 5 times the CRDL were qualified with 'J', estimated.

VII. Matrix Spike Sample Analysis

Sample 1-GW-9 was used as a spiked sample. The %R was generated within acceptable specifications with the exception of the following: arsenic (128.3%), iron (57.3%) and selenium (31.0%). Iron is considered estimated for all water samples from 9100.300 and qualified as 'J' for positive values and 'UJ' for nondetectable values. Selenium was not detected in any of the samples. The selenium non-detectable compounds were qualified 'UJ', estimated. The positive values for arsenic are qualified as 'J', estimated.

Sample 2-GW-8D was used as the spiked sample for data set 9100.332. The %R was generated within acceptable specifications with the exception of selenium at 59%. Selenium was qualified as 'UJ' for all the samples.

Sample 1-SED-4 was spiked for data set 9100.299. The %R's were all acceptable except for antimony (53.8%); iron (210%); lead (555.5%) for furnace and manganese (258.9%). Antimony was qualified as 'UJ', estimated for the nondetectable values. The positive values for iron, lead and manganese were qualified as 'J', estimated.

J. McMullan

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MEMORANDUM

TO: B. Walter, E & E Project Manager

FROM: J. McMullan, E & E QA Chemist JMM

DATE: July 1, 1991

SUBJECT: Comments on ChemWorld Environmental Inc.'s Data Validation Report for Bainbridge Naval Training Center, Work Order #2.

CC: M. Meredith, E & E QA Officer

ChemWorld Environmental Inc.'s (CW's) revised Data Validation Report for the Bainbridge Naval Training Center (BNTC), dated May 20, 1991, was performed under Work Order #2 for samples collected on February 10-14, 1991. The report covers analytical data contained in three E & E data packages; 9100.300/.309, 9100.332/.338, and 9100.299/.308/.331.

Given below are our quality assurance/quality control (QA/QC) comments regarding data usability, providing further explanation/clarification and including any differing opinions. In addition, we have included comments on overall precision based on assessment of field duplicate results for this sampling event. Revised data summary sheets are attached, which give our data qualifiers where they differ from CW's.

QA/QC COMMENTS

- Inadvertently, BNA surrogates were not added to samples extracted on 2/19/91. These samples included 1-GW-1, 1-GW-2BN, 1-GW-3, 2-SW-5BN, 2-SW-6, 2-SW-7, 2-SW-8, and 2-SW-8 DUP. Due to limited sample volume, reextraction could not be performed. Analysis was performed without surrogates as per B. Walter's instructions to the laboratory. These sample locations will be resampled in the next sampling round and comparison between the two sets of data will be performed. At that time, a decision will be made as to the usability of these BNA results.

- In our opinion, when high surrogate recoveries are obtained for volatiles or BNAs, no data qualification is necessary, in most instances. If the recoveries are excessively high, then positive results only need be qualified. In this report, CW qualified both positive results and quantitation limits due to slightly high surrogate recoveries in the following instances; volatiles in samples 1-SW-9, 1-SW-11MSD, 1-SED-10, 1-SED-10DL, and 2-SED-7RE and BNAs in sample 2-GW-8 DUP.

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- Total petroleum hydrocarbon (TPH) results for samples 2-SED-5, 2-SED-6, 2-SED-7, 2-SED-8, and 2-SED-8 DUP were rejected by CW as unusable due to blank subtraction and omission of blank spike analysis. All other quality control (QC) samples including reference standards, spikes, and duplicates gave acceptable results. In our opinion, the method blank results should be added back to the reported result. This procedure gives the following results for TPH:

Sample No.	TPH (mg/kg)
2-SED-5	63
2-SED-6	55
2-SED-7	1,200
2-SED-8	62
2-SED-8 DUP	31

  Only the TPH result for 2-SED-7 is significantly higher than the method blank levels of 22 and 47 mg/kg. The TPH results for all the other sediment samples should be considered as not detected with a "U" qualifier.

- Cyanide results for samples 2-GW-1, 2-GW-2, 2-GW-3, 2-GW-6, 2-GW-7, 2-GW-8 DUP, and 2-GW-9 were rejected by CW due to continuing calibration verification (CCV) recoveries outside QC limits. Reanalysis was not performed due to limited sample volume. In checking the CCV recoveries, we found that four were above the QC limit of 115% with values of 117%, 116%, 126%, and 122%. The remaining eight CCV recoveries were within the QC limits. In our opinion, since no cyanide was detected in these samples and it would have been if present, no qualification is necessary.

OVERALL PRECISION

- Field duplicate analysis indicated good overall precision for inorganics in groundwaters. Relative percent difference (RPD) values for GW-8 and 2-GW-8 duplicate sets ranged from 1.0 to 8.5%, except for one high RPD of 184% for zinc (see Tables 1 and 2).

- Overall precision for inorganics in surface waters was poor with most RPDs for SW-11 duplicates being greater than 100% (see Table 3).

- Overall precision for inorganics in sediments was acceptable. RPDs for SED-11 duplicates from 5.7 to 65% with a high RPD of 146% for lead. (See Table 4). RPDs for 2-SED-8 duplicates ranged from 0.3 to 89% with two high RPDs for lead and manganese at 140 and 101%, respectively. (See Table 6).

- Overall precision for organics in sediment was acceptable for 2-SED-8 duplicates, with RPDs ranging from 21 to 38% (see Table 5). No organics were detected in the other field duplicate samples.

If you have any questions, please contact me at E & E's Buffalo office, at ext. 2606.

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Table 1

BETC GROUNDWATER
FIELD DUPLICATE RESULTS - INORGANIC
(Results in µg/L)

Analyte	GW-8	GW-8D	RPD
Barium	115	112	2.6
Calcium	77,000	72,300	6.2
Cobalt	7.8	ND	IN
Copper	20.0	20.4	2.0
Iron	4,120	3,950	4.2
Lead	1.4	ND	IN
Magnesium	43,000	40,500	5.9
Manganese	7,870	7,480	5.1
Nickel	ND	9.1	IN
Potasium	3, 640	3,340	8.5
Sodium	33,700	32,400	3.9
Zinc	175	165	5.8

IN = Indeterminant
ND = Not Detected

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Table 2

BNTC GROUNDWATER
FIELD DUPLICATE RESULTS - INORGANIC
(Results in µg/L)

Analyte	2GW-8	2GW-8D	RPD
Barium	68.0	67.5	1.0
Calcium	41,500	41,800	1.0
Copper	24.1	ND	IN
Iron	9,790	10,300	5.1
Magnesium	22,700	22,900	1.0
Manganese	4,490	4,540	1.1
Potasium	8,670	8,900	2.6
Sodium	44,300	44,800	1.1
Zinc	260	11.1	184

IN = Indeterminant
ND = Not Detected

Table 3

BETC SURFACE WATER
FIELD DUPLICATE RESULTS - INORGANIC
(Results in µg/L)

Analyte	SW-11	SW-11D	RPD
Aluminum	5,040	22,700	127
Arsenic	4.5	8.6	62
Barium	120	502	123
Cadmium	7.7	25.4	107
Calcium	56,100	10,100	139
Chromium	17	62.2	114
Cobalt	61.2	169	94
Copper	25.1	115	128
Iron	58,500	168,000	97
Lead	33.8	111	106
Magnesium	23,400	34,500	38
Manganese	719	2,960	122
Nickel	19.7	78.1	119
Potasium	3,740	8,580	78
Sodium	20,300	21,200	4.3
Vanadium	20.8	87.5	123
Zinc	107	477	127

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Table 4

BNTC SEDIMENT
FIELD DUPLICATE RESULTS - INORGANIC
(Results in mg/kg)

Analyte	SED-11	SED-11D	RPD
Aluminum	8,880	9,410	5.7
Barium	55.6	66.9	18
Cadmium	2.2	2.1	4.6
Calcium	1,260	1,560	21
Chromium	45.9	36.9	22
Cobalt	6.9	9.9	36
Copper	19.0	23.2	14
Iron	16,600	18,000	8.1
Lead	52.2	8.1	146
Magnesium	6,650	6,420	3.5
Manganese	148	156	5.2
Nickel	17.0	14.3	17
Potasium	1,950	2,570	27
Sodium	79.2	155	65
Vanadium	27.6	31.0	12
Zinc	52.7	55.5	5.2

Table 5

BNTC SEDIMENT
FIELD DUPLICATE RESULTS - ORGANIC
(Results in µg/kg)

Analyte	2-SED-8	2-SED-8DUP	RPD
4,4'-DDE	10	6.8	38
4,4'-DDD	8.8	7.1	21
4,4'-DDT	17	13	26

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Table 6

BNTC SEDIMENT
FIELD DUPLICATE RESULTS - INORGANIC
(Results in mg/kg)

Analyte	2-SED-8	2-SED-8D	RPD
Aluminum	2,900	2,890	0.3
Arsenic	0.65	1.0	42
Barium	23.8	50.2	71
Cadmium	1.3	ND	IN
Calcium	843	863	2.3
Chromium	5.3	9.1	53
Cobalt	2.0	4.1	69
Copper	3.7	5.7	42
Iron	6,920	9,220	28
Lead	6.3	35.5	140
Magnesium	927	778	17
Manganese	235	719	101
Nickel	7.3	2.8	89
Potasium	226	290	25
Vanadium	7.4	9.8	28
Zinc	32.0	27.9	14

IN = Indeterminant
ND = Not Detected

April 1991 Sampling Event

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DATA VALIDATION REPORT

BAINBRIDGE NAVY REMEDIAL INVESTIGATION

SAMPLING DATES OF APRIL 15 - 20, 1991

PREPARED FOR:

Ecology and Environment, Inc.
368 Pleasantview Drive
Lancaster, New York 14086

June 1991

PREPARED BY:

ChemWorld Environmental, Inc.
4500 Avamere Street
Bethesda, Maryland 20814

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DATA VALIDATION SUMMARY

Bainbridge Navy Remedial Investigation
E & E Data Packages 9100.877, 9100.888, 9100.907,
9100.921 and 9100.938
Sampling Dates April 15 - 20, 1991

INTRODUCTION

This Data Validation Summary report was generated for Work Order #3 for water analyses for the Bainbridge Navy Remedial Investigation. The analytical laboratory work was performed by Ecology and Environment, Inc. (E & E's) Analytical Services Center.

The five data report packages referenced above include 20 groundwater and 5 surface water samples and their associated field blanks. Analytical testing consisted of volatile organic analyses by Gas Chromatography/Mass Spectroscopy (GC/MS); Base/Neutral and Acid Extractable Organics by GC/MS; Pesticides and PCB's by GC; Total Petroleum Hydrocarbons by Infrared Spectrophotometry; Inorganics by Atomic Absorption (AA) and Inductively Coupled Argon Plasma (ICP); Mercury by Cold Vapor; and Cyanides by Spectrophotometry.

The following report provides a summary of data acceptability and deviations in accordance with the Naval Energy and Environmental Support Activity (NEESA) Level C Data Validation Requirements. The site-specific Work Plan and Quality Assurance Project Plan (QAPP) were reviewed. These documents detailed the project background and requirements for the investigation.

VOLATILE ORGANICS BY GC/MS

OVERALL ASSESSMENT OF DATA

All volatile organic data generated by GC/MS are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms and within the following text. Due to a scheduling error, sample TB-2 was not analyzed for volatile organics by GC/MS. Trip Blank #11 travelled to the laboratory in a cooler which did not contain samples for volatile organics. The laboratory inadvertently analyzed the trip blank and generated paperwork within Case 9100.877. This portion of the data package was not validated. The following data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

All holding times were met within the acceptable time frame of 14 days for preserved water samples.

II. GC/MS Tuning

All tuning was generated within the acceptable limits for Bromofluorobenzene (BFB).

III. Calibration

All initial and continuing calibration was performed within acceptable limits for average Relative Response Factors ($\overline{RRF}$), Percent Relative Standard Deviation (%RSD), Relative Response Factors (RRF), and Percent Difference (%D) with the exception of the following.

(Case 9100.907)
Sample 2-GW-5A was injected at 8:12 on 4/30/91, six minutes after the 12-Hour clock had expired. The sample was qualified as 'UJ', estimated, for volatile organics.

Continuing calibration for 4/26/91 at (00:14) and (14:27) and 4/27/91 at (11:33) did not meet specifications for 2-Butanone. The RRF50 on 4/26 at (00:14) for 2-Butanone was 0.012. All RRF's must be $\geq$0.05 for all compounds. The RRF50's were also out of specification for 2-Butanone on 4/26 at (14:27) and 4/27 at (11:33). Positive results for 2-Butanone were not detected in any of the samples. The nondetectable values for 2-Butanone for samples affected on 4/26 through 4/27 were qualified as 'R', *unusable*.

Within the same continuing calibrations the following %D's were out of specification. The %D criterion is generation at $\leq$ 25%.

4/26/91 at (00:14)

Acetone	42.2%
Carbon Disulfide	30.8%
2-Butanone	78.6%
1,1,1-Trichloroethane	47.9%
trans-1,3-dichloropropene	31.2%
2-Hexanone	25.9%

The acetone values were previously qualified as 'U', not detected, through the method blank. Positive results for these compounds were not detected in any of the samples. Qualification for these non-detectable compounds was not found to be necessary.

4/26/91 at (14:27)

Carbon Disulfide	35.5%
Bromoform	29.4%
Tetrachloroethene	29.7%

Positive values for these compounds were not detected. Qualification was not found to be necessary.

4/27/91 at (11:33)

Chloromethane	33.9%
Carbon Disulfide	46.2%
2-Butanone	28.6%

Positive values for these compounds were not detected. Qualification was not found to be necessary.

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4/30/91 at (12:36)

2-Butanone	65.2%
Vinyl Acetate	33.6%
4-methyl-2-pentanone	35.0%
2-Hexanone	43.4%
1,1,2,2-tetrachloroethane	25.9%

Positive values for these compounds were not detected. Qualification was not found to be necessary.

IV. Blanks

Laboratory (Method) Blanks: Five water method blanks were analyzed for the samples from package 9100.907. Methylene chloride was found within the blanks at the following levels: VBLK-W1 at 5 ug/l, VBLK-W2 at 13 ug/l, VBLK-W3 at 6 ug/l, VBLKW4 at 3 ug/l, and VBLK-W5 at 15 ug/l. The limit used to qualify the data set was 10 times the highest methylene chloride value or 150 ug/l. All positive values for the samples in data package 9100.007 were qualified as 'U', not detected.

VBLK-W3 was also found to contain 4 ug/l estimated, of acetone. A limit of 40 ug/l was used to qualify the acetone values for the samples. All positive values for acetone for data package 9100.907 were qualified as 'U', not detected.

An additional three water method blanks were analyzed for volatiles from data package 9100.877. Methylene chloride was found within the blanks at the following levels: VBLK-W1 at 3 ug/l, estimated; VBLK-W2 at 3 ug/l, estimated and VBLK-W3 at 12 ug/l, estimated. The limit used to qualify the data set was 10 times the highest methylene chloride value or 120 ug/l. All positive values for the samples in data package 9100.877 were qualified as 'U', not detected.

VBLK-W1 was also found to contain 2 ug/l, estimated, of acetone. A limit of 20 ug/l was used to qualify the acetone values for the samples. Trip Blank #6 was qualified as 'U', not detected for acetone. Sample 2-GW-8A exhibited an acetone level of 49 ug/l. This exceeded the 20 ug/l limit, so qualification was not necessary.

Field Blanks: Four trip blanks (Trip Blanks # 1,3,9,10) were analyzed for volatiles for data package 9100.907. Methylene chloride was detected at 7, 2, 8 and 6 ug/l, respectively. The corresponding samples and the trip blanks were previously qualified as 'U', not detected for methylene chloride through the method blanks.

Four additional trip blanks for water samples were analyzed for volatiles for data package 9100.877. These included: Trip blanks #4, 5, 6 and 7. The corresponding samples and the trip blanks were previously qualified as 'U', not detected for methylene chloride and acetone through the method blanks. However, Trip Blank #6 was found to contain carbon disulfide at 7 ug/l. This was the only sample where carbon disulfide was detected.

V. Surrogate Recovery

All surrogates were found to be generated within specification for percent recoveries with the exception of the following.

The compound 1,2-Dichloroethane-d4 was out of specification for %R at 119% for sample 2-GW-9MS. The limit is (76-114%). Volatile organic compounds were not detected in sample 2-GW-9MS. The non-detectable compounds were qualified as 'UJ', estimated.

VI. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

All MS/MSD's were generated within acceptable limits for Relative Percent Difference (RPD) and Percent Recovery (%R) with the exception of the RPD's for 2 of the 5 compounds for Trip Blank #3 (9100.907). The compounds included 1,1-dichloroethene and benzene. The %R for 1,1-dichloroethene was also generated low at 36%. Surrogate spike recoveries were all generated within acceptable limits for data set 9100.907. Qualification was not required.

VII. Internal Standards Performance

All internal standards were generated within acceptable specifications for area counts and retention time variation.

SEMI-VOLATILE ORGANICS BY GC/MS
(Base/Neutral and Acid Extractable Organics)

OVERALL ASSESSMENT OF DATA

All base/neutral and acid extractable organic data generated by GC/MS are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms and within the following text. In addition to the required QC samples, a matrix spike blank (MSB) was also run with the samples for data sets 9100.907 and 9100.877. The MSB's were generated in accordance with acceptable QC criteria.

The acid phenol surrogate spiking compounds were added at a concentration twice the level required by the Statement of Work (SOW) to the samples received on 4/19 and 4/20/91. Sample 2-SW-6R required dilution due to the level of diethylphthalate present. At the dilution analyzed, the detected concentration was slightly above the calibration range. Therefore, the concentration was qualified as 'E', by the laboratory. Since the linear range was not exceeded, no further dilution was performed. All other data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

All holding times were met within the acceptable time frame for water samples (extracted within 7 days and analyzed within 40 days) with the exception of the following.

Samples 1-GW-1A and 1-GW-2A were extracted 3 days after the holding time. An earlier extraction of these samples had been mistakenly spiked with the pesticide surrogate compound. Semi-volatile compounds were not detected in the samples. The non-detectable compounds for both samples were qualified as 'UJ', estimated.

Sample 2-GW-5A was extracted 9 days after the holding time. An earlier extraction of this sample yielded unacceptable phenol surrogate recoveries. The sample was qualified as 'UJ', estimated for the nondetectable compounds. Postive results were not detected for the sample.

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II. GC/MS Tuning

All tuning was generated within acceptable limits for Decafluorotriphenylphosphine (DFTPP).

III. Calibration

All initial and continuing calibration was performed within acceptable limits for $\overline{RRF}$, %RSD, RRF, and %D with the exception of the following.

(Case 9100.907)

Continuing calibration %D's were out of specification for 5/2/91 at (22:22) and the following dates. The %D limit is ≤25%. These included:

Benzyl Alcohol	38.7%
2,4-Dinitrophenol	41.3%
4-Nitrophenol	26.9%

Positive values for these compounds were not detected. Qualification of the samples was not found to be necessary.

(Case 9100.877)

4/22/91 at (10:27)

3-Nitroaniline	54.8%
2,4-Dinitrophenol	46.4%
4-Nitrophenol	37.1%
4-chlorophenyl-phenylether	42.3%
4-nitroaniline	40.7%
3,3'-Dichlorobenzidine	50.2%

Positive values for these compounds were not detected. Qualification was not found to be necessary.

4/23/91 at (01:05)

4-Methylphenol	30.3%
3-Nitroaniline	44.4%
2,4-Dinitrophenol	41.3%
4-Nitrophenol	30.8%
4-chlorophenyl-phenylether	46.4%
4-Nitroaniline	49.8%
3,3'-Dichlorobenzidine	47.8%
Benzo(b)Fluoranthene	37.4%

These compounds were not detected in the data set. Qualification was not found to be necessary.

IV. Blanks

Laboratory (Method) Blanks:

Five laboratory method blanks were analyzed for the water samples of data set 9100.907. These included SBLK-W1 through SBLK-W5. Bis(2ethylhexyl)phthalate was detected in all five method blanks at the following levels: SBLK-W1 at 10 ug/l; SBLK-W2 at 3 ug/l, estimated; SBLK-W3 at 4 ug/l, estimated; SBLK-W4 at 5 ug/l, estimated; and SBLK-W5 at 17 ug/l. A limit of 170 ug/l was utilized to evaluate the samples (10X the highest value). All samples associated with the five method blanks were qualified as 'U' not detected.

Two laboratory method blanks were analyzed for the groundwater samples of data set 9100.877. SBLK-W2 and SBLK-W3 were found to contain 11 ug/l and 5 ug/l(estimated), respectively of bis(2ethylhexyl)phthalate. A limit of 110 ug/l was utilized to evaluate the samples. All samples asociated with the method blanks were qualified as 'U' not detected for bis(2-ethylhexyl) phthalate.

One laboratory method blank was analyzed for the surface water samples of data set 9100.877. Bis(2-ethylhexyl)phthalate was detected at 10 ug/l. Ten times this level or 100 ug/l was used to evaluate the samples. All samples were qualified as 'U', not detected for the compound.

V. Surrogate Recovery

All surrogate recovery was found to be generated within acceptable limits for the 6 surrogate compounds with the exception of samples 1-GW-8A, 1-GW-8A RE, 2-GW-4A and 2-GW-4A RE for data set 9100.907. The samples were reextracted and reanalyzed, however, similar recoveries were generated substantiating a matrix affect. The following recoveries were out of specification for the data set.

1-GW-8A	Nitrobenzene-d5	29%	(Limit 35-114%)
	2-Fluorobiphenyl	40%	(Limit 43-116%)
	Terphenyl	29%	(Limit 33-141%)

The positive results for the base/neutral compounds were qualified as 'J' and the nondetectables as 'UJ', estimated.

1-GW-8A RE	Phenol-d5	3%	(Limit 10-94%)
	2-Fluorophenol	8%	(Limit 21-100%)

The nondetectable acid extractable compounds were qualified as 'R', unusable, due to surrogate recoveries below 10%. Positive results were not detected for acid phenols.

2-GW-4A	Nitrobenzene-d5	33%	(Limit 35-114%)
	Terphenyl	31%	(Limit 33-141%)
	Phenol-d5	1%	(Limit 10-94%)
	2-Fluorophenol	2%	(Limit 21-100%)

Positive results were not detected for sample 2-GW-4A. The nondetectable base neutrals were qualified as 'UJ', estimated and the nondetectable acid extractables as 'R', unusable, due to recoveries of less than 10%.

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2-GW-4A RE	Phenol-d5	1%	(Limit 10-94%)
	2-Fluorophenol	1%	(Limit 21-100%)

The nondetectable acid extractable compounds were qualified as 'R', unusable, due to recoveries of less than 10%.

VI. MS/MSD

All MS/MSD's were generated within acceptable limits for RPD and %R with the following exception.

The RPD's for 2 of 11 compounds were out of specification. These included phenol at 43% (Limit 42%) and 2-Chlorophenol at 56% (Limit 40%). One %R for N-Nitroso-di-n-propylamine was generated high at 128% (Limit 41-116%). Surrogate spike recoveries were all generated within acceptable limits. Qualification of the MS/MSD was not required.

VII. Internal Standards Performance

All internal standards were generated within acceptable specifications for area counts and retention time variation.

PESTICIDES/PCB's BY GC

OVERALL ASSESSMENT OF DATA

All pesticide and PCB data generated by GC are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms and within the following text. The data has been generated in accordance with the site-specific QAPP and project requirements.

Six additional Matrix Spike Blanks were analyzed with the pesticide/PCB runs. All %R were generated within acceptable limits.

I. Holding Times

All holding times were met within the acceptable time frame for water samples (extracted within 7 days and analyzed within 40 days).

II. GC Instrument Performance

Adequate chromatographic resolution and instrument sensitivity were achieved through the generation of data within acceptable limits. These included DDT retention time , retention time windows/standards, DDT/Endrin degredation check, and retention time shift for dibutylchlorendate (DBC).

III. Calibration

All initial and continuing calibration was performed within acceptable limits for calibration factors (CF), percent relative standard deviation (%RSD) for linearity, and %D with the following notations.

(Cases 9100.907 and 9100.877)
The criterion of 10% for 4,4'-DDT linearity was not met for the pesticide analytical sequences. A plotted curve was used for quantitation.

IV. Blanks

a). Field Blanks: Field blanks were not analyzed for pesticides/PCB's.

b.) Laboratory (Method) Blanks: Pesticides/PCB's were not detected in any of the 6 method blanks.

V. MS/MSD

All MS/MSD's were generated within acceptable limits for %R and RPD's.

TOTAL PETROLEUM HYDROCARBONS (TPH)

OVERALL ASSESSMENT OF DATA

The TPH data generated by spectrophotometric analysis for the water samples are valid and acceptable, as noted on the data summary forms. Data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

The holding time of 28 days for water samples was met for all analyses.

II. Calibration

The 3 to 5 point curve for daily calibration was generated within specifications for the method.

III. Blank Spike

One blank spike was analyzed for each data set. Percent recoveries were generated within acceptable limits.

INORGANIC ANALYSES BY AA AND ICP
(Mercury by Cold Vapor; Cyanides by Spectrophotometry)

OVERALL ASSESSMENT OF DATA

All inorganic data generated by AA, ICP, Cold Vapor and Spectrophotometric methods are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms and within the following text. The data has been generated in accordance with the site-specific QAPP and project requirements.

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I. Holding Times

All holding times were met within the acceptable time frame for metals (6 months), mercury (28 days), and cyanide (14 days) with the exception of the following.

The reanalysis of samples 1-GW-5A and 2-GW-2A (Case 9100.907)took place beyond the holding time for cyanide. The initial analysis, conducted within the holding time, was performed under an unacceptable initial calibration verification standard. Cyanide was not detected in any of the samples. The samples were qualified as 'UJ', estimated.

All cyanide groundwater samples from Case 9100.877 were analyzed outside the holding time except for samples 1-GW-1A and 1-GW-2A. Unacceptable cyanide spike and Initial Calibration Verification (ICV) recovery (37% and 53%, respectively) were generated for samples distilled on 4/24/91 (within the holding time). Cyanide was not detected in any of the samples. The samples were qualified as 'UJ', estimated.

II. Calibration

All initial and continuing calibration was performed within acceptable limits for %R, correlation coefficients, and mid-range standards with the exception of the following.

Case (9100.877)

The %R for the cyanide ICV standard on 5/1/91 was generated at 83.9%. The lower limit for recovery is 85%. All associated samples have been previously qualified as 'UJ', estimated, through the exceedance of the holding times.

The %R for the cyanide Continuing Calibration Verifciation (CCV) standard for 5/1/91 was generated at 0%. The laboratory reported that a blank solution may have been misplaced in the autosampler, causing the 0% recovery. The ICV standard was generated within acceptable limits. The samples 1-GW-1A and 1-GW-2A were qualified as 'UJ', estimated.

III. Blanks

Laboratory (Method) Blanks: All initial calibration, continuing calibration and preparation blanks were generated in accordance within acceptable limits with the following exceptions.

(Case 9100.907)
The following elements were detected in the method blank. The values reflect the highest noted for each type of blank.

Initial Calibration Blank (ug/l)

Cobalt	7.6
Aluminum	21.8
Iron	25.6
Manganese	1.2
Vanadium	4.7
Potassium	375.7

Continuing Calibration Blank (ug/l)

Cobalt	6.6
Iron	8.3
Vanadium	6.5
Silver	4.0
Zinc	8.5
Manganese	2.4
Potassium	336

Preparation Blank (ug/l)

Potassium	349.5
Vanadium	5.7

The metal values >IDL but <5 times the amount of the blank value were qualified with 'U', not detected.

(Case 9100.877)

Initial Calibration Blank (ug/l)

Vanadium	4.2
Cobalt	5.0

Continuing Calibration Blank (ug/l)

Nickel	9.9
Sodium	220
Silver	3.9
Iron	8.3
Zinc	8.4
Vanadium	4.8

Preparation Blank (ug/l)

Aluminum	32.8
Cobalt	7.6
Iron	25.6
Manganese	1.3
Vanadium	7.1

The metal values >IDL but <5 times the amount of the blank value were qualified as 'U', not detected.

Field Blanks: Two rinsates were collected for Case 9100.907. Aluminum, cobalt, iron, manganese, potassium, vanadium and zinc were previously qualified through the method blanks. Barium, cadmium, calcium, chromium, lead, nickel, copper and sodium were detected in the rinsate samples. Positive values for these metals which were detected at less

than 5 times the blank value were qualified as 'U', not detected. Values which exceeded 5 times the corresponding blank value were not qualified.

IV. ICP Interference Check Sample (ICS)

The ICP ICS was generated within acceptable limits for %R and frequency.

V. Laboratory Control Sample (LCS)

The LCS for the analyses generated acceptable %R for all the analytes.

VI. Duplicate Sample Analysis

Sample 1-GW-4A was run in duplicate by the laboratory to determine precision for Case 9100.907. All analytes were within specifications for RPD with the exception of chromium, lead, nickel and zinc. All positive values detected for these metals were <5 times the CRDL and were not qualified.

Sample 2-GW-9A was run in duplicate by the laboratory (Case 9100.877). Analytes were within specification except aluminum, cadmium, chromium, lead, nickel and zinc. All positive values detected at <5 times the CRDL were not qualified. Samples 1-GW-2A was qualified as 'J', estimated, for chromium and sample 1-GW-1A was qualified 'J', for zinc.

VII. Matrix Spike Sample Analysis

All spike recovery was generated within acceptable limits with the exception of the following.

Selenium recovery was out of specification at 50.7% (Case 9100.907) and at 60% (Case 9100.877). Selenium was not detected within any of the samples. The nondetectable values were qualified as 'UJ', estimated.

J. McMullan

X

MEMORANDUM

TO: Buff Walter, E & E Project Manager

FROM: Joanne McMullan, E & E QA Chemist JMM

DATE: June 28, 1991

SUBJECT: Comments on ChemWorld Environmental Inc.'s Data Validation Reports for Bainbridge Naval Training Center, Work Order #3.

CC: Marcia Meredith, E & E QA Officer

ChemWorld Environmental Inc.'s (CW's) Data Validation Report for the Bainbridge Naval Training Center (BNTC), dated June 17, 1991 was performed under Work Order #3 for samples collected on April 15-20, 1991. The report covers analytical data contained in three E & E data packages; 9100.877 (surface waters), 9100.877/.888 (groundwaters), and 9100.907/.921/.938 (groundwaters).

Given below are our quality assurance/quality control (QA/QC) comments regarding data usability, providing further explanation/clarification and including any differing opinions. In addition, we have included comments on overall precision based on assessment of field duplicate results for this sampling event. Revised data summary sheets are attached which give our qualifiers where they differ from CW's.

QA/QC COMMENTS

COMMENT 1

In evaluating inorganic laboratory blanks, CW listed initial and continuing calibration blanks as well as preparation blanks. In our opinion, only preparation blank evaluation is necessary. In addition, CW qualified sample results "U" based on blank results, rather than "J" as required by the NEESA guidelines. All samples in the data package were qualified by CW, rather than qualifying only those samples associated with a particular blank. Errors were noted in the designation of analytes found in the various blanks. Rather than list errors and corrections, our own evaluation of inorganic blank contamination is given below.

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Case 9100.907 -

Preparation Blank (4/24/91)

Analyte	Concentration (µg/L)
Potassium	349.5
Vanadium	5.7

Associated samples include 1-GW-3A, 1-GW-4A, 1-GW-6A, and 1-GW-7A. Vanadium was not detected in any of these samples and potassium results were greater than 5 times the blank level. No data qualification is necessary.

Preparation Blank (4/29/91)

Analyte	Concentration (µg/L)
Aluminum	21.8
Cobalt	7.6
Iron	25.6
Manganese	1.2
Vanadium	4.7

Associated samples include 1-GW-5A, 1-GW-8A, 1-GW-9A, 1-GW-RA, 2-GW-2A, 2-GW-3A, 2-GW-4A, 2-GW-5A, and 2-GW-RA. Positive results for iron and manganese were greater than 5 times the blank level, except for samples 1-GW-RA and 2-GW-RA. Iron and manganese results for these two samples are qualified "J" as estimated. Positive results for aluminum, cobalt, and vanadium in all of the associated samples were less than 5 times the blank level and are qualified "J" as estimated.

Case 9100.877 -

Preparation Blank (4/29/91)

Analyte	Concentration (µg/L)
Aluminum	32.8
Cobalt	5.6
Iron	6.9
Manganese	1.3
Vanadium	7.1

Associated samples include 2-GW-1A, 2-GW-6A, 2-GW-7A, 2-GW-8A, 2-GW-9A, and 2-GW-9AD. Vanadium was not detected in any of these samples. Aluminum was detected in all of these samples at less than 5 times the blank level. Cobalt was detected in 2-GW-8A, 2-GW-9A, and 2-GW-9AD at less than 5 times the blank level. Iron was detected in 2-GW-1A and 2-GW-6A and manganese was detected in 2-GW-1A at less than 5 times the blank level. All results at less than 5 times the blank level are qualified "J" as estimated.

Preparation Blank (4/29/91)

Analyte	Concentration (µg/L)
Aluminum	21.8
Cobalt	7.6
Iron	25.6
Manganese	1.2
Vanadium	4.7

Associated samples include 1-GW-1A and 1-GW-2A. Vanadium and cobalt were not detected in either sample. The following analytes were detected at less than 5 times the blank level; aluminum in 1-GW-2A and iron in 1-GW-1A. Manganese levels were greater than 5 times the blank level in both samples. All results at less than 5 times the blank level are qualified "J" as estimated.

Comment 2

Two rinsates, 1-GW-RA and 2-GW-RA, were collected and analyzed under case 9100.907. CW applies these field blank results to all of the samples in Case 9100.907, but not to any of the samples in Case 9100.877. According to their descriptions on the chain-of-custody records, rinsate 1-GW-RA applies to all 1-GW samples collected in the Old Landfill area and rinsate 2-GW-RA applies to all 2-GW samples collected in the Fire Training area.

In rinsate 1-GW-RA, the following analytes were detected:

Analyte	Concentration (µg/L)
Aluminum	24.2
Barium	5.8
Cadmium	5.8
Calcium	122
Chromium	15
Cobalt	5.5
Iron	77
Lead	5.6
Manganese	2.8
Nickel	9.6
Potassium	411
Sodium	615
Vanadium	7.9
Zinc	7.4

Positive results at less than 5 times these levels in 1-GW samples are qualified "J" as estimated.

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In rinsate 2-GW-RA the following analytes were detected:

Analyte	Concentration (µg/L)
Aluminum	24.6
Cadmium	3.0
Calcium	307
Copper	8.2
Iron	72.9
Lead	3.0
Manganese	2.7
Potassium	594
Sodium	1340
Vanadium	7.1
Zinc	20.3

Positive results at less than 5 times these levels in 2-GW samples are qualified "J" as estimated.

Comment 3

CW's comment on inorganic duplicate analysis lists 1-GW-4A as the sample analyzed in duplicate for Case 9100.907, but it was 2-GW-4A which was analyzed. Only chromium results were outside QC limits for duplicate analysis, not chromium, lead, nickel, and zinc. Thus, only chromium results for Case 9100.907 need be qualified "J" as estimated.

Also for Case 9100.877, only chromium results were outside QC limits for duplicate analysis, not aluminum, cadmium, chromium, lead, nickel, and zinc. Thus, only chromium results for Case 9100.877 need be qualified.

Sample results for the other analytes listed by CW are less than 5 times CRDL and thus the control limit is ± CRDL, not 20% RPD.

OVERALL PRECISION

Field duplicate results indicated good overall precision for inorganics, with the exception of one high RPD for zinc of 140% (see Tables 1 and 2). Overall precision for organics was also good, as evidenced by RPD's ranging from 0.0% to 3.8% (see Table 3).

kvk/CD7013

Table 1

BNTC GROUNDWATER
FIELD DUPLICATE RESULTS - INORGANIC
(Results in µg/L)

Parameter	1GW7A	1GW7AD	RPD
Aluminum	87.6	125	35
Barium	92.9	93.9	1.1
Calcium	60,100	60,000	0.2
Copper	2.8	2.4	15
Iron	189	197	4.2
Lead	1.3	ND	IN
Magnesium	33,500	33,400	0.3
Manganese	104	102	1.9
Potassium	4,070	4,050	0.5
Sodium	24,300	25,000	2.8
Zinc	21.0	22.8	8.2

IN = Indeterminant
ND = Not Detected

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Table 2

BETC GROUNDWATER
FIELD DUPLICATE RESULTS - INORGANIC
(Results in µg/L)

Parameter	2GW9A	2GW9AD	RPD
Aluminum	39.1	38.8	0.7
Barium	30.6	30.2	1.3
Calcium	15,300	16,200	5.7
Chromium	37.0	39.5	6.5
Cobalt	11.3	13.9	21
Copper	ND	8.4	IN
Iron	4,510	4,430	1.8
Lead	1.4	1.3	7.4
Magnesium	6,390	6,300	1.4
Manganese	1,590	1,570	1.3
Nickel	12.9	ND	IN
Potassium	983	1,590	47
Sodium	9,290	10,900	16
Zinc	13.2	76.9	140

IN = Indeterminant
ND = Not Detected

Table 3

BNTC GROUNDWATER
FIELD DUPLICATES RESULTS - ORGANIC
(Results in µg/L)

Parameter	1GW7A	1GW7ADUP	RPD
Total-1,2-Dichloroethene	26	27	3.8
Trichloroethene	7	7	0.0
Di-n-butylphthalate	1	1	0.0

June/July 1991 Sampling Event

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DATA VALIDATION REPORT

BAINBRIDGE NAVY REMEDIAL INVESTIGATION

SAMPLING DATES OF JUNE 17-21 and JULY 16, 1991

PREPARED FOR:

Ecology and Environment, Inc.
368 Pleasantview Drive
Lancaster, New York 14086

AUGUST 1991

PREPARED BY:

ChemWorld Environmental, Inc.
4500 Avamere Street
Bethesda, Maryland 20814

DATA VALIDATION SUMMARY

Bainbridge Navy Remedial Investigation
E & E Data Packages 9101.442, 9101.457, 9101.471
9101.479 and 9101.701
Sampling Dates June 17-21 and July 16, 1991

INTRODUCTION

This Data Validation Summary report was generated for Work Order #4 for water analyses for the Bainbridge Navy Remedial Investigation. The analytical laboratory work was performed by Ecology and Environment, Inc. (E & E's) Analytical Services Center.

The five data report packages referenced above include 18 groundwater samples and their associated quality control samples. Analytical testing consisted of volatile organic analyses by Gas Chromatography/Mass Spectroscopy (GC/MS); Base/Neutral and Acid Extractable Organics by GC/MS; Pesticides and PCB's by GC; Total Petroleum Hydrocarbons by Infrared Spectrophotometry; Inorganics by Atomic Absorption (AA) and Inductively Coupled Argon Plasma (ICP); Mercury by Cold Vapor; and Cyanides by Spectrophotometry.

The following report provides a summary of data acceptability and deviations in accordance with the Naval Energy and Environmental Support Activity (NEESA) Level C Data Validation Requirements. The site-specific Work Plan and Quality Assurance Project Plan (QAPP) were reviewed. These documents detailed the project background and requirements for the investigation.

VOLATILE ORGANICS BY GC/MS

OVERALL ASSESSMENT OF DATA

All volatile organic data generated by GC/MS are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms. The following data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

All holding times were met within the acceptable time frame of 14 days for preserved water samples.

II. GC/MS Tuning

All tuning was generated within the acceptable limits for Bromofluorobenzene (BFB).

III. Calibration

All initial and continuing calibration was performed within acceptable limits for average Relative Response Factors (RRF), Percent Relative Standard Deviation (%RSD), Relative Response Factors (RRF), and Percent Difference (%D) with the exception of the following.

(Data Set 9101.471)

Continuing Calibration

6/26/91 at (09:42)		
4-Methyl-2-pentanone	27.6% D	(Limit 25%)
6/27/91 at (02:43)		
Carbon Disulfide	26.9% D	
6/27/91 at (14:22)		
Carbon Disulfide	33.1% D	
2-Butanone	33.7% D	

The compound 4-Methyl-2-pentanone was not detected in any of the samples, therefore, qualification was not found to be necessary. Carbon Disulfide and 2-Butanone were detected in Trip Blanks 8 and 6, respectively, however, the positive values were not affected by the particular continuing calibration.

IV. Blanks

Laboratory (Method) Blanks: Two water method blanks were analyzed for the samples from Data Set 9101.442. Methylene chloride was found within the blanks at the following levels: VBLK-W1 at 7 ug/l and VBLK-W2 at 4 ug/l,estimated. The limit used to qualify the data set was 10 times the highest methylene chloride value or70 ug/l. All positive values for the samples in data package 9101.442 were qualified as 'U', not detected.

An additional four water method blanks were analyzed for volatiles from Data Set 9101.471. The following includes a breakdown of contaminants:

VBLKW1	Methylene chloride	8 ug/l
VBLKW2	Methylene chloride Acetone	3 ug/l, estimated 5 ug/l, estimated
VBLKW3	Methylene chloride Acetone	2 ug/l, estimated 3 ug/l, estimated
VBLKW4	Methylene chloride	5 ug/l

The limit used to qualify the data set was 10 times the highest methylene chloride and acetone value or 80 and 50 ug/l, respectively. All positive values for the samples in Data Set 9101.471 were qualified as 'U', not detected.

Field Blanks: Four trip blanks (Trip Blanks #2,3,4,7) were analyzed for volatiles for Data Set 9101.442. The following includes a summary of trip blank contamination:

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Trip Blank #2

Methylene Chloride	2 ug/l, estimated
Acetone	13 ug/l
Carbon Disulfide	5 ug/l

Trip Blank #3

Methylene Chloride	2 ug/l, estimated
Acetone	12 ug/l

Trip Blank #4

Acetone	7 ug/l, estimated

Trip Blank #7

Acetone	10 ug/l

The highest acetone and carbon disulfide values were detected in Trip Blank #2. A limit of 10 times the acetone value and 5 times the carbon disulfide value were used to evaluate the samples. All samples were qualified as 'U', not detected, for positive values for these compounds. The corresponding samples and the trip blanks were previously qualified as 'U', not detected, for methylene chloride through the method blanks.

Six additional trip blanks for water samples were analyzed for volatiles for Data Set 9101.471. These included: Trip blanks #1,5,6,8,9 and 10. The corresponding samples and the trip blanks were previously qualified as 'U', not detected for methylene chloride and acetone through the method blanks. However, Trip Blank #6 was found to contain 1,1,1-Trichloroethane at 1 ug/l, estimated. Trip Blank #8 also contained Total-1,2-Dichloroethene at 2 ug/l, estimated, and carbon disulfide at 7 ug/l. A limit of 5 times their respective values was used to determine qualification of the data. All positive values for 1,1,1-trichloroethane were qualified as 'U', not detected. Total-1,2-Dichloroethene values which exceeded the limit of 10 were left unqualified. Values under 10 were qualified as 'U', not detected. All positive values were qualified as 'U', not detected, for carbon disulfide.

V. Surrogate Recovery

All surrogates were found to be generated within specification for percent recoveries.

VI. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

All MS/MSD's were generated within acceptable limits for Relative Percent Difference (RPD) and Percent Recovery (%R).

VII. Internal Standards Performance

All internal standards were generated within acceptable specifications for area counts and retention time variation.

SEMI-VOLATILE ORGANICS BY GC/MS
(Base/Neutral and Acid Extractable Organics)

OVERALL ASSESSMENT OF DATA

All base/neutral and acid extractable organic data generated by GC/MS are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms and within the following text. Several samples were qualified as 'R', unusable, for the acid phenol fraction due to surrogate recoveries of less than 10%. All other data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

All holding times were met within the acceptable time frame for water samples (extracted within 7 days and analyzed within 40 days) with the exception of the following.

Sample 1-GW-9B from Data Set 9101.471 was extracted 8 days beyond the hold time. An initial extraction performed within the hold time yielded an unacceptable surrogate recoveries for acid phenols. The sample was qualified as 'J', estimated, for the positive values and 'UJ', for the nondetectable compounds.

II. GC/MS Tuning

All tuning was generated within acceptable limits for Decafluorotriphenylphosphine (DFTPP).

III. Calibration

All initial and continuing calibration was performed within acceptable limits for RRF, %RSD, RRF, and %D with the exception of the following.

(Data Set 9101.442)

Continuing calibration %D's were out of specification for 6/25/91 at (00:08) and the following dates. The %D limit is <25%. These included:

2,4-Dinitrophenol	31.7%
4-Nitroaniline	38.5%
3,3'-Dichlorobenzidine	29.2%

6/25/91 at (17:50)

4-Nitroaniline	33.5%

Positive values for the compounds noted above were not detected. Qualification was not found to be necessary.

(Data Set 9101.471)

Continuing calibration %D's were also out of specification for the following:

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7/2/91 at (09:15)

4-Nitroaniline	31.1%
3,3'-Dichlorobenzidine	32%

7/8/91 at (09:45)

bis(2-chloroisopropyl)ether	26.4%
4-Nitroaniline	32.9%

7/1/91 at (11:13)

2,4-Dinitrophenol	37.5%

7/3/91 at (11:40)

2,4-Dinitrophenol	26.7%

7/11/91 at (08:45)

N-nitroso-di-n-propylamine	26%
2,4-Dinitrophenol	25.8%

All compounds above were not detected in the samples, therefore, qualification was not found to be necessary.

IV Blanks

Laboratory (Method) Blanks:

Three laboratory method blanks were analyzed for the water samples of Data Set 9101.442. These included SBLK-W1 through SBLK-W3. Bis(2ethylhexyl)phthalate was detected in two method blanks at the following levels: SBLK-W2 at 2 ug/l, estimated and SBLK-W3 at 2 ug/l, estimated. SBLK-W1 did not exibit contamination by semi-volatile organics. A limit of 20 ug/l was utilized to evaluate the samples (10X the highest value). All samples associated with the method blanks were qualified as 'U', not detected.

Five laboratory method blanks were analyzed for the water samples of Data Set 9101.471. SBLK-W1 was found to be free of contamination. SBLK-W2 through SBLK-W-5 were found to contain bis(2-ethylhexyl)phthalate at 1 ug/l, estimated, for blanks 2 and 3 and 2 ug/l, estimated, for method blanks 4 and 5. A limit of 20 ug/l was utilized to evaluate the samples. All samples asociated with the method blanks were qualified as 'U' not detected for bis(2-ethylhexyl) phthalate.

V. Surrogate Recovery

All surrogate recovery was found to be generated within acceptable limits for the 6 surrogate compounds with the exception of the following.

(Data Set 9101.442)

2-GW-2B	Phenol-d5	6%	(Limit 10-94%)
	2-Fluorophenol	7%	(Limit 21-100%)
2-GW-2B-RE	2-Fluorophenol	14%	(Limit 21-100%)
	2,4,6-Tribromophenol	4%	(Limit 10-123%)
2-GW-4B	Phenol-d5	0%	
	2-Fluorophenol	0%	
	2,4,6-Tribromophenol	3%	
2-GW-4B-RE	Phenol-d5	1%	
	2-Fluorophenol	0%	
	2,4,6-Tribromophenol	3%	

The samples 2-GW-2B and 2-GW-4B including the reruns of both samples were qualified as 'R', unusable, due to percent recoveries of phenol surrogates under 10%.

(Case 9101.471)

1-GW-3B	Phenol	1%	(Limit 10-94%)
	2-Fluorophenol	1%	(Limit 21-100%)
	2,4,6-Tribromophenol	2%	(Limit 10-123%)
1-GW-3B-RE	Phenol	4%	
	2-Fluorophenol	6%	
1-GW-6B	Phenol	2%	
	2-Fluorophenol	2%	
	2,4,6-Tribromophenol	8%	
1-GW-6B-RE	Phenol	3%	
	2-Fluorophenol	5%	
	2,4,6-Tribromophenol	8%	
1-GW-8B	Nitrobenzene	166%	(Limit 35-114%)
	2-Fluorobiphenyl	143%	(Limit 43-116%)
	Phenol	1%	
	2-Fluorophenol	1%	
	2,4,6-Tribromophenol	3%	
1-GW-8B-RE	Phenol	1%	
	2-Fluorophenol	1%	
	2,4,6-Tribromophenol	8%	
1-GW-9B-DUP	Phenol	1%	
	2-Fluorophenol	1%	
	2,4,6-Tribromophenol	1%	
1-GW-9B DUP-RE	Phenol	1%	
	2-Fluorophenol	2%	
	2,4,6-Tribromophenol	7%	

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All acid phenol compounds for the compounds above were qualified as 'R', unusable, due to percent recoveries of less than 10%. The base/neutral compounds in sample 1-GW-8B were qualified as 'UJ', estimated, for the nondetectable compounds due to high percent recoveries.

VI. MS/MSD

All MS/MSD's were generated within acceptable limits for RPD and %R with the following exception.

2-GW-6B MS/MSD

1,4-Dichlorobenzene	100% R	(Limit 36-97%)
N-Nitroso-di-n-propylamine	119%	(Limit 41-116%)
1,2,4-Trichlorobenzene	100%	(Limit 39-98%)
2,4-Dinitrotoluene	108%	(Limit 24-96%)

Qualification of the MS/MSD was not found to be necessary.

VII. Internal Standards Performance

All internal standards were generated within acceptable specifications for area counts and retention time variation with the exception of the following.

2-GW-4B	Phenanthrene	Reported Area Count:	133000	Lower Limit:	134000
	Chrysene		56900		57000

The nondetectable compounds quantitated using the internal standards above for 2-GW-4B were qualified as 'UJ', estimated.

PESTICIDES/PCB's BY GC

OVERALL ASSESSMENT OF DATA

All pesticide and PCB data generated by GC are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms and within the following text. The data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

All holding times were met within the acceptable time frame for water samples (extracted within 7 days and analyzed within 40 days).

II. GC Instrument Performance

Adequate chromatographic resolution and instrument sensitivity were achieved through the generation of data within acceptable limits. These included DDT retention time , retention time windows/standards, DDT/Endrin degredation check, and retention time shift for dibutylchlorendate (DBC).

III Calibration

All initial and continuing calibration was performed within acceptable limits for calibration factors (CF), percent relative standard deviation (%RSD) for linearity, and %D with the following notations.

The %D criterion was not met for endrin and beta-BHC in the final INDB standard of the 7/8/91 analytical sequence. Action was not taken by the laboratory since it was the final standard.

IV. Blanks

Laboratory (Method) Blanks: Pesticides/PCB's were not detected in any of the 2 method blanks for Data Set 9101.442 or the 1 method blank for Data Set 9101.471.

V. MS/MSD

All MS/MSD's were generated within acceptable limits for %R and RPD's with the exception of the following.

Due to limited sample volume, MS/MSD's were not performed for Data Set 9101.442. However, 4 pesticide blank spikes were analyzed. The following deviations were noted.

Blank Spikes 3 and 4

Aldrin	27%	RPD	(Limit 22)
Endrin	140%	R	(Limit 56-121%)

Qualification of the data was not found to be necessary.

TOTAL PETROLEUM HYDROCARBONS (TPH)

OVERALL ASSESSMENT OF DATA

The TPH data generated by spectrophotometric analysis for the water samples are valid and acceptable, as noted on the data summary forms. Data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

The holding time of 28 days for water samples was met for all analyses.

II. Calibration

The 3 to 5 point curve for daily calibration was generated within specifications for the method.

III. Blank Spike

One blank spike was analyzed for each data set. Percent recoveries were generated within acceptable limits.

INORGANIC ANALYSES BY AA AND ICP
(Mercury by Cold Vapor; Cyanides by Spectrophotometry)

OVERALL ASSESSMENT OF DATA

All inorganic data generated by AA, ICP, Cold Vapor and Spectrophotometric methods are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms and within the following text. The data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

All holding times were met within the acceptable time frame for metals (6 months), mercury (28 days), and cyanide (14 days) with the exception of the following.

Cyanide samples for Data Set 9101.442 were not preserved in the field, however, preservative was added at the laboratory prior to analysis. All cyanide samples for the Data Set were qualified as 'UJ', estimated, for the nondetectable values.

Sample 1-GW-6B from Data Set 9101.471 was also delivered to the laboratory unpreserved for both metals and cyanide. Preservatives were added at the laboratory. The sample is qualified as 'J', estimated, for the positive values and 'UJ', estimated, for the nondetectables.

The following samples were not preserved for cyanide in the field.

1-GW-3B
1-GW-8B
1-GW-9B
1-GW-9BD
2-GW-1B
1-GW-2B
1-GW-4B
1-GW-5B
1-GW-6B

Preservative was added at the laboratory. The samples were qualified as 'UJ', estimated, for the nondetectable cyanide values.

II. Calibration

All initial and continuing calibration was performed within acceptable limits for %R, correlation coefficients, and mid-range standards.

III Blanks

Laboratory (Method) Blanks: All initial calibration, continuing calibration and preparation blanks were generated in accordance within acceptable limits with the following exceptions.

(Data Set 9101.701)

Preparation Blank (ug/l)

Lead 1.0

Lead was not detected in the sample, therefore, qualification was not necessary.

(Data Set 9101.442)

Preparation Blank (ug/l)

Zinc	12.3
Iron	10.4
Manganese	7.2

All zinc values were less than the limit of 5 times the preparation blank. The positive values were qualified as 'U', not detected. Iron and manganese values which were less than 5 times the preparation blank value were qualified as 'U', not detected. All other positive values which exceeded the limit were not qualified.

(Data Set 9101.479)

Preparation Blank (ug/l)

Manganese	3.6
Vanadium	5.8

Manganese values less than the limit of 5 times the preparation blank were qualified as 'U', not detected. Values over the limit were left unqualified. Vanadium was not detected in the samples, therefore, qualification was not necessary.

IV. ICP Interference Check Sample (ICS)

The ICP ICS was generated within acceptable limits for %R and frequency with the exception of the following.

(Data Set 9101.701)

Cobalt 77.3% (Limit 80-120%)

The nondetectable cobalt value was qualified as 'UJ', estimated.

V. Laboratory Control Sample (LCS)

The LCS for the analyses generated acceptable %R for all the analytes.

VI. Duplicate Sample Analysis

The duplicate analyses for all Data Sets were generated within acceptable limits with the exception of the following.

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(Data Set 9101.471)

Chromium was out of specification at an RPD of 200%. Sample 2GW-1B was qualified as 'J', estimated, for the positive chromium value. Chromium was not detected in the other samples, therefore, they remain unqualified.

VII. Matrix Spike Sample Analysis

All spike recovery was generated within acceptable limits with the following notations.

Selenium recovery was out of specification at 68% and lead at 53.6% for Data Set 9101.701. Selenium and lead were not detected within sample 1-GW-1BR. The nondetectable values were qualified as 'UJ', estimated.

Lead and selenium were out of specification at 58.7% and 70.1%, respectively, for Data Set 9101.442. Both lead and selenium were qualified as 'UJ', estimated, for the nondetectable compounds.

Mercury, lead and selenium were out of specification for Data Set 9101.471. Mercury recovery was generated at 71%, while lead and selenium were 54.9% and 67.5%, respectively. The samples did not contain any of the three elements noted. The samples were qualified as 'UJ', estimated, for the nondetectable metals.

MEMORANDUM

TO: B. Walter, Project Manager

FROM: J. McMullan, QA Chemist JMM

DATE: August 26, 1991

SUBJECT: Comments on ChemWorld Environmental Inc.'s Data Validation Report for Bainbridge Naval Training Center, Work Order #4.

CC: M. Meredith, QA Officer

ChemWorld Environmental Inc.'s (CW's) data validation report for the Bainbridge Naval Training Center (BNTC), dated August 12, 1991 was performed under Work Order #4. This report covered samples collected by Ecology and Environment, Inc. (E & E), on July 17 to July 21, 1991 and August 16, 1991. The samples were analyzed by E & E's Analytical Services Center (ASC) and the results reported in three data packages; 9101.442/.457, 9101.471/.479, and 9101.701.

Given below are our quality assurance/quality control (QA/QC) comments regarding data usability, providing further explanation/clarification and including any differing opinions. In addition, we have included comments on overall precision based on assessment of field duplicate results for this sampling event. Revised data summary sheets are attached which give our qualifiers where they differ from CW's.

QA/QC COMMENTS

- In evaluating inorganic laboratory blanks, CW qualified sample results "U" rather than "J" as required by the Naval Energy and Environmental Support Activity (NEESA) Level C data validation guidelines, dated October 1990.

- Trip Blank #8 was reported by CW as containing total-1,2-dichloroethene (total -1,2-DCE) at 2 µg/L. However, this information was transcribed incorrectly from the Form I to the data summary sheet. 1,1,1-Trichloroethane (1,1,1-TCA) was detected at 2 µg/L in Trip Blank #8, not total-1,2-DCE. There are no positive results for 1,1,1-TCA in any samples other than the two trip blanks. The positive results for total-1,2-DCE which are qualified "U" by CW should not be qualified, except for the "J" qualifier as estimated for results below the quantitation limit.

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- o CW neglected to mention the presence of carbon disulfide in Trip Blank #5 at 6 µg/L. No change in data qualification results from this omission.

- o Only sample 1-GW-9B was noted by CW as having exceeded the BNA extraction holding time. However, due to poor surrogate recoveries for the initial BNA analysis, several samples were reanalyzed and the extraction holding time was exceeded by 4 to 12 days. The samples involved are 1-GW-3BRE, 1-GW-6BRE, 1-GW-8B RE, and 1-GW-9B DUPRE. The BNA results and limits for these samples should be qualified "J" and "UJ", respectively, as estimated.

- o CW qualified the quantitation limits for BNA compounds dibenzofuran to 4-nitroaniline in sample 2-GW-4B due to low internal standard areas for phenanthrene-d10 and chrysene-d12. These compounds are quantitated using acenaphthene-d10, which gave an acceptable internal standard area. Thus the "UJ" qualification should be deleted from the quantitation limits for these compounds.

- o In listing both volatile and BNA compounds which did not meet precision criteria for continuing calibration, CW neglected to list several compounds which gave percent difference values of greater than 25%, although with a computational minus sign indicating an increase in relative response factor (RRF). Quantitation is affected by an increase in RRF as well as by a decrease in RRF. However, none of these compounds were detected in the samples, thus no qualification is necessary.

- o CW qualified the cobalt quantitation limit for sample 1-GW-1BR due to the slightly low percent recovery (77.3%) of the interference check sample (ICS). There are no Level C NEESA guidelines regarding review of the ICS; thus no qualificiation is considered necessary.

- o The CW report contains a transcription error on page 11 of 11 in the last paragraph. The selenium spike recovery should be 55.3%, not 67.5%, as reported. The qualification of selenium data remains the same.

- o On the data summary sheets, CW qualified iron results for 9101.471 and calcium results for 9101.701 as "E" estimated due to the presence of interference. No discussion of interference was presented in the written report. In checking the case narratives, it was determined that interference was indicated by serial dilution results which gave percent difference values of greater than 10%. Review of serial dilution results is not required by Level C NEESA guidelines; thus no qualification is considered necessary. When they are reviewed for Level D data validation, only

those results which are greater than 50 times the instrument detection limit (IDL) are qualified if the serial dilution results do not agree within 10% difference.

OVERALL PRECISION

- Field duplicate results indicated good overall precision for organics and inorganics in both sets of field duplicates analyzed (see Tables 1 and 2). Only aluminum and iron results for the duplicate pair, 2-GW-1B and 2-GW-1B Dup, gave high relative percent difference (RPD) values of 100% and 79%, respectively.

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Table 1

FIELD DUPLICATE RESULTS
BAINBRIDGE NAVAL TRAINING CENTER
[Results in µg/L]

Parameter	1GW9B	1GW9B Dup	RPD(%)
Inorganic			
Aluminum	120	132	9.5
Barium	83.5	82.3	1.5
Calcium	78700	76700	2.6
Cobalt	13.9	14.3	2.8
Iron	11700	13000	11
Magnesium	45300	44900	0.9
Manganese	5770	5720	0.9
Potassium	2670	2680	0.4
Sodium	29800	29600	0.7
Zinc	7.4	<4.0	IN
Organic			
Methylene Chloride	4B	4B	IN
Acetone	18B	<10	IN
Total 1,2-Dichloroethene	23	23	0.0
Trichloroethene	6	5	0.2
Chlorobenzene	160	160	0.0
1,4-Dichlorobenzene	18	22	20
Bis(2-ethylhexyl)phthalate	2B	1	IN

RPD = Relative percent difference.

IN = Indeterminant; not detected in one sample or alsodetected in method blank.

B = Present in method blank at comparable level.

Table 2

FIELD DUPLICATE RESULTS
BAINBRIDGE NAVAL TRAINING CENTER
[Results in µg/L]

Parameter	2GW1B	2GW1B Dup	RPD(%)
Inorganic			
Aluminum	66.6	22.2	100
Antimony	55.4	<51.0	IN
Barium	22.6	22.5	0.4
Calcium	13200	13400	1.5
Chromium	10.8	<8.0	IN
Iron	63.0	145	79
Lead	1.5	<1.0	IN
Magnesium	7330	7500	2.3
Manganese	1.6	<1.0	IN
Potassium	875	892	1.9
Sodium	9150	8030	13
Zinc	8.7	<4.0	IN
Organic			
Methylene Chloride	1B	<5	IN
Diethylphthalate	16	<10	IN
Bis(2-ethylhexyl)phthalate	4	3	29

IN = Indeterment; not detected in one sample or also detected in method blank.

B = Present in method blank at comparable level.

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MEMORANDUM

TO: B. Walter, Project Manager

FROM: J. McMullan, QA Chemist JMM

DATE: 8-30-91

SUBJECT: Addendum to Memorandum dated August 26, 1991 "Comments on ChemWorld Environmental Inc.'s Data Validation Report for Bainbridge Naval Training Center, Work Order #4".

CC: M. Meredith, QA Officer

The following comment should be added to the QA/QC comments contained in the above referenced memorandum. Revised data summary sheets are attached with additional qualifiers added as noted below.

- In evaluating inorganic blank contamination, ChemWorld Environmental, Inc. (CW) neglected to consider the two rinsate samples, 1-GW-RB and 2-GW-RB. Sample 1-GW-RB, which applies to the groundwater samples in Job 9101.471, contained aluminum at 40.2 µg/L and iron at 41.8 µg/L. Sample 2-GW-RB, which applies to samples in Job 9101.442, contained aluminum at 23.8 µg/L, iron at 23.6 µg/L, manganese at 1.6 µg/L, sodium at 170 µg/L, and Zinc at 5.3 µg/L.

  Positive results for these analytes in the associated samples are qualified "J" as estimated up to five times the level detected in the rinsate blank. All of the sodium results and some of the other results are greater than five times the level detected, and thus are not qualified.

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August 1991 Sampling Event

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H:CD7171/RC1357-12/18/96-D1

DATA VALIDATION REPORT

BAINBRIDGE NAVY REMEDIAL INVESTIGATION

SAMPLING DATES OF AUGUST 12-16, 1991

PREPARED FOR:

Ecology and Environment, Inc.
368 Pleasantview Drive
Lancaster, New York 14086

OCTOBER 1991

PREPARED BY:

ChemWorld Environmental, Inc.
4500 Avamere Street
Bethesda, Maryland 20814

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DATA VALIDATION SUMMARY

Bainbridge Navy Remedial Investigation
E & E Data Packages 9101.968, 9101.987, 9102.000 and 9102.006
Sampling Dates August 12-16, 1991

INTRODUCTION

This Data Validation Summary report was generated for Work Order #5 for water and soil analyses for the Bainbridge Navy Remedial Investigation. The analytical laboratory work was performed by Ecology and Environment, Inc. (E & E's) Analytical Services Center.

The four data report packages referenced above include 34 water and 15 soil samples and their associated quality control samples. Analytical testing consisted of volatile organic analyses by Gas Chromatography/Mass Spectroscopy (GC/MS); Base/Neutral and Acid Extractable Organics by GC/MS; Pesticides and PCB's by GC; Total Petroleum Hydrocarbons by Infrared Spectrophotometry; Inorganics by Atomic Absorption (AA) and Inductively Coupled Argon Plasma (ICP); Mercury by Cold Vapor; and Cyanides by Spectrophotometry.

The following report provides a summary of data acceptability and deviations in accordance with the Naval Energy and Environmental Support Activity (NEESA) Level C Data Validation Requirements. The site-specific Work Plan and Quality Assurance Project Plan (QAPP) were reviewed. These documents detailed the project background and requirements for the investigation.

VOLATILE ORGANICS BY GC/MS

OVERALL ASSESSMENT OF DATA

All volatile organic data generated by GC/MS are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms. The following data has been generated in accordance with the site-specific QAPP and project requirements.

1. Holding Times

   All holding times were met within the acceptable time frame of 14 days for preserved water samples and soil samples, with the following exceptions.

   (Case No. 9101.987)

   1-SED-8C
   1-SED-9CDUP
   1-SED-9CDUPMS
   1-SED-11C
   1-SED-9C

   The samples above were analyzed one day beyond the holding time. Positive values for these samples were qualified as 'J', estimated. The non-detectable values were qualified as 'UJ', estimated.

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II GC/MS Tuning

All tuning was generated within the acceptable limits for Bromofluorobenzene (BFB).

III. Calibration

All initial and continuing calibration was performed within acceptable limits for average *Relative Response Factors ($\overline{RRF}$), Percent Relative Standard Deviation (%RSD), Relative* Response Factors (RRF), and Percent Difference (%D) with the exception of the following.

(Case No. 9101.968)

Continuing Calibration

8/16/91 at (02:04)		
Acetone	35.7%D	(Limit 25%)
2-Butanone	38.8%	
4-methyl-2-pentanone	39.8%	
2-Hexanone	35.3%	
8/16/91 at (13:59)		
Acetone	25.7%	
2-Butanone	34.1%	
4-methyl-2-pentanone	31.6%	
2-Hexanone	28.3%	
8/20/91 at (17:59)		
1,2-Dichloroethane	26.5%	
1,2-Dichloroethane-d4	27.2%	
8/16/91 at (17:10)		
Chloromethane	32.5%	
1,2-Dichloroethane	32.3%	
1,1,1-Trichloroethane	32.0%	
Carbon Tetrachloride	27.5%	
Bromodichloromethane	29.8%	
cis-1,3-Dichloropropene	33.9%	
1,2-Dichloroethane-d14	36.9%	
8/20/91 at (14:29)		
Chloromethane	26.7%	
1,2-Dichloroethane	28.7%	
cis-1,3-Dichloropropene	28.2%	
1,2-Dichloroethane-d4	32.5%	
8/21/91 at (08:58)		
Chloromethane	44.6%	
Vinyl Chloride	41.9%	
1,2-Dichloroethane	30.7%	
Bromodichloromethane	30.4%	
cis-1,3-Dichloropropene	29.1%	
2-Hexanone	34.3%	
1,2-Dichloroethane-d4	35.6%	

8/21/91 at (22.28)

Chloromethane	26.6%
1,2-Dichloroethane	32.8%
1,1,1-Trichloroethane	25.8%
Bromodichloromethane	32.1%
cis-1,3-Dichloropropene	34.7%
4-methyl-2-pentanone	30.3%
2-Hexanone	37.5%
1,2-Dichloroethane-d4	38%

8/22/91 at (09:11)

Chloromethane	44.3%
Vinyl Chloride	40.7%
Chloroethane	29%
Acetone	30.2%
Carbon Disulfide	26.0%
1,2-Dichloroethane	37.6%
1,1,1-Trichloroethane	32.1%
Carbon Tetrachloride	27.8%
Bromodichloromethane	36.1%
cis-1,3-Dichloropropene	40.4%
Bromoform	30.0%
2-Hexanone	32.3%
1,2-Dichloroethane-d4	37.4%

Positive results for the continuing calibration compounds above were qualified as 'J', estimated. Non-detectable values remain unqualified.

(Case 9101.987)

Continuing Calibration

8/27/91 at (19:41)

Chloromethane	42.5%D (Limit 25%)
4-methyl-2-pentanone	59%

8/23/91 at (13:00)

Acetone	30.7%
2-Butanone	61.7%

8/24/91 at (13:54)

1,1,2,2-Tetrachloroethane	26.1%

8/27/91 at (09:44)

Chloromethane	37%
Vinyl Chloride	28.5%
2-Butanone	46.5%
Bromodichloromethane	27.1%
cis-1,3-Dichloropropene	29.9%
1,2-Dichloroethane-d4	34.8%

Positive values for the compounds above were not detected; therefore, qualification of the data was not necessary.

(Case No. 9102.000)

Continuing Calibration

8/24/91 at (13:18)		
1,2-Dichloroethane	26.7%D	(Limit 25%)
8/27/91 at (21:42)		
4-methyl-2-pentanone	28.7%	
8/23/91 at (00:21)		
Chloromethane	38.4%	
Vinyl Chloride	29.9%	
Chloroethane	26.2%	
1,2-Dichloroethane	30.9%	
Bromodichloromethane	28.9%	
cis-1,3-dichloropropene	34.6%	
4-methyl-2-pentanone	45.2%	
2-Hexanone	30.2%	
1,2-Dichloroethane-d4	32.3%	
8/27/91 at (09:44)		
Chloromethane	37.0%	
Vinyl Chloride	28.5%	
2-Butanone	46.5%	
Bromodichloromethane	27.1%	
cis-1,3-dichloropropene	29.9%	
1,2-Dichloroethane-d4	34.8%	

Positive values for the compounds above were qualified as 'J', estimated. The non-detectable values remain unqualified.

IV. Blanks

Laboratory (Method) Blanks: Five water method blanks and three soil method blanks were analyzed for the samples from Case No. 9101.968. The following includes a summary of method blank contamination.

(Soil)

VBLKS1	
Methylene Chloride	5 ug/Kg
VBLKS2	
Methylene Chloride	4 ug/Kg, estimated
Acetone	7 ug/Kg, estimated
VBLKS3	
Methylene Chloride	4 ug/Kg, estimated

Ten times the highest methylene chloride and acetone values were used for review and qualification of the soil samples. Values which exceeded the limit of 10 times were left unqualified. Values which were found to be below the limit of 10 times were qualified as 'U', not detected.

(Water)

VBLKW1	
Methylene Chloride	4 ug/L, estimated
VBLKW2	
Methylene Chloride	16 ug/L
VBLKW3	
Methylene Chloride	22 ug/L
TIC unknown	12 ug/L, estimated
TIC Dimethyl Napthalene Isomer	13 ug/L, estimated
TIC Dimethyl Napthalene Isomer	12 ug/L, estimated
VBLKW4	
Methylene Chloride	9 ug/L
VBLKW5	
Methylene Chloride	22 ug/L
Acetone	60 ug/L*
TIC Freon-113	21 ug/L
TIC Hexane	17 ug/L

*Acetone for VBLKW5 exceeds the acceptable limit.

Ten times the highest methylene chloride and acetone values were used for review and qualification of the data. All values for methylene chloride and acetone were found to be below the limit of 10 times the blank value, therefore, they were qualified as 'U', not detected.

(Case No. 9101.987)

Four water method blanks and one soil method blank were analyzed for the data set. The following contamination was noted.

(Water)

VBLKW1	
Methylene Chloride	4 ug/L, estimated
Acetone	8 ug/L, estimated
VBLKW2	
Methylene Chloride	4 ug/L, estimated
Acetone	7 ug/L, estimated
VBLKW4	
Methylene Chloride	2 ug/L, estimated
VBLKW3	
Methylene Chloride	3 ug/L, estimated

(Soil)
VBLKS1

Methylene Chloride	11 ug/Kg
Acetone	3 ug/Kg, estimated

Ten times the highest methylene chloride and acetone values were used for review and qualification. All values for both compounds were found to be below the limit of 10 times the blank value; therefore, they were qualified as 'U', not detected.

(Case No. 9102.000)

Six water method blanks were analyzed for the data set. The following contamination was noted.

VBLKW1

Methylene Chloride	6 ug/L

VBLKW3

Methylene Chloride	4 ug/L
Acetone	7 ug/L, estimated

VBLKW4

Methylene Chloride	2 ug/L, estimated

VBLKW5

Methylene Chloride	3 ug/L, estimated

VBLKW2

Methylene Chloride	4 ug/L, estimated

VBLKW6

Methylene Chloride	3 ug/L, estimated

All methylene chloride and acetone values were found to be below the limit of 10 times the highest blank level. The samples were qualified as 'U', not detected for these two compounds.

Field Blanks: Four trip blanks (Trip Blanks #1, 8, 15, 16) were analyzed for volatiles for Case No. 9101.968. The following includes a summary of trip blank contamination:

Trip Blank #1

Methylene Chloride	14 ug/l, estimated
TIC for Hexane	6 ug/l, estimated

Trip Blank #8

Methylene Chloride	4 ug/l, estimated

Trip Blank #15

Methylene Chloride	4 ug/l, estimated

Trip Blank #16

Methylene Chloride	5 ug/l, estimated

The highest methylene chloride value was detected in Trip Blank #1. All samples had been qualified as 'U', not detected, through the preceding method blanks.

(Case No. 9101.987)

The following six trip blanks were analyzed for the data set.

Trip Blank 12	
Methylene Chloride	3 ug/L, estimated
Acetone	10 ug/L
Trip Blank 13	
Methylene Chloride	1 ug/L, estimated
Trip Blank 14	
Methylene Chloride	2 ug/L, estimated
Acetone	8 ug/L, estimated
Trip Blank 14RE	
Methylene Chloride	7 ug/L
TIC for 2-Propanol	17 ug/L, estimated
Trip Blank 6	
Acetone	9 ug/L, estimated
Trip Blank 7	
Methylene Chloride	3 ug/L, estimated
Trip Blank 7RE	
Methylene Chloride	10 ug/L
Carbon Disulfide	7 ug/L
TIC for 2-Propanol	240 ug/L, estimated
Trip Blank 9	
Methylene Chloride	2 ug/L, estimated
TIC-unknown	8 ug/L, estimated
Trip Blank 9RE	
Methylene Chloride	8 ug/L
TIC for 2-Propanol	37 ug/L, estimated

All samples were previously qualified for methylene chloride and acetone through the method blanks. Sample 1-SW-11C remains unqualified for carbon disulfide due to its exceedance of the limit of five times the method blank.

(Case No. 9102.000)

Eight trip blanks were analyzed for the data set. The following 6 blanks exhibited contamination by volatile organics.

Trip Blank 3	
Methylene Chloride	7 ug/L
TIC for Freon-113	16 ug/L, estimated

Trip Blank 4

Methylene Chloride	5 ug/L
Acetone	9 ug/L, estimated

Trip Blank 5

Acetone	5 ug/L, estimated
Chlorobenzene	3 ug/L, estimated
TIC-unknown	4.0 ug/L, estimated

Trip Blank 4 RE

Acetone	7 ug/L, estimated

Trip Blank 10

Methylene Chloride	1 ug/L, estimated
TIC unknown	5 ug/L, estimated

Trip Blank 17

Methylene Chloride	3 ug/L, estimated

Trip Blank 19

Methylene Chloride	6 ug/L, estimated
TIC for Freon-113	7 ug/L, estimated

The acetone and methylene chloride values were previously qualified through the method blanks. Chlorobenzene and the Tentatively Identified Compound (TIC) for Freon-113 were qualified as 'U', not detected, for values below 5 times the trip blank value. Positive values which exceeded the limit of 5 times remain unqualified.

V. Surrogate Recovery

All surrogates were found to be generated within specification for %R, with the exception of the following.

(Case No. 9101.968)

1-SED-10C

140%R	Toluene-d8	(Limit 81-117)
68%	Bromofluorobenzene	(Limit 74-121)

2-SED-7C

71%	Bromofluorobenzene

2-SED-7CDUP

70%	Bromofluorobenzene

2-SED-7CRE

71%	Bromofluorobenzene

2-SED-7CDUPMS

70%	Bromofluorobenzene

Positive values for the samples above were qualified as 'J', estimated. The non-detectable values were qualified as 'UJ', estimated, in accordance with NEESA guidelines.

(Case No. 9101.987)

(Water)
Trip Blank 14
67%R 1,2-Dichloroethane-d4 (Limit 76-114)

Trip Blank 7
111% Toluene (Limit 88-110)
67% Bromofluorobenzene (Limit 86-115)

Trip Blank 9
138% Toluene-d8 (Limit 88-110)

Trip Blank 9RE
85% Bromofluorobenzene (Limit 86-115)

(Soil)
1-SED-11C
120% Toluene-d8 (Limit 81-117)
124% 1,2-Dichloroethane-d4 (Limit 70-121)

Positive values for the samples above were qualified as 'J', estimated. The non-detectable values were qualified as 'UJ', estimated.

(Case No. 9102.000)

1-GW-4C
85%R Bromofluorobenzene (Limit 86-115)

Trip Blank 4
115% 1,2-Dichloroethane-d4 (Limit 76-114)

The samples were qualified as 'J', estimated, for the positive values and 'UJ', estimated, for the non-detectables.

VI. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

All MS/MSD's were generated within acceptable limits. Qualification of the data due to MS/MSD was not performed.

VII Internal Standards Performance

All internal standards were generated within acceptable specifications for area counts and retention time variation, with the following exceptions.

(Case No. 9101.968)

Trip Blank 1
Bromochloromethane RT: 7.77 Upper Limit: 7.73

Trip Blank 1 (MSD)		
Chlorobenzene	Reported Area Count: 68400	Lower Limit: 79500
2-SW-10C		
Chlorobenzene	RT: 17.67	Upper Limit: 17.64
Trip Blank 1		
Chlorobenzene	RT: 17.67	Upper Limit: 17.64
2-SED-7C		
Chlorobenzene	Reported Area Count: 87000	Lower Limit: 99000
2-SED-7CDUP		
Chlorobenzene	Reported Area Count: 67100	Lower Limit: 99000
1-SED-10C		
Bromochloromethane	Reported Area Count: 20500	Lower Limit: 31000
1,4-Difluorobenzene	Reported Area Count: 62700	Lower Limit: 137000
Chlorobenzene	Reported Area Count: 28900	Lower Limit: 112000

Positive results for the compounds quantitated using the standards above were qualified as 'J', estimated, for the samples in which the reported area counts were not within specification. The non-detectable values for the corresponding samples were qualified as 'UJ', estimated. Qualification was not deemed necessary for the samples in which the internal standard retention time varied by more than 30 seconds.

(Case No. 9101.987)

Trip Blank 9RE		
Chlorobenzene	Reported Area Count: 52200	Lower Limit: 62000
VBLKS1		
1,4-Difluorobenzene	RT: 12.79	Upper Limit: 12.74
Chlorobenzene	RT: 21.05	Upper Limit: 20.89

Positive results were not detected for the Trip Blank 9RE Sample. The non-detectable values for the compounds quantitated using the chlorobenzene internal standard were qualified as 'UJ', estimated. Qualification was not deemed necessary for the samples in which the internal standard retention time varied by more than 30 seconds.

SEMI-VOLATILE ORGANICS BY GC/MS
(Base/Neutral and Acid Extractable Organics)

OVERALL ASSESSMENT OF DATA

All base/neutral and acid extractable organic data generated by GC/MS are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms and within the following text. Samples 2-SW-6C and 2-SW-6CRE were qualified as 'R', unusable, for the acid phenol fraction due to surrogate recoveries of less than 10%. All other data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

All holding times were met within the acceptable time frame for water samples (extracted within 7 days and analyzed within 40 days) and soil samples (extracted within 14 days and analyzed within 40 days), with the following exceptions.

(Case No. 9101.987)

Sample 1-SW-11C was extracted 11 days beyond the 7-day holding time; however, it was analyzed by GC/MS within the 40-day holding time. The sample was qualified as 'UJ', estimated, for all non-detectable values. Positive results were not detected for the sample.

(Case No. 9102.000)

Sample 1-GW-8C was extracted 12 days beyond the 7-day extraction holding time; however, it was analyzed by GC/MS within the 40-day holding time. The sample was qualified as 'J', estimated, for positive values, and 'UJ', estimated, for the non-detectables.

II. GC/MS Tuning

All tuning was generated within acceptable limits for Decafluorotriphenylphosphine (DFTPP).

III. Calibration

All initial and continuing calibration was performed within acceptable limits for RRF, %RSD, RRF, and %D, with the exception of the following.

(Case No. 9101.968)

Initial Calibration (8/2/91)

3-nitroaniline	30.6%RSD	(Limit 30%)

The compound 3-nitroaniline was not detected in any of the samples, therefore, qualification was not necessary.

Continuing Calibration

Continuing calibration %D's were out of specification for the following dates.

8/21/91 at (21:32)		
Dibenz(a,h)anthracene	38.3%D	(Limit 25%)
8/22/91 at (10:09)		
Benzoic Acid	44.2%	
8/22/91 at (10:09)		
Dibenz(a,h)anthracene	40.7%	
8/26/91 at (08:38)		
Benzoic Acid	26%	

8/26/91 at (08:38)
Dibenz(a,h)anthracene 45.7%

8/31/91 at (12:18)
2-Fluorophenol 30.5%

9/03/91 at (10:47)
3-nitroaniline 36.8%

9/06/91 at (09:11)
4-methylphenol 30.1%

All compounds above were not detected in the samples, therefore, qualification was not found to be necessary

(Case 9101.987)

Initial Calibration (8/2/91)
3-Nitroaniline 30.6% RSD (Limit 30%)

The compound 3-nitroaniline was not detected within any of the samples. Qualification was not deemed necessary.

Continuing Calibration

8/26/91 at (08:38)
Benzoic Acid 26%D (Limit 25%)
Dibenz(a,h)anthracene 45.7%

8/26/91 at (21:22)
4-methylphenol 29%
Dibenz(a,h)anthracene 53.4%

9/3/91 at (10:47)
3-Nitroaniline 36.8%

9/6/91 at (09:11)
4-methylphenol 30.1%

9/09/91 at (08:15)
Benzyl Alcohol 28.7%
3-Nitroaniline 57.8%

All compounds above were not detected within the samples. Qualification was not found to be necessary.

(Case No. 9102.000)

Initial Calibration (8/2/91)
3-Nitroaniline 30.6% RSD (Limit 30%)

The compound 3-Nitroaniline was not detected within any of the samples. Qualification was not deemed necessary.

Continuing Calibration

8/27/91 at (09:05)
Dibenz(a,h)anthracene 45.7% (Limit 25%)

8/28/91 at (11:13)
Benzoic Acid 28.6%
Dibenz(a,h)anthracene 37.6%

8/29/91 at (01:14)
Benzoic Acid 27.9%
Dibenz(a,h)anthracene 38.8%

8/30/91 at (23:32)
bis(2-chloroisopropyl)ether 32.7%

9/3/91 at (10:47)
3-Nitroaniline 36.8%

9/6/91 at (09:11)
4-methylphenol 30.1%

All compounds above were not detected within the samples. Qualification was not found to be necessary

IV. Blanks

Laboratory (Method) Blanks:

Two laboratory method blanks were analyzed for the water samples and one for the soil samples for Case No. 9101.968.

(Water)
SBLKW1
2-methylnaphthalene 2 ug/L, estimated
bis(2-ethylhexyl)phthalate 6 ug/L, estimated
TICs were also detected, as detailed on the Data Summary Form.

SBLKW2
bis(2-ethylhexyl)phthalate 1 ug/L, estimated
TICs were also detected, as detailed on the Data Summary Form.

(Soil)
SBLKS1
bis(2-ethylhexyl)phthalate 71 ug/Kg, estimated
TICs were also detected, as detailed on the Data Summary Form.

Ten times the highest bis(2-ethylhexyl)phthalate value and five times the 2-methylnaphthalene value were used for review and qualification of the samples. All samples which exceeded the five or ten times limit remain unqualified. Values found to be below the limit were qualified as 'U', not detected.

(Case No. 9101.987)

(Water)
SBLKW1
bis(2-ethylhexyl)phthalate 2 ug/L, estimated
TIC's were detected as detailed on the Data Summary Forms.

SBLKW2
bis(2-ethylhexyl)phthalate 1 ug/L, estimated
TIC's were detected as detailed on the Data Summary Forms.

(Soil)
SBLKS1
bis(2-ethylhexyl)phthalate 50 ug/Kg, estimated
TIC's were detected as detailed on the Data Summary Forms.

Ten times the highest bis(2-ethylhexyl)phthalate value was used for review and qualification of the samples. All samples which exceeded the limit of 10 times remain unqualified. Values below the limit were qualified as 'U', not detected.

(Case No. 9102.000)

SBLKW1
bis(2-ethylhexyl)phthalate 1 ug/L, estimated

SBLKW2
bis(2-ethylhexyl)phthalate 3 ug/Kg, estimated
TIC's were detected as detailed on the Data Summary Forms.

SBLKW3
bis(2-ethylhexyl)phthalate 3 ug/L, estimated

A limit of 10 times the highest bis(2-ethylhexyl)phthalate method blank value was used for review and qualification of the data. All samples were found to be below the limit of 10 times, and, therefore, were qualified as 'U', not detected, for bis(2-ethylhexyl)phthalate.

V. Surrogate Recovery

All surrogate recovery was found to be generated within acceptable limits for the 6 surrogate compounds,with the exception of the following.

(Case No. 9101.968)

(Water)
2-GW-6C
17%R 2-Fluorophenol (Limit 21-100)

1-SW-10C
118% 2-Fluorobiphenyl (Limit 43-116)

2-SW-6C

0%	Phenol-d5	(Limit 10-94)
0%	2-Fluorophenol	
1%	2,4,6-Tribromophenol	(Limit 10-123)

2-SW-6CRE

0%	Phenol-d5
0%	2-Fluorophenol
2%	2,4,6-Tribromophenol

2-SW-8C

122%	2-Fluorobiphenyl

Samples 2-GW-8C, 1-SW-10C, and 2-SW-8C do not require qualification due to the fact that only one surrogate for the fraction is out of specification (two are required for qualification). Samples 2-SW-6C and 2-SW-6CRE were qualified as 'R', unusable, for the non-detectable values for the acid phenol fraction due to %R of <10%. Positive values were not detected for either sample with the exception of bis(2-ethylhexyl)phthalate

(Case No. 9102.000)

1-GW-3CMS

9%	2,4,6-Tribromophenol	(Limit 10-123)

Positive results were not detected for the acid phenol fraction for 1-GW-3C-MS. The non-detectable values were qualified as 'R', unusable, due to recovery of the surrogate at less than 10%.

VI. MS/MSD

All MS/MSD's were generated within acceptable limits. Qualification of the data due to MS/MSD was not performed.

VII Internal Standards Performance

All internal standards were generated within acceptable specifications for area counts and retention time variation with the exception of the following.

(Case No. 9101.968)

1-SED-3C	1,4-Dichlorobenzene-d4	RT: 7.58	Lower Limit: 7.82
2-SED-5C	1,4-Dichlorobenzene-d4	RT: 7.58	Lower Limit: 7.82
2-SED-6C	1,4-Dichlorobenzene-d4	RT: 7.58	Lower Limit: 7.82
SBLK-S1	1,4-Dichlorobenzene-d4	RT: 7.58	Lower Limit: 7.82

Qualification of the data was not found to be necessary.

(Case No. 9101.987)

1-SED-4C

Perylene-d12	Reported Area Count: 91100	Lower Limit: 104500

1-SED-5C
Perylene-d12 Reported Area Count: 91200 Lower Limit: 104500

1-SED-9CDUPMSD
Perylene-d12 Reported Area Count: 102000 Lower Limit: 104500

1-SED-9CDUP
1,4-Dichlorobenzene-d4 RT 7.22 Lower Limit: 7.32

Positive results for the compounds quantitated using the standards above were qualified as 'J', estimated, for the samples in which the reported area counts were not within specification. The non-detectable values for the corresponding samples were qualified as 'UJ', estimated. Qualification was not deemed necessary for the samples in which the internal standard retention time varied by more than 30 seconds.

Case No 9102.000

1-GW-9C	1,4-Dichlorobenzene	RT: 7.63	Lower Limit: 7.87
2-GW-1C	1,4-Dichlorobenzene	RT: 7.63	Lower Limit: 7.87
2-GW-4C	1,4-Dichlorobenzene	RT: 7.63	Lower Limit: 7.87
2-GW-5C	1,4-Dichlorobenzene	RT: 7.63	Lower Limit: 7.87
1-GW-3CMS	1,4-Dichlorobenzene	RT: 7.63	Lower Limit: 7.87
1-GW-3CMSD	1,4-Dichlorobenzene	RT: 7.63	Lower Limit: 7.87

Qualification was not found to be necessary.

PESTICIDES/PCB's BY GC

OVERALL ASSESSMENT OF DATA

All pesticide and PCB data generated by GC are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms and within the following text. The data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

All holding times were met within the acceptable time frame for water and soil samples (extracted within 7 days and analyzed within 40 days), with the exception of the following.

(Case No. 9101.968)

1-SED-3C
2-SED-5C
2-SED-6C
2-SED-7C
2-SED-7CDUP
2-SED-8C
1-SED-10C
2-SED-7DUPMS
2-SED-7DUPMSD

The samples listed above exceeded the extraction holding time by one day. All samples listed above were qualified as 'J', estimated, for positive values, and 'UJ', estimated', for the non-detectable compounds.

(Case No 9102.000)

1-GW-4C	2-GW-3C
1-GW-6C	2-GW-3CMS
2-GW-1C	2-GW-3CMSD
2-GW-2C	2-GW-3CDUP
2-GW-4C	2-GW-6C
2-GW-5C	2-GW-9C

The samples above exceeded the analysis holding time of 40 days by 1 day. The samples were all qualified as 'UJ', estimated, for the non-detectable values. Pesticides and PCB's were not detected in any of the samples.

II GC Instrument Performance

Adequate chromatographic resolution and instrument sensitivity were achieved through the generation of data within acceptable limits. These included DDT retention time , retention time windows/standards, DDT/Endrin degredation check, and retention time shift for dibutylchlorendate (DBC). The following are exceptions to be noted.

(Case No. 9101.968)

8/30/91 at (00:29) - INDB

Beta-BHC	RT: 2.55	Window: 2.56-2.62
Endrin Ketone	RT: 17.92	Window: 17.93-18.47

Qualification of the data was not found to be necessary.

III. Calibration

All initial and continuing calibration was performed within acceptable limits for calibration factors (CF), percent relative standard deviation (%RSD) for linearity, and %D.

IV. Blanks

Laboratory (Method) Blanks: Pesticides/PCB's were not detected in any of the 3 method blanks for Case Nos. 9101.968 and 9101.987. Two method blanks were analyzed for Case No. 9102.000. Pesticides/PCB's were not detected.

V. MS/MSD

All MS/MSD's were generated within acceptable limits for %R and RPD's, with the exception of the following.

(Case No. 9101.987)

1-SW-9CMS

125%R	Gamma-BHC	(Limit 56-123)
146%R	Aldrin	(Limit 40-120)
144%R	4,4'-DDT	(Limit 38-127)

1-SW-9CMSD

136%	Aldrin	(Limit 40-120)
37%RPD	Gamma-BHC	(Limit 15)

1-SED-9CDUPMS

151%R	Heptachlor	(Limit 35-130)

1-SED-9CDUPMSD

145%R	Heptachlor	(Limit 35-130)
137%R	4,4'-DDT	(Limit 23-134)

The associated blank spike was generated within specifications. Qualification of the data due to the MS/MSD was not deemed necessary.

(Case No. 9102.000)

1-GW-3CMS

0%R*	Endrin	(Limit 56-121)

* No Endrin recovery due to degredation of endrin ketone.

1-GW-3CMSD

-47%RPD	Dieldrin	(Limit 18)
-200%RPD	Endrin	(Limit 21)

2-GW-3CMSD

26%RPD	Aldrin	(Limit 22)

The associated blank spikes were generated within acceptable limits. Qualification of the data was not necessary due to MS/MSD.

TOTAL PETROLEUM HYDROCARBONS (TPH)

OVERALL ASSESSMENT OF DATA

The TPH data generated by spectrophotometric analysis for the samples are valid and acceptable, as noted on the data summary forms. Data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

The holding time of 28 days was met for all analyses.

II. Calibration

The 3 to 5 point curve for daily calibration was generated within specifications for the method.

III. Blank Spike

One blank spike was analyzed for each data set. Percent recoveries were generated within acceptable limits.

IV. Method Blank

Contamination was not present in the method blanks.

INORGANIC ANALYSES BY AA AND ICP
(Mercury by Cold Vapor; Cyanides by Spectrophotometry)

OVERALL ASSESSMENT OF DATA

All inorganic data generated by AA, ICP, Cold Vapor and Spectrophotometric methods are considered to be valid and acceptable with the appropriate qualifiers, as noted on the data summary forms and within the following text. The data has been generated in accordance with the site-specific QAPP and project requirements.

I. Holding Times

All holding times were met within the acceptable time frame for metals (6 months), mercury (28 days), and cyanide (14 days).

(Case No. 9102.000)

The holding time for mercury analysis was exceeded by 12 days for the following samples:
1-GW-4C
1-GW-4CD
1-GW-4CS
The samples were qualified as 'UJ, estimated, for mercury.

II. Calibration

All initial and continuing calibration was performed within acceptable limits, with the following exceptions.

Continuing Calibration

Cyanide	118%R	(Limit 85-115)
Arsenic	120.4%	(Limit 90-110)
Arsenic	116.5%	(Limit 90-110)
Lead	117.8%	(Limit 90-110)

All positive values for the analytes above were qualified as 'J', estimated. The non-detectable values were qualified as 'UJ', estimated.

III. Blanks

Laboratory (Method) Blanks: Preparation blanks were generated in accordance within acceptable limits with the following exceptions.

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(Case No. 9101.968)

Preparation Blank (ug/L)

Manganese	1.5
Lead	2.0
Zinc	11.6

Preparation Blank (mg/Kg)

Aluminum	2.73
Copper	0.77
Iron	4.41
Silver	0.62

All positive values which exceeded 5 times the corresponding method blank value were left unqualified. Positive values which did not exceed the limit of 5 times the blank were qualified as 'J', estimated.

(Case No. 9101.987)

Preparation Blank (ug/L)

Cobalt	5.2

Preparation Blank (mg/Kg)

Cobalt	1.65
Iron	7.34
Manganese	0.32
Vanadium	1.13

All positive values which exceeded 5 times the corresponding method blank value remain unqualified. Positive values which did not exceed the limit of 5 times the blank were qualified as 'J', estimated.

(Case No. 9102.000)

Preparation Blank (ug/L)

Aluminum	13.4
Manganese	2.0
Iron	17.2
Lead	1.1
Vanadium	16.6

All positive values which exceeded 5 times the corresponding method blank value were left unqualified. Positive values which did not exceed the limit of 5 times the blank were qualified as 'J', estimated.

IV. ICP Interference Check Sample (ICS)

The ICP ICS was generated within acceptable limits for %R and frequency.

V. Laboratory Control Sample (LCS)

The LCS for the analyses generated acceptable %R for all the analytes, with the exception of the following.

(Case No 9101.968)

Solid LCS

Antimony	53.1%R
Potassium	0 %
Selenium	57 %
Sodium	132.8%
Zinc	74.8%

Positive results for the samples above were qualified as 'J', estimated. Non-detectable values for antimony, potassium, selenium, and zinc were qualified as 'UJ', estimated, due to their % Recovery being generated at less than the control limit of 80%.

(Case No. 9101.987)

Aqueous

Thallium	123.4%R

Solid

Antimony	124.4%
Arsenic	78.8%
Potassium	0%
Selenium	58.9%

The water samples did not require qualification due to the fact that only non-detectable values were reported and the % Recovery was > 120%. Positive results for the solid samples above were qualified as 'J', estimated. Non-detectable values for arsenic, potassium and selenium were qualified as 'UJ', estimated, due to their % Recovery being generated at less than the control limit of 80%.

VI. Duplicate Sample Analysis

The duplicate analyses for all Data Sets were generated within acceptable limits with the exception of the following.

(Case No. 9101.968)

Soils

Iron	40 %
Manganese	40.8%
Mercury	32.8%
Zinc	31.1%

The positive values for the samples were qualified as 'J', estimated. The non-detectable values were qualified as 'UJ', estimated.

(Case No. 9101.987)

Soils

Chromium	34.2%
Lead	58.6%
Magnesium	49.8%
Nickel	96.2%

All soils data for the analytes above were qualified as 'J', estimated.

(Case No. 9102.000)

Waters

Mercury	200%
Iron	169%
Lead	200%
Aluminum	160%

The positive values for the water samples were qualified as 'J', estimated. The non-detectable values were qualified as 'UJ', estimated.

VII Matrix Spike Sample Analysis

All spike recovery was generated within acceptable limits with the following notations.

(Case No. 9101.968)

Water

Selenium	66.4%R	(Limit 75-125)

Solid

Mercury	66.7%R	(Limit 75-125)

Positive values for the compounds above were qualified as 'J', estimated. The non-detectable values were qualified as 'UJ', estimated.

(Case No. 9101.987)

Soils

Lead	185.7 mg/Kg	(Limit 75-125)
Manganese	30.5 mg/Kg	(Limit 75-125)

All samples were qualified as 'J', estimated, for the metals above.

Water

Selenium	67.3% ug/L	(Limit 75-125)
Cyanide	126.5% ug/L	(Limit 75-125)

Selenium and cyanide were previously qualified as estimated through deviations in preceding quality control sections of this report.

(Case No. 9102.000)

Water

Mercury	174%R	(Limit 75-215)
Lead	129.5%R	(Limit 75-125)

Mercury and lead were previously qualified as estimated through deviations in preceeding quality control sections of this report.

M E M O R A N D U M

TO: B. Walter, Project Manager

FROM: J. McMullan, QA Chemist JMM

DATE: November 4, 1991

SUBJECT: Comments on ChemWorld Environmental Inc.'s Data Validation Report for Bainbridge Naval Training Center, Work Order #5

CC: M. Meredith, QA Officer

ChemWorld Environmental Inc.'s (CW's) data validation report for the Bainbridge Naval Training Center (BNTC), dated October 11, 1991 was performed under Work Order #5. This report covered samples collected by Ecology and Environment, Inc. (E & E) on August 12 to August 16, 1991. The samples were analyzed by E & E's Analytical Services Center (ASC) and the results reported in three data packages; 9101.968, 9101.987, and 9102.000/.006.

Given below are our quality assurance/quality control (QA/QC) comments regarding data usability, providing further explanation/clarification and including any differing opinions. In addition, we have included comments on overall precision based on assessment of field duplicate results for this sampling event. Revised data summary forms (DSFs) are attached which give our qualifiers where they differ from CW's.

QA/QC COMMENTS

- The holding time for pesticide/PCB extraction of soils is 14 days, not 7 days as noted by CW. The quantitation limits for pesticides and PCBs in samples 1-GW-4C, 1-GW-6C, 2-GW-1C through 2-GW-6C, 2-GW-3C MS/MSD, 2-GW-3C DUP, and 2-GW-9C should not be qualified "UJ" for a holding time violation of one day. Also, the "UJ" qualification for analysis of pesticide/PCBs past the 40 day holding time is not valid, since it did not exceed 40 days.

- In evaluating continuing calibrations for both volatile and BNA analyses, CW neglected to consider percent difference (%D) values which had a negative sign. The negative sign is a result of calculation when the initial mean relative response factor (RRF) is greater than the calibration

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check. However, a %D greater than 25%, whether positive or negative, still means that the calibration check differs significantly from the initial RRF. There is no change in data qualification with the inclusion of more compounds failing the QC limit of 25%D, since the compounds were not detected in any of the samples. The response factors were high enough that the compounds would have been detected, if present.

- Sample 1-SW-3C was misidentified as 2-SW-3C on the Form Is, and thus transcribed incorrectly onto the DSFs. For this same sample, the "U" qualifier should be deleted from carbon disulfide, since there is no reason for it to be added. (See attached DSFs for both corrections).

- The ICP interference check sample (ICS) should not be evaluated according to Level C data validation guidelines. There were no problems based on ICS results, so no change in data qualification is necessary.

- According to Level C guidelines, LCS results outside QC limits do not affect the data unless the matrix spike results are outside QC limits also. Matrix spike recoveries were within QC limits for those analytes with poor LCS results. These analytes include antimony, potassium, selenium, sodium, and zinc for the sediments in Job 9101.968; thallium for the waters in Job 9101.987; and antimony, arsenic, potassium, and zinc in sediments in Job 9101.987. Selenium and zinc results for sediments in Job 9101.968 remain qualified as estimated due to low spike recoveries (selenium) or poor duplicate analysis (zinc). However, LCS problems should be discussed in the QC section of the laboratory report. This discussion was missing from the reports in question, namely, 9101.968 and 9101.987. Data qualification of sample results based on LCS problems should be deleted (see attached DSFs).

- CW added the "J" qualifier to aluminum results in Job 9101.968 water samples. However, aluminum was not present in the preparation blank for this job, only in the blank for Job 9102.000/.006. The "J" qualifier was deleted from these aluminum results (see attached DSFs).

- CW qualified zinc results for both waters and sediments due to poor duplicate analysis of zinc in a sediment duplicate for Job 9101.968. Only the zinc results in sediments need to be qualified (see attached DSFs).

- The continuing calibration evaluation by CW neglected to indicate which job and which samples were affected by the high recoveries. In checking the calibration and analysis

run forms (Forms 2 and 14), we determined that it was Job 9101.987 which had the high recoveries. Only the cyanide results for samples 1-SED-4C to 1-SED-6C and 1-SED-9CD and its duplicate and spike analysis were affected. There were no positive results for cyanide in these samples; thus, no qualification is necessary. Qualification of arsenic and lead results based on the high recoveries should be deleted, since no samples from Job 9101.987 were affected. (See attached DSFs).

- The qualifier "E" denoting interference was added to several analytes in waters (Jobs 9101.968 and 9101.987) by the laboratory, due to poor serial dilution results. All "E" qualifiers were deleted (see attached DSFs), since the results were either nondetects or less than 50 times CRDL.

- Two rinsate samples, 1-GW-RC and 2-GW-RC, were analyzed for inorganics, but were not evaluated by CW as field blanks. The 2-GW-RC sample gave high values for calcium, iron, magnesium, manganese, and sodium which indicates that the water used was not deionized water. Thus, the results for 2-GW-RC should not be used to qualify any of the samples. The 1-GW-RC sample gave satisfactory results and, in lieu of a proper rinsate for the 2-GW samples, should be used to qualify all the groundwater samples. Aluminum (31.9 µg/L), copper (4.1 µg/L), iron (10.9 µg/L) and zinc (5.8 µg/L) were detected in 1-GW-RC. Sample results for aluminum, copper, iron, and zinc are qualified "J" as estimated up to five times the levels found in 1-GW-RC.

- When qualifying inorganic data for poor duplicate analysis, CW qualified nondetected results "UJ" as estimated. Only positive results should be qualified "J" as estimated due to poor duplicate analysis (see attached DSFs for deletions).

OVERALL PRECISION

- Field duplicate results for organics in sediments were assessed on the duplicate pair, 2-SED-7C and 2-SED-7C DUP (see Table 1). Overall precision was good for BNA compounds, but poor for pesticides as indicated by high RPDs for 4,4'-DDD (110%) and 4,4'-DDT (190%). These high RPDs may be due to the non-homogeneous nature of sediments, which makes it difficult to obtain good field duplicates.

- Field duplicate results for TPH in sediments were assessed on two duplicate pairs, 1-SED-7C/1-SED-7C and 2-SED-7CRE/2-SED-7CDRE (see Table 2). The RE indicates reanalysis due to a problem with the original analysis. Overall precision was poor as indicated by high RPDs of

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170% and 110%, respectively. These high RPDs may be due to the non-homogeneous nature of sediments, as noted above.

- Overall precision for inorganics in sediments was assessed on two duplicate pairs, 1-SED-9C/1-SED-9CD and 2-SED-7C/2-SED-7CD (see Tables 3 and 4). For the 1-SED-9C/1-SED-9CD pair, precision was acceptable, with only one high RPD. Nickel results gave an RPD of 130%, much higher than the other RPDs which ranged from 11% to 96%. For the 2-SED-7C/2-SED-7CD pair, RPDs were generally higher, ranging from 42% to 150%. The non-homogeneous nature of sediments makes obtaining good field duplicates difficult and is most likely the reason for the high RPDs.

- Overall precision for inorganics in waters was assessed on three duplicate pairs, 1-GW-3C/1-GW-3CD, 2-GW-3C/2-GW-3CD, and 1-SW-9C/1-SW-9CD (see Tables 5, 6, and 7). The two groundwater (GW) pairs indicated good precision with RPDs ranging from 0.0% to 17%. However, the surface water (SW) pair gave high RPDs for aluminum (150%), iron (160%), lead (170%), manganese (140%), and zinc (130%), indicating poor precision for these analytes. The other analytes gave acceptable precision with RPDs from 0.3% to 47%. In all instances of poor precision, sample 1-SW-9CD gave higher values than 1-SW-9C, which indicates that the problem was associated with sampling and not analysis. Surface waters contain varying amounts of sediment, depending on how much the waters are disturbed before sampling. Differing amounts of sediment can alter analyte levels significantly and may be the explanation for poor precision.

kvk/CD7013
[SEC]165

Table 1

ORGANIC FIELD DUPLICATE RESULTS
(Results are in µg/kg dry weight)

Parameter	2-SED-7C	2-SED-7C DUP	RPD(%)
BNAs			
Phenanthrene	6,400	4,600	33
Anthracene	ND	1,200	IN
Floranthene	9,100	6,900	27
Pyrene	11,000	7,700	35
Chrysene	6,500	4,500	36
Benzo(b)fluoranthene	9,400	6,500	36
Benzo(a)pyrene	2,700	2,800	3.6
Indeno(1,2,3-cd)pyrene	4,500	2,500	57
Benzo(g,h)perylene	4,500	2,300	65
P/PCBs			
4,4'-DDD	160,000	4,500	190
4,4'-DDT	36,000	830	190

IN = Indeterminant
ND = Not Detected

BNAs = Base/Neutral/Acid Extractables
P/PCBs = Pesticide/Polychlorinated Biphenyls

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[SEC]116

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Table 3

INORGANIC FIELD DUPLICATE RESULTS
(Results are in µg/kg, dry weight)

Parameter	1-SED-9C	1-SED-9CD	RPD(%)
Aluminum	2,690	4,400	48
Arsenic	0.62	0.82	28
Barium	23.3	35.7	42
Beryllium	0.50	0.72	36
Calcium	423	646	42
Chromium	7.3	11.3	43
Cobalt	8.7	11.8	30
Copper	4.7	7.2	42
Iron	7,940	10,800	30
Lead	7.7	8.6	11
Magnesium	1,450	4,150	96
Manganese	296	425	36
Mercury	0.11	ND	IN
Nickel	10.5	32.5	130
Potassium	433	747	53
Vanadium	14.5	22.6	45
Zinc	20.5	30.8	40
Cyanide	4.1	ND	IN

IN = Indeterminant
ND = Not Detected

kvk/CD7013
[SEC]121

Table 5

INORGANIC FIELD DUPLICATE RESULTS
(Results are in µg/L)

Parameter	1-GW-3C	1-GW-3CD	RPD(%)
Aluminum	98.5	116	16
Barium	113	115	1.7
Calcium	109,000	109,000	0.0
Cobalt	19.5	16.4	17
Iron	25,000	24,800	1.0
Lead	ND	5.2	IN
Magnesium	59,400	59,200	0.3
Manganese	7,550	7,480	1.0
Potassium	3,240	3,510	8.0
Sodium	65,200	64,700	0.5
Zinc	7.8	ND	IN

IN = Indeterminant
ND = Not Detected

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[SEC]122

Table 7

INORGANIC FIELD DUPLICATE RESULTS
(Results are in µg/L)

Parameter	1-SW-9C	1-SW-9CD	RPD(%)
Aluminum	492	3,620	150
Barium	50.1	80.5	47
Calcium	34,900	34,800	0.3
Cobalt	15.2	9.3	48
Copper	ND	11.0	IN
Iron	609	5,730	160
Lead	1.1	14.5	170
Magnesium	13,800	14,400	4.3
Manganese	71.3	368	140
Mercury	ND	0.24	IN
Nickel	ND	22.2	IN
Potassium	3,300	2,700	20
Sodium	21,500	21,100	1.9
Vanadium	12.9	14.1	8.9
Zinc	10.0	46.5	130

IN = Indeterminant
ND = Not Detected

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[SEC]163

January 1994 Sampling Event

DATA VALIDATION REPORT #1

ORGANIC and INORGANIC ANALYSES

Bainbridge Project

Case Nos. 9400.144 and 9400.153

Sampling Dates of January 19 - 24, 1994

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May 1994

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Bainbridge Project
Data Validation Report #1: Organic and Inorganic Analyses

Table of Contents

		Page
	Introduction	1
1.0	Volatile Organics by GC/MS	2
1.1	Holding Times	2
1.2	System Monitoring Compound Recovery	2
1.3	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	3
1.4	Calibration	3
1.5	Blanks	4
1.6	GC/MS Instrument Performance Check	5
1.7	Tentatively Identified Compounds	6
1.8	Internal Standards	6
2.0	Semi-Volatile Organics by GC/MS	6
2.1	Holding Times	6
2.2	Surrogate Recovery	6
2.3	MS/MSD	6
2.4	Calibration	7
2.5	Blanks	7
2.6	GC/MS Instrument Performance Check	7
2.7	Tentatively Identified Compounds	7
2.8	Internal Standards	8
3.0	Pesticides/PCBs by GC	8
3.1	Holding Times	8
3.2	Surrogate Recovery	8
3.3	MS/MSD	8
3.4	Blanks	9
3.5	Instrument (GC) Performance	9
3.6	Calibration	9
3.7	Compound Identification	9
4.0	Inorganic Analyses by AA and ICP	9
4.1	Holding Times	10
4.2	Calibration	10
4.3	Blanks	10
4.4	ICP Interference Check	10
4.5	Spiked Sample Recovery	10
4.6	Laboratory Duplicates	10
4.7	Laboratory Control Sample	11
4.8	ICP Serial Dilution	11

Bainbridge Project
Data Validation Report #1: Organic and Inorganic Analyses

Appendices

A Data Summary Forms: Volatile Organics
B Data Summary Forms: Semi-Volatile Organics
C Data Summary Forms: Pesticides/PCBs
D Data Summary Forms: Inorganics
E Data Summary Forms: Tentatively Identified Compounds
F Data Qualifiers
G Case Narratives
H Chain-of-Custody Forms

DATA VALIDATION SUMMARY #1: ORGANIC and INORGANIC ANALYSES

Bainbridge Project
Case Nos. 9400.144 and 9400.153
Sampling Dates of January 19 - 24, 1994

INTRODUCTION

This Data Validation Summary report for organic and inorganic analyses was generated for 33 water samples, and the associated quality control samples for the Case Numbers referenced above. Sampling activities were conducted in support of the field investigation for the Bainbridge Project. The analytical laboratory work was performed by Ecology and Environment, Inc.'s Analytical Services Center.

Analytical testing consisted of volatile organic analyses by Gas Chromatography/Mass Spectroscopy (GC/MS); Base/Neutral and Acid Extractable Organics by GC/MS; Pesticides and Polychlorinated Biphenyls (PCBs) by GC; Inorganics by Atomic Absorption (AA) and Inductively Coupled Argon Plasma (ICP); Mercury by Cold Vapor; and Cyanide by Spectrophotometry. The analytical work was performed utilizing the most current United States Environmental Protection Agency (USEPA) Contract Laboratory Program (CLP) protocols. Additional organic and inorganic analyses were performed for the project. The Data Validation Reports for these analyses are provided under separate cover.

This report provides a summary of data acceptability and deviations in accordance with the **Naval Energy and Environmental Support Activity (NEESA) Level C requirements**, as stated in the document **Quality Assurance in Environmental Analysis, October 1990**. In addition, the CLP portion of the corresponding USEPA Statements of Work (SOW) were utilized, where applicable and relevant. The validation report pertains to the following samples:

Case No. 9400.144

1-GW-025
1-GW-035
2-GW-015
2-GW-025
2-GW-035
2-GW-045
2-GW-055
2-GW-065
2-GW-065DUP
2-GW-075
2-GW-085
2-GW-095
2-GW-105
2-GW-115
2-GW-11-TR (Trip Blank)
2-GW-125
2-GW-135
Trip Blank

Case No. 9400.153

1-GW-015
1-GW-045
1-GW-055
1-GW-055T (Trip Blank)
1-GW-065
1-GW-075
1-GW-075DUP
1-GW-085
1-GW-085DUP
1-GW-095
1-GW-13TB (Trip Blank)
1-GW-105
1-GW-115
1-GW-125
1-GW-135

1.0 VOLATILE ORGANICS BY GC/MS

The following items/criteria were reviewed:

* Holding Times
* System Monitoring Compound Recovery
* Matrix Spikes (MS) and Matrix Spike Duplicates (MSD)
* Initial and Continuing Calibration
* Blanks (Method and Field)
* GC/MS Instrument Performance Check
* Tentatively Identified Compounds (TICs)
* Internal Standards

All items above were generated within acceptable Quality Control (QC) specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

1.1 Holding Times

All holding times were met within the acceptable time frame of 14 days from collection for the acid preserved water samples.

1.2 System Monitoring Compound Recovery

All system monitoring recovery was found to be generated within acceptable limits for the three surrogate compounds, with the following exceptions.

1.2.1 Case No. 9400.153

Sample ID			
1-GW-075DUP	Toluene-d8	85% R	(Limit 88-110)
1-GW-085DUP	Toluene-d8	84%	

The samples above were qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results.

1.3 Matrix Spike/Matrix Spike Duplicates (MS/MSD)

MS/MSD sample sets were analyzed for the water samples. Acceptable accuracy (percent recovery) and precision (relative percent difference) were generated.

1.4 Calibration

All initial and continuing calibration was performed within acceptable limits for average Relative Response Factors ($\overline{RRF}$), Percent Relative Standard Deviation (% RSD), Relative Response Factors (RRF), and percent Difference (% D), with the following exceptions.

1.4.1 Case No. 9400.144

Continuing Calibration:

Date, Time		
1/25/94, 08:43	Chloromethane	35.9% D (Limit 25%)
1/26/94, 00:37	Carbon Disulfide	26.7%
	Chloroform	26.9%
1/27/94, 04:55	Bromomethane	27.1%
	Vinyl Chloride	25.9%
	Chloroethane	28.6%
1/27/94, 17:28	Chloromethane	49.4%
	Vinyl Chloride	27.0%
1/28/94, 20:12	Chloromethane	29.8%
	Acetone	28.5%

The samples associated with the continuing calibrations above were qualified as 'J', estimated, for the positive results, only. The non-detectable results did not require qualification.

1.4.2 Case No. 9400.153

Continuing Calibration:

Date, Time		
1/27/94, 17:28	Chloromethane	49.4% D (Limit 25%)
	Vinyl Chloride	27.0%
1/28/94, 08:05	Vinyl Chloride	31.0%
	Chloroethane	25.7%
	Acetone	35.0%
	2-Butanone	29.6%
	4-methyl-2-pentanone	31.7%
	2-Hexanone	25.6%

The samples associated with the continuing calibrations above were qualified as 'J', estimated, for the positive results. The non-detectable results did not require qualification.

1.5 Blanks

1.5.1 Field Blanks

1.5.1.1 Case No. 9400.144

Two trip blanks, 2-GW-11-TR and Trip Blank, were collected and analyzed for Volatile Organics. The following compounds were detected in the trip blanks.

2-GW-11-TR

1,1,1-Trichloroethane	2 ug/L, estimated

Methylene chloride, acetone, and chloroform results that were detected in the trip blanks are qualified as 'U', not detected, through *Section 1.5.2, Method Blanks.* Additional qualification is not required in relation to these compounds. The compound 1,1,1-Trichloroethane noted above was not detected in any of the samples, therefore, qualification was not required.

1.5.1.2 Case No. 9400.153

Two trip blanks (1-GW-055T and 1-GW-13TB) were collected and analyzed for Volatile Organics. The following compounds were detected in the trip blanks.

1-GW-055T

Acetone	8 ug/L, estimated
Chloroform	2 ug/L, estimated
1,1,1-Trichloroethane	2 ug/L, estimated

1-GW-13TB

Chloroform	2 ug/L, estimated
Toluene	2 ug/L, estimated

Methylene chloride results detected in the trip blanks are qualified as 'U', not detected, in *Section 1.5.2, Method Blanks*. Additional qualification is not required in relation to the methylene chloride. Limits of ten times the acetone and toluene values and five times the highest chloroform and 1,1,1-Trichloroethane values were used for review and qualification of the associated samples. The samples did not contain the compounds detected in the trip blanks, therefore, qualification was not required.

1.5.2 Method Blanks

1.5.2.1 Case No. 9400.144

Five water method blanks were analyzed for the Case. The following summarizes Volatile Organics detected.

Sample ID		
VBLKW1	Methylene Chloride	4 ug/L, estimated
	Acetone	13 ug/L
VBLKW2	Methylene Chloride	2 ug/L, estimated
	Acetone	9 ug/L, estimated
	Chloroform	3 ug/L, estimated
VBLKW3	Methylene Chloride	3 ug/L, estimated
VBLKW4	Methylene Chloride	2 ug/L, estimated
VBLKW5	Methylene Chloride	1 ug/L, estimated

Limits of ten times the highest methylene chloride and acetone values above and five times the chloroform value were used for review and qualification of the samples. Sample results which exceed the respective blank limit do not require qualification. Sample results found to be less than the blank limit and less than the Contract Required Quantitation Limit (CRQL) were qualified as 'U', not detected, at the CRQL. Sample results detected above the CRQL and below the blank limit were qualified as 'U', not detected.

1.5.2.2 Case No. 9400.153

Methylene chloride was detected in the two method blanks at 3 ug/L and 2 ug/L. All sample results were less than the CRQL and were reported at less than ten times the blank. The sample results were qualified as 'U', not detected, at the CRQL.

1.6 GC/MS Instrument Performance Check

Instrument performance was generated within acceptable limits for Bromofluorobenzene (BFB).

1.6.1 Case No. 9400.153

Sample 1-GW-095 was analyzed after the 12-hour tune clock had expired. The sample was qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results.

1.7 Tentatively Identified Compounds (TICs)

TICs, which were generated in accordance with protocol, are summarized on Data Summary Forms in Appendix E.

1.8 Internal Standards

All internal standards were generated within acceptable specifications for area counts and retention time variation.

2.0 SEMI-VOLATILE ORGANICS BY GC/MS
(Base/Neutral and Acid Extractable Organics)

The following items/criteria were reviewed:

* Holding Times
* Surrogate Recovery
* MS/MSD
* Initial and Continuing Calibration
* Blanks (Method and Field)
* GC/MS Instrument Performance Check
* TICs
* Internal Standards

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

2.1 Holding Times

All holding times were met for extraction and analysis of the water samples. The USEPA technical holding time is 7 days from collection for extraction, and 40 days from extraction to analysis.

2.2 Surrogate Recovery

All surrogate recovery was found to be generated within acceptable limits for the eight surrogate compounds.

2.3 MS/MSD

MS/MSD sample sets were analyzed for the water samples. Acceptable accuracy and precision were generated.

2.4 Calibration

All initial and continuing calibrations were performed within acceptable limits for $\overline{RRF}$, % RSD, RRF, and % D, with the exception of the following.

2.4.1 Case Nos. 9400.144 and 9400.153

Various compounds were out of specification for the initial and continuing calibrations. However, positive results were not detected for the compounds affected. The non-detectable results did not require qualification.

2.5 Blanks

2.5.1 *Field Blanks*

Field blanks were not collected for Semi-Volatile Organic analyses.

2.5.2 Method Blanks

2.5.2.1 Case No. 9400.144

Two water method blanks were analyzed for Semi-Volatile Organics. The following compound was detected for the method blanks.

Sample ID		
SBLKW1	bis(2-ethylhexyl)phthalate	8 ug/L, estimated
SBLKW2	bis(2-ethylhexyl)phthalate	1 ug/L, estimated

A limit of ten times the highest respective bis(2-ethylhexyl)phthalate value above was used for review and qualification of the samples. Sample results which exceed the blank limit do not require qualification. Sample results found to be below the respective blank limit were qualified as 'U', not detected. Sample results detected below the blank limit and reported at less than the CRQL, were qualified as 'U', not detected at the CRQL.

2.5.2.2 Case No. 9400.153

Three water method blanks were analyzed for Semi-Volatile Organics. SBLKW3 was found to contain 2 ug/L of bis(2-ethylhexyl)phthalate. All sample values for bis(2-ethylhexyl)phthalate were found to be less than the limit of ten times the blank value and were reported at less than the CRQL. The sample results for bis(2-ethylhexyl)phthalate were qualified as 'U', not detected, at the CRQL.

2.6 GC/MS Instrument Performance Check

Instrument performance was generated within acceptable limits for Decafluorotriphenylphosphine (DFTPP).

2.7 TICs

TICs were generated in accordance with protocol. The Form I's, including the appropriate qualifiers, are included in Appendix E.

2.8 Internal Standards

All internal standards were generated within acceptable specifications for area counts and retention time variation, with the following exceptions.

2.8.1 Case No. 9400.144

Sample ID	Internal Standard	Reported Area Count	Lower Limit
2-GW-085	Phenanthrene-d10	93705	99126
2-GW-085RE	Acenaphthene-d10	35386	40730
	Phenanthrene-d10	50677	56521

The samples were qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results, for the compounds associated with the particular internal standards above.

3.0 PESTICIDES/PCBs BY GC

The following items/criteria were reviewed:

* Holding Times
* Surrogate Recovery
* MS and MSD
* Blanks (Method and Field)
* Instrument (GC) Performance
* Calibration
* Compound Identification

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

3.1 Holding Times

All holding times were met within acceptable time frames for extraction and analysis of the water samples. The USEPA technical holding time is 7 days from collection for extraction and 40 days from extraction to analysis.

3.2 Surrogate Recovery

Surrogate recovery was generated within acceptable limits for both surrogate compounds.

3.3 MS/MSD

MS/MSD sample sets were analyzed for Pesticides and PCBs. Acceptable accuracy and precision was generated.

3.4 Blanks

3.4.1 Field Blanks

Field blanks were not collected for Pesticides/PCBs analyses.

3.4.2 Method Blanks

3.4.2.1 Case No. 9400.144

Three water method blanks were analyzed for the Case. Pesticides and PCBs were not detected.

3.4.2.2 Case No. 9400.153

Two water method blanks were analyzed for the Case. Pesticides and PCBs were not detected.

3.5 Instrument GC Performance

Adequate chromatographic resolution and instrument sensitivity were achieved through the generation of data within acceptable limits for the Resolution Check Mixture and Performance Evaluation Mixtures. Review items included resolution between adjacent peaks, retention time windows, Relative Percent Difference (RPD), and percent breakdown for DDT/Endrin.

3.6 Calibration

All initial and continuing calibration was performed within acceptable limits for the individual standard mixtures. Review items included resolution, retention time windows, calibration factors (CF), percent RSD for linearity, RPD and %R.

3.7 Compound Identification

GC qualitative analyses are considered to be acceptable. Data was generated in accordance with protocols.

4.0 INORGANIC ANALYSES BY AA AND ICP
(Mercury by Cold Vapor and Cyanide by Spectrophotometry)

The following items/criteria were reviewed:

* Holding Times
* Initial and Continuing Calibration
* Blanks (Initial, Continuing Calibration, and Preparation)
* Field Blanks
* ICP Interference Check Sample
* Matrix Spike Sample Recovery
* Laboratory Duplicates
* Laboratory Control Sample (LCS)
* ICP Serial Dilution

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

4.1 Holding Times

All holding times were met within the acceptable time frame from collection for metals (6 months), mercury (28 days), and cyanide (14 days).

4.2 Calibration

All initial and continuing calibration was performed within acceptable limits for percent recovery.

4.3 Blanks

4.3.1 Laboratory (Method) Blanks

All initial calibration, continuing calibration, and preparation blanks were generated in accordance with acceptable limits.

4.3.2 Field Blanks

Field blanks were not collected for Inorganic analyses.

4.4 ICP Interference Check

The ICP Interference Check samples were generated within the acceptable limit of 80-120% for recovery.

4.5 Spiked Sample Recovery

All percent recoveries for the matrix spike sample were found to be within the 75-125% limit, with the following exceptions.

4.5.1 Case No. 9400.144

Sample ID		
2-GW-055	Arsenic	34.4% R

Arsenic results for the water samples were qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results, due to low spike recovery.

4.6 Laboratory Duplicates

Precision (relative percent difference) for the water samples was found to be acceptable for all the elements, with the following exceptions.

4.6.1 Case No. 9400.144

Sample ID		
2-GW-055	Zinc	51.6% RPD

The positive results for zinc were qualified as 'J', estimated.

4.6.2 Case No. 9400.153

Sample ID		
1-GW-115	Aluminum	28.5% RPD
	Zinc	32.7%

Positive results for aluminum and zinc were qualified as 'J', estimated.

4.7 Laboratory Control Sample (LCS)

The aqueous laboratory control samples were generated within acceptable limits.

4.8 ICP Serial Dilution

ICP Serial Dilution was found to be within the acceptable10% limit for percent difference, with the following exception.

4.8.1 Case No. 9400.144

Zinc	16.2% D

All zinc results were previously qualified through *Section 4.6, Laboratory Duplicates.* Additional qualification is not required.

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MEMORANDUM

X

TO: John Walter, E & E Project Manager

FROM: Lynn Hess, E & E QA Chemist

DATE: June 8, 1994

SUBJECT: Comments on ChemWorld Environmental Inc.'s Data Validation Report for Bainbridge Naval Training Center, Work Order # 1.

CC: Marcia Meredith Galloway, E & E QA Officer

ChemWorld Environmental Inc.'s (CW's) Data Validation Report # 1 for the Bainbridge Naval Training Center (BNTC), dated May 23, 1994 was performed under Work Order # 1 for samples collected between January 19 and 24, 1994. The report covers analytical data contained in two E & E data packages; 9400.144/146/152 (groundwaters) and 9400.153/164 (ground waters).

Given below are our quality assurance/quality control (QA/QC) comments regarding data usability, providing further explanation/clarification and including any differing opinions. In addition, we have included comments on overall precision based on assessment of field duplicate results for this sampling event. Revised data summary sheets are attached which give our qualifiers where they differ from CW's.

QA/QC COMMENTS

COMMENT 1

The tentatively identified compounds are qualified with an "N" by CW. This qualification is unnecessary when an identi-

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fication is not made. Revised data summary sheets are enclosed.

COMMENT 2

The percent recovery for toluene-d8 in the volatile analyses of 1-GW-075DUP (85%) and 1-GW-085DUP (84%) were slightly low (limit 88-110). In accordance with the data validation guidelines CW qualified the results for these duplicate analyses. There was good correlation between the results for 1-GW-075 and 1-GW-075DUP, and 1-GW-085 and 1-GW-085DUP. Both the original and the duplicate analyses results can be used for all purposes, based on the correlation between the results.

√COMMENT 3

In accordance with data validation guidelines CW qualified the results for the semi-volatile analysis of 2-GW-085 and 2-GW-085RE due to unacceptable internal standard (IS) area recoveries, indicating a sample matrix effect. Results for 2-GW-085 are recommended for use as fewer compounds need to be qualified in this analysis. Phenanthrene-d10 was slightly below the lower IS area limit in 2-GW-085 and both acenaphthene-d10 and phenanthrene-d10 were less than the lower IS area limit in 2-GW-085RE.

√ COMMENT 4

On the data summary form for 2-GW-085 in Appendix B of CW's data validation report, 2-methylnaphthalene was qualified "J", mistakenly. There is no reason for 2-methylnapthalene to be qualified. The qualifier has been removed and a copy of the corrected data summary form is included in this memo.

COMMENT 5

Dimethylphthalate was detected in many of the groundwater samples at levels both above and below the contract required detection limits. Phthalate esters are common field/laboratory contaminants due to the plastic gloves used in the handling of samples. The dimethylphthalate was not

detected in any of the associated quality control samples. The positive dimethylphthalate results for the groundwaters should be used with caution.

OVERALL PRECISION

Field duplicate results indicate good overall precision for inorganics, as evidenced by RPD's ranging from 0.0% to 35.3% (see Table 1). Overall precision for organics was also good, with the exception of one high RPD for di-n-octylphthalate of 143% (see Table 2). It is likely that the di-n-octyl phthalate is due to field contamination from the gloves used while sampling.

Table 1

BNTC GROUNDWATERS

FIELD DUPLICATE RESULTS - INORGANIC

(Results in ug/L)

Parameter	2-GW-065	2-GW-065DUP	RPD
Aluminum	119	94.7	22.7
Barium	24.6	23.6	4.1
Calcium	12200	12100	0.82
Iron	232	200	14.8
Magnesium	6750	6670	1.2
Manganese	8.0	8.2	2.5
Sodium	9800	9650	1.5
Zinc	26.4	24.7	6.6

Parameter	1-GW-075	1-GW-075DUP	RPD
Aluminum	1050	735	35.3
Barium	95.0	98.1	3.2
Calcium	58300	60400	3.5
Copper	11.1	9.5	15.5
Iron	1510	1110	30.5
Magnesium	31400	32600	3.8
Manganese	103	101	2.0
Potassium	2610	3200	20.3
Sodium	31300	32600	4.1
Zinc	22.0	24.6	11.2
Nickel	ND	7.2	IN
Silver	ND	6.4	IN

IN = Indeterminant

ND = Not Detected

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Table 1 cont.

BNTC GROUNDWATERS

FIELD DUPLICATE RESULTS - INORGANIC

(Results in ug/L)

Parameter	1-GW-085	1-GW-085DUP	RPD
Aluminum	44.4	45.0	1.3
Barium	75.3	71.3	5.5
Calcium	68600	65600	4.5
Iron	2400	2210	8.2
Magnesium	36200	34800	3.9
Manganese	5470	5240	4.3
Nickel	4.9	6.5	28.1
Potassium	2250	2180	3.2
Sodium	31300	30500	2.6
Zinc	36.2	38.2	5.4

Table 2

BNTC GROUNDWATERS

FIELD DUPLICATE RESULTS - ORGANIC

(Results in ug/L)

Parameter	2-GW-065	2-GW-065DUP	RPD
Carbon Disulfide	1	1	0
Dimethylphthalate	6	7	15
Phenanthrene	1	1	0
Di-n-octylphthalate	6	1	143

Parameter	1-GW-075	1-GW-075DUP	RPD
1,2-Dichloroethene (total)	13	13	0
Trichloroethene	4	5	22
Dimethylphthalate	4	3	29

Parameter	1-GW-085	1-GW-085DUP	RPD
Chlorobenzene	6	7	15
Dimethylphthalate	34	31	9.2

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February 22, 1994 Sampling Event

DATA VALIDATION REPORT #2

ORGANIC and INORGANIC ANALYSES

Bainbridge Project

Case No. 9400.358

Sampling Date of February 22, 1994

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May 1994

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Bainbridge Project
Data Validation Report #2: Organic and Inorganic Analyses

Table of Contents

		Page
	Introduction	1
1.0	Volatile Organics by GC/MS	1
1.1	Holding Times	2
1.2	System Monitoring Compound Recovery	2
1.3	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	2
1.4	Calibration	3
1.5	Blanks	3
1.6	GC/MS Instrument Performance Check	5
1.7	Tentatively Identified Compounds	5
1.8	Internal Standards	5
2.0	Semi-Volatile Organics by GC/MS	5
2.1	Holding Times	5
2.2	Surrogate Recovery	6
2.3	MS/MSD	6
2.4	Calibration	6
2.5	Blanks	8
2.6	GC/MS Instrument Performance Check	8
2.7	Tentatively Identified Compounds	9
2.8	Internal Standards	9
3.0	Pesticides/PCBs by GC	9
3.1	Holding Times	9
3.2	Surrogate Recovery	9
3.3	MS/MSD	10
3.4	Blanks	11
3.5	Instrument (GC) Performance	11
3.6	Calibration	11
3.7	Compound Identification	12
4.0	Inorganic Analyses by AA and ICP	12
4.1	Holding Times	13
4.2	Calibration	13
4.3	Blanks	13
4.4	ICP Interference Check	13
4.5	Spiked Sample Recovery	14
4.6	Laboratory Duplicates	14
4.7	Laboratory Control Sample	14
4.8	ICP Serial Dilution	14

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Appendices

A Data Summary Forms: Volatile Organics
B Data Summary Forms: Semi-Volatile Organics
C Data Summary Forms: Pesticides/PCBs
D Data Summary Forms: Inorganics
E Data Summary Forms: Tentatively Identified Compounds
F Data Qualifiers
G Case Narratives
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DATA VALIDATION SUMMARY #2: ORGANIC and INORGANIC ANALYSES

Bainbridge Project
Case No. 9400.358
Sampling Date of February 22, 1994

INTRODUCTION

This Data Validation Summary report for organic and inorganic analyses was generated for 7 water samples, 12 soil samples, and the associated quality control samples for the Case Numbers referenced above. Sampling activities were conducted in support of the field investigation for the Bainbridge Project. The analytical laboratory work was performed by Ecology and Environment, Inc.'s Analytical Services Center.

Analytical testing consisted of volatile organic analyses by Gas Chromatography/Mass Spectroscopy (GC/MS); Base/Neutral and Acid Extractable Organics by GC/MS; Pesticides and Polychlorinated Biphenyls (PCBs) by GC; Inorganics by Atomic Absorption (AA) and Inductively Coupled Argon Plasma (ICP); Mercury by Cold Vapor; and Cyanide by Spectrophotometry. The analytical work was performed utilizing the most current United States Environmental Protection Agency (USEPA) Contract Laboratory Program (CLP) protocols and USEPA SW-846 methodology, where noted. Additional organic and inorganic analyses were performed for the project. The Data Validation Reports for these analyses are provided under separate cover.

This report provides a summary of data acceptability and deviations in accordance with the **Naval Energy and Environmental Support Activity (NEESA) Level C requirements,** as stated in the document **Quality Assurance in Environmental Analysis, October 1990.** In addition, the CLP portion of the corresponding USEPA Statements of Work (SOW) were utilized, where applicable and relevant. The validation report pertains to the following samples:

Case No. 9400.358

1-PS-1	1-PS-10
1-PS-2	1-PS-11
1-PS-3	1-PW-1
1-PS-4	1-PW-2
1-PS-5	1-PW-3
1-PS-6	1-PW-4
1-PS-7	RS-22-A (Rinsate Blank)
1-PS-8	RS-22-B (Rinsate Blank)
1-PS-9	TB-22 (Trip Blank)
1-PS-9D	

1.0 VOLATILE ORGANICS BY GC/MS

The following items/criteria were reviewed:

* Holding Times
* System Monitoring Compound Recovery
* Matrix Spikes (MS) and Matrix Spike Duplicates (MSD)

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* Initial and Continuing Calibration
* Blanks (Method and Field)
* GC/MS Instrument Performance Check
* Tentatively Identified Compounds (TICs)
* Internal Standards

All items above were generated within acceptable Quality Control (QC) specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

1.1 Holding Times

All holding times were met within the acceptable time frame of 14 days from collection for the acid preserved water samples and the soil samples.

1.2 System Monitoring Compound Recovery

All system monitoring recovery was found to be generated within acceptable limits for the three surrogate compounds, with the following exceptions.

Sample ID			
1-PS-1	Toluene-d8	83% R	(Limit 84-138)
	Bromofluorobenzene	168% R	(Limit 59-113)
1-PS-1DL	Toluene-d8	72%	
	Bromofluorobenzene	169%	
1-PS-2	Toluene-d8	81%	
	Bromofluorobenzene	149%	
1-PS-6	Toluene-d8	79%	
	Bromofluorobenzene	223%	
1-PS-6MS	Bromofluorobenzene	242%	
1-PS-6MSD	Toluene-d8	83%	
	Bromofluorobenzene	282%	

The samples above were qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results. Sample 1-PS-6MS was qualified as 'J', estimated, for the positive results, only, due to high surrogate recovery.

1.3 Matrix Spike/Matrix Spike Duplicates (MS/MSD)

MS/MSD sample sets were analyzed for the water and soil samples. Acceptable accuracy (percent recovery) and precision (relative percent difference) were generated. However, some elevated percent recoveries were noted for trichloroethene for the water MS/MSD and toluene in one of the soil MS/MSD sample sets.

1.4 Calibration

All initial and continuing calibration was performed within acceptable limits for average Relative Response Factors (RRF), Percent Relative Standard Deviation (% RSD), Relative Response Factors (RRF), and percent Difference (% D), with the following exceptions.

Initial Calibration:

Date		
2/22/94	Acetone	57.1% RSD (Limit 30%)
3/02/94	Acetone	39.2%

Positive results for acetone were qualified as 'J', estimated. The non-detectable results do not require qualification.

Continuing Calibration:

Date, Time		
3/01/94, 11:52	2-Butanone	32.9% D (Limit 25%)
	Dibromochloromethane	25.8%
	2-Hexanone	31.1%
3/03/94, 21:20	Chloromethane	26.1%
	2-Butanone	31.3%
3/04/94, 10:56	Chloromethane	34.7%
3/04/94, 16:41	Chloromethane	36.6%
	Vinyl Chloride	25.8%
	Acetone	38.7%
	2-Butanone	26.9%

The samples associated with the continuing calibrations above were qualified as 'J', estimated, for the positive results, only. The non-detectable results did not require qualification.

1.5 Blanks

1.5.1 Field Blanks

One trip blank and two rinsate blanks were collected and analyzed for Volatile Organics. The following compounds were detected in the field blanks.

Sample ID		
RS-22-A	Carbon Disulfide	2 ug/L, estimated
	1,2-Dichloroethene (total)	2 ug/L, estimated
	Chloroform	2 ug/L, estimated
	1,1,1-Trichloroethane	2 ug/L, estimated

	Trichloroethene	7 ug/L, estimated
	Tetrachloroethene	3 ug/L, estimated
	Toluene	3 ug/L, estimated
	Chlorobenzene	2 ug/L, estimated
RS-22-B	Carbon Disulfide	5 ug/L, estimated
	Chloroform	2 ug/L, estimated
	1,1,1-Trichloroethane	2 ug/L, estimated
	Toluene	1 ug/L, estimated
TB-22	Carbon Disulfide	2 ug/L, estimated
	Chloroform	2 ug/L, estimated
	1,1,1-Trichloroethane	2 ug/L, estimated
	Toluene	1 ug/L, estimated

Methylene chloride and acetone results that were detected in the field blanks are qualified as 'U', not detected, through *Section 1.5.2, Method Blanks.* Additional qualification is not required in relation to these compounds.

In reference to the contaminants noted above, a limit of ten times the highest toluene blank value and five times the blank values for the remaining compounds were used for review and qualification of the samples. Sample results which exceed the blank limit do not require qualification. Sample results reported at less than the CRQL and less than the blank limit are qualified as 'U', not detected, at the CRQL. Toluene results, only, were qualified in relation to these field blanks. The remaining sample results were not affected by the contaminants in the field blanks.

1.5.2 Method Blanks

One water method blank and three soil method blanks were analyzed for the Case. The following summarizes Volatile Organics detected.

Sample ID		
VBLKM1	Methylene Chloride	700 ug/Kg, estimated
(Medium)	Acetone	2500 ug/Kg
VBLKM2	Methylene Chloride	570 ug/Kg, estimated
(Medium)	Acetone	2700 ug/Kg
VBLKS1	Methylene Chloride	5 ug/Kg, estimated
(Low)	Acetone	12 ug/Kg
VBLKW1	Methylene Chloride	4 ug/L, estimated
(Low)	Acetone	11 ug/L

Limits of ten times the highest respective methylene chloride and acetone values above were used for review and qualification of the samples. Sample results which exceed the respective blank limit do not require qualification. Sample results found to be less than the blank limit and less than the Contract Required Quantitation Limit (CRQL) were

qualified as 'U', not detected, at the CRQL. Sample results detected above the CRQL and below the blank limit were qualified as 'U', not detected.

1.6 GC/MS Instrument Performance Check

Instrument performance was generated within acceptable limits for Bromofluorobenzene (BFB).

1.7 Tentatively Identified Compounds (TICs)

TICs, which were generated in accordance with protocol, are summarized on Data Summary Forms in Appendix E.

1.8 Internal Standards

All internal standards were generated within acceptable specifications for area counts and retention time variation.

2.0 SEMI-VOLATILE ORGANICS BY GC/MS
(Base/Neutral and Acid Extractable Organics)

The following items/criteria were reviewed:

* Holding Times
* Surrogate Recovery
* MS/MSD
* Initial and Continuing Calibration
* Blanks (Method and Field)
* GC/MS Instrument Performance Check
* TICs
* Internal Standards

All items above were generated within acceptable QC specifications, with deviations detailed as follows. The non-detectable results for benzidine were qualified as 'R', unusable, due to response factors of less than 0.05. The remaining data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

2.1 Holding Times

All holding times were met for extraction and analysis of the water and soil samples, with the following exception. The USEPA technical holding time for waters is 7 days from collection to extraction, and 40 days from extraction to analysis. Soil samples must be extracted within 14 days of collection and analyzed within 40 days of extraction.

2.1.1 Case No. 9400.358 (Soil Samples by SW-846)

Sample 1-PS-4 was re-extracted three days beyond the acceptable holding time. The sample is qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results.

2.2 Surrogate Recovery

All surrogate recovery was found to be generated within acceptable limits for the eight surrogate compounds, with the following exceptions.

2.2.1 Case No. 9400.358 (Soil Samples by SW-846)

Sample ID		
1-PS-1	2-Fluorophenol	135% R
	Phenol-d5	118%
	2,4,6-Tribromophenol	128%
	Nitrobenzene-d5	112%
	2-Fluorobiphenyl	138%
1-PS-6	Phenol-d5	115% R
	Nitrobenzene-d5	121%
1-PS-2	Nitrobenzene-d5	112% R
1-PS-3	Nitrobenzene-d5	124% R
1-PS-9	Nitrobenzene-d5	122% R

Sample 1-PS-1 was qualified as 'J', estimated, for the positive results, only, due to high surrogate recovery. The remaining samples did not require qualification due to the fact that only one surrogate per fraction was out of specification (two are required for qualification).

2.3 MS/MSD

MS/MSD sample sets were analyzed for the water and soil samples. Acceptable accuracy and precision were generated.

2.4 Calibration

All initial and continuing calibrations were performed within acceptable limits for $\overline{RRF}$, % RSD, RRF, and % D, with the exception of the following.

2.4.1 Case No. 9400.358 (Water Samples)

Initial Calibration:

Date		
2/04/94	3-Nitroaniline	45.3% RSD (Limit 30%)
	Carbazole	30.8%
	3,3'-Dichlorobenzidine	34.6%

The compounds above were not detected, therefore, qualification was not required.

Continuing Calibration:

Date, Time			
2/28/94, 16:45	2-methylphenol	27.5% D	(Limit 25%)
	4-methylphenol	34.0%	
	3,3'-Dichlorobenzidine	43.1%	
3/01/94, 10:02	4-methylphenol	30.8%	
	3-Nitroaniline	51.8%	
	4-Nitroaniline	38.5%	
	3,3'-Dichlorobenzidine	59.2%	

The samples associated with the continuing calibrations above were qualified as 'J', estimated, for the positive results, only. The non-detectable results do not require qualification.

2.4.2 Case No. 9400.358 (Soils by SW-846)

Initial Calibration:

Date			
2/03/94	Benzidine	$\overline{RF}$ = 0.025	(Limit $\geq$ 0.05)

All benzidine non-detectable results were qualified as 'R', unusable, due to the response factor of less than 0.05. Positive results were not detected for benzidine.

Continuing Calibration:

Date, Time			
3/03/94, 09:00	Hexachlorocyclopentadiene	33.51% D	(Limit 25%)
	Benzidine	RF = 0.017	(Limit $\geq$ 0.05)
		31.19% D	(Limit 25%)
	3-Nitroaniline	61.86%	
	4-Nitroaniline	41.96%	
	3,3'-Dichlorobenzidine	43.25%	
3/04/94, 08:59	Benzidine	RF = 0.016	
		35.32% D	
	3-Nitroaniline	37.08%	
	4-Nitroaniline	29.51%	
3/11/94, 09:55	2,2'-oxybis(1-Chloropropane)	34.3% D	
	3-Nitroaniline	64.74%	
	4-Nitroaniline	49.27%	
	3,3'-Dichlorobenzidine	26.15%	

The benzidine non-detectable results were previously qualified in the Inital Calibration section, above. Additional qualification is not required, in relation to benzidine.

The associated samples did not require qualification in relation to the Continuing Calibration deviations, above. Positive results were not detected for the compounds affected.

2.5 Blanks

2.5.1 Field Blanks

2.5.1.1 Case No. 9400.358

Two rinsate blanks were collected and analyzed for the Case. Semi-Volatile Organics were detected as follows.

Sample ID		
RS-22-A	Di-n-butylphthalate	19 ug/L
RS-22-B	Di-n-butylphthalate	17 ug/L

Bis(2-ethylhexyl)phthalate detected in sample RS-22-A was qualified in *Section 2.5.2, Method Blanks*. Additional qualification is regards to this compound is not required. The di-n-butyl phthalate compound above was not detected in the samples, therefore, qualification was not required.

2.5.2 Method Blanks

2.5.2.1 Case No. 9400.358 (Waters)

One water method blank was analyzed for Semi-Volatile Organics. The following compounds were detected.

Sample ID		
SBLKW1	bis(2-ethylhexyl)phthalate	1 ug/L, estimated
	TIC for Aldol Condensation Product	4 ug/L, estimated

A limit of ten times the bis(2-ethylhexyl)phthalate value above and five times the TIC for Aldol Condensation Product was used for review and qualification of the water samples. Sample results which exceed the blank limit do not require qualification. Sample results found to be below the respective blank limit were qualified as 'U', not detected. Sample results detected below the blank limit and reported at less than the CRQL, were qualified as 'U', not detected at the CRQL.

2.5.2.2 Case No. 9400.358 (Soils by SW-846)

Two soil method blanks were analyzed for Semi-Volatile Organics. Both method blanks were found to be free of contamination.

2.6 GC/MS Instrument Performance Check

Instrument performance was generated within acceptable limits for Decafluorotriphenylphosphine (DFTPP).

2.7 TICs

TICs were generated in accordance with protocol. The Form I's, including the appropriate qualifiers, are included in Appendix E.

2.8 Internal Standards

All internal standards were generated within acceptable specifications for area counts and retention time variation.

3.0 PESTICIDES/PCBs BY GC

The following items/criteria were reviewed:

* Holding Times
* Surrogate Recovery
* MS and MSD
* Blanks (Method and Field)
* Instrument (GC) Performance
* Calibration
* Compound Identification

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

3.1 Holding Times

All holding times were met within acceptable time frames for extraction and analysis of the water and soil samples, with the following exceptions. The USEPA technical holding time for water samples is 7 days from collection to extraction and 40 days from extraction to analysis. Soil samples must be extracted within 14 days of collection and analyzed within 40 days of extraction.

Sample 1-PS-5 and 1-PS-5DL were extracted 15 days beyond the acceptable holding time. The samples are qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results.

3.2 Surrogate Recovery

Surrogate recovery was generated within acceptable limits for both surrogate compounds, with the following exceptions.

Sample ID			
PBI KW1	TCX1	47%	(Advisory Limit 60-150)
	TCX2	42%	
	DCB2	56%	

1-PW-2	TCX1	42%
	TCX2	44%
	DCB1	48%
	DCB2	45%
1-PW-3	TCX1	41%
	TCX2	41%
	DCB1	45%
	DCB2	43%
1-PW-4	TCX1	42%
	TCX2	42%
	DCB1	49%
	DCB2	46%
RS-22-A	TCX1	45%
	TCX2	42%
	DCB1	46%
	DCB2	42%
RS-22B	TCX1	48%
	TCX2	44%
	DCB1	40%
	DCB2	39%
1-PW-4MS	TCX1	38%
	TCX2	38%
	DCB1	42%
	DCB2	41%
1-PW-4MSD	TCX1	47%
	TCX2	47%
	DCB1	50%
	DCB2	48%
1-PS-3	TCX1	0%
	TCX2	0%
	DCB1	0%
	DCB2	0%
1-PS-8	TCX2	26%
	DCB1	0%

Sample 1-PS-3 was qualified as 'J', estimated, for the positive results, and 'R', unusable, for the non-detectable results, due to surrogate recovery of less than 10% for both compounds. The remaining samples were qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results, due to low surrogate recovery.

3.3 MS/MSD

MS/MSD sample sets for both water and soils were analyzed for Pesticides and PCBs. The water MS/MSD sample, 1-PW-4, exhibited low spike recovery for gamma-BHC,

dieldrin, and endrin. Precision was found to be poor for gamma-BHC, aldrin, and dieldrin. The soil MS/MSD 1-PS-6 required dilution, therefore, accuracy and precision could not be generated for the sample set.

3.4 Blanks

3.4.1 Field Blanks

Two rinsate blanks were collected and analyzed for Pesticides and PCBs. Positive results were not detected for either rinsate blank.

3.4.2 Method Blanks

One water method blank and three soil method blanks were analyzed for the Case. Pesticides and PCBs were not detected in any of the method blanks.

3.5 Instrument GC Performance

Adequate chromatographic resolution and instrument sensitivity were achieved through the generation of data within acceptable limits for the Resolution Check Mixture and Performance Evaluation Mixtures, with the following exceptions. Review items included resolution between adjacent peaks, retention time windows, Relative Percent Difference (RPD), and percent breakdown for DDT/Endrin.

Performance Evaluation Mixtures:

Date, Time		
3/24/94, 12:44	Methoxychlor	34.4% RPD (Limit 25%)
3/25/94, 10:19	Methoxychlor	37.0%

All affected samples were qualified as 'UJ', estimated, for methoxychlor. Positive results were not detected for the compound.

3.6 Calibration

All initial and continuing calibration was performed within acceptable limits for the individual standard mixtures, with the following exceptions. Review items included resolution, retention time windows, calibration factors (CF), percent RSD for linearity, RPD and %R.

Individual Standard Mixtures:

Date, Time		
3/22/94, 17:21	Methoxychlor	28.0% RPD (Limit 25%)
3/23/94, 16:12	4,4'-DDT Methoxychlor	70.9% 44.5%
3/23/94, 17:01	Endrin Ketone	34.1%

3/24/94, 22:31	Methoxychlor	46.8%
3/25/94, 22:08	4,4'-DDT	62.9%
3/23/94, 16:11	4,4'-DDT Methoxychlor	73.1% 52.5%
3/23/94, 17:01	Endrin Ketone	33.0%
3/25/94, 22:08	4,4'-DDT Methoxychlor	66.8% 32.5%

The associated samples were qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results.

GPC Calibration:

Date			
3/18/94	Heptachlor	111% R	(Limit 80-110)

Positive results, only, for heptachlor were qualified as 'J', estimated.

3.7 Compound Identification

GC qualitative analyses are considered to be acceptable. Data was generated in accordance with protocols. Various positive results were qualified as 'J', estimated, where the percent difference between the two GC columns exceeded 25%. The lower of the two results is reported, as per the protocol.

4.0 INORGANIC ANALYSES BY AA AND ICP
(Mercury by Cold Vapor and Cyanide by Spectrophotometry)

The following items/criteria were reviewed:

* Holding Times
* Initial and Continuing Calibration
* Blanks (Initial, Continuing Calibration, and Preparation)
* Field Blanks
* ICP Interference Check Sample
* Matrix Spike Sample Recovery
* Laboratory Duplicates
* Laboratory Control Sample (LCS)
* ICP Serial Dilution

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

4.1 Holding Times

All holding times were met within the acceptable time frame from collection for metals (6 months), mercury (28 days), and cyanide (14 days).

4.2 Calibration

All initial and continuing calibration was performed within acceptable limits for percent recovery.

4.3 Blanks

4.3.1 Laboratory (Method) Blanks

All initial calibration, continuing calibration, and preparation blanks were generated in accordance with acceptable limits.

4.3.2 Field Blanks

Two rinsate samples were collected and analyzed for inorganics. Inorganics were detected as follows.

Sample ID	
RS-22-4	(ug/L)
Iron	100
Managnese	1.9
Nickel	6.3
Silver	4.7
Zinc	6.6
RS-22-B	(ug/L)
Antimony	39.6
Chromium	3.5
Iron	13.8
Manganese	0.87
Silver	5.7
Zinc	9.4

A limit of five times the highest respective results above was used for review and qualification of the samples. Sample results found to be less than five times the respective blank value were qualified as 'J', estimated, as per the NEESA Level C guidelines. Sample results which exceed the respective blank limit do not require qualification.

4.4 ICP Interference Check

The ICP Interference Check samples were generated within the acceptable limit of 80-120% for recovery.

4.5 Spiked Sample Recovery

All percent recoveries for the matrix spike sample were found to be within the 75-125% limit, with the following exceptions.

Sample ID		
1-PW-4	Thallium	67.8% R

Thallium results for the water samples were qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results, due to low spike recovery.

Sample ID		
1-PS-6	Mercury	45.4% R
	Selenium	65.6%
1-PS-7	Silver	48.3% R

The soil samples were qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results, for mercury, selenium and silver.

4.6 Laboratory Duplicates

Precision (relative percent difference) for the water and soil samples was found to be acceptable for all the elements, with the following exceptions.

Sample ID		
1-PS-6	Mercury	200% RPD

The positive results for mercury for the soil samples were qualified as 'J', estimated.

4.7 Laboratory Control Sample (LCS)

The aqueous and solid laboratory control samples were generated within acceptable limits.

4.8 ICP Serial Dilution

ICP Serial Dilution was found to be within the acceptable10% limit for percent difference.

MEMORANDUM

TO: John Walter, E & E Project Manager

FROM: Lynn Hess, E & E QA Chemist

DATE: June 13, 1994

SUBJECT: Comments on ChemWorld Environmental Inc.'s Data Validation Report for Bainbridge Naval Training Center, Work Order # 1.

CC: Marcia Meredith Galloway, E & E QA Officer

ChemWorld Environmental Inc.'s (CW's) Data Validation Report # 2 for the Bainbridge Naval Training Center (BNTC), dated May 27, 1994 was performed under Work Order # 1 for samples collected on February 22, 1994. The report covers analytical data contained in E & E data package 9400.358 (pit waters and pit soils).

Given below are our quality assurance/quality control (QA/QC) comments regarding data usability, providing further explanation/clarification and including any differing opinions. In addition, we have included comments on overall precision based on assessment of field duplicate results for this sampling event. Revised data summary sheets are attached which give our qualifiers where they differ from CW's.

QA/QC COMMENTS

COMMENT 1

The tentatively identified compounds are qualified with an "N" by CW. This qualification is not necessary when an

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identification is not made. Revised data summary sheets are enclosed.

COMMENT 2

Surrogate recovery criterion was not met in the initial volatile analysis for 1-PS-1, 1-PS-2 and 1-PS-6. Reanalysis indicates that a matrix interference is likely responsible for the poor surrogate recoveries in samples 1-PS-1 and 1-PS-6. Sample 1-PS-2 was not reanalyzed, however matrix interference is evident from the chromatogram. In accordance with the data validation quidelines the results for samples 1-PS-1, 1-PS-2 and 1-PS-6 were qualified by CW.

COMMENT 3

The sediment samples for semivolatiles were analyzed using SW-846 methodology as opposed to CLP due to problems encountered during extraction. The project manager was notified and granted permission. In accordance with the data validation quidelines the results for benzidine were qualified by CW as "R" as unusable. However, benzidine and benzoic acid are not compounds analyzed for in CLP, therefore the quantitation of these compounds is not important to the useability of the results.

COMMENT 4

Surrogate recovery criterion was not met in the initial semivolatile analysis of 1-PS-4. The sample was re-extracted 3 days beyond the acceptable holding time. The sample re-extraction was analyzed twice, both times internal standard (IS) areas were outside the acceptable range. In analysis 1-PS-4 (EE-94-02324) perylene-d12 is below the acceptable criterion and in 1-PS-4 (EE-94-02324 (RA)) chrysene-d12 and perylene-d12 are below the acceptable criterion. The analytical results from 1-PS-4 (EE-94-02324) for the semivolatiles are recommended for use, as only one IS was below the acceptable criterion. In accordance with the data validation quidelines the results for sample 1-PS-4 (EE-94-02324 (RA)) were qualified by CW. However, sample 1-PS-4 (EE-94-02324)

also needs to be qualified due to holding times. The revised data summary sheets for 1-PS-4 (EE-94-02324) are enclosed.

COMMENT 5

Surrogate recovery criterion was not met for the semi-volatile analysis of samples 1-PS-1, 1-PS-2, 1-PS-3, 1-PS-6 and 1-PS-9. In accordance with the data validation quidelines the results for sample 1-PS-1 only were qualified by CW. Sample 1-PS-1 was not re-extracted due to the tar like nature of the sample.

COMMENT 6

In the pesticide/PCB analyses samples 1-PS-5 and 1-PS-5DL were re-extracted 15 days beyond the acceptable holding time as the original extract was lost during clean-up. In accordance with the data validation quidelines the results for samples 1-PS-5 and 1-PS-5DL were qualified by CW.

COMMENT 7

Neither the GPC or the florisil clean-up could be done on samples 1-PS-1, 1-PS-3 and 1-PS-5 for pesticide/PCB analyses due to the tar like sample matrix. This did not effect the contract required detection limits.

COMMENT 8

Dilutions were made on pesticide/PCB samples due to the complex sample matrix and high levels of pesticides detected. No GC/MS confirmations were performed since the oil interference would have required dilutions and/or prevented detection of any pesticides.

COMMENT 9

The sample reported as 1-PS-10 in the pesticide/PCB faction has been mislabeled, it is actually sample 1-PS-9D. Samples reported as 1-PS-10DL, 1-PS-11, 1-PS-11DL, 1-PS-12 and 1-PS-12DL in the pesticide/PCB faction are actually samples 1-PS-9DDL, 1-PS-10, 1-PS-10DL, 1-PS-11 and 1-PS-11DL, respective-

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ly. The laboratory was notified and has made all necessary corrections.

COMMENT 10

Several organics analysis (volatiles, semivolatiles and pesticide/PCBs) required dilutions due to the sample matrix and/or high levels of various contaminants. In some cases both analyses were reported. The validation qualifier "R" was used in these cases on the data summary sheets and in the database to indicate the result that is considered less reliable.

OVERALL PRECISION

Field duplicate results indicate good overall precision for the inorganics, with the exception of cobalt with an RPD of 47%, lead with an RPD of 64% and cyanide with an RPD of 85% (see Table 1). Overall precision for organics was also good with the exception of toluene with an RPD of 167%, ethylbenzene with an RPD of 82% and xylenes(total) with an RPD of 96% (see Table 2).

TABLE 1

BNTC PIT SOILS

FIELD DUPLICATE RESULTS - INORGANICS

(Results in ug/kg)

Parameter	1-PS-9	1-PS-9D	RPD
Aluminum	15600	22600	37
Arsenic	1.3	1.7	27
Barium	164	153	6.9
Beryllium	0.71	0.73	2.8
Calcium	1450	1370	5.7
Chromium	119	161	30
Cobalt	26.3	42.5	47
Copper	93.7	95.2	1.6
Iron	22700	31900	34
Lead	2420	1250	64
Magnesium	14000	19800	34
Manganese	244	364	40
Nickel	101	135	29
Potassium	1080	1180	8.8
Selenium	0.68	0.69	1.5
Sodium	375	ND	IN
Vanadium	59.9	72.6	19
Zinc	175	130	30
Cyanide	0.81	2.0	85

IN = Indeterminant

ND = Not detected

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Table 2

BNTC PIT SOILS

FIELD DUPLICATE RESULTS - ORGANICS

(Results in ug/kg)

Parameter	1-PS-9	1-PS-9D	RPD
Toluene	180	2000	167
Ethylbenzene	920	2200	82
Xylenes(total)	4200	12000	96
Phenanthrene	16	12	29
Fluoranthene	10	ND	IN
Pyrene	8.8	ND	IN
Bis(2-ethylhexyl)phthalate	16	17	6.1
2-Methylnaphthalene	15	13	14
Aldrin	20	25	22
Heptachlor epoxide	19	29	42
4,4'-DDE	ND	83	IN
4,4'-DDD	250	260	3.9
Endrin ketone	27	ND	IN
alpha-Chlordane	20	22	9.5
gamma-Chlordane	21	18	15

IN = Indeterminant

ND = Not detected

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February 28, 1994 Sampling Event

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11:CD7171/RC1357-1/18/96-D1

DATA VALIDATION REPORT #3

ORGANIC and INORGANIC ANALYSES

Bainbridge Project

Case No. 9400.396

Sampling Date of February 28, 1994

PREPARED FOR:

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June 1994

PREPARED BY:

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Bainbridge Project
Data Validation Report #3: Organic and Inorganic Analyses

Table of Contents

		Page
	Introduction	1
1.0	Volatile Organics by GC/MS	2
1.1	Holding Times	2
1.2	System Monitoring Compound Recovery	2
1.3	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	2
1.4	Calibration	2
1.5	Blanks	3
1.6	GC/MS Instrument Performance Check	4
1.7	Tentatively Identified Compounds	4
1.8	Internal Standards	4
2.0	Semi-Volatile Organics by GC/MS	4
2.1	Holding Times	4
2.2	Surrogate Recovery	5
2.3	MS/MSD	5
2.4	Calibration	5
2.5	Blanks	6
2.6	GC/MS Instrument Performance Check	6
2.7	Tentatively Identified Compounds	6
2.8	Internal Standards	6
3.0	Pesticides/PCBs by GC	7
3.1	Holding Times	7
3.2	Surrogate Recovery	7
3.3	MS/MSD	7
3.4	Blanks	8
3.5	Instrument (GC) Performance	8
3.6	Calibration	8
3.7	Compound Identification	8
4.0	Inorganic Analyses by AA and ICP	9
4.1	Holding Times	9
4.2	Calibration	9
4.3	Blanks	9
4.4	ICP Interference Check	9
4.5	Spiked Sample Recovery	9
4.6	Laboratory Duplicates	10
4.7	Laboratory Control Sample	10
4.8	ICP Serial Dilution	10

Bainbridge Project
Data Validation Report #3: Organic and Inorganic Analyses

Appendices

A Data Summary Forms: Volatile Organics
B Data Summary Forms: Semi-Volatile Organics
C Data Summary Forms: Pesticides/PCBs
D Data Summary Forms: Inorganics
E Data Summary Forms: Tentatively Identified Compounds
F Data Qualifiers
G Case Narratives
H Chain-of-Custody Forms

DATA VALIDATION SUMMARY #3: ORGANIC and INORGANIC ANALYSES

Bainbridge Project
Case No. 9400.396
Sampling Date of February 28, 1994

INTRODUCTION

This Data Validation Summary report for organic and inorganic analyses was generated for 7 water samples, 11 soil samples, and the associated quality control samples for the Case Numbers referenced above. Sampling activities were conducted in support of the field investigation for the Bainbridge Project. The analytical laboratory work was performed by Ecology and Environment, Inc.'s Analytical Services Center.

Analytical testing consisted of volatile organic analyses by Gas Chromatography/Mass Spectroscopy (GC/MS); Base/Neutral and Acid Extractable Organics by GC/MS; Pesticides and Polychlorinated Biphenyls (PCBs) by GC; Inorganics by Atomic Absorption (AA) and Inductively Coupled Argon Plasma (ICP); Mercury by Cold Vapor; and Cyanide by Spectrophotometry. The analytical work was performed utilizing the most current United States Environmental Protection Agency (USEPA) Contract Laboratory Program (CLP) protocols. Additional organic and inorganic analyses were performed for the project. The Data Validation Reports for these analyses are provided under separate cover.

This report provides a summary of data acceptability and deviations in accordance with the **Naval Energy and Environmental Support Activity (NEESA) Level C** requirements, as stated in the document **Quality Assurance in Environmental Analysis, October 1990.** In addition, the CLP portion of the corresponding USEPA Statements of Work (SOW) were utilized, where applicable and relevant. The validation report pertains to the following samples:

Case No. 9400.396

1-SD-3	1-SD-12
1-SD-5	1-SD-13
1-SD-6	1-SW-7
1-SD-7	1-SW-7D
1-SD-7D	1-SW-8
1-SD-8	1-SW-10
1-SD-9	1-SW-13
1-SD-10	1-SW-16
1-SD-11	TB-28 (Trip Blank)

1.0 VOLATILE ORGANICS BY GC/MS

The following items/criteria were reviewed:

* Holding Times
* System Monitoring Compound Recovery
* Matrix Spikes (MS) and Matrix Spike Duplicates (MSD)
* Initial and Continuing Calibration
* Blanks (Method and Field)
* GC/MS Instrument Performance Check
* Tentatively Identified Compounds (TICs)
* Internal Standards

All items above were generated within acceptable Quality Control (QC) specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

1.1 Holding Times

All holding times were met within the acceptable time frame of 14 days from collection for the acid preserved water samples and the soil samples.

1.2 System Monitoring Compound Recovery

All system monitoring recovery was found to be generated within acceptable limits for the three surrogate compounds, with the following exceptions. Sample 1-SD-7 generated high surrogate recovery at 116% for Bromofluorobenzene (Limit 59-113). Positive results were not detected and qualification was not required, due to the high surrogate recovery.

1.3 Matrix Spike/Matrix Spike Duplicates (MS/MSD)

MS/MSD sample sets were analyzed for the water and soil samples. Acceptable accuracy (percent recovery) and precision (relative percent difference) were generated.

1.4 Calibration

All initial and continuing calibration was performed within acceptable limits for average Relative Response Factors ($\overline{RRF}$), Percent Relative Standard Deviation (% RSD), Relative Response Factors (RRF), and percent Difference (% D), with the following exceptions.

Continuing Calibration:

Date, Time		
3/08/94, 23:54	Carbon Disulfide	27.7% D (Limit 25%)

3/09/94, 10:39	Acetone	93.4%
	2-Butanone	130.8%
	4-methyl-2-pentanone	28.1%
	2-Hexanone	47.5%
	1,1,2,2-Tetrachloroethane	29.0%
3/07/94, 10:30	Chloromethane	48.3%
	Methylene Chloride	28.0%
	Acetone	32.4%
	2-Butanone	30.0%
3/10/94, 06:01	Bromomethane	26.0%
	Chloroethane	26.9%
	Carbon Disulfide	28.6%
	2-Butanone	31.0%
	4-methyl-2-pentanone	26.9%
	2-Hexanone	28.4%

The samples associated with the continuing calibrations above were qualified as 'J', estimated, for the positive results, only. The non-detectable results did not require qualification.

1.5 Blanks

1.5.1 Field Blanks

One trip blank was collected and analyzed for Volatile Organics. The following compounds were detected in the trip blank.

Sample ID		
TB-28	Methylene Chloride	11 ug/L
	Chloroform	2 ug/L, estimated
	1,1,1-Trichloroethane	2 ug/L, estimated

A limit of ten times the methylene chloride blank value and five times the blank values for the remaining compounds were used for review and qualification of the samples. Sample results which exceed the blank limit do not require qualification. Sample results reported at less than the Contract Required Quantitation Limit (CRQL) and less than the blank limit were qualified as 'U', not detected, at the CRQL. The compound 1,1,1-Trichloroethane was not detected in the samples, therefore, qualification was not required in relation to this compound.

1.5.2 Method Blanks

Two water method blanks and two soil method blanks were analyzed for the Case. The following summarizes Volatile Organics detected.

Sample ID		
VBLKS1	Methylene Chloride	1 ug/Kg, estimated

VBLKS2	Methylene Chloride	12 ug/Kg
	Acetone	*5 ug/Kg, estimated*

Limits of ten times the highest respective methylene chloride and acetone values above were used for review and qualification of the soil samples. Sample results found to be less than the blank limit and less than the CRQL were qualified as 'U', not detected, at the CRQL. Sample results detected above the CRQL and below the blank limit were qualified as 'U', not detected.

1.6 GC/MS Instrument Performance Check

Instrument performance was generated within acceptable limits for Bromofluorobenzene (BFB).

1.7 Tentatively Identified Compounds (TICs)

TICs, which were generated in accordance with protocol, are summarized on Data Summary Forms in Appendix E.

1.8 Internal Standards

All internal standards were generated within acceptable specifications for area counts and retention time variation.

2.0 SEMI-VOLATILE ORGANICS BY GC/MS
(Base/Neutral and Acid Extractable Organics)

The following items/criteria were reviewed:

* Holding Times
* Surrogate Recovery
* MS/MSD
* Initial and Continuing Calibration
* Blanks (Method and Field)
* GC/MS Instrument Performance Check
* TICs
* Internal Standards

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

2.1 Holding Times

All holding times were met for extraction and analysis of the water and soil samples. The USEPA technical holding time for waters is 7 days from collection to extraction, and 40 days from extraction to analysis. Soil samples must be extracted within 14 days of collection and analyzed within 40 days of extraction.

2.2 Surrogate Recovery

All surrogate recovery was found to be generated within acceptable limits for the eight surrogate compounds.

2.3 MS/MSD

MS/MSD sample sets were analyzed for the water and soil samples. Acceptable accuracy and precision were generated. However, the soil MS/MSD generated very low recovery for pentachlorophenol. The MS and MSD soil samples (1-SD-5) are qualified as 'J', estimated, for pentachlorophenol, due to the low recovery.

2.4 Calibration

All initial and continuing calibrations were performed within acceptable limits for $\overline{RRF}$, % RSD, RRF, and % D, with the exception of the following.

Initial Calibration:

Date			
2/04/94	3-Nitroaniline	45.3% RSD	(Limit 30%)
	Carbazole	30.8%	
	3,3'-Dichlorobenzidine	34.6%	

The compounds above were not detected for the affected samples, therefore, qualification was not required.

Continuing Calibration:

Date, Time			
3/10/94, 09:22	4-Chloroaniline	29.9% D	(Limit 25%)
	3-Nitroaniline	123.7%	
	2,4-Dinitrophenol	33.2%	
	4-Nitroaniline	93.9%	
	Carbazole	49.6%	
	Pyrene	39.2%	
	3,3'-Dichlorobenzidine	182.3%	
3/11/94, 10:11	4-Methylphenol	26.5%	
	4-Chloroaniline	31.4%	
	3-Nitroaniline	148.9%	
	4-Nitroaniline	65.5%	
	Carbazole	37.7%	
3/16/94, 01:04	Hexachlorobutadiene	27.2%	
	Hexachlorocyclopentadiene	38.4%	

3/21/94, 05:02	Hexachlorobutadiene	29.6%
	Hexachlorocyclopentadiene	35.2%
	3-nitroaniline	27.6%
	2,4-Dinitrophenol	37.8%
	4-Nitrophenol	48.1%
	4-Bromophenylphenylether	29.0%

The samples associated with the continuing calibrations above were qualified as 'J', estimated, for the positive results, only. The non-detectable results do not require qualification.

2.5 Blanks

2.5.1 Field Blanks

Field blanks were not collected for Semi-Volatile Organics analyses.

2.5.2 Method Blanks

One water method blank and two soil method blanks were analyzed for Semi-Volatile Organics. The following compounds were detected.

Sample ID		
SBLKW1	bis(2-ethylhexyl)phthalate	2 ug/L, estimated
SBLKS1	TIC for Aldol Condensation Product	830 ug/Kg, estimated
SBLKS2	TIC for Aldol Condensation Product	880 ug/Kg, estimated

A limit of ten times the bis(2-ethylhexyl)phthalate value above and five times the highest TIC for the Aldol Condensation Product was used for review and qualification of the samples. Sample results which exceed the blank limit do not require qualification. Sample results found to be below the respective blank limit were qualified as 'U', not detected. Sample results detected below the blank limit and reported at less than the CRQL, were qualified as 'U', not detected at the CRQL.

2.6 GC/MS Instrument Performance Check

Instrument performance was generated within acceptable limits for Decafluorotriphenylphosphine (DFTPP).

2.7 TICs

TICs were generated in accordance with protocol. The Form I's, including the appropriate qualifiers, are included in Appendix E.

2.8 Internal Standards

All internal standards were generated within acceptable specifications for area counts and retention time variation, with the following exceptions.

Sample ID	Internal Standard	Reported Area Count	Lower Limit
1-SW-7D MSD	Acenaphthene-d10	47375	51036
	Phenanthrene-d10	63560	67984
	Chrysene-d12	38886	45934
	Perylene-d12	37004	46672

The sample above was qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results, for the compounds associated with the particular internal standards above.

3.0 PESTICIDES/PCBs BY GC

The following items/criteria were reviewed:

* Holding Times
* Surrogate Recovery
* MS and MSD
* Blanks (Method and Field)
* Instrument (GC) Performance
* Calibration
* Compound Identification

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

3.1 Holding Times

All holding times were met within acceptable time frames for extraction and analysis of the water and soil samples. The USEPA technical holding time for water samples is 7 days from collection to extraction and 40 days from extraction to analysis. Soil samples must be extracted within 14 days of collection and analyzed within 40 days of extraction.

3.2 Surrogate Recovery

Surrogate recovery was generated within acceptable limits, with one exception for soil method blank SBLKS2. Soil method blank SBLKS2 exhibited low recovery for both surrogate compounds. The method blank is qualified as 'UJ', estimated, for the non-detectable results. Positive results were not detected for Pesticides and PCBs.

Several samples exhibited low recovery for Tetrachloro-m-xylene. However, both surrogates are required to be out of specification for qualification of the samples. The remaining samples did not require qualification.

3.3 MS/MSD

MS/MSD sample sets for both water and soils were analyzed for Pesticides and PCBs. Acceptable accuracy and precision were generated.

3.4 Blanks

3.4.1 Field Blanks

Field blanks were not collected for Pesticides and PCBs analyses.

3.4.2 Method Blanks

One water method blank and three soil method blanks were analyzed for the Case. Pesticides and PCBs were not detected in any of the method blanks.

3.5 Instrument GC Performance

Adequate chromatographic resolution and instrument sensitivity were achieved through the generation of data within acceptable limits for the Resolution Check Mixture and Performance Evaluation Mixtures. Review items included resolution between adjacent peaks, retention time windows, Relative Percent Difference (RPD), and percent breakdown for DDT/Endrin.

3.6 Calibration

All initial and continuing calibration was performed within acceptable limits for the individual standard mixtures, with the following exceptions. Review items included resolution, retention time windows, calibration factors (CF), percent RSD for linearity, Relative Percent Difference (RPD) and %R.

Individual Standard Mixtures:

Date, Time		
3/18/94, 08:48	Methoxychlor	30.5% RPD (Limit 25%)

The associated samples were qualified as 'UJ', estimated, for the non-detectable results for the compound. Positive results were not detected in methoxychlor.

3.7 Compound Identification

GC qualitative analyses are considered to be acceptable. Data was generated in accordance with protocols. Various positive results were qualified as 'J', estimated, where the percent difference between the two GC columns exceeded 25%. The lower of the two results is reported, as per the protocol.

4.0 INORGANIC ANALYSES BY AA AND ICP
(Mercury by Cold Vapor and Cyanide by Spectrophotometry)

The following items/criteria were reviewed:

* Holding Times
* Initial and Continuing Calibration
* Blanks (Initial, Continuing Calibration, and Preparation)
* Field Blanks
* ICP Interference Check Sample
* Matrix Spike Sample Recovery
* Laboratory Duplicates
* Laboratory Control Sample (LCS)
* ICP Serial Dilution

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

4.1 Holding Times

All holding times were met within the acceptable time frame from collection for metals (6 months), mercury (28 days), and cyanide (14 days).

4.2 Calibration

All initial and continuing calibration was performed within acceptable limits for percent recovery.

4.3 Blanks

4.3.1 Laboratory (Method) Blanks

All initial calibration, continuing calibration, and preparation blanks were generated in accordance with acceptable limits.

4.3.2 Field Blanks

Field blanks were not collected for Inorganic analyses.

4.4 ICP Interference Check

The ICP Interference Check samples were generated within the acceptable limit of 80-120% for recovery.

4.5 Spiked Sample Recovery

All percent recoveries for the matrix spike samples were found to be within the 75-125% limit, with the following exceptions.

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Sample ID		
1-SD-5	Arsenic	57.1% R
	Lead (AA)	-15.5%
	Manganese	261.8%
	Mercury	37.0%
	Selenium	39.6%

The soil samples were qualified as 'J', estimated, for the positive results, only, for manganese. The soils samples were also qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results, for the remaining elements above.

4.6 Laboratory Duplicates

Precision (relative percent difference) for the water and soil samples was found to be acceptable for all the elements, with the following exceptions.

Sample ID		
1-SW-7D	Lead (AA)	200% RPD

The positive results for lead for the water samples were qualified as 'J', estimated.

4.7 Laboratory Control Sample (LCS)

The aqueous and solid laboratory control samples were generated within acceptable limits.

4.8 ICP Serial Dilution

ICP Serial Dilution was found to be within the acceptable10% limit for percent difference.

MEMORANDUM

X

TO: John Walter, E & E Project Manager

FROM: Lynn Hess, E & E QA Chemist

DATE: June 8, 1994

SUBJECT: Comments on ChemWorld Environmental Inc.'s Data Validation Report for Bainbridge Naval Training Center, Work Order # 1.

CC: Marcia Meredith Galloway, E & E QA Officer

ChemWorld Environmental Inc.'s (CW's) Data Validation Report # 3 for the Bainbridge Naval Training Center (BNTC), dated May 27, 1994 was performed under Work Order # 1 for samples collected on February 28, 1994. The report covers analytical data contained in E & E data package 9400.396 (surface waters and sediments).

Given below are our quality assurance/quality control (QA/QC) comments regarding data usability, providing further explanation/clarification and including any differing opinions. In addition, we have included comments on overall precision based on assessment of field duplicate results for this sampling event. Revised data summary sheets are attached which give our qualifiers where they differ from CW's.

QA/QC COMMENTS

COMMENT 1

The semivolatile matrix spike/matrix spike duplicate (MS/MSD) run on sample 1-SD-5 gave low percent recoveries for pentachlorophenol. The results for 1-SD-5MS and 1-SD-

5MSD were qualified by CW, sample 1-SD-5 should also be qualified "UJ" for pentachlorophenol. A revised data summary sheets is enclosed.

COMMENT 2

The volatile tentatively identified compounds (TICs) are qualified with an "N" which is unnecessary when an identification is not made. Revised data summary sheets are enclosed.

OVERALL PRECISION

Field duplicate results indicate good overall precision for the inorganics, with the exception of aluminium with an RPD of 43% and magnesium with an RPD of 50% in the sediment sample set 1-SD-7/1-SD-7D (see Table 1). Overall precision for organics was poor for sample set 1-SD-7/1-SD-7D (see Table 2). The high RPDs may be attributable to the sample matrix, sediment sample can be non-homogenous.

TABLE 1

BNTC SEDIMENTS

FIELD DUPLICATE RESULTS - INORGANICS

(Results in ug/kg)

Parameter	1-SD-7	1-SD-7D	RPD
Aluminum	1770	1140	43
Arsenic	1.5	2.1	33
Barium	136	112	19
Beryllium	0.60	0.46	26
Calcium	5440	4460	20
Chromium	12.9	11.2	14
Cobalt	40.4	33.6	18
Copper	52.3	42.9	20
Iron	208000	176000	17
Lead	23.1	17.1	30
Magnesium	660	397	50
Manganese	3210	2240	36
Nickel	41.5	35.7	15
Sodium	ND	2820	IN
Vanadium	28.1	20.3	32
Zinc	11.4	8.1	34

IN = Indeterminant

ND = Not detected

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TABLE 1 cont.

BNTC SURFACE WATERS

FIELD DUPLICATE RESULTS - INORGANICS

(Results in ug/L)

Parameter	1-SW-7	1-SW-7D	RPD
Aluminum	60.3	53.7	12
Barium	39.3	38.1	3.1
Beryllium	ND	0.16	IN
Calcium	67500	71700	6.0
Cobalt	3.1	3.1	0
Copper	2.7	3.8	34
Iron	21900	19400	12
Magnesium	16800	17900	6.3
Manganese	2880	2950	2.4
Potassium	2770	ND	IN
Sodium	18000	19300	7.0

IN = Indeterminant

ND = Not detected

Table 2

BNTC SEDIMENTS

FIELD DUPLICATE RESULTS - ORGANICS

(Results in ug/kg)

Parameter	1-SD-7	1-SD-7D	RPD
Percent Solid	65	61	6.4
1,4-Dichlorobenzene	100	44	78
Phenanthrene	170	68	86
Fluoranthene	330	140	81
Pyrene	190	80	81
Benzo(a)Antracene	130	64	68
Chrysene	130	56	80
Bis(2-ethylhexyl)phthalate	82	75	8.9
Benzo(b)Fluoranthene	150	70	73
Benzo(k)Fluoranthene	49	ND	IN
Benzo(a)pyrene	93	ND	IN
Indeno(1,2,3-cd)pyrene	77	ND	IN
4,4'-DDE	29	19	42
4,4'-DDD	110	68	47
4,4'-DDT	39	16	84

IN = Indeterminant

ND = Not detected

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Table 2 cont.

BNTC SURFACE WATERS

FIELD DUPLICATE RESULTS - ORGANICS

(Results in ug/L)

Parameter	1-SW-7	1-SW-7D	RPD
Acetone	16	17	6.1
Chlorobenzene	11	ND	IN
1,4-Dichlorobenzene	2	2	0

IN = Indeterminant

ND = Not detected

February 28 to March 1, 1994 Sampling Event

DATA VALIDATION REPORT #4

ORGANIC and INORGANIC ANALYSES

Bainbridge Project

Case No. 9400.397

Sampling Dates of February 28 - March 1, 1994

PREPARED FOR:

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June 1994

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Bainbridge Project
Data Validation Report #4: Organic and Inorganic Analyses

Table of Contents

		Page
	Introduction	1
1.0	Volatile Organics by GC/MS	2
1.1	Holding Times	2
1.2	System Monitoring Compound Recovery	2
1.3	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	2
1.4	Calibration	2
1.5	Blanks	3
1.6	GC/MS Instrument Performance Check	3
1.7	Tentatively Identified Compounds	3
1.8	Internal Standards	3
2.0	Semi-Volatile Organics by GC/MS	4
2.1	Holding Times	4
2.2	Surrogate Recovery	4
2.3	MS/MSD	5
2.4	Calibration	5
2.5	Blanks	5
2.6	GC/MS Instrument Performance Check	6
2.7	Tentatively Identified Compounds	6
2.8	Internal Standards	6
3.0	Pesticides/PCBs by GC	6
3.1	Holding Times	7
3.2	Surrogate Recovery	7
3.3	MS/MSD	7
3.4	Blanks	7
3.5	Instrument (GC) Performance	7
3.6	Calibration	8
3.7	Compound Identification	8
4.0	Inorganic Analyses by AA and ICP	8
4.1	Holding Times	8
4.2	Calibration	8
4.3	Blanks	9
4.4	ICP Interference Check	9
4.5	Spiked Sample Recovery	9
4.6	Laboratory Duplicates	9
4.7	Laboratory Control Sample	9
4.8	ICP Serial Dilution	10

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DATA VALIDATION SUMMARY #4: ORGANIC and INORGANIC ANALYSES

Bainbridge Project
Case No. 9400.397
Sampling Dates of February 28 - March 1, 1994

INTRODUCTION

This Data Validation Summary report for organic and inorganic analyses was generated for 4 water samples, 10 soil samples, and the associated quality control samples for the Case Numbers referenced above. Sampling activities were conducted in support of the field investigation for the Bainbridge Project. The analytical laboratory work was performed by Ecology and Environment, Inc.'s Analytical Services Center.

Analytical testing consisted of volatile organic analyses by Gas Chromatography/Mass Spectroscopy (GC/MS); Base/Neutral and Acid Extractable Organics by GC/MS; Pesticides and Polychlorinated Biphenyls (PCBs) by GC; Inorganics by Atomic Absorption (AA) and Inductively Coupled Argon Plasma (ICP); Mercury by Cold Vapor; and Cyanide by Spectrophotometry. The analytical work was performed utilizing the most current United States Environmental Protection Agency (USEPA) Contract Laboratory Program (CLP) protocols. Additional organic and inorganic analyses were performed for the project. The Data Validation Reports for these analyses are provided under separate cover.

This report provides a summary of data acceptability and deviations in accordance with the **Naval Energy and Environmental Support Activity (NEESA) Level C** requirements, as stated in the document **Quality Assurance in Environmental Analysis, October 1990.** In addition, the CLP portion of the corresponding USEPA Statements of Work (SOW) were utilized, where applicable and relevant. The validation report pertains to the following samples:

Case No. 9400.397

1-SD-14	2-SD-2
1-SD-15	2-SD-3
1-SD-16	2-SD-4
1-SD-17	2-SD-4D
1-SD-18	2-SW-1
1-SW-4	2-SW-4
2-SD-1	TB-01 (Trip Blank)

1.0 VOLATILE ORGANICS BY GC/MS

The following items/criteria were reviewed:

* Holding Times
* System Monitoring Compound Recovery
* Matrix Spikes (MS) and Matrix Spike Duplicates (MSD)
* Initial and Continuing Calibration
* Blanks (Method and Field)

* GC/MS Instrument Performance Check
* Tentatively Identified Compounds (TICs)
* Internal Standards

All items above were generated within acceptable Quality Control (QC) specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

1.1 Holding Times

All holding times were met within the acceptable time frame of 14 days from collection for the acid preserved water samples and the soil samples.

1.2 System Monitoring Compound Recovery

All system monitoring recovery (%R) was found to be generated within acceptable limits for the three surrogate compounds.

1.3 Matrix Spike/Matrix Spike Duplicates (MS/MSD)

MS/MSD sample sets were analyzed for the water and soil samples. Acceptable accuracy (percent recovery) and precision (relative percent difference) were generated.

1.4 Calibration

All initial and continuing calibration was performed within acceptable limits for average Relative Response Factors (RRF), Percent Relative Standard Deviation (% RSD), Relative Response Factors (RRF), and percent Difference (% D), with the following exceptions.

Continuing Calibration:

Date, Time		
3/09/94, 10:39	Acetone	93.4% D (Limit 25%)
	2-Butanone	130.8%
	4-methyl-2-pentanone	28.1%
	2-Hexanone	47.5%
	1,1,2,2-Tetrachloroethane	29.0%
3/08/94, 00:55	Chloromethane	62.4%
	Vinyl Chloride	37.8%
	Carbon Disulfide	25.6%

The samples associated with the continuing calibrations above were qualified as 'J', estimated, for the positive results, only. The non-detectable results did not require qualification.

1.5 Blanks

1.5.1 Field Blanks

One trip blank was collected and analyzed for Volatile Organics. The following compounds were detected in the trip blank.

Sample ID		
TB-01	Methylene Chloride	11 ug/L
	Chloroform	2 ug/L, estimated
	1,1,1-Trichloroethane	2 ug/L, estimated
	Acetone	12 ug/L

A limit of ten times the methylene chloride and acetone blank values and five times the blank values for the remaining two compounds were used for review and qualification of the samples. Sample results reported at less than the Contract Required Quantitation Limit (CRQL) and less than the blank limit were qualified as 'U', not detected, at the CRQL. Sample results found to be below the respective blank limit but above the CRQL were qualified as 'U', not detected.

1.5.2 Method Blanks

One water method blank and one soil method blank were analyzed for the Case. The following summarizes Volatile Organics detected.

Sample ID		
VBLKS1	Methylene Chloride	5 ug/Kg, estimated

A limit of ten times the methylene chloride value above was used for review and qualification of the soil samples. All associated sample results were found to be less than the blank limit and less than the CRQL, and were qualified as 'U', not detected, at the CRQL.

1.6 GC/MS Instrument Performance Check

Instrument performance was generated within acceptable limits for Bromofluorobenzene (BFB).

1.7 Tentatively Identified Compounds (TICs)

TICs, which were generated in accordance with protocol, are summarized on Data Summary Forms in Appendix E.

1.8 Internal Standards

All internal standards were generated within acceptable specifications for area counts and retention time variation, with the following exception.

Sample ID	Internal Standard	Reported Area Count	Lower Limit
2-SD-4	Chlorobenzene-d5	99650	118664

The sample was qualified as 'UJ', estimated, for the non-detectable results, for the compounds associated with the chlorobenzene internal standard. Positive results were not detected for the compounds affected.

2.0 SEMI-VOLATILE ORGANICS BY GC/MS
(Base/Neutral and Acid Extractable Organics)

The following items/criteria were reviewed:

* Holding Times
* Surrogate Recovery
* MS/MSD
* Initial and Continuing Calibration
* Blanks (Method and Field)
* GC/MS Instrument Performance Check
* TICs
* Internal Standards

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

2.1 Holding Times

All holding times were met for extraction and analysis of the water and soil samples, with the following exceptions. The USEPA technical holding time for waters is 7 days from collection to extraction, and 40 days from extraction to analysis. Soil samples must be extracted within 14 days of collection and analyzed within 40 days of extraction.

The following samples were qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results, due to extraction 8 days beyond the holding time.

Sample ID

1-SW-4RE
2-SW-1RE
2-SW-4RE
1-SW-4RE MS
1-SW-4RE MSD

2.2 Surrogate Recovery

All surrogate recovery was found to be generated within acceptable limits for the eight surrogate compounds, with the following exceptions.

Sample ID			
SBLKW2	Nitrobenzene-d5	10% R	(Limit 35-114)
	2-Fluorobiphenyl	12%	(Limit 43-116)
	Terphenyl-d14	11%	(Limit 33-141)
	2-Fluorophenol	11%	(Limit 21-110)
	2,4,6-Tribromophenol	8%	(Limit 10-123)
	2-Chlorophenol-d4	10%	(Limit 33-110)
	1,2-Dichlorobenzene	11%	(Limit 16-110)

Much of the final extract from SBLKW2 was lost in a laboratory accident, generating the low surrogate recoveries above. Sample SBLKW2 was qualified as 'UJ', estimated, for the non-detectable results. Positive results were not detected. The affected samples were re-extracted and re-analyzed out of holding time with an acceptable blank.

2.3 MS/MSD

MS/MSD sample sets were analyzed for the water and soil samples. Acceptable accuracy and precision were generated. However, several compounds exhibited low spike recovery and poor precision for sample 2-SD-3.

2.4 Calibration

All initial and continuing calibrations were performed within acceptable limits for $\overline{RRF}$, % RSD, RRF, and % D, with the following exceptions.

There were instances where compounds were found to be out of specification for the initial and continuing calibrations. Positive results were not detected for the affected compounds, therefore, qualification was not required.

2.5 Blanks

2.5.1 Field Blanks

Field blanks were not collected for Semi-Volatile Organics analyses.

2.5.2 Method Blanks

Two water method blanks and two soil method blanks were analyzed for Semi-Volatile Organics. TCL semi-volatile organics were not detected. However, the following TICs were detected.

Sample ID		
SBLKS1	TIC for Aldol Condensation Product	980 ug/Kg, estimated
SBLKS2	TIC for Aldol Condensation Product	760 ug/Kg, estimated

A limit of five times the highest TIC value for the Aldol Condensation Product was used for review and qualification of the soil samples. All sample results were found to be below the respective blank limit and were qualified as 'U', not detected, for the aldol condensation product.

2.6 GC/MS Instrument Performance Check

Instrument performance was generated within acceptable limits for Decafluorotriphenylphosphine (DFTPP).

2.7 TICs

TICs were generated in accordance with protocol. The Form I's, including the appropriate qualifiers, are included in Appendix E.

2.8 Internal Standards

All internal standards were generated within acceptable specifications for area counts and retention time variation, with the following exceptions.

Sample ID	Internal Standard	Reported Area Count	Lower Limit
2-SD-4	1,4-Dichlorobenzene-d4	16013	20044
	Naphthalene-d8	34659	71370
	Acenaphthene-d10	13740	43853
	Phenanthrene-d10	10477	51656
	Chrysene-d12	16980	27600
	Perylene-d12	23619	30219
2-SD-4D	Phenanthrene-d10	72484	155361
	Chrysene-d12	94035	117785
	Perylene-d12	124364	126127
2-SD-4DL	Phenanthrene-d10	65428	120760
2-SD-4DRE	Phenanthrene-d10	27029	120760

The samples above were qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results, for the compounds associated with the particular internal standards noted.

3.0 PESTICIDES/PCBs BY GC

The following items/criteria were reviewed:

* Holding Times
* Surrogate Recovery
* MS and MSD
* Blanks (Method and Field)
* Instrument (GC) Performance
* Calibration
* Compound Identification

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

3.1 Holding Times

All holding times were met within acceptable time frames for extraction and analysis of the water and soil samples. The USEPA technical holding time for water samples is 7 days from collection to extraction and 40 days from extraction to analysis. Soil samples must be extracted within 14 days of collection and analyzed within 40 days of extraction.

3.2 Surrogate Recovery

Surrogate recovery was generated within acceptable limits, with the following exception.

Sample ID			
2-SD-4D	TCX1	35% R	(Advisory Limit 60-150)
	DCB1	14%	
	DCB2	330%	

The sample above was qualified as 'J', estimated, for the positive results and 'UJ', estimated, for the non-detectable results, due to low surrogate recovery.

Several samples exhibited low recovery for either Tetrachloro-m-xylene or Decachlorobiphenyl. However, both surrogates are required to be out of specification for qualification of the samples. The remaining samples did not require qualification.

3.3 MS/MSD

MS/MSD sample sets for both water and soils were analyzed for Pesticides and PCBs. Acceptable accuracy and precision were generated.

3.4 Blanks

3.4.1 Field Blanks

Field blanks were not collected for Pesticide and PCB analyses.

3.4.2 Method Blanks

One water method blank and four soil method blanks were analyzed for the Case. Pesticides and PCBs were not detected in any of the method blanks.

3.5 Instrument GC Performance

Adequate chromatographic resolution and instrument sensitivity were achieved through the generation of data within acceptable limits for the Resolution Check Mixture and Performance Evaluation Mixtures. Review items included resolution between adjacent peaks, retention time windows, Relative Percent Difference (RPD), and percent breakdown for DDT/Endrin.

3.6 Calibration

All initial and continuing calibration was performed within acceptable limits for the individual standard mixtures, with the following exceptions. Review items included resolution, retention time windows, calibration factors (CF), percent RSD for linearity, RPD and %R.

Individual Standard Mixtures:

Date, Time		
3/22/94, 17:21	Methoxychlor	28.0% RPD (Limit 25%)

The associated samples were qualified as 'UJ', estimated, for the non-detectable results for the compound. Positive results were not detected for methoxychlor.

3.7 Compound Identification

GC qualitative analyses are considered to be acceptable. Data was generated in accordance with protocols. Various positive results were qualified as 'J', estimated, where the percent difference between the two GC columns exceeded 25%. The lower of the two results is reported, as per the protocol.

4.0 INORGANIC ANALYSES BY AA AND ICP
(Mercury by Cold Vapor and Cyanide by Spectrophotometry)

The following items/criteria were reviewed:

* Holding Times
* Initial and Continuing Calibration
* Blanks (Initial, Continuing Calibration, and Preparation)
* Field Blanks
* ICP Interference Check Sample
* Matrix Spike Sample Recovery
* Laboratory Duplicates
* Laboratory Control Sample (LCS)
* ICP Serial Dilution

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

4.1 Holding Times

All holding times were met within the acceptable time frame from collection for metals (6 months), mercury (28 days), and cyanide (14 days).

4.2 Calibration

All initial and continuing calibration was performed within acceptable limits for percent recovery.

4.3 Blanks

4.3.1 Laboratory (Method) Blanks

All initial calibration, continuing calibration, and preparation blanks were generated in accordance with acceptable limits.

4.3.2 Field Blanks

Field blanks were not collected for Inorganic analyses.

4.4 ICP Interference Check

The ICP Interference Check samples were generated within the acceptable limit of 80-120% for recovery.

4.5 Spiked Sample Recovery

All percent recoveries for the matrix spike samples were found to be within the 75-125% limit, with the following exceptions.

Sample ID		
2-SD-3	Arsenic	67.4% R
	Lead (AA)	74.3%
	Manganese	-42.8%
	Mercury	49.2%

The soil samples were qualified as 'J', estimated, for the positive results and 'UJ', estimated, for the non-detectable results, for the elements above.

Sample ID		
1-SW-4	Selenium	58.2% R

The water samples were qualified as 'UJ', estimated, for the non-detectable results for selenium. Positive results were not detected.

4.6 Laboratory Duplicates

Precision (relative percent difference) for the water and soil samples was found to be acceptable for all the elements, with the following exceptions.

Sample ID		
1-SW-4	Zinc	31.6% RPD

The positive results for zinc for the water samples were qualified as 'J', estimated.

4.7 Laboratory Control Sample (LCS)

The aqueous and solid laboratory control samples were generated within acceptable limits.

4.8 ICP Serial Dilution

ICP Serial Dilution was found to be within the acceptable10% limit for percent difference, with the following exceptions.

Soils:	Zinc	11.1% D
Waters:	Iron	11.3% D

Positive results for zinc (soils) and iron (waters) which exceeded 50 times the Instrument Detection Limit were qualified as 'J', estimated.

MEMORANDUM

TO: John Walter, E & E Project Manager

FROM: Lynn Hess, E & E QA Chemist

DATE: June 13, 1994

SUBJECT: Comments on ChemWorld Environmental Inc.'s Data Validation Report for Bainbridge Naval Training Center, Work Order # 1.

CC: Marcia Meredith Galloway, E & E QA Officer

ChemWorld Environmental Inc.'s (CW's) Data Validation Report # 4 for the Bainbridge Naval Training Center (BNTC), dated June 2, 1994 was performed under Work Order # 1 for samples collected between February 28 and March 1, 1994. The report covers analytical data contained in E & E data package 9400.397 (surface waters and sediments).

Given below are our quality assurance/quality control (QA/QC) comments regarding data usability, providing further explanation/clarification and including any differing opinions. In addition, we have included comments on overall precision based on assessment of field duplicate results for this sampling event. Revised data summary sheets are attached which give our qualifiers where they differ from CW's.

QA/QC COMMENTS

COMMENT 1

The tentatively identified compounds are qualified with an "N" by CW. This qualification is not necessary when an

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identification is not made. Revised data summary sheets are enclosed.

COMMENT 2

The validation report from CW includes samples 2-SD-5, 2-SD-6, 2-SD-7, 2-SD-8, 2-SD-8D and 2-SD-9 for semivolatile and pesticide/PCB analysis. These samples were not listed in CW introduction.

COMMENT 3

The internal standard (IS) response criterion was not met for the volatile analysis of sample 2-SD-4. Sample 2-SD-4 was not reanalyzed however the field duplicate sample 2-SD-4D volatile analysis gave similar IS results (low, but within the acceptable criterion) indicating a matrix effect.

COMMENT 4

Samples 1-SW-4RE, 2-SW-1RE and 2-SW-4RE were reextracted for semivolatiles due to poor surrogate recoveries in the associated method blank. The reextraction was performed 8 days beyond the acceptable holding time. The original sample extraction had acceptable surrogate recoveries and are recommended for use.

COMMENT 5

The internal standard (IS) response criterion was not met for the semivolatile analyses of samples 2-SD-4, 2-SD-4DL, 2-SD-4D and 2-SD-4DRE indicating a matrix effect.

COMMENT 6

Several organics analysis (volatiles, semivolatiles and pesticide/PCBs) required dilutions due to the sample matrix and/or high levels of various contaminants. In some cases both analyses were reported. The validation qualifier "R" was used in these cases on the data summary sheets and in the database to indicate the result that is considered less reliable.

OVERALL PRECISION

Field duplicate results for 2-SD-4/2-SD 4D indicate good overall precision for the inorganics, with the exception of lead with an RPD of 73% (see Table 1). Overall precision for organics in 2-SD-4/2-SD-4D was also good with the exception of fluoranthene with an RPD of 41%, benzo(b)fluoranthene with an RPD of 85%, benzo(k) fluoranthene with an RPD of 82%, benzo(a)pyrene with an RPD of 47%, dibenz(a,h)-anthracene with an RPD of 86% and endosulfan sulfate with an RPD of 109% (see Table 2). Overall precision for organics in 2-SD-8/2-SD-8D was also good with the exception of 4,4'-DDE with an RPD of 43%, 4,4'-DDD with an RPD of 68% and 4,4'-DDT with an RPD of 44% (see Table 3). The lack of precision is attributable to the low levels and the sample non-homogeneity.

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TABLE 1

BNTC SEDIMENTS

FIELD DUPLICATE RESULTS - INORGANICS

(Results in ug/kg)

Parameter	2-SD-4	2-SD-4D	RPD
Aluminum	5490	5740	4.4
Arsenic	2.1	2.9	32
Barium	57.4	60.7	5.6
Beryllium	0.47	0.51	8.2
Calcium	1980	2290	15
Chromium	12.1	11.4	5.9
Cobalt	7.3	7.7	5.3
Copper	29.2	29.2	0
Iron	12000	12600	4.9
Lead	74.5	161	73
Magnesium	1250	1240	0.8
Manganese	114	122	6.8
Nickel	8.1	7.9	2.5
Sodium	654	ND	IN
Vanadium	30.6	34.0	11
Zinc	127	136	6.8
Cyanide	1.6	1.2	29

IN = Indeterminant

ND = Not detected

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Table 2
BNTC SEDIMENTS
FIELD DUPLICATE RESULTS - ORGANICS
(Results in ug/kg)

Parameter	2-SD-4	2-SD-4D	RPD
Naphthalene	340	460	30
2-Methylnaphthalene	960	1200	22
Acenaphthene	340	ND	IN
Phenanthrene	1900	ND	IN
Fluoranthene	7900	12000	41
Pyrene	3900	4200	7.4
Benzo(a)Anthracene	1700	ND	IN
Chrysene	6300	5500	14
Bis(2-ethylhexyl)phthalate	ND	860	IN
Benzo(b)fluoranthene	6700	2700	85
Benzo(k)fluoranthene	6900	2900	82
Benzo(a)pyrene	1300	2100	47
Indeno(1,2,3-cd)Pyrene	3800	2900	27
Dibenz(a,h)Anthracene	500	200	86
Benzo(g,h,i)Perylene	1500	1100	31
Heptachlor epoxide	54	60	11
4,4'-DDE	160	220	32
Endrin	77	100	26
4,4'-DDD	1900	2500	27
Endrin aldehyde	ND	180	IN
alpha-Chlordane	ND	47	IN
Endosulfan sulfate	180	610	109
4,4-DDT	89	ND	IN

IN = Indeterminant
ND = Not detected

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Table 3

BNTC SEDIMENTS

FIELD DUPLICATE RESULTS - ORGANICS

(Results in ug/kg)

Parameter	2-SD-8	2-SD-8D	RPD
Di-n-Butylphthalate	ND	61	IN
Bis(2-ethylhexyl)phthalate	67	79	16
4,4'-DDE	310	480	43
4,4'-DDD	54	110	68
4,4-DDT	160	250	44

IN = Indeterminant

ND = Not detected

CW CHEMWORLD ENVIRONMENTAL, INC.
Environmental Consultants

MEMORANDUM

TO: Lynn Hess, Ecology & Environment, Inc.

FROM: Andrea Schuessler, ChemWorld Environmental, Inc. AS

DATE: June 7, 1994

RE: Bainbridge Project - General Chemistry Review/NEESA Level C
Total Recoverable Petroleum Hydrocarbons (TRPH)
Case No.'s 9400.144, 9400.146, 9400.152, 9400.153, 9400.164, 9400.358, 9400.396, 9400.397, 9400.409 and 9400.410

The general chemistry analytical data review for the Bainbridge Project has been completed for Total Recoverable Petroleum Hydrocarbons (TRPH). All quality control data as presented in the data packages referenced above was found to be acceptable, with the following exceptions as described below. Review items included the following areas :

* Holding Times (28 days from collection)
* Reference Standards (Limit 80-120% for recovery)
* Method Blanks (Contamination should not be detected)
* Laboratory Control Samples or Blank Spikes (Limit 75-125% for recovery)
* Matrix Spike Recovery (Limit 75-125%)
* Laboratory Duplicate Samples (Limit 25% waters, 35% Soils)

The following areas were found to be out of specification for the Cases.

Case No. 9400.144

Blank Spike recovery was generated at 133% for the water samples. The positive results, only, for TRPH are qualified as 'J', estimated, due to high spike recovery.

Case No. 9400.146

Blank Spike recovery was generated at 152% for the water samples. The positive results, only, for TRPH are qualified as 'J', estimated, due to high spike recovery.

Case No. 9400.396

Laboratory Control Sample (LCS) recovery was generated at 126% for the water samples. The positive result for TRPH for sample 1-PW-3 is qualified as 'J', estimated, due to high spike recovery.

Case No. 9400.409

Laboratory Control Sample (LCS) recovery was generated at 126% for the water samples. The positive result for TRPH for sample 1-SW-4 is qualified as 'J', estimated, due to high spike recovery.

14 Orchard Way North, Rockville, Maryland 20854, Tel. (301) 294-6144, Fax (301) 309-6640
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DATA VALIDATION REPORT #5

ORGANIC and INORGANIC ANALYSES

Bainbridge Project

Case No. 9400.410

Sampling Date of March 1, 1994

PREPARED FOR:

Ecology and Environment, Inc.
368 Pleasantview Drive
Lancaster, New York 14086

June 1994

PREPARED BY:

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Bainbridge Project
Data Validation Report #5: Organic and Inorganic Analyses

Table of Contents **Page**

	Introduction	1
1.0	Volatile Organics by GC/MS	1
1.1	Holding Times	2
1.2	System Monitoring Compound Recovery	2
1.3	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	2
1.4	Calibration	2
1.5	Blanks	3
1.6	GC/MS Instrument Performance Check	3
1.7	Tentatively Identified Compounds	3
1.8	Internal Standards	3
2.0	Semi-Volatile Organics by GC/MS	4
2.1	Holding Times	4
2.2	Surrogate Recovery	4
2.3	MS/MSD	4
2.4	Calibration	4
2.5	Blanks	5
2.6	GC/MS Instrument Performance Check	6
2.7	Tentatively Identified Compounds	6
2.8	Internal Standards	6
3.0	Pesticides/PCBs by GC	6
3.1	Holding Times	7
3.2	Surrogate Recovery	7
3.3	MS/MSD	7
3.4	Blanks	7
3.5	Instrument (GC) Performance	7
3.6	Calibration	7
3.7	Compound Identification	8
4.0	Inorganic Analyses by AA and ICP	8
4.1	Holding Times	8
4.2	Calibration	8
4.3	Blanks	8
4.4	ICP Interference Check	9
4.5	Spiked Sample Recovery	9
4.6	Laboratory Duplicates	9
4.7	Laboratory Control Sample	9
4.8	ICP Serial Dilution	9

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DATA VALIDATION SUMMARY #5 ORGANIC and INORGANIC ANALYSES

Bainbridge Project
Case No. 9400.410
Sampling Date of March 1, 1994

INTRODUCTION

This Data Validation Summary report for organic and inorganic analyses was generated for 4 soil samples and the associated quality control samples for Case Number 9400.410. Sampling activities were conducted in support of the field investigation for the Bainbridge Project. The analytical laboratory work was performed by Ecology and Environment, Inc.'s Analytical Services Center.

Analytical testing consisted of volatile organic analyses by Gas Chromatography/Mass Spectroscopy (GC/MS); Base/Neutral and Acid Extractable Organics by GC/MS; Pesticides and Polychlorinated Biphenyls (PCBs) by GC; Inorganics by Atomic Absorption (AA) and Inductively Coupled Argon Plasma (ICP); Mercury by Cold Vapor; and Cyanide by Spectrophotometry. The analytical work was performed utilizing the most current United States Environmental Protection Agency (USEPA) Contract Laboratory Program (CLP) protocols. Additional organic and inorganic analyses were performed for the project. The Data Validation Reports for these analyses are provided under separate cover.

This report provides a summary of data acceptability and deviations in accordance with the **Naval Energy and Environmental Support Activity (NEESA) Level C** requirements, as stated in the document **Quality Assurance in Environmental Analysis, October 1990**. In addition, the CLP portion of the corresponding USEPA Statements of Work (SOW) were utilized, where applicable and relevant. The validation report pertains to the following samples:

Case No. 9400.410

1-SD-1
1-SD-2
1-SD-4
2-SD-10 (Semi-volatiles and Inorganics, only)

1.0 VOLATILE ORGANICS BY GC/MS

The following items/criteria were reviewed:

* Holding Times
* System Monitoring Compound Recovery
* Matrix Spikes (MS) and Matrix Spike Duplicates (MSD)
* Initial and Continuing Calibration
* Blanks (Method and Field)
* GC/MS Instrument Performance Check
* Tentatively Identified Compounds (TICs)
* Internal Standards

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All items above were generated within acceptable Quality Control (QC) specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

1.1 Holding Times

All holding times were met within the acceptable time frame of 14 days from collection for the soil samples.

1.2 System Monitoring Compound Recovery

All system monitoring recovery (%R) was found to be generated within acceptable limits for the three surrogate compounds.

1.3 Matrix Spike/Matrix Spike Duplicates (MS/MSD)

One MS/MSD sample set was analyzed for the soil samples. Acceptable accuracy (percent recovery) and precision (relative percent difference) were generated.

1.4 Calibration

All initial and continuing calibration was performed within acceptable limits for average Relative Response Factors ($\overline{RRF}$), Percent Relative Standard Deviation (% RSD), Relative Response Factors (RRF), and percent Difference (% D), with the following exceptions.

Initial Calibration:

Date			
3/02/94	Acetone	39.2% RSD	(Limit 30%)

Acetone was not detected in the samples, therefore, qualification is not required.

Continuing Calibration:

Date, Time			
3/10/94, 06:01	Bromomethane	26.0% D	(Limit 25%)
	Chloroethane	26.9%	
	Carbon Disulfide	28.6%	
	2-Butanone	31.0%	
	4-methyl-2-pentanone	26.9%	
	2-Hexanone	28.4%	
3/08/94, 00:55	Chloromethane	62.4%	
	Vinyl Chloride	37.8%	
	Carbon Disulfide	25.6%	

The samples associated with the continuing calibrations above were qualified as 'J', estimated, for the positive results, only. The non-detectable results did not require qualification.

1.5 Blanks

1.5.1 Field Blanks

One trip blank was collected and analyzed for Volatile Organics (included in Case 9400.397). The following compounds were detected in the trip blank.

Sample ID		
TB-01	Methylene Chloride	11 ug/L
	Chloroform	2 ug/L, estimated
	1,1,1-Trichloroethane	2 ug/L, estimated
	Acetone	12 ug/L

The sample results from Case No. 9400.410 were not affected by the trip blank above. The affected compounds either were qualified through *Section 1.5.2, Method Blanks* or were not detected.

1.5.2 Method Blanks

Two soil method blanks were analyzed for the Case. The following summarizes Volatile Organics detected.

Sample ID		
VBLKS1	Methylene Chloride	5 ug/Kg, estimated
VBLKS2	Methylene Chloride	12 ug/Kg
	Acetone	5 ug/Kg, estimated

A limit of ten times the highest methylene chloride and acetone values above were used for review and qualification of the soil samples. Sample results that were found to be less than the blank limit and less than the CRQL were qualified as 'U', not detected, at the CRQL. Sample results that were found to be reported above the CRQL and below the blank limit were qualified as 'U', not detected.

1.6 GC/MS Instrument Performance Check

Instrument performance was generated within acceptable limits for Bromofluorobenzene (BFB).

1.7 Tentatively Identified Compounds (TICs)

TICs, which were generated in accordance with protocol, are summarized on Data Summary Forms in Appendix E.

1.8 Internal Standards

All internal standards were generated within acceptable specifications for area counts and retention time variation, with the following exceptions.

Sample ID	Internal Standard	Reported Area Count	Lower Limit
1-SD-2	Chlorobenzene-d5	169535	185424
1-SD-2RE	Chlorobenzene-d5	164771	185424

The samples were qualified as 'UJ', estimated, for the non-detectable results, for the compounds associated with the chlorobenzene internal standard. Positive results were not detected for the compounds affected.

2.0 SEMI-VOLATILE ORGANICS BY GC/MS
(Base/Neutral and Acid Extractable Organics)

The following items/criteria were reviewed:

* Holding Times
* Surrogate Recovery
* MS/MSD
* Initial and Continuing Calibration
* Blanks (Method and Field)
* GC/MS Instrument Performance Check
* TICs
* Internal Standards

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

2.1 Holding Times

All holding times were met for extraction and analysis of the soil samples. Soil samples must be extracted within 14 days of collection and analyzed within 40 days of extraction.

2.2 Surrogate Recovery

All surrogate recovery was found to be generated within acceptable limits for the eight surrogate compounds.

2.3 MS/MSD

One MS/MSD sample set was analyzed for the soil samples. Acceptable accuracy and precision were generated.

2.4 Calibration

All initial and continuing calibrations were performed within acceptable limits for $\overline{RRF}$, % RSD, RRF, and % D, with the following exceptions.

Continuing Calibration:

Date, Time		
3/16/94, 01:04	Hexachlorobutadiene	27.2% D (Limit 25%)
	Hexachlorocyclopentadiene	38.4%
3/21/94, 05:02	Hexachlorobutadiene	29.6%
	Hexachlorocyclopentadiene	35.2%
	3-Nitroaniline	27.6%
	2,4-Dinitrophenol	37.8%
	4-nitrophenol	48.1%
	4-Nitroaniline	44.5%
	4-Bromophenyl-phenylether	29.0%
3/23/94, 22:14	4-Chloroaniline	34.4%
	3-Nitroaniline	60.7%
	4-Nitroaniline	59.2%
	Di-n-butylphthalate	36.1%
	Pyrene	30.0%
	Butylbenzylphthalate	52.8%
	3,3'-Dichlorobenzidine	77.8%
	bis(2-ethylhexyl)phthalate	52.6%
	Di-n-octylphthalate	58.1%
3/24/94, 11:14	2,4-Dinitrophenol	26.6%
	4-Nitrophenol	26.9%
	2,4-Dinitrotoluene	32.8%
	Pyrene	28.4%
	Butylbenzylphthalate	47.6%
	3,3'-Dichlorobenzidine	53.9%
	bis(2-ethylhexyl)phthalate	50.7%
	Di-n-octylphthalate	59.4%

The samples associated with the continuing calibrations above were qualified as 'J', estimated, for the positive results, only. The non-detectable results do not require qualification.

2.5 Blanks

2.5.1 Field Blanks

Field blanks were not collected for Semi-Volatile Organic analyses.

2.5.2 Method Blanks

Two soil method blanks were analyzed for Semi-Volatile Organics. Target Compound List (TCL) semi-volatile organics were not detected. However, the following TICs were detected.

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Sample ID		
SBLKS1	TIC for Aldol Condensation Product	980 ug/Kg, estimated
SBLKS2	TIC for Aldol Condensation Product	880 ug/Kg, estimated

A limit of five times the highest TIC value for the Aldol Condensation Product was used for review and qualification of the soil samples. All sample results were found to be below the respective blank limit and were qualified as 'U', not detected, for the aldol condensation product.

2.6 GC/MS Instrument Performance Check

Instrument performance was generated within acceptable limits for Decafluorotriphenylphosphine (DFTPP).

2.7 TICs

TICs were generated in accordance with protocol. The Form I's, including the appropriate qualifiers, are included in Appendix E.

2.8 Internal Standards

All internal standards were generated within acceptable specifications for area counts and retention time variation, with the following exceptions.

Sample ID	Internal Standard	Reported Area Count	Lower Limit
1-SD-2	Phenanthrene-d10	88502	104448
	Chrysene-d12	54906	58988
2-SD-10MS	Chrysene-d12	57641	58988
1-SD-2DL	Perylene-d12	84462	91670

The samples above were qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results, for the compounds associated with the particular internal standards noted.

3.0 PESTICIDES/PCBs BY GC

The following items/criteria were reviewed:

* Holding Times
* Surrogate Recovery
* MS and MSD
* Blanks (Method and Field)
* Instrument (GC) Performance
* Calibration
* Compound Identification

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

3.1 Holding Times

All holding times were met within acceptable time frames for extraction and analysis of the soil samples. Soil samples must be extracted within 14 days of collection and analyzed within 40 days of extraction.

3.2 Surrogate Recovery

Surrogate recovery was generated within acceptable limits for the two surrogate compounds.

3.3 MS/MSD

An MS/MSD sample set for soils was included from Case 9400.397. Acceptable accuracy and precision were generated.

3.4 Blanks

3.4.1 Field Blanks

Field blanks were not collected for Pesticide and PCB analyses.

3.4.2 Method Blanks

Two soil method blanks were analyzed for the Case. Pesticides and PCBs were not detected in the method blanks.

3.5 Instrument GC Performance

Adequate chromatographic resolution and instrument sensitivity were achieved through the generation of data within acceptable limits for the Resolution Check Mixture and Performance Evaluation Mixtures. Review items included resolution between adjacent peaks, retention time windows, Relative Percent Difference (RPD), and percent breakdown for DDT/Endrin.

3.6 Calibration

All initial and continuing calibration was performed within acceptable limits for the individual standard mixtures, with the following exceptions. Review items included resolution, retention time windows, calibration factors (CF), percent RSD for linearity, RPD and %R.

Individual Standard Mixtures:

Date, Time		
3/22/94, 17:21	Methoxychlor	28.0% RPD (Limit 25%)

The associated samples were qualified as 'UJ', estimated, for the non-detectable results for the compound. Positive results were not detected for methoxychlor.

3.7 Compound Identification

GC qualitative analyses are considered to be acceptable. Data was generated in accordance with protocols. Various positive results were qualified as 'J', estimated, where the percent difference between the two GC columns exceeded 25%. The lower of the two results is reported, as per the protocol.

4.0 INORGANIC ANALYSES BY AA AND ICP
(Mercury by Cold Vapor and Cyanide by Spectrophotometry)

The following items/criteria were reviewed:

* Holding Times
* Initial and Continuing Calibration
* Blanks (Initial, Continuing Calibration, and Preparation)
* Field Blanks
* ICP Interference Check Sample
* Matrix Spike Sample Recovery
* Laboratory Duplicates
* Laboratory Control Sample (LCS)
* ICP Serial Dilution

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms and within the following text.

4.1 Holding Times

All holding times were met within the acceptable time frame from collection for metals (6 months), mercury (28 days), and cyanide (14 days).

4.2 Calibration

All initial and continuing calibration was performed within acceptable limits for percent recovery.

4.3 Blanks

4.3.1 Laboratory (Method) Blanks

All initial calibration, continuing calibration, and preparation blanks were generated in accordance with acceptable limits.

4.3.2 Field Blanks

Field blanks were not collected for Inorganic analyses.

4.4 ICP Interference Check

The ICP Interference Check samples were generated within the acceptable limit of 80-120% for recovery.

4.5 Spiked Sample Recovery

All percent recoveries for the matrix spike samples were found to be within the 75-125% limit, with the following exceptions.

Sample ID		
1-SD-4	Antimony	70.4% R
	Mercury	73.2%

The soil samples were qualified as 'UJ', estimated, for the non-detectable results, for the elements above. Positive results were not detected for the compounds affected.

4.6 Laboratory Duplicates

Precision (relative percent difference) for the soil samples was found to be acceptable for all the elements.

4.7 Laboratory Control Sample (LCS)

The solid laboratory control sample was generated within acceptable limits.

4.8 ICP Serial Dilution

ICP Serial Dilution was not performed for the soil samples.

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MEMORANDUM

TO: John Walter, E & E Project Manager

FROM: Lynn Hess, E & E QA Chemist

DATE: June 13, 1994

SUBJECT: Comments on ChemWorld Environmental Inc.'s Data Validation Report for Bainbridge Naval Training Center, Work Order # 1.

CC: Marcia Meredith Galloway, E & E QA Officer

ChemWorld Environmental Inc.'s (CW's) Data Validation Report # 5 for the Bainbridge Naval Training Center (BNTC), dated June 3, 1994 was performed under Work Order # 1 for samples collected on March 1, 1994. The report covers analytical data contained in E & E data package 9400.410 (sediment samples).

Given below are our quality assurance/quality control (QA/QC) comments regarding data usability, providing further explanation/clarification and including any differing opinions. In addition, we have included comments on overall precision based on assessment of field duplicate results for this sampling event. Revised data summary sheets are attached which give our qualifiers where they differ from CW's.

QA/QC COMMENTS

COMMENT 1

The tentatively identified compounds are qualified with an "N" by CW. This qualification is not necessary when an identification is not made. Revised data summary sheets are enclosed.

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COMMENT 2

Sample 2-SD-10 was analyzed for semivolatiles and pesticide/PCBs, not for inorganics as stated in CWS report.

COMMENT 3

The internal standard (IS) response criterion was not met for volatile sample 1-SD-2. The sample was reanalyzed and gave similar IS responses indicating a matrix effect.

COMMENT 4

The internal standard (IS) response criterion was not met for semivolatile sample 1-SD-2. The sample was reanalyzed at a dilution again giving unacceptable IS responses, indicating a sample matrix effect.

COMMENT 5

A dichlorobenzene isomer was detected in the volatile analysis of samples 1-SD-2 and 1-SD-4 and reported as a tentatively identified compound (TIC). The same TIC was detected in the laboratory blank associated with sample 1-SD-2. The blank associated with 1-SD-4 was free of the dichlorobenzene isomer. In the semivolatile analysis of these samples there was no dichlorobenzene detected. Due to the dichlorobenzenes isomer presence in the one blank, the lack of this compound in the semivolatile analyses and the low level detected in the volatile analyses the dichlorobenzene isomer should be considered not detected in both of these samples.

COMMENT 6

Several organics analysis (volatiles, semivolatiles and pesticide/PCBs) required dilutions due to the sample matrix and/or high levels of various contaminants. In some cases both analyses were reported. The validation qualifier "R" was used in these cases on the data summary sheets and in the database to indicate the results that is considered less reliable.

OVERALL PRECISION

There were no field duplicate analysis included in this report. However, the laboratory quality control indicates good overall precision.

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March 22 to April 8, 1994 Sampling Event

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11:CD7171/RC1357-12/18/96-D1

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DATA VALIDATION REPORT #6

ORGANIC and INORGANIC ANALYSES

Bainbridge Project

Case No. 9400.547, 9400.557, 9400.675 and 9400.676

Sampling Dates of March 22 - April 8, 1994

Volume 1 of 2

PREPARED FOR:

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July 1994

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Bainbridge Project
Data Validation Report #6: Organic and Inorganic Analyses

Table of Contents **Page**

	Introduction	1
1.0	Volatile Organics by GC/MS	2
1.1	Holding Times	2
1.2	System Monitoring Compound Recovery	2
1.3	Matrix Spike/Matrix Spike Duplicate (MS/MSD)	3
1.4	Calibration	3
1.5	Blanks	4
1.6	GC/MS Instrument Performance Check	5
1.7	Tentatively Identified Compounds	5
1.8	Internal Standards	5
2.0	Semi-Volatile Organics by GC/MS	6
2.1	Holding Times	6
2.2	Surrogate Recovery	6
2.3	MS/MSD	6
2.4	Calibration	6
2.5	Blanks	7
2.6	GC/MS Instrument Performance Check	8
2.7	Tentatively Identified Compounds	8
2.8	Internal Standards	8
3.0	Pesticides/PCBs by GC	9
3.1	Holding Times	9
3.2	Surrogate Recovery	10
3.3	MS/MSD	12
3.4	Blanks	12
3.5	Instrument (GC) Performance	12
3.6	Calibration	13
3.7	Compound Identification	13
4.0	Inorganic Analyses by AA and ICP	13
4.1	Holding Times	13
4.2	Calibration	14
4.3	Blanks	14
4.4	ICP Interference Check	14
4.5	Spiked Sample Recovery	14
4.6	Laboratory Duplicates	14
4.7	Laboratory Control Sample	14
4.8	ICP Serial Dilution	14

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DATA VALIDATION SUMMARY #6: ORGANIC and INORGANIC ANALYSES

Bainbridge Project
Case No. 9400.547, 9400.557, 9400.675, and 9400.676
Sampling Dates of March 22 - April 8, 1994

INTRODUCTION

This Data Validation Summary report for organic and inorganic analyses was generated for 38 water samples, 25 soil samples, and the associated quality control samples for the Case Numbers referenced above. Sampling activities were conducted in support of the field investigation for the Bainbridge Project. The analytical laboratory work was performed by Ecology and Environment, Inc.'s Analytical Services Center.

Analytical testing consisted of volatile organic analyses by Gas Chromatography/Mass Spectroscopy (GC/MS); Base/Neutral and Acid Extractable Organics by GC/MS; Pesticides and Polychlorinated Biphenyls (PCBs) by GC; Inorganics by Atomic Absorption (AA) and Inductively Coupled Argon Plasma (ICP); Mercury by Cold Vapor; and Cyanide by Spectrophotometry. The analytical work was performed utilizing the most current United States Environmental Protection Agency (USEPA) Contract Laboratory Program (CLP) protocols (OLM01.8 and ILM03.0). Additional organic and inorganic analyses were performed for the project. The Data Validation Reports for these analyses are provided under separate cover.

This report provides a summary of data acceptability and deviations in accordance with the **Naval Energy and Environmental Support Activity (NEESA) Level C** requirements, as stated in the document **Quality Assurance in Environmental Analysis, October 1990**, and the applicable portions for Pesticide review from the USEPA's CLP **National Functional Guidelines for Organic Data Review, February 1994**. In addition, the CLP portion of the corresponding USEPA Statements of Work (SOW) were utilized, where applicable and relevant. The validation report pertains to the following samples:

Case No. 9400.547

1-GW-36	2-GW-46	2-GW-106
1-GW-36D	2-GW-56	2-GW-116
1-GW-46	2-GW-66	2-GW-126
1-GW-66	2-GW-76	2-GW-126D
1-GW-86	2-GW-86	2-GW-136
2-GW-26	2-GW-96	3-22-TB6 (Trip Blank)
2-GW-36		

Case No. 9400.557

1-GW-16	1-GW-106	1-GW-136
1-GW-26	1-GW-116	2-GW-1
1-GW-56	1-GW-11D6	3-23-TB6 (Trip Blank)
1-GW-76	1-GW-126	3-24-TB (Trip Blank)
1-GW-96		

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Case No. 9400.675

1-GW-016B
1-GW-026B
1-GW-076B
1-GW-TT (Trip Blank 4/08/94)

(Pesticide/PCBs, only)

2-SS-1	2-SS-2	2-SS-6
2-SS-10	2-SS-2D	2-SS-7
2-SS-11	2-SS-3	2-SS-8
2-SS-12	2-SS-4	2-SS-9
2-SS-13	2-SS-5	2-BH-5R (Rinsate Blank 4/8/94)

Case No. 9400.676

2-BH-5	2-BH-10	2-SS-14
2-BH-7	2-BH-11	2-SS-15
2-BH-8	2-BH-11D	2-SS-15R (Rinsate Blank 4/7/94)
2-BH-9	2-BH-12	2-SS-16

2-BH-6 ALSO

1.0 VOLATILE ORGANICS BY GC/MS

The following items/criteria were reviewed:

* Holding Times
* System Monitoring (Surrogate) Compound Recovery
* Matrix Spikes (MS) and Matrix Spike Duplicates (MSD)
* Initial and Continuing Calibration
* Blanks (Method and Field)
* GC/MS Instrument Performance Check
* Tentatively Identified Compounds (TICs)
* Internal Standards

All items above were generated within acceptable Quality Control (QC) specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms in Appendix A and within the following text.

1.1 Holding Times

All holding times were met within the acceptable time frame of 14 days from collection for the acid preserved water samples.

1.2 System Monitoring Compound Recovery

All system monitoring recovery (%R) was found to be generated within acceptable limits for the three surrogate compounds.

1.3 Matrix Spike/Matrix Spike Duplicates (MS/MSD)

MS/MSD sample sets were analyzed for the water samples. Acceptable accuracy (percent recovery) and precision (relative percent difference) were generated.

1.4 Calibration

All initial and continuing calibration was performed within acceptable limits for average Relative Response Factors ($\overline{RRF}$), Percent Relative Standard Deviation (% RSD), Relative Response Factors (RRF), and percent Difference (% D), with the following exceptions.

1.4.1 Case No. 9400.547

Continuing Calibration:

Date, Time		
3/25/94, 17:06	Carbon Disulfide	35.8% D (Limit 25%)
3/28/94, 04:46	Acetone	44.4%
	2-Butanone	42.5%
	4-methyl-2-pentanone	25.6%
	2-Hexanone	48.3%
3/28/94, 16:35	Acetone	59.5%
	2-Butanone	44.5%
	2-Hexanone	39.8%
3/29/94, 04:30	Acetone	43.5%
	2-Butanone	44.8%
	2-Hexanone	41.8%

Sample 1-GW-86DL was qualified as 'J', estimated, for acetone. The remaining non-detectable results for the associated samples did not require qualification in relation to the continuing calibrations above.

1.4.2 Case No. 9400.557

Continuing Calibration:

Date, Time		
3/28/94, 16:35	Acetone	59.5% D (Limit 25%)
	2-Butanone	44.5%
	2-Hexanone	39.8%

Sample 3-24-TB is qualified as 'J', estimated, for acetone in relation to the continuing calibration above. The remaining non-detectable results for the associated samples did not require qualification in relation to the deviations above.

1.4.3 Case No. 9400.675

Continuing Calibration:

Date, Time		
4/18/94, 11:11	Chloromethane	40.4% D (Limit 25%)
	Vinyl Chloride	33.5%
	Chloroethane	35.4%
	Carbon Disulfide	57.2%

The compounds above were not detected in the associated samples, therefore, qualification was not required.

1.5 Blanks

1.5.1 Field Blanks

1.5.1.1 Case No. 9400.547

One trip blank was collected and analyzed for Volatile Organics. The following compound was detected in the trip blank.

Sample ID		
3-22-TB6	Methylene Chloride	6 ug/L, estimated

A limit of ten times the methylene chloride blank value was used for review and qualification of the water samples. Sample 1-GW-86DL was qualified as 'U', not detected, for methylene chloride. The compound was not detected in the remaining samples.

1.5.1.2 Case No. 9400.557

Two trip blanks were collected and analyzed for the Case. Volatile Organics were detected as follows.

Sample ID		
3-23-TB6	Methylene Chloride	6 ug/L, estimated
	Chloroform	1 ug/L, estimated
	1,1,1-Trichloroethane	1 ug/L, estimated
3-24-TB	Methylene Chloride	6 ug/L, estimated
	Acetone	8 ug/L, estimated
	Chloroform	1 ug/L, estimated
	1,1,1-Trichloroethane	1 ug/L, estimated

Limits of ten times the highest methylene chloride and acetone values and five times the remaining compound values were used for review and qualification of the water samples. The compounds were not detected in the water samples, therefore, qualification was not required.

1.5.1.3 Case No. 9400.675

One trip blank was collected and analyzed for Volatile Organics. The following summarizes the compounds detected.

Sample ID		
1-GW-TT	Methylene Chloride	4 ug/L, estimated
	Acetone	9 ug/L, estimated

A limit of ten times each compound above was used for review and qualification of the associated water samples. All affected sample results for the compounds above were qualified as 'U', not detected, at the CRQL. The affected sample results were all reported at less than the CRQL.

1.5.2 Method Blanks

1.5.2.1 Case No. 9400.547

Four water method blanks were analyzed for the Case. Volatile Organics were not detected within the method blanks.

1.5.2.2 Case No. 9400.557

One water method blank was analyzed for Volatile Orgnics for the Case. Positive results were not detected.

1.5.2.3 Case No. 9400.675

Two water method blanks were analyzed for Volatile Organics for the Case. Positive results were not detected.

1.6 GC/MS Instrument Performance Check

Instrument performance was generated within acceptable limits and frequency for Bromofluorobenzene (BFB).

1.7 Tentatively Identified Compounds (TICs)

TICs, which were generated in accordance with protocol, are summarized on Data Summary Forms in Appendix E.

1.8 Internal Standards

All internal standards were generated within acceptable specifications for area counts and retention time variation.

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2.0 SEMI-VOLATILE ORGANICS BY GC/MS
(Base/Neutral and Acid Extractable Organics)

The following items/criteria were reviewed:

* Holding Times
* Surrogate Recovery
* MS/MSD
* Initial and Continuing Calibration
* Blanks (Method and Field)
* GC/MS Instrument Performance Check
* TICs
* Internal Standards

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms in Appendix B and within the following text.

2.1 Holding Times

All holding times were met for extraction and analysis of the water samples. The USEPA technical holding time for waters is 7 days from collection to extraction, and 40 days from extraction to analysis.

2.2 Surrogate Recovery

All surrogate recovery was found to be generated within acceptable limits for the eight surrogate compounds.

2.3 MS/MSD

MS/MSD sample sets were analyzed for the water samples. Acceptable accuracy and precision were generated. However, several compounds exhibited high spike recovery for sample 1-GW-46 from Case No. 9400.547.

2.4 Calibration

All initial and continuing calibrations were performed within acceptable limits for $\overline{RRF}$, % RSD, RRF, and % D, with the following exceptions.

2.4.1 Case No. 9400.547

Continuing Calibration:

Date, Time		
3/29/94, 11:26	4-Nitroaniline	54.2% D (Limit 25%)
	3,3'-Dichlorobenzidine	48.0%
	Di-n-octylphthalate	36.8%

3/30/94, 09:19	2,4-Dinitrophenol	37.2%
	4-Nitrophenol	29.4%
	2,4-Dinitrotoluene	27.1%
	3,3'-Dichlorobenzidine	52.0%
	Di-n-octylphthalate	51.4%
3/30/94, 22:07	Pentachlorophenol	34.9%
	Di-n-octylphthalate	31.8%

The samples associated with the continuing calibrations above were qualified as 'J', estimated, for the positive results, only, for the compounds noted above. The non-detectable results did not require qualification.

2.4.2 Case No. 9400.557

There were instances where compounds were found to be out of specification for the continuing calibrations. Positive results were not detected for the affected compounds, therefore, qualification was not required.

2.4.3 Case No. 9400.675

Continuing Calibration:

Date, Time		
4/20/94, 08:26	Hexachlorocyclopentadiene	29.0% D (Limit 25%)
	2-Nitroaniline	26.7%
	bis(2-ethylhexyl)phthalate	38.1%
	Di-n-octylphthalate	41.6%
4/25/94, 09:26	2,2'-oxybis(1-Chloropropane)	28.4%
	2,4-Dinitrophenol	32.6%

Sample SBLKW1 is qualified as 'J', estimated, for bis(2-ethylhexyl)phthalate. The remaining samples did not require qualification, due to the fact that positive results were not detected for the affected compounds. Bis(2-ethylhexyl)phthalate results are also qualified in *Section 2.5.2, Method Blanks*.

2.5 Blanks

2.5.1 Field Blanks

Field blanks were not collected for Semi-Volatile Organics analyses.

2.5.2 Method Blanks

2.5.2.1 Case No. 9400.547

Two water method blanks were analyzed for Semi-Volatile Organics. TCL semi-volatile organics were detected as follows.

Sample ID

SBLKW2	bis(2-ethylhexyl)phthalate	3 ug/L, estimated

A limit of ten times the bis(2-ethylhexyl)phthalate value above was used for review and qualification of the water samples. Sample results which were found to be below the respective blank limit and reported at less than the CRQL were qualified as 'U', not detected, at the CRQL. The remaining sample results found to be below the blank limit were qualified as 'U', not detected. In addition, sample results which exceed the limit do not require qualification.

2.5.2.2 Case No. 9400.557

One water method blank was analyzed for the Case. Semi-Volatile Organics were detected as follows.

Sample ID

SBLKW1	bis(2-ethylhexyl)phthalate	80 ug/L

Due to laboratory oversight, the Method Blank above was not re-extracted and reanalyzed. The sample results for bis(2-ethylhexyl)phthalate were reported at less than the CRQL or near the CRQL. All sample results for the compound were qualified as 'U', not detected. Sample results for bis(ethylhexyl)phthalate which were reported at less than the CRQL were qualified as 'U', not detected, at the CRQL.

2.5.2.3 Case No. 9400.675

One water method blank was analyzed for the Case. Bis(2-ethylhexyl)phthalate was detected at 2 ug/L. A limit of ten times the bis(2-ethylhexyl)phthalate value was used for review and qualification of the water samples. All sample results for the compound were qualified as 'U', not detected, at the CRQL.

2.6 GC/MS Instrument Performance Check

Instrument performance was generated within acceptable limits and frequency for Decafluorotriphenylphosphine (DFTPP).

2.7 TICs

TICs were generated in accordance with protocol. The Form I's, including the appropriate qualifiers, are included in Appendix E.

2.8 Internal Standards

All internal standards were generated within acceptable specifications for area counts and retention time variation, with the following exceptions.

2.8.1 Case No. 9400.557

Sample ID	Internal Standard	Reported Area Count	Lower Limit
1-GW-96MS	Perylene-d12	58631	92644

The sample above was qualified as 'UJ', estimated, for the non-detectable results, for the compounds associated with the perylene internal standard. Positive results were not detected for the affected compounds.

2.8.2 Case No. 9400.675

Sample ID	Internal Standard	Reported Area Count	Lower Limit
1-GW-016B MSD	Chrysene-d12	149766	150179
	Perylene-d12	130481	138780

The sample above was qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results, for the compounds associated with the internal standards noted above.

3.0 PESTICIDES/PCBs BY GC

The following items/criteria were reviewed:

* Holding Times
* Surrogate Recovery
* MS and MSD
* Blanks (Method and Field)
* Instrument (GC) Performance
* Calibration
* Compound Identification

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms in Appendix C and within the following text.

3.1 Holding Times

All holding times were met within acceptable time frames for extraction and analysis of the water and soil samples, with the following exceptions. The USEPA technical holding time for water samples is 7 days from collection to extraction and 40 days from extraction to analysis. Soil samples must be extracted within 14 days of collection and analyzed within 40 days of extraction.

3.1.1 Case No. 9400.547

Sample 2-GW-36 was extracted two days beyond the acceptable holding time. The sample was qualified as 'UJ', estimated, for the non-detectable results. Positive results were not detected for the sample.

3.1.2 Case No. 9400.676

Sample 2-BH-6 was extracted 3 days beyond the acceptable holding time. The sample was qualified as 'UJ', estimated, for the non-detectable results. Positive results were not detected for Pesticides and PCBs.

3.2 Surrogate Recovery

Surrogate recovery was generated within the acceptable limit of 30-150%, as per the USEPA Functional Guidelines, (February 1994), with the following exceptions.

3.2.1 Case No. 9400.675

Sample ID			
2-SS-10	TCX1	28% R	(Limit 30-150)
	TCX2	23%	
	DCB1	25%	
	DCB2	23%	
2-SS-12	TCX1	20%	
	TCX2	22%	
	DCB1	24%	
	DCB2	24%	
2-SS-13	TCX1	20%	
	TCX2	19%	
	DCB1	20%	
	DCB2	21%	
2-SS-3	TCX1	23%	
	TCX2	21%	
	DCB1	21%	
	DCB2	20%	
2-SS-4	TCX1	20%	
	TCX2	20%	
	DCB1	23%	
	DCB2	22%	
2-SS-5	TCX1	26%	
	TCX2	25%	
	DCB1	30%	
	DCB2	28%	

2-SS-6	TCX1	0%
	TCX2	0%
	DCB1	0%
	DCB2	0%
2-SS-7	TCX1	12%
	TCX2	12%
	DCB1	15%
	DCB2	14%
2-SS-8	TCX1	15%
	TCX2	14%
	DCB1	17%
	DCB2	17%
2-SS-9	TCX1	20%
	TCX2	21%
	DCB1	28%
	DCB2	23%
2-SS-13MS	TCX1	23%
	TCX2	21%
	DCB1	25%
	DCB2	27%
2-SS-13MSD	TCX1	23%
	TCX2	25%
	DCB2	28%

The samples above were qualified as 'J', estimated, for the positive results, and 'UJ', estimated, for the non-detectable results, due to low surrogate recovery generated. It appears that sample 2-SS-6 may inadvertently not have been spiked with the surrogate compounds. The sample is qualified as 'UJ', estimated, for the non-detectable results.

3.2.2 Case No. 9400.676

Sample ID		
2-BH-11	TCX1	0%
	TCX2	0%
	DCB1	0%
	DCB2	0%
2-BH-6MS	TCX1	3%
	TCX2	3%
	DCB1	13%
	DCB2	12%

Sample 2-BH-6MS was qualified as 'UJ', estimated, for the non-detectable results, due to low surrogate spike recovery. Sample 2-BH-11 was also qualified as 'UJ', estimated, for the non-detectable results. It appears that the sample may not have been spiked with the surrogate compounds. The corresponding field duplicate generated acceptable recovery of the surrogates.

3.3 MS/MSD

MS/MSD sample sets for both water and soils were analyzed for Pesticides and PCBs. Acceptable accuracy and precision were generated. However, for Case No. 9400.675, the soil MS/MSD 2-SS-13 exhibited low spike recovery for five of the six compounds. Precision was found to be acceptable for the soil MS/MSD. One Matrix Spike Blank (MSB) for the soils was also analyzed with the Case. Acceptable accuracy was generated. It appears that the MS/MSD sample set 2-BH-6 for Case 9400.676 inadvertently was not spiked with the MS/MSD Pesticide compounds, due to 0% recovery for both the MS and MSD. An MSB for soils also was analyzed for the Case. Acceptable percent recovery was generated.

3.4 Blanks

3.4.1 Field Blanks

3.4.1.1 Case No. 9400.675

One rinsate blank (2-BH-5R) was collected on 4/08/94 and analyzed for Pesticides and PCBs. Positive results were not detected.

3.4.1.2 Case No. 9400.676

One rinsate blank (2-SS-15R) was collected on 4/07/94 and analyzed for Pesticide and PCBs. Positive results were not detected.

3.4.2 Method Blanks

3.4.2.1 Case No. 9400.547

Three water method blanks were analyzed for the Case. Pesticides and PCBs were not detected in any of the method blanks.

3.4.2.2 Case No. 9400.557

One water method blank was analyzed for the Case. Pesticides and PCBs were not detected.

3.4.2.3 Case No. 9400.675

One water method blank and two soil method blanks were analyzed for the Case. Pesticides and PCBs were not detected in the method blanks.

3.4.2.4 Case No. 9400.676

One water method blank and three soil method blanks were analyzed for the Case. Pesticides and PCBs were not detected in the method blanks.

3.5 Instrument GC Performance

Adequate chromatographic resolution and instrument sensitivity were achieved through the generation of data within acceptable limits for the Resolution Check Mixture and

Performance Evaluation Mixtures. Review items included resolution between adjacent peaks, retention time windows, Relative Percent Difference (RPD), and percent breakdown for DDT/Endrin.

3.6 Calibration

All initial and continuing calibration was performed within acceptable limits for the individual standard mixtures, with the following exceptions. Review items included resolution, retention time windows, calibration factors (CF), percent RSD for linearity, RPD and %R.

3.6.1 Case No. 9400.675 and 9400.676

GPC Calibration:

Aldrin	115% R	(Limit 80-110)

The associated positive results for aldrin were qualified as 'J', estimated.

3.7 Compound Identification

GC qualitative analyses are considered to be acceptable. Data was generated in accordance with protocols. Various positive results were qualified as 'J', estimated, where the percent difference between the two GC columns exceeded 25%. The lower of the two results is reported, as per the protocol.

4.0 INORGANIC ANALYSES BY AA AND ICP
(Mercury by Cold Vapor and Cyanide by Spectrophotometry)

The following items/criteria were reviewed:

* Holding Times
* Initial and Continuing Calibration
* Blanks (Initial, Continuing Calibration, and Preparation)
* Field Blanks
* ICP Interference Check Sample
* Matrix Spike Sample Recovery
* Laboratory Duplicates
* Laboratory Control Sample (LCS)
* ICP Serial Dilution

All items above were generated within acceptable QC specifications, with deviations detailed as follows. All data is considered to be valid and usable with the appropriate qualifiers, as noted on the data summary forms in Appendix D and within the following text.

4.1 Holding Times

All holding times were met within the acceptable time frame from collection for metals (6 months), mercury (28 days), and cyanide (14 days).

4.2 Calibration

All initial and continuing calibration was performed within acceptable limits for percent recovery. However, sodium exceeded the acceptable recovery limit on 3/30/94 at 15:03 for Case No. 9400.547. The samples are qualified for sodium in *Section 4.6, Laboratory Duplicates* and do not require additional qualification.

4.3 Blanks

4.3.1 Laboratory (Method) Blanks

All initial calibration, continuing calibration, and preparation blanks were generated in accordance with acceptable limits.

4.3.2 Field Blanks

Field blanks were not collected for Inorganic analyses.

4.4 ICP Interference Check

The ICP Interference Check samples were generated within the acceptable limit of 80-120% for recovery.

4.5 Spiked Sample Recovery

All percent recoveries for the matrix spike samples were found to be within the 75-125% limit.

4.6 Laboratory Duplicates

Precision (relative percent difference) for the water samples was found to be acceptable for all the elements, with the following exceptions.

4.6.1 Case No. 9400.547

Sample ID		
2-GW-76	Sodium	94.5% RPD

The positive results for sodium for the water samples were qualified as 'J', estimated.

4.7 Laboratory Control Sample (LCS)

The aqueous laboratory control samples were generated within acceptable limits.

4.8 ICP Serial Dilution

ICP Serial Dilution was found to be within the acceptable 10% limit for percent difference, with the following exceptions.

4.8.1 Case No. 9400.675

Iron	21.7% D
Manganese	17.9%

Positive results for iron and manganese which exceeded 50 times the Instrument Detection Limit were qualified as 'J', estimated.

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MEMORANDUM

TO: John Walter, E & E Project Manager

FROM: Lynn Hess, E & E QA Chemist

DATE: September 6, 1994

SUBJECT: Comments on ChemWorld Environmental Inc.'s Data Validation Report for Bainbridge Naval Training Center, Work Order # 2.

CC: Marcia Meredith Galloway, E & E QA Officer

ChemWorld Environmental Inc.'s (CW's) Data Validation Report # 6 for the Bainbridge Naval Training Center (BNTC), dated July 1994 was performed under Work Order # 2 for samples collected between March 22 and April 8, 1994. The report covers analytical data contained in four E & E data packages; 9400.547/557/675/676.

Given below are our quality assurance/quality control (QA/QC) comments regarding data usability, providing further explanation/clarification and including any differing opinions. In addition, we have included comments on overall precision based on assessment of field duplicate results for this sampling event. Revised data summary sheets are attached which give our qualifiers where they differ from CW's.

QA/QC COMMENTS

COMMENT 1

Samples 1-GW-16, 1-GW-26, and 1-GW-76 from job 9400.557 were resampled for semivolatiles and pesticide/PCBs due to the temperature of the cooler they were shipped in upon receipt

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at the laboratory. The semivolatile and pesticide/PCBs were reported in job 9400.675.

COMMENT 2

The quantitation limits reported on the FORM I's for 1-GW-016BMS and 1-GW-016BMSD are incorrect. The quantitation limits should be two times the reported value due to the limited samples amounts extracted (500 mls).

COMMENT 3

Several volatile and pesticide/PCBs analysis required dilutions due to the high levels of various contaminants. In some cases both analyses were reported. The validation qualifier "R" was used in these cases on the data summary sheets to indicate the result that is considered less reliable.

OVERALL PRECISION

Field duplicate results indicate good overall precision for inorganics, with the exception of aluminum with an RPD of 142%, copper with an RPD of 117% and zinc with an RPD of 132% in 1-GW-36/1-GW-36D duplicate set (see Table 1). The soluble metals show food RPD while the insoluble metal show poor precision which could be due to varying level of total suspended solids. These may have implications if the ground-water was filtered. Overall precision for organics was good (see Table 2).

Table 1

BNTC GROUNDWATERS

FIELD DUPLICATE RESULTS - INORGANIC

(Results in ug/L)

Parameter	1-GW-36	1-GW-36D	RPD
Aluminum	121	717	142
Barium	113	114	0.9
Calcium	77600	77300	0.4
Chromium	4.6	6.5	34.2
Cobalt	7.3	9.4	25.1
Copper	5.9	22.4	117
Iron	37500	37200	0.8
Lead	1.5	2.3	42.1
Magnesium	36800	36500	0.8
Manganese	6550	6530	0.3
Nickel	11.2	12.3	9.4
Potassium	5350	5120	4.4
Sodium	46400	45400	2.2
Zinc	2.0	9.8	132

Parameter	2-GW-126	2-GW-126D	RPD
Aluminum	80.3	127	45.0
Barium	25.5	22.8	11.2
Calcium	14400	13000	10.2
Iron	225	193	15.3
Lead	1.4	IN	NC
Magnesium	6760	6380	5.8
Manganese	50.2	43.7	13.8
Nickel	5.6	IN	NC
Silver	2.9	IN	NC
Sodium	11500	14700	24.4
Zinc	16.9	13.5	22.4
Chromium	IN	2.9	NC

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Table 1 cont.

BNTC GROUNDWATERS

FIELD DUPLICATE RESULTS - INORGANIC

(Results in ug/L)

Parameter	1-GW-116	1-GW-11D6	RPD
Aluminum	1450	1740	18.2
Barium	46.0	47.7	3.6
Beryllium	0.18	0.26	36.4
Calcium	25700	26600	3.4
Copper	12.1	133.6	11.7
Iron	2540	2920	13.9
Lead	1.6	1.2	28.6
Magnesium	13000	13500	3.8
Manganese	63.5	68.7	7.9
Potassium	3250	3140	3.4
Sodium	41500	42300	1.9
Vanadium	8.6	8.0	7.2
Zinc	43.8	39.5	10.3

IN = Indeterminant

ND = Not Detected

Table 2

BNTC GROUNDWATERS

FIELD DUPLICATE RESULTS - ORGANIC

(Results in ug/L)

Parameter	1-GW-36	1-GW-36D	RPD
Chlorobenzene	430	480	11.0
2-Chlorophenol	5	6	18.2
1,4-Dichlorobenzene	25	29	14.8
Naphthalene	2	2	0
Diethylphthalate	IN	1	NC

Parameter	1-GW-36	1-GW-36D	RPD
Chlorobenzene	370	340	8.5

Parameter	2-GW-126	2-GW-126D	RPD
1,1,2,2-Tetrachloroethane	7	5	33.3
Dimethylphthalate	10	12	18.2

Parameter	1-GW-116	1-GW-11D6	RPD
1,2-Dichloroethene(total)	3	3	0
Dimethylphthalate	1	1	0

Parameter	2-SS-2	2-SS-2D	RPD
4,4'-DDE	13000	18000	32.2
4,4'-DDD	13000	18000	32.2
4,4'-DDT	30000	40000	28.6

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Table 2 cont.

BNTC GROUNDWATERS

FIELD DUPLICATE RESULTS - ORGANIC

(Results in ug/L)

Parameter	2-SS-2DL	2-SS-2DDL	RPD
4,4'-DDE	13000	18000	32.2
4,4'-DDD	14000	20000	35.3
4,4'-DDT	66000	77000	15.4

Parameter	2-BH-11	2-BH-11D	RPD
4,4'-DDE	IN	1.8	NC
4,4'-DDD	IN	6.4	NC

IN = Indeterminant

ND = Not Detected

CW CHEMWORLD ENVIRONMENTAL, INC.
Environmental Consultants

MEMORANDUM

TO: Lynn Hess, Ecology & Environment, Inc.

FROM: Andrea Schuessler, ChemWorld Environmental, Inc. ARS

DATE: July 29, 1994

RE: Bainbridge Project - General Chemistry Review/NEESA Level C
Total Recoverable Petroleum Hydrocarbons (TRPH)
Case No.'s 9400.547, 9400.557 and 9400.675

The general chemistry analytical data review for the Bainbridge Project has been completed for Total Recoverable Petroleum Hydrocarbons (TRPH) for the water samples. All quality control data as presented in the data packages referenced above was found to be acceptable. The TRPH data does not require qualification based upon review of the associated quality control data. Review items included the following areas :

* Holding Times (28 days from collection)
* Reference Standards (Limit 80-120% for recovery)
* Method Blanks (Contamination should not be detected)
* Laboratory Control Samples or Blank Spikes (Limit 75-125% for recovery)

Matrix Spike samples and laboratory duplicates were not analyzed for the three Cases reviewed.

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DATA VALIDATION

MEMORANDUM

TO: John Walter, Ecology and Environment, Inc., Project Manager

FROM: Lynn Hess, Ecology and Environment, Inc., Quality Assurance Chemist

DATE: September 7, 1994

SUBJECT: Data Validation Report for Bainbridge Naval Training Center, Groundwaters round 7. Ecology and Environment, Inc., Analytical Service Center job number 9401.193.

CC: Marcia Galloway, Ecology and Environment, Inc., Quality Assurance Officer

Samples and Matrix: Twelve water samples.

1-GW-27	1-GW-117	2-GW-087
1-GW-37	1-GW-127	2-GW-097
1-GW-37D	2-GW-77	2-GW-107
1-GW-77	2-GW-77D	TB-60294

Twelve water samples were collected for some/all of the following analyses: Inorganics by Atomic Absorption (AA) and Inductively Coupled Argon Plasma (ICP); Mercury by Cold Vapor; and Cyanide by Spectrophotometry; total recoverable petroleum hydrocarbons (TRPH) Method 418.1; base neutral/acid extractable organic compounds (BNA) by GC/MS; chlorinated pesticides/polychlorinated biphenyls (Pest/PCB) by GC; and volatile organic compounds (VOC) by GC/MS. Specific analyses conducted on each sample are documented in the chain-of-custody forms provided. The analytical laboratory work was performed by Ecology and Environments, Inc.'s (E & E) Analytical Services Center (ASC).

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This report provides a summary of data acceptability and deviations in accordance with the **Naval Energy and Environmental Support Activity (NEESA) Level C** requirements, as stated in the document **Quality Assurance in Environmental Analysis, October 1990**, and the applicable portions for Pesticides/PCB review from the USEPA's **CLP National Function Guidelines for Organic Data Review, February 1994**. In addition, the Contract Laboratory Program (CLP) portion of the corresponding USEPA Statements of Work (SOW) were utilized, where applicable and relevant.

1.0 VOLATILE ORGANICS BY GC/MS

1.1 HOLDING TIMES

All holding times were met within the acceptable time frame of 14 days from collection for the acid preserved waters.

1.2 SYSTEM MONITORING COMPOUND

All system monitoring recovery (%R) was found to be generated within acceptable limits for the three surrogate compounds, with the following exception:

Toluene-d8	1-GW-77	117% R (Limit 88-110)

Results for sample 1-GW-77 were qualified "R" as not usable, results from sample 1-GW-77RE for VOC should be used.

1.3 MATRIX SPIKE/MATRIX SPIKE DUPLICATES (MS/MSD)

Sample 1-GW-77 was analyzed as an MS/MSD for water samples. Acceptable accuracy (percent recovery) and precision (relative percent difference) were generated.

1.4 CALIBRATION

All initial and continuing calibrations were performed within acceptable limits for average Relative Response Factors, Percent Relative Standard Deviation (%RSD),

Relative Response Factors (RRF), and percent Difference (%D), with the following exception:

Date	Time	Compound	% D	Limit
6/8/94	03:41	Chloromethane	32.1%	25%
		Bromomethane	29.6%	
		Vinyl Chloride	32.6%	
		Chloroethane	26.0%	
		Carbon Disulfide	28.0%	

None of the compounds listed above were detected in the samples associated with this continuing calibration, no qualification is necessary.

1.5 BLANKS

1.5.1 Field Blanks

One trip blank, TB-60294 was collected and analyzed for VOCs with no positive results.

1.5.2 Method Blanks

Two water method blanks were analyzed for VOCs, compounds were detected as follows:

Blank		
VBLKW2	Methylene Chloride	2 ug/L, estimated

A limit of ten times the methylene chloride blank value was used for review and qualification of the water samples. No qualification is required, methylene chloride was not detected in any of the associated samples.

1.6 GC/MS INSTRUMENT PERFORMANCE CHECK

Instrument performance was within acceptable limits and frequency for Bromofluorobenzene (BFB).

1.7 TENTATIVELY IDENTIFIED COMPOUNDS (TICs)

TICs, which were generated in accordance with protocol, are summarized on Data Summary Form 1 VOA-TIC.

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1.8 INTERNAL STANDARDS

All internal standards were within acceptable specifications for area counts and retention time variation.

2.0 SEMI-VOLATILE ORGANICS BY GC/MS

2.1 HOLDING TIMES

All holding times were met for extraction and anlysis of the water samples. The USEPA technical holding time for water is 7 days from collection to extraction, and 40 days from extraction to analysis.

2.2 SURROGATE RECOVERY

All surrogate recoveries were within acceptable limits for the eight surrogate compounds.

2.3 MS/MSD

Sample 1-GW-117 was analyzed as an MS/MSD for water samples. Acceptable accuracy (percent recovery) and precision (relative percent difference) were generated with the exception of:

	% RECOVERY		
Compound	MS	MSD	Limit
4-Nitrophenol	84	92	(10-80)

Due to the high percent recoveries and 4-nitrophenol not detected in the samples, no qualification is necessary.

2.4 CALIBRATION

All initial and continuing calibrations were performed within acceptable limits for average Relative Response Factors, %RSD, RRF, and %D, with the following exception:

Date	Time	Compound	% D	Limit
6/10/94	12:52	3,3'-Dichlorobenzidine	36.9%	25%

Date	Time	Compound	% D	Limit
6/16/94	11:38	4-Chloro-3-methylphenol	-28.0	25%
		Di-n-butylphthalate	-33.8	
		3,3'-Dichlorobenzidine	-39.2	
		Dibenz(a,h)anthracene	-30.0	
		Benzo(g,h,i)perylene	-27.4	

Sample 1-GW-117MS and 1-GW-117MSD are qualified "J" as estimated for 4-chloro-3-methylphenol, no other compounds listed above were detected in the samples associated with this continuing calibration, therefore no further qualification is necessary.

2.5 BLANKS

2.5.1 Field Blanks

Field blanks were not collected for BNAs analyses.

2.5.2 Method Blanks

Two water method blanks were analyzed for BNAs, compounds were detected as follows:

Blank

SBLKW2 bis(2-Ethylhexyl)phthalate 1 ug/L, estimated

A limit of ten times the bis(2-Ethylhexyl)phthalate blank value was used for review and qualification of the water samples. Sample results which were found to be below the respective blank limit and reported at less than the CRQL were qualified as "U", not detected, at the CRQL.

2.6 GC/MS INSTRUMENT PERFORMANCE CHECK

Instrument performance was within acceptable limits and frequency for Decafluorophenylphosphine (DFTPP).

2.7 TENTATIVELY IDENTIFIED COMPOUNDS (TICs)

TICs, which were generated in accordance with protocol, are summarized on Data Summary Form 1 SV-TIC.

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2.8 INTERNAL STANDARDS

All internal standards were within acceptable specifications for area counts and retention time variation, with the following exceptions.

Sample ID	Internal Standard	Reported Area Count	Lower Limit
2-GW-087	Perylene-d12	96244	130831

The sample above was qualified as "J", estimated, for the positive results, and "UJ", estimated, for the non-detectable results, for the compounds associated with the internal standard noted above. Some compounds are qualified "R" as unuseable due to the level detected or there present in the diluted reanalysis, 2-GW-087DL. Most of the results from 2-GW-087DL are qualified "R" as unuseable due to the elevated detection limit, some are useable due to their level or lack of detection in 2-GW-087.

3.0 PESTICIDE/PCBs BY GC

3.1 HOLDING TIMES

All holding times were met for extraction and analysis of the water samples. The USEPA technical holding time for water is 7 days from collection to extraction, and 40 days from extraction to analysis.

3.2 SURROGATE RECOVERY

All surrogate recoveries were within acceptable limit of 30-150% as per the USEPA Functional Guidelines, (February 1994).

3.3 MS/MSD

MS/MSD sample set was reported with job number 9401.-174. Acceptable accuracy (percent recovery) and precision (relative percent difference) were generated.

3.4 BLANKS

3.4.1 Field Blanks

Field blanks were not collected for Pest/PCBs.

3.4.2 Method Blanks

One water method blank was analyzed for Pest/PCBs. Pesticide and PCBs were not detected in the method blank.

3.5 INSTRUMENT GC PERFORMANCE

Adequate chromatographic resolution and instrument sensitivty were achieved through the generation of data within acceptable limits for the Resolution Check Mixture and Performance Evaluation Mixtures. Review items included resolution between adjacent peaks, retention time windows, RPD, and percent breakdown for DDT/Endrin.

3.6 CALIBRATION

All initial and continuing calibrations were performed within acceptable limits for the individual standard mixture. Review items included resolution, retention time windows, calibration factors (CF), percent RSD for linearity, RPD and %R.

3.7 COMPOUND IDENTIFICATION

GC qualitative analyses are considered acceptable. Data was generated in accordance with protocols.

4.0 TOTAL RECOVERABLE PETROLEUM HYDROCARBON

4.1 HOLDING TIMES

All holding times were met within the acceptable time frame of 28 days from collection for the acid preserved waters.

4.2 REFERENCE STANDARDS

All reference standards recoveries were within acceptable limit of 80-120%.

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4.3 BLANKS

4.3.1 Field Blanks

Field blanks were not collected for TRPH analyses.

4.3.2 Method Blanks

Two water method blanks were analyzed for TRPH. TRPHs were not detected in any of the method blanks.

4.4 LABORATORY CONTROL SAMPLES (LCS)

The percent recoveries for the aqueous laboratory control samples were within acceptable limits (75-125%).

5.0 INORGANIC ANALYSES BY AA AND ICP

(Mercury by Cold Vapor & Cyanide by Spectrophotometry)

5.1 HOLDING TIMES

All holding times were met within the acceptable time frame from collection for metals (6 months), mercury (28 days), and cyanide (14 days).

5.2 CALIBRATION

All initial and continuing calibration were performed within acceptable limits for percent recovery.

5.3 BLANKS

5.3.1 Laboratory Method Blanks

All initial calibration, continuing calibration, and preparation blanks were within acceptable limits with the exception of manganese at 1.4 ug/L in the continuing calibration blank. A limit of five times this manganese value was used for review and qualification of the water samples. Associated sample results which were detected below the blank limit and reported at less than the CRDL were qualified as, "J" estimated values.

5.3.2 Field Blanks

Field blanks were not collected for Inorganic analyses.

5.4 ICP INTERFERENCE CHECK

The ICP Interference Check samples were within acceptable limits of 80-120% recovery.

5.5 SPIKE SAMPLE RECOVERY

All percent recoveries for the matrix spike samples were found to be within the 75-125% limit.

5.6 LABORATORY DUPLICATES

Precision (relative percent difference) for the water samples was found to be acceptable for all the elements, with the following exceptions.

Sample ID	Element	% RPD
1-GW-77	Zinc	68.7 % RPD

The positive results for zinc for the water samples were qualified as "J", estimated values.

5.7 LCS

The aqueous LCS were within acceptable limits.

5.8 ICP SERIAL DILUTION

ICP Serial Dilution was found to be within the acceptable 10% limit for percent difference, with the following exceptions.

Element	% RPD
Iron	17.5%
Sodium	15.4%
Zinc	10.5%

Positive results for iron, sodium and zinc which exceeded 50 times the Instrument Detection Limit were qualified as "J", estimated.

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OVERALL PRECISION

Field duplicate results indicate good overall precision for inorganics, with the exception of aluminum with an RPD of 49.5% and iron with an RPD of 45.8% (see Table 1). Overall precision for organics was also good with the exception of bis(2-Ethylhexyl)phthalate with an RPD of 66.7% (see Table 2). The lack of precision is attributable to the low levels of the contaminants. The dimethylphthalate and bis(2-Ethylhexyl)phthalate at the levels reported is most likely due to field or laboratory contamination. The dimethylphthalate and bis(2-Ethylhexyl)phthalate are a common plasticizer found in the gloves used in the field and laboratory.

Table 1

BNTC GROUNDWATERS

FIELD DUPLICATE RESULTS - INORGANIC

(Results in ug/L)

Parameter	1-GW-37	1-GW-37D	RPD
Aluminum	766	462	49.5
Barium	106	115	8.3
Calcium	73100	80200	9.3
Cobalt	9.7	10.9	11.6
Copper	17.7	18.1	2.2
Iron	32400	35000	7.7
Lead	1.2	ND	IN
Magnesium	35700	39100	9.1
Manganese	5940	6570	10.1
Nickel	8.0	7.4	7.8
Potassium	3840	4030	4.8
Sodium	49500	50900	2.8
Vanadium	7.0	7.2	2.8
Zinc	131	140	2.6

Parameter	2-GW-77	2-GW-77D	RPD
Aluminum	56.7	60.0	5.6
Barium	25.5	23.6	7.7
Calcium	12000	11800	1.7
Iron	71.0	112	44.8
Magnesium	6050	6040	0.2
Manganese	4.2	4.4	4.6
Sodium	8230	7980	3.1
Zinc	9.7	7.3	28.2

IN = Indeterminant

ND = Not Detected

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Table 2

BNTC GROUNDWATERS

FIELD DUPLICATE RESULTS - ORGANIC

(Results in ug/L)

Parameter	1-GW-37	1-GW-37D	RPD
Chlorobenzene	160	160	0
2-Chlorophenol	4	4	0
1,4-Dichlorobenzene	22	28	24.0
bis(2-Ethylhexyl)phthalate	1	2	66.7

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DATA VALIDATION

MEMORANDUM

TO: John Walter, Ecology and Environment, Inc., Project Manager

FROM: Lynn Hess, Ecology and Environment, Inc., Quality Assurance Chemist

DATE: September 8, 1994

SUBJECT: Data Validation Report for Bainbridge Naval Training Center, Groundwaters round 7. Ecology and Environment, Inc., Analytical Service Center job numbers 9401.174 and 9401.192.

CC: Marcia Galloway, Ecology and Environment, Inc., Quality Assurance Officer

Samples and Matrix: Nineteen water samples.

1-GW-17	1-GW-97	2-GW-47	2-GW-117
1-GW-47	1-GW-137	2-GW-57	2-GW-127
1-GW-57	2-GW-17	2-GW-67	2-GW-137
1-GW-67	2-GW-27	2-GW-107	TB-60194
1-GW-87	2-GW-37	2-GW-107D	

Nineteen water samples were collected for some/all of the following analyses: Inorganics by Atomic Absorption (AA) and Inductively Coupled Argon Plasma (ICP); Mercury by Cold Vapor; and Cyanide by Spectrophotometry; total recoverable petroleum hydrocarbons (TRPH) Method 418.1; base neutral/acid extractable organic compounds (BNA) by GC/MS; chlorinated pesticides/polychlorinated biphenyls (Pest/PCB) by GC; and volatile organic compounds (VOC) by GC/MS. Specific analyses conducted on each sample are documented in the chain-of-custody forms provided. The analytical laboratory work was performed by Ecology and Environments, Inc.'s (E & E) Analytical Services Center (ASC).

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This report provides a summary of data acceptability and deviations in accordance with the **Naval Energy and Environmental Support Activity (NEESA) Level C** requirements, as stated in the document **Quality Assurance in Environmental Analysis, October 1990**, and the applicable portions for Pesticides review from the USEPA's **CLP National Function Guidelines for Organic Data Review, February 1994**. In addition, the Contract Laboratory Program (CLP) portion of the corresponding USEPA Statements of Work (SOW) were utilized, where applicable and relevant.

1.0 VOLATILE ORGANICS BY GC/MS

1.1 HOLDING TIMES

All holding times were met within the acceptable time frame of 14 days from collection for the acid preserved waters.

1.2 SYSTEM MONITORING COMPOUND

All system monitoring recovery (%R) was found to be generated within acceptable limits for the three surrogate compounds, with the following exception:

Toluene-d8	2-GW-107	117% R (Limit 88-110)
Bromofluorobenzene	2-GW-107RE	85% R (Limit 86-115)

Results for sample 2-GW-107RE were qualified "R" as not usable, results from sample 2-GW-107 for VOC should be used. No qualification is necessary due to high percent recovery, all compounds were not detected.

1.3 MATRIX SPIKE/MATRIX SPIKE DUPLICATES (MS/MSD)

Sample 1-GW-67 and 2-GW-37 were analyzed as an MS/MSDs for water samples. Acceptable accuracy [percent recovery (%R)] and precision [relative percent difference (RPD)] were generated with the exception of:

Compound	RPD	Limit
Benzene	12	(11)

Since benzene was not detected in the samples, no qualification is necessary.

1.4 CALIBRATION

All initial and continuing calibrations were performed within acceptable limits for average Relative Response Factors, Percent Relative Standard Deviation (%RSD), Relative Response Factors (RRF), and percent Difference (%D), with the following exception:

Date	Time	Compound	% D	Limit
6/3/94	15:41	Chloromethane	42.6%	25%
		Vinyl Chloride	29.8%	
		Chloroethane	26.0%	
		Acetone	-48.4%	
		Carbon Disulfide	27.3%	
		4-Methyl-2-pentanone	31.6%	
6/7/94	12:54	Chloromethane	26.8%	25%
		4-Methyl-2-pentanone	26.2%	
6/8/94	16:05	Acetone	49.2%	25%
		Carbon Disulfide	33.8%	
		2-Butanone	29.1%	
		2-Hexanone	47.8	
6/9/94	09:03	Chloromethane	-25.5%	25%
		Acetone	45.8%	
		2-Butanone	32.1%	
		2-Hexanone	34.4	
6/6/94	09:49	Chloromethane	-38.9%	25%
		Vinyl Chloride	-30.2%	
		Carbon Disulfide	-117.5%	
		2-Butanone	-27.1%	

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Date	Time	Compound	% D	Limit
6/8/94	03:41	Chloromethane	32.1%	25%
		Bromomethane	29.6%	
		Vinyl Chloride	32.6%	
		Chloroethane	26.0%	
		Carbon Disulfide	28.0%	

None of the compounds listed above were detected in the samples associated with the continuing calibration, no qualification is necessary.

1.5 BLANKS

1.5.1 Field Blanks

One trip blank, TB-60194 was collected and analyzed for VOCs with no positive results.

1.5.2 Method Blanks

Six water method blanks were analyzed for VOCs, compounds were detected as follows:

Blank		
VBLKW3	Methylene Chloride	2 ug/L, estimated
VBLKW6	Methylene Chloride	2 ug/L, estimated

A limit of ten times the methylene chloride blank value was used for review and qualification of the water samples. No qualification is required, methylene chloride was not detected in any of the associated samples.

1.6 GC/MS INSTRUMENT PERFORMANCE CHECK

Instrument performance was within acceptable limits and frequency for Bromofluorobenzene (BFB).

1.7 TENTATIVELY IDENTIFIED COMPOUNDS (TICs)

TICs, which were generated in accordance with protocol, are summarized on Data Summary Form 1 VOA-TIC.

1.8 INTERNAL STANDARDS

All internal standards were within acceptable specifications for area counts and retention time variation.

2.0 SEMI-VOLATILE ORGANICS BY GC/MS

2.1 HOLDING TIMES

All holding times were met for extraction and anlysis of the water samples. The USEPA technical holding time for water is 7 days from collection to extraction, and 40 days from extraction to analysis.

2.2 SURROGATE RECOVERY

All surrogate recoveries were within acceptable limits for the eight surrogate compounds.

2.3 MS/MSD

Samples 1-GW-67 and 2-GW-37 was analyzed as an MS/MSD for water samples. Acceptable accuracy, %R, and precision, RPD were generated with the exception of:

	% RECOVERY		
Compound	MS	MSD	Limit
4-Nitrophenol	97	97	(10-80)
Pentachlorophenol	109	108	(9-103)

for 1-GW-67 and

	% RECOVERY		
Compound	MS	MSD	Limit
4-Nitrophenol	88	84	(10-80)

for 2-GW-37.

Due to the high percent recoveries and 4-nitrophenol and pentachlorophenol not detected in the samples, no qualification is necessary.

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2.4 CALIBRATION

All initial and continuing calibrations were performed within acceptable limits for average Relative Response Factors, %RSD, RRF, and %D, with the following exception:

Date	Time	Compound	% D	Limit
6/10/94	00:31	N-Nitroso-Di-n-propylamine	-27.1	25%
		4-Nitroaniline	36.6	
		Di-n-butylphthalate	-39.2	
		Butylbenzylphthalate	-25.8	
		3,3'-Dichlorobenzidine	44.8	
		bis(2-Ethylhexyl)phthalate	-31.4	
		Di-n-octylphthalate	-25.4	
6/7/94	11:52	2,4-Dinitrophenol	29.0	
6/8/94	02:53	Di-n-butylphthalate	-25.6	
		3,3'-Dichlorobenzidine	-39.2	
		Di-n-octylphthalate	-31.7	
		Dibenz(a,h)anthracene	-30.2	
		Benzo(g,h,i)perylene	-27.0	
6/8/94	15:04	Di-n-butylphthalate	-35.1	
		3,3'-Dichlorobenzidine	-49.7	
		Di-n-octylphthalate	-32.6	
		Indeno(1,2,3-cd)perylene	-30.4	
		Dibenz(a,h)anthracene	-36.4	
		Benzo(g,h,i)perylene	-30.4	

Method blank SBLKW2 is qualified "J" as estimated for bis(2-Ethylhexyl)phthalate, no other compounds listed above were detected in the samples associated with this continuing calibration, therefore no further qualification is necessary. Bis(2-Ethylhexyl)phthalate results are also qualified in Section 2.5.2, Method Blanks.

2.5 BLANKS

2.5.1 Field Blanks

Field blanks were not collected for BNAs analyses.

2.5.2 Method Blanks

Three water method blanks were analyzed for BNAs, compounds were detected as follows:

Blank

SBLKW2 bis(2-Ethylhexyl)phthalate 2 ug/L, estimated

A limit of ten times the bis(2-Ethylhexyl)phthalate blank value was used for review and qualification of the water samples. Sample results which were found to be below the respective blank limit and reported at less than the CRQL were qualified as "U", not detected, at the CRQL.

2.6 GC/MS INSTRUMENT PERFORMANCE CHECK

Instrument performance was within acceptable limits and frequency for Decafluorophenylphosphine (DFTPP).

2.7 TENTATIVELY IDENTIFIED COMPOUNDS (TICs)

TICs, which were generated in accordance with protocol, are summarized on Data Summary Form 1 SV-TIC.

2.8 INTERNAL STANDARDS

All internal standards were within acceptable specifications for area counts and retention time variation.

3.0 PESTICIDE/PCBs BY GC

3.1 HOLDING TIMES

All holding times were met for extraction and analysis of the water samples. The USEPA technical holding time for water is 7 days from collection to extraction, and 40 days from extraction to analysis.

3.2 SURROGATE RECOVERY

All surrogate recoveries were within acceptable limit of 30-150% as per the USEPA Functional Guidelines, (February 1994).

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3.3 MS/MSD

Acceptable accuracy (percent recovery) and precision (relative percent difference) were generated for the MS/MSD sets for Pest/PCBs.

3.4 BLANKS

3.4.1 Field Blanks

Field blanks were not collected for Pest/PCBs.

3.4.2 Method Blanks

One water method blank was analyzed for Pest/PCBs. Pesticide and PCBs were not detected in the method blank.

3.5 INSTRUMENT GC PERFORMANCE

Adequate chromatographic resolution and instrument sensitivty were achieved through the generation of data within acceptable limits for the Resolution Check Mixture and Performance Evaluation Mixtures. Review items included resolution between adjacent peaks, retention time windows, RPD, and percent breakdown for DDT/Endrin.

3.6 CALIBRATION

All initial and continuing calibrations were performed within acceptable limits for the individual standard mixture, with the following exceptions. Review items included resolution, retention time windows, calibration factors (CF), percent RSD for linearity, RPD and %R.

Column	Date	Compound	%RSD	Limit
RTX-5	6/13/94	Endrin ketone	20.6%	(20)
RTX-35	6/13/94	Methoxychlor	25.7%	(20)

Column	Date	Compound	%RPD	Limit
RTX-35	6/14/94	Methoxychlor	25.5%	(25)

The samples associated with the above listed calibra-

tion are qualified estimated, "UJ" when the compounds are not detected and "J" when detected.

3.7 COMPOUND IDENTIFICATION

GC qualitative analyses are considered acceptable. Data was generated in accordance with protocols.

4.0 TOTAL RECOVERABLE PETROLEUM HYDROCARBON

4.1 HOLDING TIMES

All holding times were met within the acceptable time frame of 28 days from collection for the acid preserved waters. Sample 1-GW-17 was not preserved and therefore has been qualified as an estimated value "UJ".

4.2 REFERENCE STANDARDS

All reference standards recoveries were within acceptable limit of 80-120%.

4.3 BLANKS

4.3.1 Field Blanks

Field blanks were not collected for TRPH analyses.

4.3.2 Method Blanks

Two water method blanks were analyzed for TRPH. TRPHs were not detected in any of the method blanks.

4.4 LABORATORY CONTROL SAMPLES (LCS)

The percent recoveries for the aqueous laboratory control samples were within acceptable limits (75-125%).

5.0 INORGANIC ANALYSES BY AA AND ICP

(Mercury by Cold Vapor & Cyanide by Spectrophotometry)

5.1 HOLDING TIMES

All holding times were met within the acceptable time frame from collection for metals (6 months), mercury (28 days), and cyanide (14 days).

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5.2 CALIBRATION

All initial and continuing calibration were performed within acceptable limits for percent recovery.

5.3 BLANKS

5.3.1 Laboratory Method Blanks

All initial calibration, continuing calibration, and preparation blanks were within acceptable limits with the exception of calcium at 137 ug/L in the continuing calibration blank and aluminum at 42.4 ug/L, iron at 11.1 ug/L, manganese at 2.75 ug/L, and zinc at 2.01 ug/L in the preparation blank. A limit of five times these values was used for review and qualification of the water samples. Associated sample results which were detected below the blank limit and reported at less than the CRDL were qualified as, "J" estimated values.

5.3.2 Field Blanks

Field blanks were not collected for Inorganic analyses.

5.4 ICP INTERFERENCE CHECK

The ICP Interference Check samples were within acceptable limits of 80-120% recovery.

5.5 SPIKE SAMPLE RECOVERY

All percent recoveries for the matrix spike samples were found to be within the 75-125% limit.

5.6 LABORATORY DUPLICATES

Precision (relative percent difference) for the water samples was found to be acceptable for all the elements, with the following exceptions.

Sample ID	Element	% RPD
1-GW-67	Zinc	22.4% RPD

The positive results for zinc for the water samples were qualified as "J", estimated values.

5.7 LCS

The aqueous LCS were within acceptable limits.

5.8 ICP SERIAL DILUTION

ICP Serial Dilution was found to be within the acceptable 10% limit for percent difference, with the following exceptions.

Element	% RPD
Sodium	25.9%

Positive results for sodium which exceeded 50 times the Instrument Detection Limit were qualified as "J", estimated.

OVERALL PRECISION

Field duplicate results indicate good overall precision for inorganics (see Table 1). Overall precision for organics was also good with the exception of bis(2-Ethylhexyl)phthalate with an RPD of 85.7% (see Table 2). The lack of precision is attributable to the low levels detected. The bis(2-Ethylhexyl)phthalate at the levels reported is most likely due to field or laboratory contamination. The bis(2-Ethylhexyl)phthalate is a common plasticizer found in the gloves used in the field and laboratory.

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Table 1

BNTC GROUNDWATERS

FIELD DUPLICATE RESULTS - INORGANIC

(Results in ug/L)

Parameter	2-GW-107	2-GW-107D	RPD
Aluminum	1360	1790	27.3
Barium	15.9	18.0	12.4
Calcium	8050	8380	4.0
Chromium	7.1	8.4	16.8
Copper	3.0	2.3	26.4
Iron	3590	4620	25.1
Lead	2.7	3.0	10.5
Magnesium	4870	5260	7.7
Manganese	63.6	75.3	16.8
Potassium	1270	1420	11.2
Sodium	15800	15900	0.6
Vanadium	ND	5.8	IN
Zinc	56.4	48.5	15.1

IN = Indeterminant

ND = Not Detected

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Table 2

BNTC GROUNDWATERS

FIELD DUPLICATE RESULTS - ORGANIC

(Results in ug/L)

Parameter	2-GW-107	2-GW-107D	RPD
bis(2-Ethylhexyl)phthalate	2	5	85.7

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August 1994 Sampling Event

DATA VALIDATION

MEMORANDUM

TO: John Walter, Ecology and Environment, Inc., Project Manager

FROM: Lynn Hess and Joanne McMullan, Ecology and Environment, Inc., Quality Assurance Chemists

DATE: November 3, 1994

SUBJECT: Data Validation Report for Bainbridge Naval Training Center, Groundwaters Round 8. Ecology and Environment, Inc., Analytical Service Center Job Numbers 9401.717/738/751.

CC: Marcia Galloway, Ecology and Environment, Inc., Quality Assurance Officer

Samples and Matrix: Forty-one water samples.

1-GW-018	1-GW-118	1-SW-148	2-GW-118
1-GW-028	1-GW-128	1-SW-168	2-GW-128
1-GW-038	1-GW-128D	1-SW-198	2-GW-138
1-GW-048	1-GW-138	2-GW-018	2-SW-018
1-GW-058	1-SW-048	2-GW-028	2-SW-048
1-GW-068	1-SW-078	2-GW-038	8-9-94-TB1
1-GW-068D	1-SW-088	2-GW-048	8-11-94TB1
1-GW-078	1-SW-108	2-GW-058	TRIP_BLANK
1-GW-088	1-SW-118	2-GW-078	
1-GW-098	1-SW-138	2-GW-078D	
1-GW-108	1-SW-138D	2-GW-108	

Forty-one water samples were collected for some/all of the following analyses: Inorganics by Atomic Absorption (AA) and Inductively Coupled Argon Plasma (ICP); Mercury by Cold Vapor; and Cyanide by Spectrophotometry; total recoverable petroleum hydrocarbons (TRPH) Method 418.1; base neutral/acid extractable organic compounds (BNA) by GC/MS; chlorinated pesticides/polychlorinated biphenyls (Pest/PCB) by GC; and volatile organic compounds (VOC) by GC/MS. Specific analyses conducted on each sample are documented in the chain-of-custody forms provided. Both total and dissolved metals analysis was requested for the groundwater (GW) samples. The analytical laboratory work was performed by Ecology and Environment, Inc.'s (E & E) Analytical Services Center (ASC).

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This report provides a summary of data acceptability and deviations in accordance with the Naval Energy and Environmental Support Activity (NEESA) Level C requirements as stated in the NEESA document Quality Assurance in Environmental Analysis, October 1990, and the applicable portions for Pesticides/PCB review from the USEPA's CLP National Functional Guidelines for Organic Data Review, February 1994. In addition, the Contract Laboratory Program (CLP) portion of the corresponding USEPA Statements of Work (SOW) were utilized, where applicable and relevant.

1.0 VOLATILE ORGANICS BY GC/MS

1.1 HOLDING TIMES

All holding times were met within the acceptable time frame of 14 days from collection for the acid preserved waters.

1.2 SYSTEM MONITORING COMPOUND

All system monitoring compound percent recovery (%R) was found to be generated within acceptable limits for the three surrogate compounds.

1.3 MATRIX SPIKE/MATRIX SPIKE DUPLICATES (MS/MSD)

Acceptable frequency, accuracy (percent recovery) and precision (relative percent difference) were generated for MS/MSDs.

1.4 CALIBRATION

All initial and continuing calibrations were performed within acceptable limits for average relative response factors (RRF), percent relative standard deviation (%RSD), and percent Difference (%D), with the following exceptions:

Date	Time	Compound	% D	Limit
8/12/94	00:20	2-Butanone	27.8	25
		2-Hexanone	29.4	
8/12/94	12:19	Chloromethane	30.7	25
		Acetone	63.6	
		2-Butanone	53.8	
		2-Hexanone	51.6	
8/16/94	10:30	Chloromethane	44.4	25
		Vinyl Chloride	26.1	
		Acetone	-143	
		Carbon Disulfide	36.8	
		2-Butanone	49.6	
		2-Hexanone	47.4	
8/17/94	07:34	1,1,2,2-Tetrachloroethane	-25.5	25

8/17/94	22:10	2-Butanone	26.3	25
		Bromoform	-36.4	
		1,1,2,2-Tetrachloroethane	-36.4	
8/23/94	01:55	Acetone	33.0	25
		Carbon Disulfide	31.7	
		2-Butanone	33.2	
		2-Hexanone	29.8	
8/22/94	03:22	Chloroethane	33.4	25
		Methylene Chloride	29.1	
		Acetone	64.0	
		Carbon Disulfide	30.1	
		2-Butanone	61.2	
		1,1,1-Trichloroethane	-27.7	
		Carbon Tetrachloride	-33.0	
		1,2-Dichloropropane	27.5	
8/22/94	03:22	4-Methyl-2-Pentanone	30.4	25
		2-Hexanone	48.0	

When the compounds listed above were detected in a sample or blank associated with the continuing calibration, a "J" qualifier was added to indicate an estimated concentration. Acetone in one method blank and sample 2-SW-048 and 1,1,2,2-tetrachloroethene in sample 2-GW-128 were the only compounds detected in the associated samples.

1.5 BLANKS

1.5.1 Field Blanks

Three trip blanks were collected and analyzed for VOCs. Acetone was detected in 8-11-94TB1 and in Trip_Blank at a maximum level of 16 µg/L; the 8-9-94TB1 had no positive results. The samples associated with 8-11-94TB1 and Trip_Blank were qualified "U" as not detected for acetone due to method blank contamination (see Section 1.5.2.).

1.5.2 Method Blanks

Eight water method blanks were analyzed for VOCs. Acetone was detected in four of the blanks at a maximum level of 39 µg/L. Associated sample results less than ten times the blank level were qualified "U" as not detected and elevated to the contract required quantitation limit (CRQL), if reported below the CRQL.

1.6 GC/MS INSTRUMENT PERFORMANCE CHECK

Instrument performance was within acceptable limits and frequency for Bromofluorobenzene (BFB).

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1.7 TENTATIVELY IDENTIFIED COMPOUNDS (TICs)

TICs, which were generated in accordance with protocol, are summarized on Data Summary Form 1 VOA-TIC.

1.8 INTERNAL STANDARDS

All internal standards were within acceptable specifications for area counts. The retention time for Chlorobenzene-d5 was slightly outside the acceptable retention time window (16.28-17.28) for sample 2-GW-028 (17.30). No qualification is necessary as this was a clean sample and no peaks were present.

1.9 COMPOUND QUANTITATION

Sample 1-GW-038 was analyzed at a twofold dilution due to chlorobenzene which exceeded the calibration limit. The chlorobenzene result from the diluted analysis and the undiluted results for the remaining compounds are considered more acceptable data.

2.0 SEMIVOLATILE ORGANICS BY GC/MS

2.1 HOLDING TIMES

All holding times were met for extraction and analysis of the water samples. The USEPA technical holding time for water is 7 days from collection to extraction, and 40 days from extraction to analysis.

2.2 SURROGATE RECOVERY

All surrogate recoveries were within acceptable limits for the eight surrogate compounds with the following exceptions:

Sample	Compound	% Recovery	Limit
SBLKW2	2-Fluorobiphenyl	42	43-116
2-SW-048	Terphenyl-d14	27	33-141

No qualification of the above listed samples is necessary according to the guidelines as only one surrogate was outside of the acceptable limits.

2.3 MS/MSD

Acceptable frequency, accuracy (percent recovery) and precision (relative percent difference) were generated with the following exceptions:

Compound	% Recovery MS	Limit
4-Nitrophenol	84	(10-80)

Due to the high percent recovery and 4-nitrophenol not being detected in the samples, no qualification is necessary.

2.4 CALIBRATION

All initial and continuing calibrations were performed within acceptable limits for average RRF, %RSD, and %D, with the following exceptions:

Date	Time	Compound	% D	Limit
8/19/94	13:35	2,4-Dinitrophenol	-34.8	25
8/22/94	10:27	Di-n-Butylphthalate	-26.3	25
8/22/94	21:42	4-Nitrophenol	30.1	25
8/23/94	10:01	2,4-Dinitrophenol	-27.1	25
8/25/94	06:06	Hexachlorocyclopentadiene	28.7	25
		2,4-Dinitrotoluenene	-30.4	
		Diethylphthalate	-29.6	
		4-Bromophenyl-phenylether	27.8	
		Butylbenzylphthalate	-32.2	
		bis(2-Ethylhexyl)phthalate	-25.0	
		Benzo(g,h,i)perylene	32.3	
8/26/94	08:29	2,4,5-Trichlorophenol	-26.0	25
		3,3'-Dichlorobenzidine	29.1	

When the compounds listed above were detected in a sample or blank associated with the continuing calibration, a "J" qualifier was added to indicate an estimated concentration. Bis(2-ethylhexyl)phthalate in samples 1-GW-018 and 1-GW-048 was the only compound detected in the associated samples.

2.5 BLANKS

2.5.1 Field Blanks

Field blanks were not collected for semivolatile analysis.

2.5.2 Method Blanks

Six method blanks were analyzed for semivolatiles and bis(2-ethylhexyl)phthalate (BEHP) was detected in two of the blanks at a maximum concentration of 24 µg/L. A limit of ten times the BEHP blank value was used for review and qualification of the associated samples. Sample results below the blank limit were qualified "U" as not detected and elevated to the CRQL, if reported below the CRQL.

2.6 GC/MS INSTRUMENT PERFORMANCE CHECK

Instrument performance was within acceptable limits and frequency for Decafluorophenylphosphine (DFTPP).

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2.7 TENTATIVELY IDENTIFIED COMPOUNDS (TICs)

TICs, which were generated in accordance with protocol, are summarized on Data Summary Form 1 SV-TIC. TICs which were also present in the associated method blank were qualified "U" as not detected.

2.8 INTERNAL STANDARDS

All internal standards for semivolatile analysis were within acceptable specifications for area counts and retention time variations.

3.0 PESTICIDE/PCBs BY GC

3.1 HOLDING TIMES

All holding times were met for extraction and analysis of the water samples. The USEPA technical holding time for water is 7 days from collection to extraction, and 40 days from extraction to analysis.

3.2 SURROGATE RECOVERY

All surrogate recoveries were within acceptable limit of 30-150% as per the USEPA Functional Guidelines, (February 1994) with the following exceptions:

Sample	Compound	% Recovery
PBLKW1	TCX1	11
	TCX2	9
	DCB1	8
	DCB2	7

TCX1 - Tetrachloro-m-xylene primary column
TCX2 - Tetrachloro-m-xylene confirmation column
DCB1 - Decachlorobiphenyl primary column
DCB2 - Decachlorobiphenyl confirmation column

No qualification is necessary as the recoveries in all of the associated samples were within the acceptable limit.

3.3 MS/MSD

Acceptable frequency, accuracy (percent recovery) and precision (relative percent difference) were generated.

3.4 BLANKS

3.4.1 Field Blanks

Field blanks were not collected for pesticide/PCBs analysis.

3.4.2 Method Blanks

No pesticide/PCB compounds were detected in the any of the method blanks.

3.5 INSTRUMENT GC PERFORMANCE

Adequate chromatographic resolution and instrument sensitivty were achieved through the generation of data within acceptable limits for the Resolution Check Mixture and Performance Evaluation Mixtures, with the following exceptions:

Date	Time	Compound	% RPD	Limit
9/6/94	13:27	Methoxychlor	27.2	25

No qualification was necessary, since there were no positive results for methoxychlor in associated samples. Review items included resolution between adjacent peaks, retention time windows, % RPD, and percent breakdown for DDT/Endrin.

3.6 CALIBRATION

All initial and continuing calibrations were performed within acceptable limits for the individual standard mixture. Review items included resolution, retention time windows, calibration factors (CF), percent RSD for linearity, RPD and %R.

3.7 COMPOUND IDENTIFICATION

GC qualitative analyses are considered acceptable. Data was generated in accordance with protocols.

4.0 TOTAL RECOVERABLE PETROLEUM HYDROCARBON

4.1 HOLDING TIMES

All holding times were met within the acceptable time frame of 28 days from collection for the acid preserved waters.

4.2 REFERENCE STANDARDS

All reference standards recoveries were within acceptable limit of 80-120%.

4.3 BLANKS

4.3.1 Field Blanks

Field blanks were not collected for total recoverable petroleum hydrocarbon (TRPH) analysis.

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4.3.2 Method Blanks

TRPHs were not detected in any of the method blanks, except one method blank in Job 9401.717 which contained TRPH at 4.4 mg/L. The associated sample, 2-GW-078D, was blank subtracted and reported as not detected for TRPH. The sample was not reanalyzed due to insufficient volume. The laboratory was experiencing a contamination problem with the Freon used. The field duplicate for this sample, 2-GW-078, was analyzed with an acceptable blank and gave a result of not detected. No data qualification is necessary.

4.4 LABORATORY CONTROL SAMPLES (LCS)

The percent recoveries for the aqueous laboratory control samples were within acceptable limits (75-125%).

5.0 INORGANIC ANALYSES BY AA AND ICP
(Mercury by Cold Vapor & Cyanide by Spectrophotometry)

5.1 HOLDING TIMES

All holding times were met within the acceptable time frame from collection for metals (6 months), mercury (28 days), and cyanide (14 days).

5.2 CALIBRATION

All initial and continuing calibration were performed within acceptable limits for percent recovery.

5.3 BLANKS

5.3.1 Laboratory Method Blanks

All initial calibration, continuing calibration, and preparation blanks were within acceptable limits with the following exceptions:

For Job 9401.717, manganese was detected in one preparation blank and two continuing calibration blanks (CCBs) at a maximum concentration of 5.9 µg/L. Associated samples are all eight filtered groundwaters in this report; 1-GW-118F, 1-GW-128F, 1-GW-128DF, 1-GW-138F, 2-GW-018F, 2-GW-038F, 2-GW-078F, and 2-GW-078DF.

For Job 9401.738, aluminum, manganese, and silver were detected in CCBs at maximum concentrations of 153 µg/L, 7.4 µg/L, and 3.5 µg/L, respectively. Associated samples are three filtered groundwaters; 1-GW-108DISS, 2-GW-108-DISS, and 2-GW-128DISS.

For Job 9401.751, aluminum was detected in one CCB at 34.6 µg/L. Associated samples are 1-GW-048, 2-GW-048, 2-GW-058, 1-GW-068, 1-GW-068D, and 1-SW-088.

Minor contamination not affecting any sample results is not listed above. A limit of five times the highest blank value was used for review and qualification of the water samples. Associated sample results which were detected below the blank limit were qualified "J", as estimated values.

5.3.2 Field Blanks

Field blanks were not collected for inorganic analyses.

5.4 ICP INTERFERENCE CHECK

The ICP Interference Check samples were within acceptable limits of 80-120% recovery.

5.5 SPIKE SAMPLE RECOVERY

All percent recoveries for the matrix spike samples were found to be within the 75-125% limit, with the following exceptions:

Job 9401.738

Sample ID	Element	% Recovery
2-GW-108	Arsenic	71.4
	Selenium	70.6

Job 9401.751

Sample ID	Element	% Recovery
1-GW-038	Selenium	128
	Thallium	67.6
	Silver	137
2-GW-118F	Selenium	175

For Job 9401.738, sample 1-GW-078 spike recoveries were acceptable for all elements. Sample 2-GW-108 has a much higher aluminum and iron content than does sample 1-GW-078. Thus, associated samples for low recoveries of arsenic and selenium are only those unfiltered samples with levels of aluminum and iron comparable to sample 2-GW-108.

For Job 9401.751, associated samples for sample 1-GW-038 are all unfiltered samples and associated samples for sample 2-GW-118F are all filtered samples.

For low spike recoveries, associated sample results and quantitation limits were qualified "J" and "UJ" as estimated, respectively. For high spike recoveries, the associated sample results were qualified "J" as estimated.

5.6 LABORATORY DUPLICATES

Precision (relative percent difference) for the water samples was found to be acceptable for all elements, with the following exceptions:

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Job 9401.717

Sample ID	Element	% RPD
1-SW-198	Zinc	25.4

Job 9401.738

Sample ID	Element	% RPD
1-GW-078	Zinc	94.0
2-GW-108	Zinc	59.0
1-GW-078DISS	Lead	152

Job 9401.751

Sample ID	Element	% RPD
2-GW-118F	Zinc	52.0

For Job 9401.717, associated samples are all samples in the report.

For Job 9401.738, sample 2-GW-108DISS for dissolved metals gave acceptable duplicate results for all elements including lead. The major difference between samples 1-GW-078DISS and 2-GW-108DISS is the high calcium and magnesium content in sample 1-GW-078DISS. Therefore, associated samples for poor lead duplicate results are only those filtered samples with high levels of calcium and magnesium. Associated samples for poor zinc duplicate results are all unfiltered samples.

For Job 9401.751, associated samples are all filtered samples in the report.

Positive results for the elements listed above were qualified "J" as estimated values in the associated samples.

5.7 LABORATORY CONTROL SAMPLE

The aqueous laboratory control samples (LCS) were within acceptable limits.

5.8 ICP SERIAL DILUTION

ICP serial dilution analysis was within the acceptable 10% limit for percent difference (% D), with the following exceptions:

Job 9401.717

Sample ID	Element	% D
1-GW-138F	Sodium	12.0

Job 9401.751

Sample ID	Element	% D
1-GW-068DF	Sodium	13.5

Associated samples for both jobs include only filtered samples, since serial dilution results for the unfiltered samples were acceptable. Positive results for sodium which exceeded 50 times the Instrument Detection Limit were qualified "J" as estimated in the associated samples.

5.9 FURNACE AA QUALITY CONTROL

Quality control results for furnace atomic absorption was acceptable with the following exception:

For Job 9401.717, standard addition analysis for lead in sample 1-SW-108 gave a correlation coefficient of less than 0.995. The lead result in this sample was qualified "J" as estimated.

OVERALL PRECISION

Field duplicate results indicated good overall precision for inorganics, with the following exceptions; aluminum with RPDs of 71% to 99% in four field duplicate sets, zinc with RPDs of 66% to 110% in three sets, iron with RPDs of 67% to 100% in two sets, lead with RPDs of 82% to 130% in two sets, and manganese in one set with an RPD of 93 (see Table 1). In general, the values associated with the high RPDs were at levels below the contract required detection limit (CRDL), which may account for the lack of precision.

Overall precision for organics was acceptable for all compounds detected (see Table 2). Dimethylphthalate (DMP) and BEHP at the levels reported are most likely due to field or laboratory contamination. Phthalate esters are common plasticizers found in the gloves used in the field and laboratory.

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Table 1
BNTC GROUNDWATERS
FIELD DUPLICATE RESULTS - INORGANIC
(Results in ug/L)

Parameter	1-SW-138	1-SW-138D	% RPD
Aluminum	95.4	212	74
Barium	31.5	36.3	14
Calcium	33200	27500	19
Iron	127	394	10
Lead	3.8	2.4	45
Magnesium	11700	10300	13
Manganese	8.6	23.6	93
Potassium	2300	2220	3.5
Sodium	15300	14900	2.6
Zinc	24.9	30.4	20

Parameter	2-GW-078	2-GW-078D	% RPD
Aluminum	22.5	66.6	99
Barium	22.2	20.9	6.0
Beryllium	ND	0.26	IN
Calcium	8250	8230	0.2
Iron	35.4	54.0	42
Lead	1.2	5.6	130
Magnesium	4880	5040	3.2
Manganese	ND	3.2	IN
Potassium	774	777	0.4
Sodium	7890	8270	4.7
Zinc	55.3	17.8	100

Parameter	1-GW-128	1-GW-128D	% RPD
Aluminum	256	214	18
Barium	56.6	53.4	1.4
Beryllium	0.20	ND	IN
Calcium	42900	50200	16
Copper	ND	18.5	IN
Iron	614	485	24
Lead	3.6	1.5	82
Magnesium	20200	19000	6.1
Manganese	202	190	6.1
Nickel	9.9	ND	IN
Potassium	6500	6090	6.5
Sodium	31500	29700	5.9
Zinc	183	129	35

Parameter	1-GW-128F	1-GW-128DF	% RPD
Aluminum	46.3	96.9	71
Barium	47.5	50.9	6.9
Calcium	46700	50200	7.2
Copper	ND	2.4	IN

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Iron	163	221	30
Lead	ND	7.1	IN
Magnesium	18700	19700	5.2
Manganese	182	199	8.9
Potassium	5940	6410	7.6
Sodium	28900	30900	6.7
Zinc	62.9	61.9	1.6

Parameter	2-GW-078F	2-GW-078DF	% RPD
Aluminum	19.4	52.4	92
Barium	22.2	18.8	17
Beryllium	ND	0.25	IN
Calcium	9270	9190	0.9
Copper	6.3	5.2	19
Iron	71.7	144	67
Magnesium	4990	4850	2.8
Manganese	8.3	7.9	11
Potassium	918	778	17
Sodium	9100	7590	18
Zinc	239	121	66

Parameter	1-GW-068	1-GW-068D	% RPD
Aluminum	146	118	21
Barium	82.4	80.9	1.8
Beryllium	0.29	0.30	3.4
Calcium	43100	42400	1.6
Copper	7.3	6.8	7.1
Iron	4220	3800	10
Magnesium	17300	17100	1.2
Manganese	240	231	3.8
Potassium	3700	3660	1.1
Sodium	20900	20600	1.4
Zinc	64.4	72.8	12

Parameter	1-GW-068F	1-GW-068DF	% RPD
Aluminum	40.7	ND	IN
Barium	77.9	72.9	6.6
Calcium	36600	40100	9.1
Chromium	ND	16.8	IN
Iron	124	140	12
Magnesium	16900	16800	0.6
Manganese	213	207	2.9
Potassium	4200	4210	0.2
Sodium	22700	22500	0.9
Zinc	45.4	153	110

IN = Indeterminant
ND = Not Detected

Table 2
BNTC GROUNDWATERS
FIELD DUPLICATE RESULTS - ORGANIC
(Results in ug/L)

Parameter	1-GW-128	1-GW-128D	RPD
Methylene Chloride	1	ND	IN
Carbon Disulfide	1	1	0
1,2-Dichloroethene (total)	4	4	0
Trichloroethene	1	1	0
Dimethylphthalate	12	12	0
Methoxychlor	0.17	ND	IN

Parameter	1-GW-068	1-GW-068D	RPD
Methylene Chloride	120	74	47
1,2-Dichloroethene (total)	6	4	40
Trichloroethene	12	10	18

Parameter	1-SW-138	1-SW-138D	RPD
Chloroform	9	8	10
Bromodichloromethane	2	2	0
Methoxychlor	ND	0.31	IN

IN = Indeterminant
ND = Not Detected

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October 1994 Sampling Event

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DATA REVIEW

MEMORANDUM

TO: John Walter, Ecology and Environment, Inc., Project Manager

FROM: Joanne McMullan, JMM Ecology and Environment, Inc., Quality Assurance Chemist

DATE: November 14, 1994

SUBJECT: Data Review Report for Bainbridge Naval Training Center, Groundwaters Round 9. Ecology and Environment, Inc., Analytical Service Center Job Numbers 9402.156/179/187.

CC: Marcia Galloway, Ecology and Environment, Inc., Quality Assurance Officer

Samples and Matrix: Twenty-nine water samples.

Job 9402.156

1-GW-119	1-GW-129	1-GW-139	2-GW-029
2-GW-039	2-GW-049	2-GW-109	2-GW-119
2-GW-129	2-GW-139	2-GW-139D	TB-10494

Job 9402.179

1-GW-029*	1-GW-059	1-GW-079*	1-GW-089*
1-GW-099*	1-GW-109*	2-GW-019	2-GW-079
TB-10594			

Job 9402.187

1-GW-019	1-GW-039*	1-GW-049	1-GW-049D
1-GW-069*	1-GW-069D*	2-GW-059	TB-10694

Twenty-nine water samples were collected for some/all of the following analyses: inorganics by atomic absorption (AA) and inductively coupled plasma (ICP); mercury by cold vapor; and cyanide by spectrophotometry; total recoverable petroleum hydrocarbons (TRPH) Method 418.1; semivolatile organic compounds by gas chromatography/ mass spectroscopy (GC/MS); pesticide/PCBs by gas chromatography (GC); and volatile organic compounds (VOC) by GC/MS. Samples identified with an asterisk were analyzed for vinyl chloride by GC to obtain a lower detection limit. Specific analyses conducted on each sample are documented in the chain-of-custody forms provided. Both total and dissolved metals analyses were requested for the groundwater (GW) samples. The analytical laboratory work was performed by Ecology and Environment, Inc.'s (E & E) Analytical Services Center (ASC).

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This report provides a summary of data acceptability and deviations in accordance with the **Naval Energy and Environmental Support Activity (NEESA) Level C** requirements as stated in the NEESA document **Quality Assurance in Environmental Analysis, October 1990**, and the applicable portions for Pesticides/PCB review from the USEPA's **Contract Laboratory Program (CLP) National Functional Guidelines for Organic Data Review, February 1994**. In addition, the CLP portion of the corresponding USEPA Statements of Work (SOW) were utilized, where applicable and relevant. Initial and continuing calibrations, tuning, internal standards, mass spectra, and chromatograms were not reviewed unless the report forms or case narrative indicated a major problem. Historical data from the previous rounds were compared with this round to determine if any anomalies were present.

1.0 VOLATILE ORGANICS BY GC/MS

1.1 HOLDING TIMES

All holding times were met within the acceptable time frame of 14 days from collection for the acid preserved waters.

1.2 SYSTEM MONITORING COMPOUND

System monitoring compound percent recoveries (%Rs) were within acceptable limits for all surrogate compounds.

1.3 MATRIX SPIKE/MATRIX SPIKE DUPLICATES (MS/MSD)

Acceptable frequency, accuracy (percent recovery) and precision (relative percent difference) were generated for MS/MSDs.

1.4 BLANKS

1.4.1 Field Blanks

Three trip blanks were collected and analyzed for VOCs, one for each day of sample collection. Acetone was detected in two of them, TB-10594 and TB-10694, at a maximum concentration of 5 µg/L. Toluene and total xylenes were detected in all three trip blanks at maximum levels of 5 µg/L and 3 µg/L, respectively. Associated sample results for acetone less than ten times the blank level were qualified "U" as not detected and elevated to the contract required quantitation limit (CRQL), if reported below the CRQL. There were no positive results for toluene and xylenes in the samples, so no qualification was necessary.

1.4.2 Method Blanks

Six method blanks were analyzed for VOCs. Methylene chloride was detected in two of the VOC blanks at 1 µg/L, one each in Jobs 9402.179 and 9402.187. Associated sample

results less than ten times the blank level were qualified "U" as not detected and elevated to the CRQL, if reported below the CRQL. In sample 2-GW-019, the methylene chloride result of 12 µg/L was greater than ten times the blank level. Thus, the "U" qualifier was not added and the laboratory "B" qualifier was deleted.

1.5 COMPOUND QUANTITATION

Sample 1-GW-039 was analyzed at a two-fold dilution due to chlorobenzene which exceeded the calibration limit. The chlorobenzene result from the diluted analysis and the undiluted results for the remaining compounds are considered more acceptable data.

2.0 VINYL CHLORIDE BY GC

2.1 HOLDING TIMES

All holding times were met within the acceptable time frame of 14 days from collection for the acid preserved waters.

2.2 SURROGATE RECOVERY

Percent recoveries for all surrogates were within acceptable limits.

2.3 MATRIX SPIKE/MATRIX SPIKE DUPLICATES (MS/MSD)

Acceptable frequency, accuracy (percent recovery) and precision (relative percent difference) were generated for MS/MSDs.

2.4 BLANKS

2.4.1 Field Blanks

Field blanks were not collected for vinyl chloride analysis.

2.4.2 Method Blanks

Vinyl chloride was not detected in either of the two method blanks analyzed.

2.5 COMPOUND QUANTITATION

Initial calibration for vinyl chloride exceeded the QC limit of 20% with a 22% RSD due to a low response for the 10 ng standard (2 µg/L). The laboratory feels that the peak area for the 10 ng standard is sufficient to justify a detection limit of 1.0 µg/L. No vinyl chloride was detected in the samples; the quantitation limits were qualified "UJ" as estimated.

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3.0 SEMIVOLATILE ORGANICS BY GC/MS

3.1 HOLDING TIMES

All holding times were met for extraction and analysis of the water samples. The USEPA technical holding time for water is 7 days from collection to extraction, and 40 days from extraction to analysis.

3.2 SURROGATE RECOVERY

Percent recoveries were within acceptable limits for all surrogate compounds for semivolatile organics.

3.3 MS/MSD

Acceptable frequency, accuracy (percent recovery) and precision (relative percent difference) were generated with the following exceptions:

Compound	% Recovery MS	Limit
4-Nitrophenol	83	(10-80)
Pentachlorophenol	104	(9-103)

Due to the high percent recoveries and the compounds not being detected in the samples, no qualification is necessary.

3.4 BLANKS

3.4.1 Field Blanks

Field blanks were not collected for semivolatile analysis.

3.4.2 Method Blanks

No semivolatile compounds were detected in any of the method blanks, except for tentatively identified compounds (TICs). Where present in the associated samples at a comparable level, these TICs were qualified "U" as not detected.

4.0 PESTICIDE/PCBs BY GC

4.1 HOLDING TIMES

All holding times were met for extraction and analysis of the water samples. The USEPA technical holding time for water is 7 days from collection to extraction, and 40 days from extraction to analysis.

4.2 SURROGATE RECOVERY

All surrogate recoveries were within acceptable limit of 30-150% as per the USEPA Functional Guidelines, (February 1994).

4.3 MS/MSD

Acceptable frequency, accuracy (percent recovery) and precision (relative percent difference) were generated.

4.4 BLANKS

4.4.1 Field Blanks

Field blanks were not collected for pesticide/PCBs analysis.

4.4.2 Method Blanks

No pesticide/PCB compounds were detected in any of the method blanks.

5.0 TOTAL RECOVERABLE PETROLEUM HYDROCARBON

5.1 HOLDING TIMES

All holding times were met within the acceptable time frame of 28 days from collection for the acid preserved waters.

5.2 BLANKS

5.2.1 Field Blanks

Field blanks were not collected for total recoverable petroleum hydrocarbon (TRPH) analysis.

5.2.2 Method Blanks

TRPHs were not detected in any of the method blanks.

5.3 LABORATORY CONTROL SAMPLES (LCS)

The percent recoveries for the aqueous laboratory control samples were within acceptable limits (75-125%).

6.0 INORGANIC ANALYSES BY AA AND ICP
(Mercury by Cold Vapor & Cyanide by Spectrophotometry)

6.1 HOLDING TIMES

All holding times were met within the acceptable time frame from collection for metals (6 months), mercury (28 days), and cyanide (14 days).

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6.2 BLANKS

6.2.1 Field Blanks

Field blanks were not collected for inorganic analyses; none were required.

6.2.2 Laboratory Method Blanks

All initial calibration, continuing calibration, and preparation blanks were within acceptable limits with the following exceptions:

For Job 9402.156, thallium was detected in one preparation blank at 1.1 µg/L. Associated samples are all eleven groundwaters in this report, for both total and dissolved metals.

For Job 9402.179, selenium was detected in a continuing calibration blank (CCB) at 2.8 µg/L. Associated samples are three groundwaters; 1-GW-099, 2-GW-079, and 2-GW-019. Aluminum was detected in two CCBs at negative values of -21.5 and -20.3 µg/L. Associated samples include all groundwaters for total metals and 1-GW-029DISS, 1-GW-059DISS, and 1-GW-079DISS.

For Job 9402.187, aluminum was detected in one CCB at 20.2 µg/L. Associated samples include all samples for total metals except 1-GW-019 and four samples for dissolved metals (1-GW-019DISS, 1-GW-039DISS, 1-GW-049DISS and 1-GW-049DDISS). Aluminum was also detected in the final CCB at 150 µg/L. Associated samples include the three remaining samples for dissolved metals (1-GW-069DISS, 1-GW-069DDISS, and 2-GW-059).

Minor contamination not affecting any sample results is not listed above. A limit of five times the highest blank value was used for review and qualification of the water samples. For negative blank values, five times the absolute value is used. Associated sample results which were detected below the blank limit were qualified "J", as estimated values.

6.3 SPIKE SAMPLE RECOVERY

All percent recoveries for the matrix spike samples were found to be within the 75-125% limit, with the following exceptions:

Job 9402.156

Sample ID	Element	% Recovery
2-GW-139D	Selenium	53.3
2-GW-139D DISS	Selenium	70.9

Job 9402.179

Sample ID	Element	% Recovery
1-GW-029	Barium	25.0

Job 9402.187

Sample ID	Element	% Recovery
2-GW-059 DISS	Arsenic	132

For low spike recoveries, associated sample results and quantitation limits were qualified "J" and "UJ" as estimated, respectively. For high spike recoveries, the associated sample results were qualified "J" as estimated.

6.4 LABORATORY DUPLICATES

Precision (relative percent difference) for the water samples was found to be acceptable for all elements.

6.5 LABORATORY CONTROL SAMPLE

The aqueous laboratory control samples (LCS) were within acceptable limits.

6.6 ICP SERIAL DILUTION

ICP serial dilution results were within the acceptable 10% limit for percent difference (% D).

6.7 FURNACE AA QUALITY CONTROL

Quality control results for furnace atomic absorption were acceptable with the following exception:

For Job 9402.179, standard addition analysis for selenium in sample 1-GW-109 gave a correlation coefficient of less than 0.995. The selenium quantitation limit in this sample was qualified "UJ" as estimated.

OVERALL PRECISION

Field duplicate results indicated good overall precision for inorganics, with the following exceptions; iron with RPDs of 60% to 92% in two sets and copper in one set with an RPD of 57% (see Table 1). In general, the values associated with the high RPDs were at levels below the contract required detection limit (CRDL), which may account for the lack of precision.

Overall precision for organics was acceptable for all compounds detected (see Table 2). Dimethylphthalate (DMP), di-n-butylphthalate (DBP), and BEHP at the levels reported are most likely due to field or laboratory contamination. Phthalate esters are common plasticizers found in the gloves used in the field and laboratory.

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HISTORICAL DATA COMPARISON

Review of the Bainbridge historical data indicated two general concerns and some specific anomalies. In all instances the raw data were checked for correct calculation and transcription. No problems were found.

The two general concerns are the low levels of acetone detected in several wells in Round 9 which were not detected previously and zinc in several filtered samples at levels higher than the unfiltered samples, especially well 2-GW-7 in Round 8 (August 1994).

Previously, acetone at low levels was attributed to laboratory contamination based on acetone detected in the method blanks. However, method blanks are much cleaner since the laboratory has moved to new facilities. In Round 8 performed in the old facilities, acetone was detected in four of the eight method blanks at a maximum level of 16 μg/L. In Round 9 performed in the new facilities, acetone was not detected in any of the method blanks.

The higher levels of zinc in the filtered samples may be due to contamination from dust during filtration. The most outstanding example is discussed below under specific concerns.

The specific anomalies include the following:

Methylene chloride was detected in both 2-GW-13 and 2-GW-13D at 100 μg/L in Round 9, but was not detected in previous rounds. Methylene chloride was not detected in 1-GW-6 and 1-GW-6S in Round 9, but was present at 120 μg/L and 74 μg/L, respectively, in Round 8. Previous rounds indicated no methylene chloride in this well. The methylene chloride results appear to be actual site contamination since the levels are higher than those usually attributed to field/laboratory contamination. In Round 8 performed in the old laboratory facilities, methylene chloride was not detected, while in Round 9 performed in the new facilities, methylene chloride was detected in two of the six method blanks at an estimated 1 μg/L. No methylene chloride was detected in the trip blanks for either round.

In Round 9, zinc was detected in 2-GW-3 at 7450 μg/L, a level approximately fifty times the previous high of 114 μg/L. The reason for this inconsistency is unknown. In Round 8, the filtered levels of zinc determined on field duplicates of 2-GW-7 were at least twice the unfiltered levels. Field filtration may have introduced zinc contamination as noted above.

Table 1
BNTC GROUNDWATERS
FIELD DUPLICATE RESULTS - INORGANIC
(Results in ug/L)

Parameter	2-GW-139	2-GW-139D	% RPD
Aluminum	19.8	20.9	5.4
Barium	15.2	15.4	1.3
Calcium	22400	21800	2.7
Iron	28.4	15.3	60
Magnesium	4530	4410	2.7
Manganese	3.0	2.8	6.7
Potassium	1670	1760	5.2
Sodium	11400	11500	0.9

Parameter	2-GW-139DISS	2-GW-139DDISS	% RPD
Barium	14.2	14.6	2.8
Calcium	24500	23700	3.3
Copper	2.4	ND	IN
Magnesium	4740	4660	1.7
Manganese	4.0	3.3	19
Potassium	1440	1460	1.3
Sodium	11400	11100	2.7

Parameter	1-GW-049	1-GW-049D	% RPD
Aluminum	238	231	3.0
Barium	60.4	64.8	7.0
Beryllium	0.25	0.31	21
Calcium	55100	61300	11
Copper	6.4	5.8	9.8
Iron	258	287	11
Magnesium	18000	20000	11
Manganese	264	257	2.7
Potassium	2310	2550	9.9
Sodium	20700	23000	11
Zinc	7.7	11.3	38

Parameter	1-GW-069	1-GW-069D	% RPD
Aluminum	218	236	7.9
Barium	85.9	87.0	1.3
Beryllium	0.25	0.30	18
Calcium	41100	40700	1.0
Copper	8.3	8.4	1.2
Iron	2650	2580	2.7
Magnesium	17400	17400	0.0
Manganese	295	298	1.0
Potassium	3720	3830	2.9
Sodium	22300	22700	1.8
Zinc	9.7	10.6	8.9

Parameter	1-GW-049DISS	1-GW-049DDISS	% RPD
Aluminum	50.1	60.3	18
Barium	62.0	60.6	2.3
Calcium	59900	60600	1.2
Copper	5.3	4.6	14
Iron	9.9	26.7	92
Magnesium	19200	19700	2.6
Manganese	266	248	7.0
Potassium	2640	2560	3.1
Sodium	22000	20600	6.6
Zinc	11.6	12.8	9.8

Parameter	1-GW-069DISS	1-GW-069DDISS	% RPD
Aluminum	45.4	33.6	30
Barium	82.1	85.0	3.5
Calcium	42200	44000	4.2
Copper	3.9	7.0	57
Iron	110	120	8.7
Magnesium	17500	18200	3.9
Manganese	272	289	6.1
Potassium	3740	3920	4.7
Sodium	21600	21900	1.4
Zinc	9.0	12.2	30

IN - Indeterminant
ND - Not Detected

Table 2
BNTC GROUNDWATERS
FIELD DUPLICATE RESULTS - ORGANIC
(Results in ug/L)

Parameter	1 GW-049	1 GW-049D	RPD
Di-n-butylphthalate	1	1	0
Bis(2-ethylhexyl)phthalate	ND	1	IN

Parameter	1-GW-069	1-GW-069D	RPD
1,2-Dichloroethene (total)	4	4	0
1,2-Dichloropropane	1	ND	IN
Trichloroethene	9	9	0
Di-n-butylphthalate	1	ND	IN
Bis(2-ethylhexyl)phthalate	ND	3	IN

Parameter	2-GW-139	2-GW-139D	RPD
Methylene chloride	100	100	0
Acetone	4	4	0
Dimethylphthalate	2	ND	IN
Bis(2-ethylhexyl)phthalate	1	ND	IN

IN = Indeterminant
ND = Not Detected

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December 1994 Sampling Event

DATA VALIDATION

MEMORANDUM

TO: John Walter, Ecology and Environment, Inc., Project Manager

FROM: Lynn Hess, Ecology and Environment, Inc., Quality Assurance Chemist

DATE: January 11, 1995

SUBJECT: Data Review Report for Bainbridge Naval Training Center, Groundwaters Round 10.
Ecology and Environment, Inc., Analytical Service Center Job Numbers 9402.737/747/770/785/791.

CC: Marcia Galloway, Ecology and Environment, Inc., Quality Assurance Officer

Samples and Matrix: Twenty four groundwater samples and thirteen trip blanks.

1-GW-5-10	1-GW13-10	1-GW8-10	2-GW11-10
1-GW1-10	2-GW13-10	1-GW9-10	TB-8
1-GW10-10	2-GW5-10	2-GW1-10	TB-9
1-GW3-10	TB-1	2-GW10-10	TB-10
1-GW4-10	TB-2	2-GW2-10	TB-11
1-GW6-10	TB-3	2-GW3-10	TB-12
1-GW7-10	TB-4	2-GW4-10	TB-13
1-GW11-10	TB-5	2-GW7-10	
1-GW12-10	TB-6	2-GW12-10	
1-GW12-10D	TB-7	2-GW12D-10	

Twenty four groundwater samples and thirteen trip blanks were collected for some/all of the following analyses: Inorganics by Atomic Absorption (AA) and Inductively Coupled Argon Plasma (ICP); Mercury by Cold Vapor; and Cyanide by Spectrophotometry; total recoverable petroleum hydrocarbons

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(TRPH) Method 418.1; semivolatile organic compounds by GC/MS; chlorinated pesticides/polychlorinated biphenyls (Pest/PCB) by GC; and volatile organic compounds (VOC) by GC/MS and vinyl chloride by GC to obtain a lower detection limit. Specific analyses conducted on each sample are documented in the chain-of-custody forms provided. Both total and dissolved metals analyses were requested for the groundwater (GW) samples. The analytical laboratory work was performed by Ecology and Environment, Inc.'s (E & E's) Analytical Services Center (ASC).

This report provides a summary of data acceptability and deviations in accordance with the **Naval Energy and Environmental Support Activity (NEESA) Level C** requirements, as stated in the NEESA document **Quality Assurance in Environmental Analysis, October 1990**, and the applicable portions for Pesticides/PCB review from the USEPA's **Contract Laboratory Program (CLP) National Function Guidelines for Organic Data Review, February 1994**. In addition, the CLP portion of the corresponding USEPA Statements of Work (SOW) were utilized, where applicable and relevant. Initial and continuing calibrations, tuning, internal standards, mass spectra, and chromatograms were not reviewed unless the report forms or case narrative indicated a major problem.

1.0 VOLATILE ORGANICS BY GC/MS

1.1 HOLDING TIMES

All holding times were met within the acceptable time frame of 14 days from collection for the acid preserved waters.

1.2 SYSTEM MONITORING COMPOUND

All system monitoring percent recoveries were within acceptable limits for the three surrogate compounds.

1.3 MATRIX SPIKE/MATRIX SPIKE DUPLICATES (MS/MSD)

Acceptable frequency, accuracy (percent recovery) were generated for MS/MSDs. The precision (relative percent difference) for MS/MSD set 2-GW11-10 was slightly outside

the quality control (QC) limits for benzene and toluene. No qualification is considered necessary.

1.4 BLANKS

1.4.1 Field Blanks

Thirteen trip blanks were collected and analyzed for VOCs. No volatile compounds were detected in any of the trip blanks.

1.4.2 Method Blanks

Ten water method blanks were analyzed for VOCs. No volatile compounds were detected in any of the method blanks.

1.5 COMPOUND QUANTITATION

Sample 1-GW3-10 was analyzed at a two fold dilution (1-GW3-10DL) due to the level of chlorobenzene which exceeded the calibration range. The chlorobenzene result from the diluted analysis (1-GW3-10DL) and the undiluted (1-GW3-10) results for the remaining compounds are considered more acceptable data. The MS/MSD analyses of sample 2-GW11-10 were analyzed at a two fold dilution due to limited sample volume. The quantitation limits have been elevated accordingly.

2.0 VINYL CHLORIDE BY GC

2.1 HOLDING TIMES

All holding times were within the acceptable time frame of 14 days from collection for the acid preserved waters.

2.2 SURROGATE RECOVERY

Percent recoveries for all surrogates were within the acceptable limits.

2.3 MS/MSD

Acceptable frequency, accuracy (percent recovery) and precision (relative percent difference) were generated for MS/MSDs.

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2.4 BLANKS

2.4.1 Field Blanks

Field blanks were not collected for vinyl chloride analysis.

2.4.2 Method Blanks

Vinyl chloride was not detected in any of the method blanks analyzed.

2.5 COMPOUND QUANTITATION

Due to the level of other volatile compounds present, samples 1-GW5-10, 1-GW-8-10, and 1-GW-9-10 required analysis at a 2.5 fold dilution and sample 1-GW3-10 was analyzed at a ten fold dilution. Reported quantitation limits have been elevated accordingly. The continuing calibration criterion for vinyl chloride exceeded the QC limit of 20% with a 31.1% difference due to the low response on 12/7/94. The laboratory feels that the response was sufficient for detection of the compound. No vinyl chloride was detected in samples 1-GW3-10, 1-GW6-10, 1-GW7-10, and 1-GW10-10; the quantitation limits were qualified "UJ" as estimated for these samples.

3.0 SEMIVOLATILE ORGANICS BY GC/MS

3.1 HOLDING TIMES

All holding times were met for extraction and analysis of the water samples. The USEPA technical holding time for water is 7 days from collection to extraction, and 40 days from extraction to analysis.

3.2 SURROGATE RECOVERY

All surrogate recoveries were within acceptable limits for the eight semivolatile surrogate compounds.

3.3 MS/MSD

Acceptable frequency, accuracy (percent recovery) was generated for batch-QC reported with the following exceptions:

	% RECOVERY		
Compound	MS	MSD	Limit
4-Nitrophenol	83	88	10-80
Pentachlorophenol	--	111	9-103

Compound	% RECOVERY MS	MSD	Limit
1,4-Dichlorbenzene	--	29	36-97
1,2,4-Trichlorobenzene	--	30	39-98
4-Nitrophenol	96	--	10-80
2,4-Dinitrotoluene	124	--	24-96
Pentachlorophenol	104	--	9-103
Pyrene	--	20	26-127

Acceptable precision (relative percent difference) was generated for the batch-QC reported with the exception of the following:

Compound	RPD	Limit
1,4-Dichlorbenzene	45	28
1,2,4-Trichlorobenzene	52	28
Acenaphthene	39	31
4-Nitrophenol	123	50
Pyrene	49	31

Since MS/MSD results are highly matrix dependent and the sample analyzed was not from this project, no qualification is considered necessary.

3.4 BLANK

3.4.1 Field Blanks

Field blanks were not collected for semivolatile analysis.

3.4.2 Method Blanks

Four method blanks were analyzed for semivolatile. Bis(2-ethylhexyl) phthalate was detected in two of the semivolatile method blanks at 1 and 2 ug/L. Associated sample results less than ten times the blank level were qualified "U" as not detected and elevated to the CRQL, if reported below the CRQL. In sample 1-GW10-10, the bis(2-ethylhexyl) phthalate result of 25 ug/L was greater than ten times the blank level and is considered site contamination. Thus the "U" qualifier was not added and the laboratory "B" qualifier was deleted. Tentatively identified compounds (TICs) detected in the method blanks were qualified "U" when detected in associated samples at comparable levels.

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3.5 COMPOUND QUANTITATION

Elevated quantitation limits were reported for numerous samples due to limited extraction volumes.

4.0 PESTICIDE/PCBs BY GC

4.1 HOLDING TIMES

All holding times were met for extraction and analysis of the water samples. The USEPA technical holding time for water is 7 days from collection to extraction, and 40 days from extraction to analysis.

4.2 SURROGATE RECOVERY

All percent recoveries were within acceptable limits for all surrogate compounds.

4.3 MS/MSD

Acceptable frequency, accuracy (percent recovery) and precision (relative percent difference) were generated with the following exceptions for batch-QC:

	% RECOVERY		
Compound	MS	MSD	Limit
Endrin	0	--	56-121

Compound	RPD	Limit
Aldrin	23	22
Endrin	200	21

Since MS/MSD results are highly matrix dependent and the sample analyzed was not from this project, no qualification is considered necessary.

4.4 BLANKS

4.4.1 Field Blanks

Field blanks were not collected for Pest/PCBs.

4.4.2 Method Blanks

Pest/PCBs were not detected in the any of the method blanks.

4.5 COMPOUND QUANTITATION

Elevated quantitation limits were reported for numerous samples due to limited extraction volumes.

5.0 TOTAL RECOVERABLE PETROLEUM HYDROCARBON (TRPH)

5.1 HOLDING TIMES

All holding times were met within the acceptable time frame of 28 days from collection for the acid preserved waters.

5.2 BLANKS

5.2.1 Field Blanks

Field blanks were not collected for TRPH analyses.

5.2.2 Method Blanks

TRPHs were not detected in any of the method blanks.

5.3 DUPLICATE AND SPIKE ANALYSIS

No laboratory duplicates or spikes were performed on these samples due to a limited sample volume. All LCS were within acceptable limits.

5.4 LABORATORY CONTROL SAMPLES (LCS)

The percent recoveries for the aqueous laboratory control samples were within acceptable limits (75-125%).

6.0 INORGANIC ANALYSES BY AA AND ICP
(Mercury by Cold Vapor & Cyanide by Spectrophotometry)

6.1 HOLDING TIMES

All holding times were met within the acceptable time frame from collection for metals (6 months), mercury (28 days), and cyanide (14 days).

6.2 BLANKS

6.2.1 Field Blanks

Field blanks were not collected for Inorganic analyses.

6.2.2 Laboratory Method Blanks

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All initial calibration, continuing calibration, and preparation blanks were within acceptable limits with the exception of the following:

- Iron was detected at 7.1 ug/L in the preparation blank. Associated samples include 2-GW13-10-DISS.
- Sodium was detected in four continuing calibration blanks at 651 ug/L, 3370 ug/L, 4079 ug/L and 4105 ug/L. Associated samples include 2-GW13-10-DISS, 2-GW11-10, 1-GW9-10-DISS, 2-GW1-10-DISS, 2-GW2-10-DISS, 2-GW4-10-DISS, 2-GW7-10-DISS, and 2-GW11-10.
- Cobalt was detected at 5.1 ug/L in the preparation blank. Associated samples include 1-GW8-10, 1-GW9-10, 2-GW2-10, 2-GW4-10, 2-GW11-10, 1-GW8-10-DISS, 1-GW9-10-DISS, 2-GW1-10-DISS, 2-GW2-10-DISS, 2-GW4-10-DISS, 2-GW7-10-DISS, and 2-GW11-10-DISS.
- Lead was detected at 1.1 ug/L in the preparation blank. Associated samples include 2-GW10-10, 2-GW12-10, 2-GW12D-10, 2-GW3-10-DISS, 2-GW10-10-DISS, and 2-GW12-10-DISS.

Minor contamination not affecting any sample results was not listed above. A limit of five times the highest blank value was used for review and qualification of the water samples. Associated sample results which were detected below the blank limit and reported at less than the CRDL were qualified as, "J" as estimated values.

6.3 SPIKE SAMPLE RECOVERY

All percent recoveries for the matrix spike samples were found to be within the 75-125% limit, with the following exceptions:

Sample ID	Element	% Recovery
1-GW11-10	Lead	127.5
1-GW11-10	Silver	70.8
2-GW11-10-DISS	Arsenic	126.6
2-GW3-10	Silver	36.6

For low spike recoveries, associated sample results and quantitation limits were qualified "J" and "UJ" as estimat-

ed, respectively. For high spike recoveries, the associated sample results were qualified "J" as estimated.

6.4 LABORATORY DUPLICATES

Precision (relative percent difference) for the water samples was found to be acceptable for all the elements, with the following exceptions:

Sample ID	Element	% RPD
1-GW11-10	Chromium	200
1-GW11-10	Iron	29.2
2-GW11-10-DISS	Zinc	93.0

The positive results for the associated samples were qualified as "J", estimated values.

6.5 LCS

The aqueous LCS results were within acceptable limits.

6.6 ICP SERIAL DILUTION

ICP serial dilution was found to be within the acceptable 10% limit for percent difference.

6.7 FURNACE AA QUALITY CONTROL

The quality control results for furnace atomic absorption were acceptable.

OVERALL PRECISION

Field duplicate results indicate good overall precision for inorganics, with the exception of iron with an RPD of 103% (see Table 1). Overall precision for organics was also good (see Table 2). The lack of precision for iron is attributable to the low level detected.

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Table 1

BNTC GROUNDWATERS

FIELD DUPLICATE RESULTS - INORGANIC

(Results in ug/L)

Parameter	1GW12-10	1GW12-10D	RPD
Aluminum	84.8	79.2	6.8
Barium	51.0	51.8	1.6
Calcium	47400	46500	1.9
Iron	154	143	7.4
Lead	1.4	1.1	24
Magnesium	17200	16900	1.8
Manganese	108	105	2.8
Potassium	5200	5020	3.5
Selenium	2.8	ND	IN
Sodium	36700	36000	1.9
Zinc	23.0	18.5	22

Parameter	1GW12-10DISS	1GW12-10DDISS	RPD
Aluminum	45.2	37.0	20
Barium	51.6	50.1	2.9
Calcium	47100	46600	1.1
Iron	20.5	17.1	18
Lead	1.7	1.4	19
Magnesium	17100	16900	1.2
Manganese	87.3	85.5	2.1
Potassium	5120	5090	0.6
Sodium	36600	36200	1.1
Zinc	18.2	15.6	15

IN = Indeterminant

ND = Not Detected

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Table 1 cont.

BNTC GROUNDWATERS

FIELD DUPLICATE RESULTS - INORGANIC

(Results in ug/L)

Parameter	2-GW-12-10	2-GW-12D-10	RPD
Aluminum	125	128	2.4
Barium	22.9	22.4	2.2
Calcium	13200	13200	0
Iron	225	244	8.1
Lead	2.3	2.0	14
Magnesium	6520	6520	0
Manganese	31.9	33.2	4.0
Potassium	1130	1110	1.8
Sodium	12500	12600	0.8
Zinc	164	210	25

Parameter	2-GW-12-10-DISS	2-GW-12D-10-DISS	RPD
Barium	22.3	21.2	5.1
Calcium	13800	14000	1.4
Copper	4.4	ND	IN
Iron	22.7	7.3	103
Lead	1.2	ND	IN
Magnesium	6550	6620	1.1
Manganese	32.2	32.5	0.9
Nickel	ND	8.5	IN
Potassium	1140	1140	0
Sodium	12900	13100	1.5
Zinc	24.7	26.4	6.7

IN = Indeterminant

ND = Not Detected

Table 2

BNTC GROUNDWATERS

FIELD DUPLICATE RESULTS - ORGANIC

(Results in ug/L)

Parameter	1GW12-10	1GW12-10D	RPD
1,2-Dichloroethene (total)	5	4	22
Trichloroethene	1	1	0
Dimethylphthalate	11	9	20
bis(2-Ethylhexyl)phthalate	4	3	29

Parameter	2-GW-12-10	2-GW-12D-10	RPD
1,1,2,2-Tetrachloroethane	5	5	0
Dimethylphthalate	18	16	12
Bis(2-ethylhexyl)phthalate	3	2	40

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H Results of Domestic Well and Spring Surveys and Sampling 1988, 1992, and 1993 Port Deposit, Maryland

State of Maryland

DEPARTMENT OF THE ENVIRONMENT

201 WEST PRESTON STREET • BALTIMORE, MARYLAND 21201

William Donald Schaefer
Governor

Martin W. Walsh, Jr.
Secretary

TELECOPY #: (301) 225-6451

COVER LETTER

DATE: August 23, 1988

TO: Mr. John G. Kresky

DEPARTMENT: U.S. Navy LANDIV Norfolk, Va.

TELECOPY NUMBER: (804) 445-6653

FROM: Mr. Harold L. Dye, Jr.

DEPARTMENT: Hazardous Waste Enforcement Division

TELEPHONE NUMBER: (301) 225-5731

Number of pages: Two Pages

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Domestic Well Survey
Bainbridge Naval Training Center
Cecil County, Maryland

1. Research existing well records for any wells within a half mile radius downgradient of monitoring wells exhibiting contamination.

2. Perform physical reconnaissance of residences downgradient to determine the presence or existence of any wells.

3. If wells are in existence, a water sample should be obtained and analyzed for volatile organics constituents using acceptable sampling and analytical methodology. Also, obtain any pertinent well data, i.e., age, depth, construction, date of [redacted] construction, etc.

Note: Given proper notification, personnel within the Hazardous and Solid Waste Management Administration's Groundwater and Special Investigation Division (GWSID) will assist with the physical survey. Should there be any further questions on this matter, please contact Ms. Arlene Weiner, Acting Chief, GWSID, at (301) 333-2950.

MEMORANDUM

Copies { James Pittman
Bainbridge File

To Mr. Harold Dye From Arlene G. Weiner AGW Date 09-23-88

Subject Residential Well Sampling - Bainbridge Naval Training Facility - Cecil County, Maryland

On September 7, 1988, Anthony Queen, G.W.S.I.D., met with John Kresky to assist in the residential well survey. The following information summarizes his findings:

1. Public water was put in at the Navy's expense in 1935;
2. They tapped into a spring for the source at that time;
3. The town (Port Deposit) is now using the river as a drinking water source;
4. The town had the wells and springs filled in when public water was installed;
5. Anthony Queen and John Kresky visited eighteen (18) residences to confirm this. A list of the residents survey is attached: and,
6. The Susquehana River is one-half mile downgradient.

Since no homes were found to be on wells in the downgradient direction, it was agreed (between M.D.E. and the Navy) that the three (3) homes on wells just upgradient from the entrance to the Job Corps Center would be sampled. This would provide any information on contaminants which could potentially migrate on-site. The following three (3) homes were sampled:

Betella M. Love
2371 Frenchtown Road
Port Deposit, Maryland
SAMPLE NUMBER: AQ09078802

William Lingenfelder
2463 Frenchtown Road
Port Deposit, Maryland
SAMPLE NUMBER: AQ09078803

Muriel Ewing
2464 Frenchtown Road
Port Deposit, Maryland
SAMPLE NUMBER: AQ09078801

The sample results (SEE ATTACHED) show no volatile organics present.

In summary, the Navy has fulfilled the requirements of the residential well survey.

RESIDENTIAL WELL SURVEY - PORT DEPOSIT, MARYLAND

Within 1/2 mile downgradient of Bainbridge Naval Training Facility.

The residents of ALL homes were surveyed, and were ALL found to be on public water:

ADDRESSES:

1 Center Street
10 Center Street
21 Center Street
26 Center Street
52 Center Street
55 Center Street

10 South Main Street
12 South Main Street
14 South Main Street
18 South Main Street
20 South Main Street
22 South Main Street

11 High Street
19 High Street
23 High Street
25 High Street
29 High Street
33 High Street

Memo to the file:

From: John Kresky, Code 1142

On 7 September 1988, a domestic well survey was conducted by Mr. Anthony Queen, R.S., Maryland Department of Environment and Mr. John Kresky, R.S., LANTNAVFACENGCOM. The survey was conducted according to the procedure set forth by Ms. Arlene Weiner in a communication faxed to LANTNAVFACENGCOM dated 23 Aug 88 at 13:39 hrs.

Residences on Center St. (aka Jacob Tome Hwy) from 55 Center St to 1 Center St. were visited. All locations were occupied or abandoned single family detached dwellings with te exception of the Mason Lodge, A. J. Webster Heating and Air Conditioning at 10 Center St., and a large multiple family dwelling at 1 Center St.

Mr. Horace Stewart, 77, of 21 Center St, stated that Port Deposit begin supplying water in 1936. Residents were encouraged but not required to hook up. Most residents hooked up to city water as quickly as possible. Prior to 1936, most residents relied on spring water rather than well water.

The survey was continued on Main St. Buildings surveyed included 1 Main St. (a bank) thru 48 Main St. (next to Town Hall). A short street, High St., was also surveyed. One abandoned well was reported at 21 High St. The homeowner stated that he was told that there was a dug well next to his house buried under concrete. The homeowner stated that the alleged well was covered before his ownership and had no information as to the depth of the concrete. It was apparent that the well had been abandoned for many years and that any efforts to lift the concrete would be futile.

A telephone call was placed by Mr. Queen to his supervisors in Baltimore, MD. In addition to the work completed, Mr. Queen was instructed to begin canvassing the area across the highway from the main gate and to continue untill he had collected three water samples.

As Mr. Queen executed his instructions from the Maryland Department of Environment, the author accompanied, assisted and simultaneously collected samples at the same locations as Mr. Queen. These samples were collected according to EPA protocol and sent to the Navy contract laboratory.

The survey was suspended when Mr. Queen determined that the action was complete.

STATE OF MARYLAND
DEPARTMENT OF HEALTH AND MENTAL HYGIENE
Laboratories Administration
201 W. Preston Street
J. Mahsen Joseph, Ph.D., Director

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SEP 16 '97

TRACE ORGANICS LABORATORY
VOLATILE ORGANICS ANALYSIS

BOTTLE NUMBER AQ09078802 COLLECTOR A. Queen HSWMA ENFORCEMENT FROM Cecil County

SOURCE OF SAMPLE Bettella M. Love
(Include Address) 2371 - Frenchtown Road, Port Deposit

SAMPLE TYPE: Community ____ Noncommunity ____ Domestic ✓ STP Station ____
Observation Well ____ Stream ____ Tidal Waters ____ Industrial Effluent ____
Other (Specify) ____
Preservative Used none

IMPORTANT: First time sampled YES Last known sampling date ____
Reason for submitting sample: Survey ✓ Suspected Petroleum Contamination ____
Suspected ~~Industrial~~ Chemical Contamination ✓ Other (Specify) ____

CHAIN OF CUSTODY: From: ____ To: ____
From: ____ To: ____

REMARKS: Sample Collected at 2:10 P.M. - Phone # 378-2416

1	2 3	4 5 6 7	8 9 10 11	12 13 14 15 16 17	18 19
				0 9 0 7 8 8	
TRANS TYPE	COUNTY	PLANT NO.	SAMPLING STATION	DATE COLLECTED	CARD NO.

20 21 22	23 24	25 26
FIELD pH	FIELD RESID. CHLORINE: FREE	TOTAL

Purgeable Halocarbons (EPA 601)				Other Purgeables	
Chloromethane	<5.	trans-1,3-Dichloropropene	<1.	Benzene	<1.
Bromomethane	<1.	Trichloroethene	↓	Toluene	↓
Dichlorodifluoromethane	↓	Dibromochloromethane	↓	Ethylbenzene	↓
Vinyl chloride	↓	1,1,2-Trichloroethane	↓	Total Xylenes	<2
Chloroethane	↓	cis-1,3-Dichloropropene	↓	Total Purgeable Hydrocarbons	
Methylene chloride	↓	2-Chloroethylvinylether	<10.	Tetrahydrofuran	N.D.
Trichlorofluoromethane	↓	Bromoform	<1.	(2-Butanone MEK)	↓
1,1-Dichloroethene	↓	1,1,2,2-Tetrachloroethane	↓	Methylisobutylketone (MIBK)	↓
1,1-Dichloroethane	↓	Tetrachloroethene	↓	Acrolein	↓
trans-1,2-Dichloroethane	↓	Chlorobenzene	↓	Acrylonitrile	↓
Chloroform	↓	Total Trihalomethanes	↓	Carbon Disulfide	↓
1,2-Dichloroethane	↓	Other Purgeable Organics	N.D.	Vinyl Acetate	↓
1,1,1-Trichloroethane	↓			Acetone	↓
Carbon Tetrachloride	↓			2-Hexanone	↓
Bromodichloromethane	↓			Styrene	↓
1,2-Dichloropropane	↓				

D' \RTMENT OF HEALTH AND MENTAL HYC E

Laboratories Administration
201 W. Preston Street
J. Mahsen Joseph, Ph.D., Director

TRACE ORGANICS LABORATORY
VOLATILE ORGANICS ANALYSIS

BOTTLE NUMBER AQ09078803 COLLECTOR A. Owens County Cecil

SOURCE OF SAMPLE William R. Lingenfelter
(Include Address) 3463 Frenchtown Road, Port Deposit

SAMPLE TYPE: Community ____ Noncommunity ____ Domestic ✓ STP Station ____
Observation Well ____ Stream ____ Tidal Waters ____ Industrial Effluent ____
Other (Specify) ____
Preservative Used none

IMPORTANT: First time sampled YES Last known sampling date ____
Reason for submitting sample: Survey ____ Suspected Petroleum Contamination ____
Suspected Industrial Chemical Contamination ✓ Other (Specify) ____

CHAIN OF CUSTODY: From: ____ To: ____
From: ____ To: ____

REMARKS The well is 190 feet deep - Phone # 378-3137

1	2 3	4 5 6 7	8 9 10 11	12 13 14 15 16 17	18 19
				09 07 88	
TRANS TYPE	COUNTY	PLANT NO.	SAMPLING STATION	DATE COLLECTED	CARD NO

20 21 22		23 24		25 26
FIELD PH	FIELD RESID. CHLORINE: FREE		TOTAL	

Purgeable Halocarbons (EPA 601)				Other Purgeables	
Chloromethane	<5.	trans-1,3-Dichloropropene	<1.	Benzene	<1.
Bromomethane	<1.	Trichloroethene		Toluene	
Dichlorodifluoromethane		Dibromochloromethane		Ethylbenzene	
Vinyl chloride		1,1,2-Trichloroethane		Total Xylenes	
Chloroethane		cis-1,3-Dichloropropene		Total Purgeable Hydrocarbons	
Methylene chloride		2-Chloroethylvinylether	<10.	Tetrahydrofuran	N.D
Trichlorofluoromethane		Bromoform	<1.	(2-Butanone MEK)	
1,1-Dichloroethene		1,1,2,2-Tetrachloroethane		Methylisobutylketone (MIBK)	
1,1-Dichloroethane		Tetrachloroethane		Acrolein	
trans-1,2-Dichloroethene		Chlorobenzene		Acrylonitrile	
Chloroform		Total Trihalomethanes		Carbon Disulfide	
1,2-Dichloroethane		Other Purgeable Organics: N.D		Vinyl Acetate	
1,1,1-Trichloroethane				Acetone	
Carbon Tetrachloride				2-Hexanone	
Bromodichloromethane				Styrene	
1,2-Dichloropropane					

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Laboratories Administration
201 W. Preston Street
J. Mansen Joseph, Ph.D., Director

SEP 19 1988

TRACE ORGANICS LABORATORY
VOLATILE ORGANICS ANALYSIS

BOTTLE NUMBER AQ09078801 COLLECTOR A. Queen ENFORCEMENT PROGRAM HSWMA County

SOURCE OF SAMPLE Muriel Flynn
(Include Address) 2464 Frenchtown Road, Port Deposit

SAMPLE TYPE: Community ____ Noncommunity ____ Domestic ✓ STP Station ____
Observation Well ____ Stream ____ Tidal Waters ____ Industrial Effluent ____
Other (Specify) ____
Preservative Used None

IMPORTANT: First time sampled YES Last known sampling date ____
Reason for submitting sample: Survey ____ Suspected Petroleum Contamination ____
Suspected ~~Industrial~~ Chemical Contamination ✓ Other (Specify) ____

CHAIN OF CUSTODY: From: ____ To: ____
From ____ To: ____

REMARKS: Sample collected at 1:30PM - Phone # 378-2089

1	2 3	4 5 6 7	8 9 10 11	12 13 14 15 16 17	18 19
TRANS TYPE	COUNTY	PLANT NO.	SAMPLING STATION	0 9 0 7 8 8 DATE COLLECTED	CARD NO.

FIELD pH 20 21 22 ____ FIELD RESID. CHLORINE: FREE 23 24 ____ TOTAL 25 26 ____

Purgeable Halocarbons (EPA 601)				Other Purgeables	
Chloromethane	<5.	trans-1,3-Dichloropropene	<1.	Benzene	<1.
Bromomethane	<1.	Trichloroethene		Toluene	
Dichlorodifluoromethane		Dibromochloromethane		Ethylbenzene	
Vinyl choride		1,1,2-Trichloroethane		Total Xylenes	<2
Chloroethane		cis-1,3-Dichloropropene		Total Purgeable Hydrocarbons	
Methylene chloride		2-Chloroethylvinylether	<10.	Tetrahydrofuran	ND
Trichlorofluoromethane		Bromoform	<1.	(2-Butanone MEK)	
1,1-Dichloroethene		1,1,2,2-Tetrachloroethene		Methylisobutylketone (MIBK)	
1,1-Dichloroethane		Tetrachloroethene		Acrolein	
trans-1,2-Dichloroethene		Chlorobenzene		Acrylonitrile	
Chloroform		Total Trihalomethanes		Carbon Disulfide	
1,2-Dichloroethane		Other Purgeable Organics:	ND	Vinyl Acetate	
1,1,1-Trichloroethane				Acetone	
Carbon Tetrachloride				2-Hexanone	
Bromodichloromethane				Styrene	
1,2-Dichloropropane					

Results reported in micrograms per liter (parts per million) / ecology and environment

OFFICE OF
MAYOR AND TOWN COUNCIL

P.O. BOX 95
PORT DEPOSIT, MD. 21904
Telephone 378-2121

ERMA M. KEETLEY, MAYOR

Council Members
Kerry A. Abrams
James K. Chapman, Sr.
Donald H. Cunningham
Frank K. Cunningham
Glen D. Longacre
William P. Stewart

Nancy L. Peters, Clerk-Treasurer

July 13, 1992

CHES NAV FAC ENG COM
Code 18, Building 212
Washington Navy Yard
Washington, D. C. 20374

ATTN: Ms. Sabrina Green
1-202-433-3760

Re: Town of Port Deposit
(Wells & Springs)

Dear Ms. Green:

Per our conversation on July 7, 1992 and July 13, 1992, the following is a list of springs/wells/spring fed wells within the Town of Port Deposit. This is a result of a survey taken on July 13, 1992.

LOCATION	DESCRIPTION
1.) Rose Hill (Rt. 222 at Entrance to Town, right side)	Spring-used approximately ten (10) years ago.(functional)
2.) End of High Street	Shallow Open Well/Catch Basin Spring Fed Spring
3.) 33 High Street	Left of House (Brick Area)
4.) 62 South Main Street (Douglass Property)	Swimming Pool-Cracked and reported to be spring fed (not used)
5.) Directly behind Town Hall 64 South Main Street	Dry Well-Spring Fed
6.) Keetley Motors South Main Street	Spring Fed-Small Natural Well on Cliff
7.) 75 South Main Street (Huss Property)	Shallow Well-Not Used
8.) 68 North Main Street	Spring Above Back of Property
9.) 170 North Main Street	Spring Above Back of Property
10) 54 Granite Avenue (Banner Property)	Spring Right of House-Drains into Creek

LOCATION	DESCRIPTION
11) Intersection of Old School-House Road and Liberty Grove Road	Piped Spring w/PVC. May be used for consumption or washing.
12) Entrance to Owens Estate-Right of Freeman Hall off Old Schoolhouse Road	Just out of Town Limits-Gray House with reported well
13) 34 Liberty Grove Road	Unused well
14) 36 Liberty Grove Road	Unused well (left side of property
15) 38 Liberty Grove Road	Unused well (left side of property
16) Just above 38 Liberty Grove Road	Spring near Road-Possible Catch Basin (overgrown area)

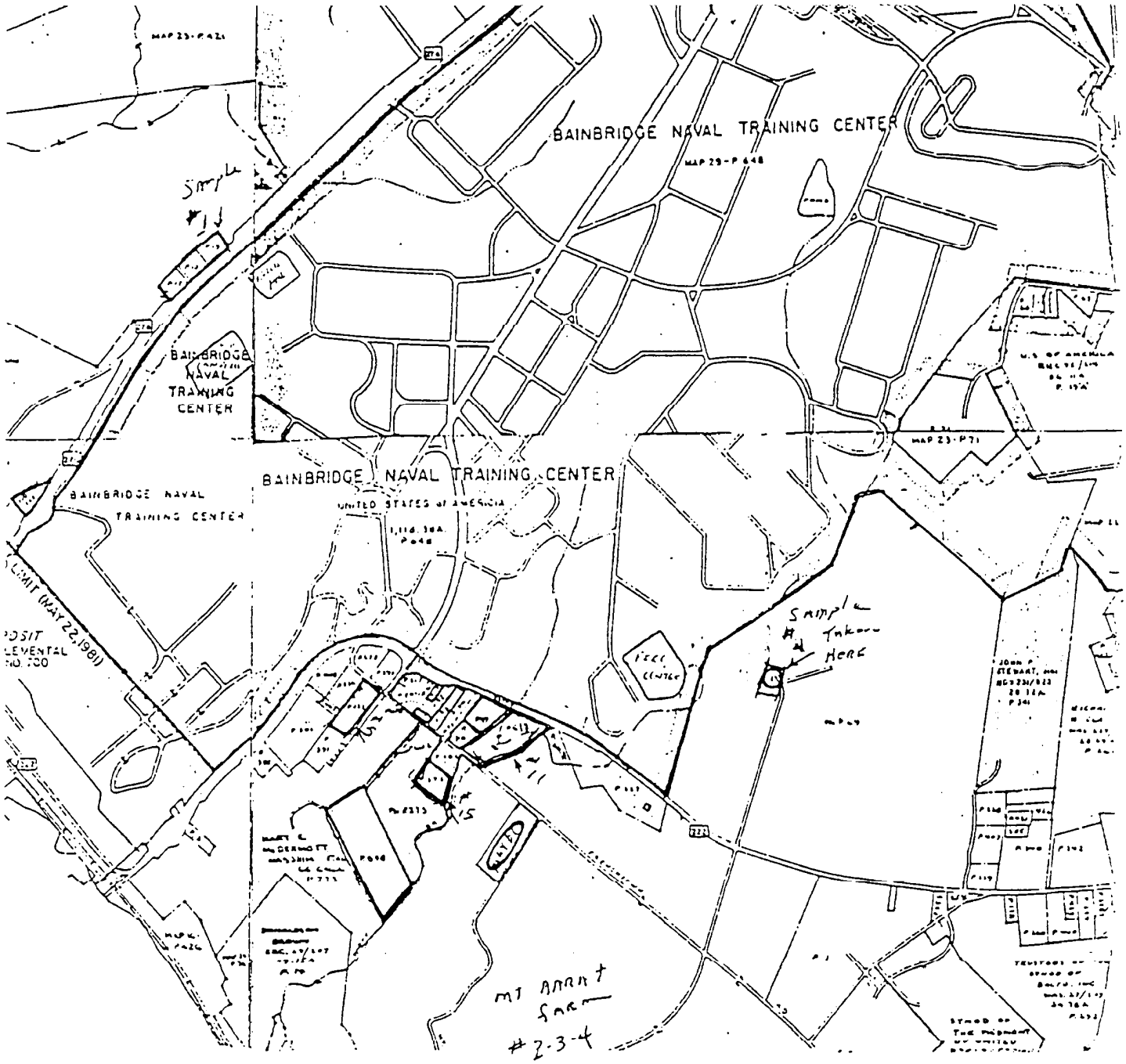
Sincerely,

Paul H. Kozloski,
Zoning/Town Administrator

PHK/plp

cc: Erma M. Keetley, Mayor
Janet Gleisner, CACR(MOP)
File (2)

Street Address	Owner	Tax Map-Parcel	Phone	Time	Bottle #	Comments - Well Test/Contamination
301 Tome Hwy	Wm Keefer	22-17	378-9248			
321 Tome Hwy	Jay Bowman	22-18	378-4355			
? 339 Tome Hwy	Patricia Murray	22-19	938-3148 Unknown	3-23-93 11:35	CEOR-01	1938 Dug well In House Sep. Cont.
						1951
						Tenant - Unavailable for interview
415 Bainbridge Rd	Ed Harris	29-317	378-4604			
o 421 Bainbridge Rd	Charles Keefer	29-90	378-3539	3-23-93 11:50	CEOR-06	Drilled well in House K. sink
? 427 Bainbridge Rd	Sarah Hamilton	29-92	Unknown	3-23-93 1:00	CEOR 07	PA. CE 93-3287 O. side
o 437 Bainbridge Rd	Charles Cuff	29-93	378-4229	3-23-93 1:30	CEOR 08	PA. Well 93/11 closing K sink
o 447 Bainbridge Rd	Peter Barrera	29-94	378-9431	3-23-93 1:45	CEOR-10	UNKNOWN WELL TYPE O. side
o 487 Bainbridge Rd	Tom Kance	29-97	938-1120	3-23-93 2:20	CEOR-16	drilled 100 ft K sink
o 521 Bainbridge Rd	Henry Rogers	29-616	378-3036	3-23-93 2:45	CEOR 11	Drilled well 50 ft Deep K sink
o 605 Bainbridge Rd	Larry Grace	29-337	938-0180	3-23-93 3:15	CEOR-12	Drilled well in Pit K sink
? 2371 Frenchtown Rd	Arthur Lore	29-232	Unknown	3-23-93 11:10	CEOR 14	Dug well 60 x overflow atta
o 2375 Frenchtown Rd	~~Henry~~ Mary Weber	29-372	378-2578	3-23-93 12:50	CEOR-13	PA. Drilled K sink
o 2377 Frenchtown Rd	Charles Cuff, Jr.	29-91	378-2012	3-23-93 1:40	CEOR 09	PA. 90 ft Deep K sink
o 2455 Frenchtown Rd	Walter Buck, Jr.	29-123	378-2757	3-23-93 11:45	CEOR. 05	PA Deep well 175' Well house
72 Beechwood Dr	Tom Cousins	29-578	378-2239	3-23-93 11:30	CEOR-15	Spring for both Houses O. side
120 Beechwood Dr	Henry Cuff	29-273	378-2243			
Bainbridge Rd	Mt Airy Farm		378-4144	3-23-93 11:35	CE 02	Inside Garage Oil Spill on Floor Spring 40 x 20 x 8 Tank
	" " "		" "	3-23-93 11:40	CE 03	Farm Spring 160' Drilled well milk House
	" " "		" "	3-23-93 11:50	CE 04	Farm H2 Spring / Heinz Fire Cont


BAINBRIDGE NAVAL TRAINING CENTER
BAINBRIDGE NAVAL TRAINING CENTER
BAINBRIDGE NAVAL TRAINING CENTER
BAINBRIDGE NAVAL TRAINING CENTER
Sample #1
Sample #4 Taken Here
Mt Airy Farm #2-3-4

SEND REPORT TO: Cecil Co. Health Dept.

DEPARTMENT OF HEALTH AND MENTAL HYGIENE
Laboratories Administration
201 W. Preston Street
P.O. Box 2355, Baltimore, Maryland 21203
J. Mehsen Joseph, Ph.D., Director

LAB NO: 913-05-19

APR 2 1993

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY
SDWA ANALYSIS REPORT FORM

COLLECTOR: [illegible] / 3-25-93 (NAME/TIME/DATE)
SAMPLE SOURCE: [illegible] DEPT
BOTTLE NUMBER: CE-[illegible]-15
PRESERVATION USED: HCl
PWSID #:
SYSTEM NAME:

CHAIN OF CUSTODY: FROM: (NAME/TIME/DATE) TO: (NAME/TIME/DATE)
FROM: TO:
FROM: TO:

REMARKS: Laboratory NTC

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
TRIHALOMETHANES						
Chloroform	2941		<.5	Dibromomethane	2408	<.5
Bromodichloromethane	2943			p-Xylene	2962	
Dibromochloromethane	2944			o-Xylene	2997	
Bromoform	2942			m-Xylene	2995	
TOTAL THMs	2950	100		1,1-Dichloropropene	2410	<.5
REGULATED				trans-1,3-Dichloropropene	2224	
Benzene	2990	5	<.5	cis-1,3-Dichloropropene	2413	
Carbon Tetrachloride	2982	5		1,1,2,2-Tetrachloroethane	2988	
p-Dichlorobenzene	2969	75		1,3-Dichloropropane	2412	
Dichloroethane	2977	7		2,2-Dichloropropane	2416	
,-Dichloroethane	2980	5		o-Chlorotoluene	2965	
1,1,1-Trichloroethane	2981	200		p-Chlorotoluene	2966	
Trichloroethene	2984	5		Bromobenzene	2993	
Vinyl Chloride	2976	2		1,2,4-Trimethylbenzene	2418	
UNREGULATED				1,2,4-Trichlorobenzene	2378	
trans-1,2-Dichloroethene	2979	100		1,2,3-Trichlorobenzene	2420	
cis-1,2-Dichloroethene	2380	70		n-Propylbenzene	2998	
1,2-Dichlorobenzene	2968	600		n-Butylbenzene	2422	
1,2-Dichloropropane	2983	5		Naphthalene	2248	
Tetrachloroethene	2987	5		Hexachlorobutadiene	2246	
Chlorobenzene	2989	100		Isopropylbenzene	2994	
Toluene	2991	1000		1,2,3-Trichloropropane	2414	
Ethylbenzene	2992	700		1,2-Dibromo-3-Chloropropane	2931	
Total Xylenes	2955	10000		1,3,5-Trimethylbenzene	2424	<.5
Styrene	2996	100		p-Isopropyltoluene	2030	
hloromethane	2210			tert-Butylbenzene	2426	
romomethane	2214			sec-Butylbenzene	2428	
ichlorodifluoromethane	2212			Bromochloromethane	2430	
hloroethane	2216			Dichloromethane	2964	
ichlorofluoromethane	2218			1,1,2-Trichloroethane	2985	
1-Dichloroethane	2978			1,1,1,2-Tetrachloroethane	2986	
-Dichlorobenzene	2967			1,2-Dibromoethane		
ethylene Chloride	2964					

PROPOSED MCLs

ATE RECEIVED: 3/[illegible]/93 DATE ANALYZED: 3/31/93 CHEMIST: [illegible]

parts per billion (micrograms per liter)
— maximum contaminant level
) — not detected
— not analyzed

MH 4362 6/90

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recycled paper

ecology and environment

SEND REPORT TO: Cecil Co. Health Dept.

DEPARTMENT OF HEALTH AND MENTAL HYGIENE
Laboratories Administration
201 W. Preston Street
P.O. Box 2355, Baltimore, Maryland 21203
J. Mehsen Joseph, Ph.D., Director

LAB NO. 93-0539

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY
SDWA ANALYSIS REPORT FORM

COLLECTOR: Von Stadein / [illegible] / 3-25-93 (NAME/TIME/DATE)

SAMPLE SOURCE: 339 Tome Hill

BOTTLE NUMBER: CE-ER-01

PRESERVATION USED: HCl

PWSID #: CYP

SYSTEM NAME:

CHAIN OF CUSTODY: FROM: _____ (NAME/TIME/DATE) TO: _____ (NAME/TIME/DATE)

FROM: _____ TO: _____

FROM: _____ TO: _____

REMARKS: Gasoline NTC

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
TRIHALOMETHANES						
Chloroform	2941		<.5	Dibromomethane	2408	<.5
Bromodichloromethane	2943			p-Xylene	2962	
Dibromochloromethane	2944			o-Xylene	2997	
Bromoform	2942			m-Xylene	2995	
TOTAL THMs	2950	100		1,1-Dichloropropene	2410	<.5
REGULATED				trans-1,3-Dichloropropene	2224	
Benzene	2990	5	<.5	cis-1,3-Dichloropropene	2413	
Carbon Tetrachloride	2982	5		1,1,2,2-Tetrachloroethane	2988	
p-Dichlorobenzene	2969	75		1,3-Dichloropropane	2412	
1,1-Dichloroethene	2977	7		2,2-Dichloropropane	2416	
1,2-Dichloroethane	2980	5		o-Chlorotoluene	2965	
1,1,1-Trichloroethane	2981	200		p-Chlorotoluene	2966	
Trichloroethene	2984	5		Bromobenzene	2993	
Vinyl Chloride	2976	2		1,2,4-Trimethylbenzene	2418	
UNREGULATED				1,2,4-Trichlorobenzene	2378	
*trans-1,2-Dichloroethene	2979	100		1,2,3-Trichlorobenzene	2420	
*cis-1,2-Dichloroethene	2380	70		n-Propylbenzene	2968	
*1,2-Dichlorobenzene	2968	600		n-Butylbenzene	2422	
*1,2-Dichloropropane	2983	5		Naphthalene	2248	
*Tetrachloroethene	2987	5		Hexachlorobutadiene	2246	
*Chlorobenzene	2989	100		Isopropylbenzene	2994	
*Toluene	2991	1,000		1,2,3-Trichloropropane	2414	
*Ethylbenzene	2992	700		1,2-Dibromo-3-Chloropropane	2931	<.5
*Total Xylenes	2955	10000		1,3,5-Trimethylbenzene	2424	<.5
*Styrene	2996	100	<.5	p-Isopropyltoluene	2030	
Chloromethane	2210			tert-Butylbenzene	2426	
Bromomethane	2214		<.5	sec-Butylbenzene	2428	
Dichlorodifluoromethane	2212			Bromochloromethane	2430	
Chloroethane	2216			Dichloromethane	2964	
Trichlorofluoromethane	2218			1,1,2-Trichloroethane	2985	
1,1-Dichloroethane	2978			1,1,1,2-Tetrachloroethane	2986	
m-Dichlorobenzene	2967			1,2-Dibromoethane		
Methylene Chloride	2964					

* PROPOSED MCLs

DATE RECEIVED: 3-24-93 DATE ANALYZED: 3/29/93 CHEMIST: [illegible]

ppb — parts per billion (micrograms per liter)
MCL — maximum contaminant level
ND — not detected
NA — not analyzed

DHMH 4362 6/90

SUBMITTER'S COPY

SEND REPORT TO: Cecil County Health Dept.

DEPARTMENT OF HEALTH AND MENTAL HYGIENE
Laboratories Administration
201 W. Preston Street
P.O. Box 2355, Baltimore, Maryland 21203
J. Mehsen Joseph, Ph.D., Director

LAB NO. 93-0539

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY
SDWA ANALYSIS REPORT FORM

COLLECTOR: [illegible] / [illegible] / 3-22-93 (NAME/TIME/DATE)
SAMPLE SOURCE: [illegible]
BOTTLE NUMBER: CE-ER-02
PRESERVATION USED: HCl
PWSID #:
SYSTEM NAME:

CHAIN OF CUSTODY: FROM: (NAME/TIME/DATE) TO: (NAME/TIME/DATE)
FROM: TO:
FROM: TO:

REMARKS: [illegible] NTC

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
TRIHALOMETHANES						
Chloroform	2941		<.5	Dibromomethane	2408	<.5
Bromodichloromethane	2943			p-Xylene	2962	
Dibromochloromethane	2944			o-Xylene	2997	
Bromoform	2942			m-Xylene	2995	
TOTAL THMs	2950	100		1,1-Dichloropropene	2410	<.5
REGULATED				trans-1,3-Dichloropropene	2224	
Benzene	2990	5	<.5	cis-1,3-Dichloropropene	2413	
Carbon Tetrachloride	2982	5		1,1,2,2-Tetrachloroethane	2988	
p-Dichlorobenzene	2969	75		1,3-Dichloropropane	2412	
Dichloroethene	2977	7		2,2-Dichloropropane	2416	
-Dichloroethane	2980	5		o-Chlorotoluene	2965	
1,1,1-Trichloroethane	2981	200		p-Chlorotoluene	2966	
Trichloroethene	2984	5		Bromobenzene	2993	
Vinyl Chloride	2976	2		1,2,4-Trimethylbenzene	2418	
UNREGULATED				1,2,4-Trichlorobenzene	2378	
*trans-1,2-Dichloroethene	2979	100		1,2,3-Trichlorobenzene	2420	
*cis-1,2-Dichloroethene	2380	70		n-Propylbenzene	2998	
*1,2-Dichlorobenzene	2968	600		n-Butylbenzene	2422	
*1,2-Dichloropropane	2983	5		Naphthalene	2248	
*Tetrachloroethene	2987	5		Hexachlorobutadiene	2246	
*Chlorobenzene	2989	100		Isopropylbenzene	2994	
*Toluene	2991	1000		1,2,3-Trichloropropane	2414	
*Ethylbenzene	2992	700		1,2-Dibromo-3-Chloropropane	2931	<.5
*Total Xylenes	2955	10000	<1	1,3,5-Trimethylbenzene	2424	<.5
*Styrene	2996	100	<.5	p-Isopropyltoluene	2030	
Chloromethane	2210		<.1	tert-Butylbenzene	2426	
Bromomethane	2214		<.5	sec-Butylbenzene	2428	
Dichlorodifluoromethane	2212			Bromochloromethane	2430	
Chloroethane	2216			Dichloromethane	2964	
Trichlorofluoromethane	2218			1,1,2-Trichloroethane	2985	
1,1-Dichloroethane	2978			1,1,1,2-Tetrachloroethane	2986	
-Dichlorobenzene	2967			1,1-Dichloroethane		
Methylene Chloride	2964					

PROPOSED MCLs

DATE RECEIVED: 3-24-93 DATE ANALYZED: 3/25/93 CHEMIST: [illegible]

parts per billion (micrograms per liter)
— maximum contaminant level
D — not detected
A — not analyzed

HMH 4362 6/90

SUBMITTER'S COPY

recycled paper

ecology and environment

SEND REPORT TO: Cecil Co. Health Dept.

DEPARTMENT OF HEALTH AND MENTAL HYGIENE
Laboratories Administration
201 W. Preston Street
P.O. Box 2355, Baltimore, Maryland 21203
J. Mehsen Joseph, Ph.D., Director

LAB NO. 93-0539

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY
SDWA ANALYSIS REPORT FORM

COLLECTOR: Van Staden / CHA / 3-22-93 (NAME/TIME/DATE)
BOTTLE NUMBER: CF-EN-03 CA
PWSID #:
SAMPLE SOURCE: Farm Pond Farm Spring
PRESERVATION USED: HCl
SYSTEM NAME:

CHAIN OF CUSTODY: FROM: (NAME/TIME/DATE) TO: (NAME/TIME/DATE)
FROM: TO:
FROM: TO:

REMARKS: Benzene NTC Birch Spring

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
TRIHALOMETHANES						
Chloroform	2941		<.5	Dibromomethane	2408	<.5
Bromodichloromethane	2943			p-Xylene	2962	
Dibromochloromethane	2944			o-Xylene	2997	
Bromoform	2942			m-Xylene	2995	
TOTAL THMs	2950	100		1,1-Dichloropropene	2410	<.5
REGULATED				trans-1,3-Dichloropropene	2224	
Benzene	2990	5		cis-1,3-Dichloropropene	2413	
Carbon Tetrachloride	2982	5		1,1,2,2-Tetrachloroethane	2988	
p-Dichlorobenzene	2969	75		1,3-Dichloropropane	2412	
1,1-Dichloroethane	2977	7		2,2-Dichloropropane	2416	
1,2-Dichloroethane	2980	5		o-Chlorotoluene	2965	
1,1,1-Trichloroethane	2981	200		p-Chlorotoluene	2966	
Trichloroethene	2984	5		Bromobenzene	2993	
Vinyl Chloride	2976	2		1,2,4-Trimethylbenzene	2418	
UNREGULATED				1,2,4-Trichlorobenzene	2378	
*trans-1,2-Dichloroethene	2979	100		1,2,3-Trichlorobenzene	2420	
*cis-1,2-Dichloroethene	2980	70		n-Propylbenzene	2998	
*1,2-Dichlorobenzene	2968	600		n-Butylbenzene	2422	
*1,2-Dichloropropane	2983	5		Naphthalene	2248	
*Tetrachloroethene	2987	5		Hexachlorobutadiene	2246	
*Chlorobenzene	2989	100		Isopropylbenzene	2994	
*Toluene	2991	1000		1,2,3-Trichloropropane	2414	
*Ethylbenzene	2992	700		1,2-Dibromo-3-Chloropropane	2931	
*Total Xylenes	2955	10000		1,3,5-Trimethylbenzene	2424	
*Styrene	2996	100		p-Isopropyltoluene	2030	
Chloromethane	2210			tert-Butylbenzene	2426	
Bromomethane	2214			sec-Butylbenzene	2428	
Dichlorodifluoromethane	2212			Bromochloromethane	2430	
Chloroethane	2216			Dichloromethane	2964	
Trichlorofluoromethane	2218			1,1,2-Trichloroethane	2985	
1,1-Dichloroethane	2978			1,1,1,2-Tetrachloroethane	2986	
o-Dichlorobenzene	2967			1,2,3-Tribromopropane		
Methylene Chloride	2964					

PROPOSED MCLs

DATE RECEIVED: 3-24-93 DATE ANALYZED: 3/29/93 CHEMIST: [illegible]

ppb — parts per billion (micrograms per liter)
MCL — maximum contaminant level
ND — not detected
NA — not analyzed

HMH 4362 6/90

SUBMITTER'S COPY

Cecil Co. Health Dept

DEPARTMENT OF HEALTH AND MENTAL HYGIENE
Laboratories Administration
201 W. Preston Street
P.O. Box 2355, Baltimore, Maryland 21203
J. Mehsen Joseph, Ph.D., Director

APR 2 1993 LAB NO. 93-0534

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY
SDWA ANALYSIS REPORT FORM

MT TRR + T FIR

COLLECTOR: von Strasen / CR 12-22-92 (NAME/TIME/DATE)
SAMPLE SOURCE: from F2 SPRING
BOTTLE NUMBER: CF-RA-04 CR
PRESERVATION USED: HCl
PWSID #:
SYSTEM NAME:

CHAIN OF CUSTODY: FROM: (NAME/TIME/DATE) TO: (NAME/TIME/DATE)
FROM: TO:
FROM: TO:

REMARKS: Resubmitted NTC

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
TRIHALOMETHANES						
Chloroform	2941		<.5	Dibromomethane	2408	<.5
Bromodichloromethane	2943			p-Xylene	2962	
Dibromochloromethane	2944			o-Xylene	2997	
Bromoform	2942			m-Xylene	2995	
TOTAL THMs	2950	100		1,1-Dichloropropene	2410	<.5
REGULATED				trans-1,3-Dichloropropene	2224	
Benzene	2990	5	<.5	cis-1,3-Dichloropropene	2413	
Carbon Tetrachloride	2982	5		1,1,2,2-Tetrachloroethane	2988	
p-Dichlorobenzene	2969	75		1,3-Dichloropropane	2412	
1-Dichloroethene	2977	7		2,2-Dichloropropane	2416	
1-Dichloroethane	2980	5		o-Chlorotoluene	2965	
1,1,1-Trichloroethane	2981	200		p-Chlorotoluene	2966	
Trichloroethene	2984	5		Bromobenzene	2993	
Vinyl Chloride	2976	2		1,2,4-Trimethylbenzene	2418	
UNREGULATED				1,2,4-Trichlorobenzene	2378	
*trans-1,2-Dichloroethene	2979	100		1,2,3-Trichlorobenzene	2420	
*cis-1,2-Dichloroethene	2380	70		n-Propylbenzene	2996	
*1,2-Dichlorobenzene	2968	600		n-Butylbenzene	2422	
*1,2-Dichloropropane	2983	5		Naphthalene	2248	
*Tetrachloroethene	2987	5		Hexachlorobutadiene	2246	
*Chlorobenzene	2989	100		Isopropylbenzene	2994	
Toluene	2991	1,000		1,2,3-Trichloropropane	2414	<.5
Ethylbenzene	2992	700		1,2-Dibromo-3-Chloropropane	2931	<.5
Total Xylenes	2955	10000	<.1	1,3,5-Trimethylbenzene	2424	<.5
Styrene	2996	100	<.5	p-Isopropyltoluene	2030	
Chloromethane	2210		<.1	tert-Butylbenzene	2426	
Bromomethane	2214		<.5	sec-Butylbenzene	2428	
Dichlorodifluoromethane	2212			Bromochloromethane	2430	
Chloroethane	2216			Dichloromethane	2964	
Trichlorofluoromethane	2218			1,1,2-Trichloroethane	2985	
1,1-Dichloroethane	2978			1,1,1,2-Tetrachloroethane	2986	
1,2-Dichlorobenzene	2967			1,2-Dibromoethane		
Methylene Chloride	2964					

*PROPOSED MCLs

DATE RECEIVED: 3-24-93 DATE ANALYZED: 3/29/93 CHEMIST: [illegible]

ppb — parts per billion (micrograms per liter)
MCL — maximum contaminant level
( ) — not detected
( ) — not analyzed

MH 4362 6/90

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SEND REPORT TO: Cecil Co. Health Dept.

DEPARTMENT OF HEALTH AND MENTAL HYGIENE
Laboratories Administration
201 W. Preston Street
P.O. Box 2355, Baltimore, Maryland 21203
J. Mohsen Joseph, Ph.D., Director

LAB NO. 93-0559

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY
SDWA ANALYSIS REPORT FORM

COLLECTOR: [illegible] Staden / [illegible] / 3-23-93 (NAME/TIME/DATE)
SAMPLE SOURCE: 2955 [illegible] Rd. Well
BOTTLE NUMBER: CE-EX-05
PRESERVATION USED: HCl
PWSID #:
SYSTEM NAME:

CHAIN OF CUSTODY: FROM: (NAME/TIME/DATE) TO: (NAME/TIME/DATE)
FROM: TO:
FROM: TO:

REMARKS: Bacteriological NTC

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
TRIHALOMETHANES						
Chloroform	2941		<.5	Dibromomethane	2408	<.5
Bromodichloromethane	2943			p-Xylene	2962	
Dibromochloromethane	2944			o-Xylene	2997	
Bromoform	2942			m-Xylene	2995	
TOTAL THMs	2950	100		1,1-Dichloropropene	2410	<.5
REGULATED				trans-1,3-Dichloropropene	2224	
Benzene	2990	5	<.5	cis-1,3-Dichloropropene	2413	
Carbon Tetrachloride	2982	5		1,1,2,2-Tetrachloroethane	2988	
o-Dichlorobenzene	2969	75		1,3-Dichloropropane	2412	
1,1-Dichloroethene	2977	7		2,2-Dichloropropane	2416	
1,2-Dichloroethane	2980	5		o-Chlorotoluene	2965	
1,1,1-Trichloroethane	2981	200		p-Chlorotoluene	2966	
Trichloroethene	2984	5		Bromobenzene	2993	
Vinyl Chloride	2976	2		1,2,4-Trimethylbenzene	2418	
UNREGULATED				1,2,4-Trichlorobenzene	2378	
trans-1,2-Dichloroethene	2979	100		1,2,3-Trichlorobenzene	2420	
cis-1,2-Dichloroethene	2380	70		n-Propylbenzene	2996	
1,2-Dichlorobenzene	2968	600		n-Butylbenzene	2422	
1,2-Dichloropropane	2983	5		Naphthalene	2248	
Tetrachloroethene	2987	5		Hexachlorobutadiene	2246	
Chlorobenzene	2989	100		Isopropylbenzene	2994	
Toluene	2991	1000		1,2,3-Trichloropropane	2414	
Ethylbenzene	2992	700		1,2-Dibromo-3-Chloropropane	2931	<.5
Total Xylenes	2955	10000		1,3,5-Trimethylbenzene	2424	<.5
Styrene	2996	100	<.5	p-Isopropyltoluene	2030	
Bromomethane	2210			tert-Butylbenzene	2426	
Chloromethane	2214		<.5	sec-Butylbenzene	2428	
Dichlorodifluoromethane	2212			Bromochloromethane	2430	
Chloroethane	2216			Dichloromethane	2964	
Trichlorofluoromethane	2218			1,1,2-Trichloroethane	2985	
1,1-Dichloroethane	2978			1,1,1,2-Tetrachloroethane	2986	
1,4-Dichlorobenzene	2967			1,2-Dibromoethane		
Methylene Chloride	2964					

PROPOSED MCLs

DATE RECEIVED: 3-24-93 DATE ANALYZED: 3/29/93 CHEMIST: [illegible]

ppb — parts per billion (micrograms per liter)
MCL — maximum contaminant level
— not detected
— not analyzed

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SEND REPORT TO: Cecil Co. Health Dept.

DEPARTMENT OF HEALTH AND MENTAL HYGIENE
Laboratories Administration
201 W. Preston Street
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J. Mehsen Joseph, Ph.D., Director

LAB NO. 93-0559

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY
SDWA ANALYSIS REPORT FORM

Charles Keesey

COLLECTOR: Von Stade / CR / 3-22-93 (NAME/TIME/DATE)

SAMPLE SOURCE: 421 Bainbridge Rd Elk

BOTTLE NUMBER: CE-EX-26

PRESERVATION USED: HCl

PWSID #:

SYSTEM NAME: Linton

CHAIN OF CUSTODY: FROM: (NAME/TIME/DATE) TO: (NAME/TIME/DATE)

FROM: TO:

FROM: TO:

REMARKS: Bainbridge NTC

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
RIHALOMETHANES						
hloroform	2941		<.5	Dibromomethane	2408	<.5
romodichloromethane	2943			p-Xylene	2962	
ibromochloromethane	2944			o-Xylene	2997	
romoform	2942			m-Xylene	2995	
OTAL THMs	2950	100		1,1-Dichloropropene	2410	<.5
EGULATED				trans-1,3-Dichloropropene	2224	
enzene	2990	5	<.5	cis-1,3-Dichloropropene	2413	
arbon Tetrachloride	2982	5		1,1,2,2-Tetrachloroethane	2988	
Dichlorobenzene	2969	75		1,3-Dichloropropane	2412	
chloroethene	2977	7		2,2-Dichloropropane	2416	
Dichloroethane	2980	5		o-Chlorotoluene	2965	
1,1-Trichloroethane	2981	200		p-Chlorotoluene	2966	
richloroethene	2984	5		Bromobenzene	2993	
nyl Chloride	2976	2		1,2,4-Trimethylbenzene	2418	
NREGULATED				1,2,4-Trichlorobenzene	2378	
rans-1,2-Dichloroethene	2979	100		1,2,3-Trichlorobenzene	2420	
s-1,2-Dichloroethene	2380	70		n-Propylbenzene	2998	
,2-Dichlorobenzene	2968	600		n-Butylbenzene	2422	
,2-Dichloropropane	2983	5		Naphthalene	2248	
etrachloroethene	2987	5		Hexachlorobutadiene	2246	
hlorobenzene	2989	100		Isopropylbenzene	2994	
oluene	2991	1000		1,2,3-Trichloropropane	2414	
thylbenzene	2992	700		1,2-Dibromo-3-Chloropropane	2931	<.5
otal Xylenes	2955	10000	<1	1,3,5-Trimethylbenzene	2424	<.5
tyrene	2996	100	<.5	p-Isopropyltoluene	2030	
loromethane	2210		<1	tert-Butylbenzene	2426	
omomethane	2214		<.5	sec-Butylbenzene	2428	
chlorodifluoromethane	2212			Bromochloromethane	2430	
loroethane	2216			Dichloromethane	2964	
chlorofluoromethane	2218			1,1,2-Trichloroethane	2985	
-Dichloroethane	2978			1,1,1,2-Tetrachloroethane	2986	
Dichlorobenzene	2967			1,2-Dibromoethane		
thylene Chloride	2964					

ROPOSED MCLs

TE RECEIVED: 3-24-93 DATE ANALYZED: 3/29/93 CHEMIST: [illegible]

arts per billion (micrograms per liter)
– maximum contaminant level
— not detected
— not analyzed

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DEPARTMENT OF HEALTH AND MENTAL HYGIENE
Laboratories Administration
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J. Mehsen Joseph, Ph.D., Director

APR 1993 LAB NO. 93-0539

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY
SDWA ANALYSIS REPORT FORM

COLLECTOR: [illegible] / 3-23-93 (NAME/TIME/DATE)
SAMPLE SOURCE: [illegible]
BOTTLE NUMBER: CE-BX-07 [illegible]
PRESERVATION USED: HCl
PWSID #:
SYSTEM NAME:

CHAIN OF CUSTODY: FROM: (NAME/TIME/DATE) TO: (NAME/TIME/DATE)
FROM: TO:
FROM: TO:

REMARKS: [illegible] NTC

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
TRIHALOMETHANES						
Chloroform	2941		<0.5	Dibromomethane	2408	<0.5
Bromodichloromethane	2943			p-Xylene	2962	
Dibromochloromethane	2944			o-Xylene	2997	
Bromoform	2942			m-Xylene	2995	
TOTAL THMs	2950	100		1,1-Dichloropropene	2410	<0.5
REGULATED				trans-1,3-Dichloropropene	2224	
Benzene	2990	5	<0.5	cis-1,3-Dichloropropene	2413	
Carbon Tetrachloride	2982	5		1,1,2,2-Tetrachloroethane	2988	
-Dichlorobenzene	2969	75		1,3-Dichloropropane	2412	
,1-Dichloroethene	2977	7		2,2-Dichloropropane	2416	
,2-Dichloroethane	2980	5		o-Chlorotoluene	2965	
,1,1-Trichloroethane	2981	200		p-Chlorotoluene	2966	
Trichloroethene	2984	5		Bromobenzene	2993	
Vinyl Chloride	2976	2		1,2,4-Trimethylbenzene	2418	
UNREGULATED				1,2,4-Trichlorobenzene	2378	
trans-1,2-Dichloroethene	2979	100		1,2,3-Trichlorobenzene	2420	
cis-1,2-Dichloroethene	2380	70		n-Propylbenzene	2998	
1,2-Dichlorobenzene	2968	600		n-Butylbenzene	2422	
1,2-Dichloropropane	2983	5		Naphthalene	2248	
Tetrachloroethene	2987	5		Hexachlorobutadiene	2246	
Chlorobenzene	2989	100		Isopropylbenzene	2994	
Toluene	2991	1000		1,2,3-Trichloropropane	2414	
Ethylbenzene	2992	700		1,2-Dibromo-3-Chloropropane	2931	<0.5
Total Xylenes	2955	10000		1,3,5-Trimethylbenzene	2424	<0.5
Styrene	2996	100	<0.5	p-Isopropyltoluene	2030	
Chloromethane	2210			tert-Butylbenzene	2426	
Bromomethane	2214		<0.5	sec-Butylbenzene	2428	
Dichlorodifluoromethane	2212			Bromochloromethane	2430	
Chloroethane	2216			Dichloromethane	2964	
Trichlorofluoromethane	2218			1,1,2-Trichloroethane	2985	
1-Dichloroethane	2978			1,1,1,2-Tetrachloroethane	2986	
-Dichlorobenzene	2967			1,2-Dibromoethane		
Methylene Chloride	2964					

PROPOSED MCLs

DATE RECEIVED: 3-24-93 DATE ANALYZED: 3/29/93 CHEMIST: [illegible]

ppb — parts per billion (micrograms per liter)
MCL — maximum contaminant level
ND — not detected
— not analyzed

MH 4362 6/90

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STATE OF MARYLAND
DEPARTMENT OF HEALTH AND MENTAL HYGIENE
Laboratories Administration
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P.O. Box 2355, Baltimore, Maryland 21203
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APR 12 1993

SEND REPORT TO: Cecil County Health Dept.

LAB NO. 93-0539

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY
SDWA ANALYSIS REPORT FORM

Charles Burke

COLLECTOR: Jim Stover / CR / 3-23-93 (NAME/TIME/DATE)

SAMPLE SOURCE: 437 Bainbridge Rd

BOTTLE NUMBER: CE-EP-02 CR

PRESERVATION USED: HCl

PWSID #:

SYSTEM NAME:

CHAIN OF CUSTODY: FROM: (NAME/TIME/DATE) TO: (NAME/TIME/DATE)

FROM: TO:

FROM: TO:

REMARKS: Barrasville NTS

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
TRIHALOMETHANES						
Chloroform	2941		<.5	Dibromomethane	2408	<.5
Bromodichloromethane	2943			p-Xylene	2962	
Dibromochloromethane	2944			o-Xylene	2997	
Bromoform	2942		✓	m-Xylene	2995	
TOTAL THMs	2950	100		1,1-Dichloropropene	2410	<.5
REGULATED				trans-1,3-Dichloropropene	2224	
Benzene	2990	5	<.5	cis-1,3-Dichloropropene	2413	
Carbon Tetrachloride	2982	5		1,1,2,2-Tetrachloroethane	2988	
[illegible]lorobenzene	2969	75		1,3-Dichloropropane	2412	
[illegible]chloroethene	2977	7		2,2-Dichloropropane	2416	
1,2-Dichloroethane	2980	5		o-Chlorotoluene	2965	
1,1,1-Trichloroethane	2981	200		p-Chlorotoluene	2966	
Trichloroethene	2984	5		Bromobenzene	2993	
Vinyl Chloride	2976	2		1,2,4-Trimethylbenzene	2418	
UNREGULATED				1,2,4-Trichlorobenzene	2378	
*trans-1,2-Dichloroethene	2979	100		1,2,3-Trichlorobenzene	2420	
*cis-1,2-Dichloroethene	2380	70		n-Propylbenzene	2998	
*1,2-Dichlorobenzene	2968	600		n-Butylbenzene	2422	
*1,2-Dichloropropane	2983	5		Naphthalene	2248	
*Tetrachloroethene	2987	5		Hexachlorobutadiene	2246	
*Chlorobenzene	2989	100		Isopropylbenzene	2994	
*Toluene	2991	[illegible]		1,2,3-Trichloropropane	2414	✓
*Ethylbenzene	2992	700	✓	1,2-Dibromo-3-Chloropropane	2931	<.5
*Total Xylenes	2955	10000	<1	1,3,5-Trimethylbenzene	2424	<.5
*Styrene	2996	100	<.5	p-Isopropyltoluene	2030	
Chloromethane	2210		--	tert-Butylbenzene	2425	
Bromomethane	2214		--	sec-Butylbenzene	2428	
Dichlorodifluoromethane	2212			Bromochloromethane	2430	
Chloroethane	2216			Dichloromethane	2964	
Trichlorofluoromethane	2218			1,1,2-Trichloroethane	2985	
1,1-Dichloroethane	2978			1,1,1,2-Tetrachloroethane	2986	
m-Dichlorobenzene	2967			1,2 Dibromoethane		✓
Methylene Chloride	2964		✓			

PROPOSED MCLs

RECEIVED: 3-24-93 DATE ANALYZED: 3/29/93 CHEMIST: [illegible]

ppb — parts per billion (micrograms per liter)
MCL — maximum contaminant level
ND — not detected
NA — not analyzed

HMH 4362 6/90

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SEND REPORT TO: Cecil Co. Health Dept.

DEPARTMENT OF HEALTH AND MENTAL HYGIENE 1993 LAB NO. 93-0529

Laboratories Administration
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J. Mehsen Joseph, Ph.D., Director

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY
SDWA ANALYSIS REPORT FORM

Charles Burke Jr.

COLLECTOR: via Stan / CK / 2-23-93 (NAME/TIME/DATE)

SAMPLE SOURCE: 2395 Pinkston Rd

BOTTLE NUMBER: CC-CH-07

PRESERVATION USED: HCl

PWSID #:

SYSTEM NAME:

CHAIN OF CUSTODY: FROM: (NAME/TIME/DATE) TO: (NAME/TIME/DATE)

FROM: TO:

FROM: TO:

REMARKS: Bennetts NYC

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
TRIHALOMETHANES						
Chloroform	2941		<.5	Dibromomethane	2408	<.5
Bromodichloromethane	2943			p-Xylene	2962	
Dibromochloromethane	2944			o-Xylene	2997	
Bromoform	2942			m-Xylene	2995	
TOTAL THMs	2950	100		1,1-Dichloropropene	2410	<.5
REGULATED				trans-1,3-Dichloropropene	2224	
Benzene	2990	5	<.5	cis-1,3-Dichloropropene	2413	
Carbon Tetrachloride	2982	5		1,1,2,2-Tetrachloroethane	2988	
p-Dichlorobenzene	2969	75		1,3-Dichloropropane	2412	
1,1-Dichloroethene	2977	7		2,2-Dichloropropane	2416	
1,2-Dichloroethane	2980	5		o-Chlorotoluene	2965	
1,1,1-Trichloroethane	2981	200		p-Chlorotoluene	2966	
Trichloroethene	2984	5		Bromobenzene	2993	
Vinyl Chloride	2976	2		1,2,4-Trimethylbenzene	2418	
UNREGULATED				1,2,4-Trichlorobenzene	2378	
*trans-1,2-Dichloroethene	2979	100		1,2,3-Trichlorobenzene	2420	
*cis-1,2-Dichloroethene	2980	70		n-Propylbenzene	2998	
*1,2-Dichlorobenzene	2968	600		n-Butylbenzene	2422	
*1,2-Dichloropropane	2983	5		Naphthalene	2248	
*Tetrachloroethene	2987	5		Hexachlorobutadiene	2246	
*Chlorobenzene	2989	100		Isopropylbenzene	2994	
*Toluene	2991	2000		1,2,3-Trichloropropane	2414	
*Ethylbenzene	2992	700		1,2-Dibromo-3-Chloropropane	2931	<.5
*Total Xylenes	2955	10000		1,3,5-Trimethylbenzene	2424	<.5
*Styrene	2996	100		p-Isopropyltoluene	2030	
Chloromethane	2210			tert-Butylbenzene	2426	
Bromomethane	2214			sec-Butylbenzene	2428	
Dichlorodifluoromethane	2212			Bromochloromethane	2430	
Chloroethane	2216			Dichloromethane	2964	
Trichlorofluoromethane	2218			1,1,2-Trichloroethane	2985	
1,1-Dichloroethane	2978			1,1,1,2-Tetrachloroethane	2986	
m-Dichlorobenzene	2967			1,2-Dibromoethane (EDB)		
Methylene Chloride	2964					

* PROPOSED MCLs

DATE RECEIVED: 3-24-93 DATE ANALYZED: 3/29/93 CHEMIST: [illegible]

ppb — parts per billion (micrograms per liter)
MCL — maximum contaminant level
ND — not detected
NA — not analyzed

DHMH 4362 6/90

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SEND REPORT TO: Cecil Co. Health Dept.

DEPARTMENT OF HEALTH AND MENTAL HYGIENE
Laboratories Administration
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P.O. Box 2355, Baltimore, Maryland 21203
J. Mehsen Joseph, Ph.D., Director

APR 2 1993

LAB NO. 93-0539

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY
SDWA ANALYSIS REPORT FORM

COLLECTOR: [illegible] (NAME/TIME/DATE) 3-15-93 SAMPLE SOURCE: [illegible]

BOTTLE NUMBER: CE-[illegible]-10 PRESERVATION USED: HCl

PWSID #: SYSTEM NAME:

CHAIN OF CUSTODY: FROM: (NAME/TIME/DATE) TO: (NAME/TIME/DATE)

FROM: TO:

FROM: TO:

REMARKS: [illegible] MC

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
TRIHALOMETHANES						
Chloroform	2941		<.5	Dibromomethane	2408	<.5
Bromodichloromethane	2943			p-Xylene	2962	
Dibromochloromethane	2944			o-Xylene	2997	
Bromoform	2942			m-Xylene	2995	
TOTAL THMs	2950	100		1,1-Dichloropropene	2410	<.5
REGULATED				trans-1,3-Dichloropropene	2224	
Benzene	2990	5	<.5	cis-1,3-Dichloropropene	2413	
Carbon Tetrachloride	2982	5		1,1,2,2-Tetrachloroethane	2988	
-Dichlorobenzene	2969	75		1,3-Dichloropropane	2412	
-Dichloroethene	2977	7		2,2-Dichloropropane	2416	
1,2-Dichloroethane	2980	5		o-Chlorotoluene	2965	
1,1,1-Trichloroethane	2981	200		p-Chlorotoluene	2966	
Trichloroethene	2984	~~7~~		Bromobenzene	2993	
Vinyl Chloride	2976	~~2~~		1,2,4-Trimethylbenzene	2418	
UNREGULATED				1,2,4-Trichlorobenzene	2378	
*trans-1,2-Dichloroethene	2979	100		1,2,3-Trichlorobenzene	2420	
*cis-1,2-Dichloroethene	2980	70		n-Propylbenzene	2998	
*1,2-Dichlorobenzene	2968	600		n-Butylbenzene	2422	
*1,2-Dichloropropane	2983	5		Naphthalene	2248	
*Tetrachloroethene	2987	5		Hexachlorobutadiene	2246	
*Chlorobenzene	2989	100		Isopropylbenzene	2994	
*Toluene	2991	1000		1,2,3-Trichloropropane	2414	
*Ethylbenzene	2992	700		1,2-Dibromo-3-Chloropropane	2931	<.5
*Total Xylenes	2955	10000		1,3,5-Trimethylbenzene	2424	<.5
*Styrene	2996	100	<.5	p-Isopropyltoluene	2030	
Chloromethane	2210			tert-Butylbenzene	2426	
Bromomethane	2214		<.5	sec-Butylbenzene	2428	
Dichlorodifluoromethane	2212			Bromochloromethane	2430	
Chloroethane	2216			Dichloromethane	2964	
Trichlorofluoromethane	2218			1,1,2-Trichloroethane	2985	
1,1-Dichloroethane	2978			1,1,1,2-Tetrachloroethane	2986	
m-Dichlorobenzene	2967			1,2-Dibromo-[illegible]		
Methylene Chloride	2964					

* PROPOSED MCLs

DATE RECEIVED: 3-26-93 DATE ANALYZED: 3/29/93 CHEMIST: [illegible]

— parts per billion (micrograms per liter)
MCL — maximum contaminant level
ND — not detected
NA — not analyzed

DHMH 4362 6/90

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SEND REPORT TO: Cecil Co. Health Dept.

DEPARTMENT OF HEALTH AND MENTAL HYGIENE
Laboratories Administration
201 W. Preston Street
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J. Mohsen Joseph, Ph.D., Director

1995 LAB NO. 93-0537

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY
SDWA ANALYSIS REPORT FORM

COLLECTOR: [illegible] / CK 12-[illegible]-93 (NAME/TIME/DATE)
SAMPLE SOURCE: 521 [illegible]
BOTTLE NUMBER: CE-[illegible]-11
PRESERVATION USED: HCl
PWSID #:
SYSTEM NAME:

CHAIN OF CUSTODY: FROM: (NAME/TIME/DATE) TO: (NAME/TIME/DATE)
FROM: TO:
FROM: TO:

REMARKS: Brandywine NTC

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
TRIHALOMETHANES						
Chloroform	2941		<.5	Dibromomethane	2408	<.5
Bromodichloromethane	2943			p-Xylene	2962	
Dibromochloromethane	2944			o-Xylene	2997	
Bromoform	2942			m-Xylene	2995	
TOTAL THMs	2950	100		1,1-Dichloropropene	2410	<.5
REGULATED				trans-1,3-Dichloropropene	2224	
Benzene	2990	5	<.5	cis-1,3-Dichloropropene	2413	
Carbon Tetrachloride	2982	5		1,1,2,2-Tetrachloroethane	2988	
p-Dichlorobenzene	2969	75		1,3-Dichloropropane	2412	
1,1-Dichloroethene	2977	7		2,2-Dichloropropane	2416	
1,2-Dichloroethane	2980	5		o-Chlorotoluene	2965	
1,1,1-Trichloroethane	2981	200		p-Chlorotoluene	2966	
Trichloroethene	2984	5		Bromobenzene	2993	
Vinyl Chloride	2976	2		1,2,4-Trimethylbenzene	2418	
UNREGULATED				1,2,4-Trichlorobenzene	2378	
*trans-1,2-Dichloroethene	2979	100		1,2,3-Trichlorobenzene	2420	
*cis-1,2-Dichloroethene	2380	70		n-Propylbenzene	2998	
*1,2-Dichlorobenzene	2968	600		n-Butylbenzene	2422	
*1,2-Dichloropropane	2983	5		Naphthalene	2248	
*Tetrachloroethene	2987	5		Hexachlorobutadiene	2246	
*Chlorobenzene	2989	100		Isopropylbenzene	2994	
*Toluene	2991	[illegible]		1,2,3-Trichloropropane	2414	
*Ethylbenzene	2992	700		1,2-Dibromo-3-Chloropropane	2931	<.5
*Total Xylenes	2955	10000	<.1	1,3,5-Trimethylbenzene	2424	<.5
*Styrene	2996	100	<.5	p-Isopropyltoluene	2030	
Chloromethane	2210		<.1	tert-Butylbenzene	2426	
Bromomethane	2214		<.5	sec-Butylbenzene	2428	
Dichlorodifluoromethane	2212			Bromochloromethane	2430	
Chloroethane	2216			Dichloromethane	2964	
Trichlorofluoromethane	2218			1,1,2-Trichloroethane	2985	
1,1-Dichloroethane	2978			1,1,1,2-Tetrachloroethane	2986	
m-Dichlorobenzene	2967			1,2-Dibromoethane		
Methylene Chloride	2964					

* PROPOSED MCLs

DATE RECEIVED: 3-24-93 DATE ANALYZED: 3/29/93 CHEMIST: [illegible]

ppb — parts per billion (micrograms per liter)
MCL — maximum contaminant level
ND — not detected
NA — not analyzed

DHMH 4362 6/90

SUBMITTER'S COPY

SEND REPORT TO: Cecil Co. Health Dept.

DEPARTMENT OF HEALTH AND MENTAL HYGIENE
Laboratories Administration
201 W. Preston Street
P.O. Box 2355, Baltimore, Maryland 21203
J. Mehsen Joseph, Ph.D., Director

LAB NO. 91-0534

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY
SDWA ANALYSIS REPORT FORM

COLLECTOR: [illegible] / CAR 12-[illegible]-93 (NAME/TIME/DATE)
BOTTLE NUMBER: 01-22-12
PWSID #:
SAMPLE SOURCE: [illegible]
PRESERVATION USED: HCl
SYSTEM NAME:

CHAIN OF CUSTODY: FROM: (NAME/TIME/DATE) TO: (NAME/TIME/DATE)
FROM: TO:
FROM: TO:

REMARKS: Chlorinated HTC

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
TRIHALOMETHANES						
Chloroform	2941		<.5	Dibromomethane	2408	<.5
Bromodichloromethane	2943			p-Xylene	2962	
Dibromochloromethane	2944			o-Xylene	2997	
Bromoform	2942			m-Xylene	2995	
TOTAL THMs	2950	100		1,1-Dichloropropene	2410	<.5
REGULATED				trans-1,3-Dichloropropene	2224	
Benzene	2990	5		cis-1,3-Dichloropropene	2413	
Carbon Tetrachloride	2982	5		1,1,2,2-Tetrachloroethane	2988	
o-Dichlorobenzene	2969	75		1,3-Dichloropropane	2412	
1,1-Dichloroethene	2977	7		2,2-Dichloropropane	2416	
1,2-Dichloroethane	2980	5		o-Chlorotoluene	2965	
1,1,1-Trichloroethane	2981	200		p-Chlorotoluene	2966	
Trichloroethene	2984	X		Bromobenzene	2993	
Vinyl Chloride	2976	X		1,2,4-Trimethylbenzene	2418	
UNREGULATED				1,2,4-Trichlorobenzene	2378	
trans-1,2-Dichloroethene	2979	100		1,2,3-Trichlorobenzene	2420	
cis-1,2-Dichloroethene	2980	70		n-Propylbenzene	2998	
1,2-Dichlorobenzene	2968	600		n-Butylbenzene	2422	
1,2-Dichloropropane	2983	5		Naphthalene	2248	
Tetrachloroethene	2987	5		Hexachlorobutadiene	2246	
Chlorobenzene	2989	100		Isopropylbenzene	2994	
Toluene	2991	[illegible]		1,2,3-Trichloropropane	2414	
Ethylbenzene	2992	700		1,2-Dibromo-3-Chloropropane	2931	<.5
Total Xylenes	2955	10000		1,3,5-Trimethylbenzene	2424	<.5
Styrene	2996	100		p-Isopropyltoluene	2030	
Chloromethane	2210			tert-Butylbenzene	2426	
Bromomethane	2214			sec-Butylbenzene	2428	
Dichlorodifluoromethane	2212			Bromochloromethane	2430	
Chloroethane	2216			Dichloromethane	2964	
Trichlorofluoromethane	2218			1,1,2-Trichloroethane	2985	
1,1-Dichloroethane	2978			1,1,1,2-Tetrachloroethane	2986	
m-Dichlorobenzene	2967			1,2,3-Trichloropropane		
Methylene Chloride	2964					

PROPOSED MCLs

RECEIVED: 3-24-93 DATE ANALYZED: 3/29/93 CHEMIST: [illegible]

– parts per billion (micrograms per liter)
MCL — maximum contaminant level
D — not detected
A — not analyzed

HMH 4362 6/90

recycled paper

SUBMITTER'S COPY

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SEND REPORT TO:
Cecil Co. Health Dept.

DEPARTMENT OF HEALTH AND MENTAL HYGIENE
Laboratories Administration
201 W. Preston Street
P.O. Box 2355, Baltimore, Maryland 21203
J. Mensen Joseph, Ph.D., Director

APR 2 1993 LAB NO. 93-05-19

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY.
SDWA ANALYSIS REPORT FORM

COLLECTOR: [illegible] / [illegible] / 3-15-93 (NAME/TIME/DATE)
SAMPLE SOURCE: [illegible]
BOTTLE NUMBER: CE-EH-12
PRESERVATION USED: HCl
PWSID #:
SYSTEM NAME:

CHAIN OF CUSTODY: FROM: (NAME/TIME/DATE) TO: (NAME/TIME/DATE)
FROM: TO:
FROM: TO:

REMARKS: [illegible]

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
TRIHALOMETHANES						
Chloroform	2941		<.5	Dibromomethane	2408	<.5
Bromodichloromethane	2943			p–Xylene	2962	
Dibromochloromethane	2944			o–Xylene	2997	
Bromoform	2942			m–Xylene	2995	
TOTAL THMs	2950	100		1,1–Dichloropropene	2410	<.5
REGULATED				trans–1,3–Dichloropropene	2224	
Benzene	2990	5	<.5	cis–1,3–Dichloropropene	2413	
Carbon Tetrachloride	2982	5		1,1,2,2–Tetrachloroethane	2986	
p–Dichlorobenzene	2969	75		1,3–Dichloropropane	2412	
1,1–Dichloroethene	2977	7		2,2–Dichloropropane	2416	
1,2–Dichloroethane	2980	5		o–Chlorotoluene	2965	
1,1,1–Trichloroethane	2981	200		p–Chlorotoluene	2966	
Trichloroethene	2984	5		Bromobenzene	2993	
Vinyl Chloride	2976	2		1,2,4–Trimethylbenzene	2418	
UNREGULATED				1,2,4–Trichlorobenzene	2378	
*trans–1,2–Dichloroethene	2979	100		1,2,3–Trichlorobenzene	2420	
*cis–1,2–Dichloroethene	2380	70		n–Propylbenzene	2998	
*1,2–Dichlorobenzene	2968	600		n–Butylbenzene	2422	
*1,2–Dichloropropane	2983	5		Naphthalene	2248	
*Tetrachloroethene	2987	5		Hexachlorobutadiene	2246	
*Chlorobenzene	2989	100		Isopropylbenzene	2994	
*Toluene	2991	[illegible]		1,2,3–Trichloropropane	2414	
*Ethylbenzene	2992	700		1,2–Dibromo–3–Chloropropane	2931	<.5
*Total Xylenes	2955	10000		1,3,5–Trimethylbenzene	2424	<.5
*Styrene	2996	100		p–Isopropyltoluene	2030	
Chloromethane	2210			tert–Butylbenzene	2426	
Bromomethane	2214			sec–Butylbenzene	2428	
Dichlorodifluoromethane	2212			Bromochloromethane	2430	
Chloroethane	2216			Dichloromethane	2964	
Trichlorofluoromethane	2218			1,1,2–Trichloroethane	2985	
1,1–Dichloroethane	2978			1,1,1,2–Tetrachloroethane	2986	
m–Dichlorobenzene	2967			1,2–Dibromoethane		
Methylene Chloride	2964					

* PROPOSED MCLs

DATE RECEIVED: [illegible] DATE ANALYZED: 3/31/93 CHEMIST: [illegible]

ppb — parts per billion (micrograms per liter)
MCL — maximum contaminant level
ND — not detected
NA — not analyzed

DHMH 4362 6/90

SUBMITTER'S COPY

SEND REPORT TO: Cecil Co. Health Dept.

DEPARTMENT OF HEALTH AND MENTAL HYGIENE
Laboratories Administration
201 W. Preston Street
P.O. Box 2355, Baltimore, Maryland 21203
J. Mehsen Joseph, Ph.D., Director

LAB NO. 93-05-19

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY
SDWA ANALYSIS REPORT FORM

COLLECTOR: [illegible] 3-22-93 (NAME/TIME/DATE)
SAMPLE SOURCE: [illegible]
BOTTLE NUMBER: CE-[illegible] 14
PRESERVATION USED: HCl
PWSID #:
SYSTEM NAME:

CHAIN OF CUSTODY: FROM: (NAME/TIME/DATE) TO: (NAME/TIME/DATE)
FROM: TO:
FROM: TO:

REMARKS: [illegible]

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
TRIHALOMETHANES						
Chloroform	2941		<.5	Dibromomethane	2408	<.5
Bromodichloromethane	2943			p-Xylene	2962	
Dibromochloromethane	2944			o-Xylene	2997	
Bromoform	2942			m-Xylene	2995	
TOTAL THMs	2950	100		1,1-Dichloropropene	2410	<.5
REGULATED				trans-1,3-Dichloropropene	2224	
Benzene	2990	5	<.5	cis-1,3-Dichloropropene	2413	
Carbon Tetrachloride	2982	5		1,1,2,2-Tetrachloroethane	2988	
Dichlorobenzene	2969	75		1,3-Dichloropropane	2412	
Dichloroethene	2977	7		2,2-Dichloropropane	2416	
1,2-Dichloroethane	2980	5		o-Chlorotoluene	2965	
1,1,1-Trichloroethane	2981	200		p-Chlorotoluene	2966	
Trichloroethene	2984	5		Bromobenzene	2993	
Vinyl Chloride	2976	2		1,2,4-Trimethylbenzene	2418	
UNREGULATED				1,2,4-Trichlorobenzene	2378	
*trans-1,2-Dichloroethene	2979	100		1,2,3-Trichlorobenzene	2420	
*cis-1,2-Dichloroethene	2380	70		n-Propylbenzene	2998	
*1,2-Dichlorobenzene	2968	600		n-Butylbenzene	2422	
*1,2-Dichloropropane	2983	5		Naphthalene	2248	
*Tetrachloroethene	2987	5		Hexachlorobutadiene	2246	
*Chlorobenzene	2989	100		Isopropylbenzene	2994	
*Toluene	2991	1000		1,2,3-Trichloropropane	2414	
*Ethylbenzene	2992	700		1,2-Dibromo-3-Chloropropane	2931	<.5
*Total Xylenes	2955	10000		1,3,5-Trimethylbenzene	2424	<.5
*Styrene	2996	100	<.5	p-Isopropyltoluene	2030	
Chloromethane	2210			tert-Butylbenzene	2426	
Bromomethane	2214		<.5	sec-Butylbenzene	2428	
Dichlorodifluoromethane	2212			Bromochloromethane	2430	
Chloroethane	2216			Dichloromethane	2964	
Trichlorofluoromethane	2218			1,1,2-Trichloroethane	2985	
1,1-Dichloroethane	2978			1,1,1,2-Tetrachloroethane	2986	
m-Dichlorobenzene	2967			1,2,4-Trichlorobenzene		
Methylene Chloride	2964					

* PROPOSED MCLs

DATE RECEIVED: 3/26/93 DATE ANALYZED: 3/31/93 CHEMIST: [illegible]

ppb — parts per billion (micrograms per liter)
MCL — maximum contaminant level
ND — not detected
NA — not analyzed

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H-31

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SEND REPORT TO: CECIL CO. HEALTH DEPT.

DEPARTMENT OF HEALTH AND MENTAL HYGIENE
Laboratories Administration
201 W. Preston Street
P.O. Box 2355, Baltimore, Maryland 21203
J. Mehsen Joseph, Ph.D., Director

LAB NO. 93-05-19

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY
SDWA ANALYSIS REPORT FORM

COLLECTOR: [illegible] / [illegible] / 3-25-93 (NAME/TIME/DATE)
SAMPLE SOURCE: [illegible]
BOTTLE NUMBER: CE-RK-15
PRESERVATION USED: HCl
PWSID #:
SYSTEM NAME:

CHAIN OF CUSTODY: FROM: (NAME/TIME/DATE) TO: (NAME/TIME/DATE)
FROM: TO:
FROM: TO:

REMARKS: [illegible] NTC

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
TRIHALOMETHANES						
Chloroform	2941		<.5	Dibromomethane	2408	<.5
Bromodichloromethane	2943			p-Xylene	2962	
Dibromochloromethane	2944			o-Xylene	2997	
Bromoform	2942			m-Xylene	2995	
TOTAL THMs	2950	100		1,1-Dichloropropene	2410	
REGULATED				trans-1,3-Dichloropropene	2224	
Benzene	2990	5	<.05	cis-1,3-Dichloropropene	2413	
Carbon Tetrachloride	2982	5		1,1,2,2-Tetrachloroethane	2988	
-Dichlorobenzene	2969	75		1,3-Dichloropropane	2412	
,1-Dichloroethene	2977	7		2,2-Dichloropropane	2416	
,2-Dichloroethane	2980	5		o-Chlorotoluene	2965	
,1,1-Trichloroethane	2981	200		p-Chlorotoluene	2966	
Trichloroethene	2984	5		Bromobenzene	2993	
Vinyl Chloride	2976	2		1,2,4-Trimethylbenzene	2418	
UNREGULATED				1,2,4-Trichlorobenzene	2378	
trans-1,2-Dichloroethene	2979	100		1,2,3-Trichlorobenzene	2420	
cis-1,2-Dichloroethene	2980	70		n-Propylbenzene	2998	
1,2-Dichlorobenzene	2968	600		n-Butylbenzene	2422	
1,2-Dichloropropane	2983	5		Naphthalene	2248	
Tetrachloroethene	2987	5		Hexachlorobutadiene	2246	
Chlorobenzene	2989	100		Isopropylbenzene	2994	
Toluene	2991	1000		1,2,3-Trichloropropane	2414	
Ethylbenzene	2992	700		1,2-Dibromo-3-Chloropropane	2931	<.5
Total Xylenes	2955	10000		1,3,5-Trimethylbenzene	2424	
Styrene	2996	100		p-Isopropyltoluene	2030	
hloromethane	2210			tert-Butylbenzene	2426	
romomethane	2214		<.5	sec-Butylbenzene	2428	
chlorodifluoromethane	2212			Bromochloromethane	2430	
hloroethane	2216			Dichloromethane	2964	
chlorofluoromethane	2218			1,1,2-Trichloroethane	2985	
1-Dichloroethane	2978			1,1,1,2-Tetrachloroethane	2986	
-Dichlorobenzene	2967			1,2-Dibromoethane		
ethylene Chloride	2964					

PROPOSED MCLs

DATE RECEIVED: 3/26/93 DATE ANALYZED: 3/31/93 CHEMIST: [illegible]

b — parts per billion (micrograms per liter)
CL — maximum contaminant level
) — not detected
\ — not analyzed

IMH 4362 6/90

SUBMITTER'S COPY

Cecil Co. Health Dept.

Laboratories Administration
201 W. Preston Street
P.O. Box 2355, Baltimore, Maryland 21203
J. Mehsen Joseph, Ph.D., Director

APR 2 1993

LAB NO. _____

GAS CHROMATOGRAPHY–MASS SPECTROMETRY LABORATORY
SDWA ANALYSIS REPORT FORM

COLLECTOR: [illegible] (NAME/TIME/DATE)
BOTTLE NUMBER: [illegible]
PWSID #: _____

SAMPLE SOURCE: [illegible]
PRESERVATION USED: [illegible]
SYSTEM NAME: _____

CHAIN OF CUSTODY: FROM: _____ (NAME/TIME/DATE) TO: _____ (NAME/TIME/DATE)
FROM: _____ TO: _____
FROM: _____ TO: _____

REMARKS: [illegible]

CONTAMINANT	EPACONT ID	MCL	ACTUAL LEVEL (ppb)	CONTAMINANT	EPACONT ID	ACTUAL LEVEL (ppb)
TRIHALOMETHANES						
Chloroform	2941		<.5	Dibromomethane	2408	<.5
Bromodichloromethane	2943			p–Xylene	2962	
Dibromochloromethane	2944			o–Xylene	2997	
Bromoform	2942			m–Xylene	2995	
TOTAL THMs	2950	100		1,1–Dichloropropene	2410	<.5
REGULATED				trans–1,3–Dichloropropene	2224	
Benzene	2990	5	<.5	cis–1,3–Dichloropropene	2413	
Carbon Tetrachloride	2982	5		1,1,2,2–Tetrachloroethane	2988	
p–Dichlorobenzene	2969	75		1,3–Dichloropropane	2412	
1,1–Dichloroethene	2977	7		2,2–Dichloropropane	2416	
1,2–Dichloroethane	2980	5		o–Chlorotoluene	2965	
1,1,1–Trichloroethane	2981	200		p–Chlorotoluene	2966	
Trichloroethene	2984	5 ~~7~~		Bromobenzene	2993	
Vinyl Chloride	2976	2 ~~1~~		1,2,4–Trimethylbenzene	2418	
UNREGULATED				1,2,4–Trichlorobenzene	2378	
trans–1,2–Dichloroethene	2979	100		1,2,3–Trichlorobenzene	2420	
cis–1,2–Dichloroethene	2980	70		n–Propylbenzene	2998	
1,2–Dichlorobenzene	2968	600		n–Butylbenzene	2422	
1,2–Dichloropropane	2983	5		Naphthalene	2248	
Tetrachloroethene	2987	5		Hexachlorobutadiene	2246	
Chlorobenzene	2989	100		Isopropylbenzene	2994	
Toluene	2991	1000 ~~[illegible]~~		1,2,3–Trichloropropane	2414	✓
Ethylbenzene	2992	700	✓	1,2–Dibromo–3–Chloropropane	2931	<.5
Total Xylenes	2955	10000		1,3,5–Trimethylbenzene	2424	<.5
Styrene	2996	~~[illegible]~~100	<.5	p–Isopropyltoluene	2030	
Chloromethane	2210			tert–Butylbenzene	2426	
Bromomethane	2214		<.5	sec–Butylbenzene	2428	
Dichlorodifluoromethane	2212			Bromochloromethane	2430	
Chloroethane	2216			Dichloromethane	2964	
Trichlorofluoromethane	2218			1,1,2–Trichloroethane	2985	
1,1–Dichloroethane	2978			1,1,1,2–Tetrachloroethane	2986	
1,3–Dichlorobenzene	2967			1,2–Dibromo–[illegible]		✓
Methylene Chloride	2964		✓			

PROPOSED MCLs

DATE RECEIVED: 3-26-93 DATE ANALYZED: 3/29/93 CHEMIST: K. [illegible]

ppb — parts per billion (micrograms per liter)
MCL — maximum contaminant level
ND — not detected
NA — not analyzed

1 of ~16 samples

HMH 4362 5/90

H-33
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Appendix H

Attachment A

Town of Port Deposit Code

Service Connection Ordinance 15-4

15-4 SERVICE CONNECTION.

15-4.1 Time for Connection; Closing of Private Wells, Privy Vaults, etc. When any water main or sanitary sewer main is declared ready for operation by the Town and reasonable notice given, all abutting property owners shall immediately connect all fixtures with the water or sewer main or both the water and sewer mains where both mains are available. Upon notification that the sewage system is operational, all property owners shall within six (6) months at their own expense abandon, clean out, disinfect and permanently fill up their respective privy vaults, wells (filled or capped), cesspools and other drainage or sewage receptacles with clean fresh earth; provided that clean ashes or other approved material may be used with the permission of the Town. (Ord. #80-3, §XII)

15-4.2 Non-Compliance. That should any owner of any such property refuse, neglect or fail to comply with any of the terms and requirements of the notice within the time therein stated, then upon the expiration of the time stated, the Town, its servants, agents and employees, are hereby empowered and directed to enter upon the premises and to perform all the work required of the owner of the property, and to supply all the material needed therefor at the expense of the owner, and upon the completion of the materials, and all expenses incurred, may be recovered by the Town from the owner, by suit or otherwise, if necessary; but, in the discretion of the Town Council, no owner or other person in default under the provisions of this Chapter, shall be permitted any use of the sewer or water or any part thereof, until security, adequate in the judgment of the Town Council, shall be given for the full payment and satisfaction of all costs and expenses incurred in any manner by it for the benefit of such owner or other person, under the provisions of this Chapter, and, in addition thereto, the owner who shall refuse, neglect or fail to comply with any of the terms and requirements of the notice, may be

I Screening Analysis of Dermal Contact with Metals in Surface Water

This appendix contains the following: a transmittal letter from Drew Lausch, the Remedial Project Manager (EPA Region III), and an attachment relevant to the human health risk assessments at Sites 1 and 2.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
841 Chestnut Building
Philadelphia, Pennsylvania 19107-4431

REPLY TO ATTENTION OF:

Federal Facilities Branch (3HW50)

FEDERAL EXPRESS

May 10, 1996

Department of the Navy
Engineering Field Activity Chesapeake
Building 212, Code 1812
901 M Street, S.E.
Washington, D.C. 20374-5018

Attn: Frank P. Zepka
Environmental Engineer

Re: Human Health Risk Assessment ("HHRA") Issues
Remedial Investigation Report
Former Naval Training Center - Bainbridge
Port Deposit, MD

Dear Mr. Zepka:

Please reference U.S. Environmental Protection Agency Region III ("EPA Region III" or "Agency") correspondence to your office dated April 26, 1996. The aforementioned correspondence summarized issues and action items discussed among the U.S. Navy, Ecology and Environment, Inc. ("E&E"), Agency and the Maryland Department of the Environment during an April 24th teleconference call.

As you know, one of the unresolved issues at the time of the teleconference call related to E&E's opinion that a quantitative assessment of metals in surface water at the Old Base Landfill and Former Fire Training Area would not be necessary. Although levels of certain metals exceeded surface water screening concentrations, E&E asserted that these samples exhibited high turbidity due to the presence of suspended sediment. Consequently, E&E believed that risks to human receptors posed by this medium could be addressed by considering risks associated with sediment. EPA Region III requested additional time to consider E&E's position with respect to "screening out" surface water metals.

We have now completed our evaluation of E&E's position. After careful consideration, EPA Region III has determined that the Agency cannot accept the explanation offered by E&E as adequate justification for eliminating metals in surface water from further consideration in the HHRA. Although turbid surface water samples

contained high concentrations of metals, the relative portion of metals that could be attributed to dissolved metals, as opposed to suspended sediments, cannot be stated with confidence. Due to this uncertainty, the Agency believes that it is not appropriate to address dermal absorption of metals from surface water by an estimate of sediment exposure. Therefore, EPA Region III has performed an evaluation of exposure to surface water metals using a conservative risk-based screening approach. Our evaluation is included for your information and use **[Attachment]**. Although we would recommend that a similar, or identical, approach to that described in the Attachment be incorporated into the HHRA, the U.S. Navy and E&E may choose to generate an independent evaluation using the same principles.

In closing, discussion in the Attachment is intended only to address surface water exposure through dermal absorption of metals. EPA Region III has not considered human consumption of aquatic organisms in surface water bodies located adjacent to the Old Base Landfill and Former Fire Training Area since this does not appear to represent a complete exposure pathway. Additionally, it should be noted that non-human receptors are generally more sensitive to metals in surface water. A comparison to federal Ambient Water Quality Criteria ("AWQCs") shows that many of the metals detected in seeps and surface water exceed respective AWQCs. Potential impacts to non-human environmental receptors will be evaluated in more detail as part of the ecological risk assessment.

If you or E&E have any questions with respect to our evaluation, please contact me at (215) 597-3161 [new number will be (215) 566-3359 effective May 20, 1996] or at my e-mail address "lausch.robert@epamail.epa.gov". You may also contact Jennifer Hubbard directly at (215) 597-1309 [new number will be (215) 566-3328 effective May 20, 1996].

Sincerely,

Drew Lausch
Remedial Project Manager

Attachment

cc w/attachment:

John Fairbank (MDE)
Deirdre Murphy (MDE)

cc w/o attachment:

Mike Burke (EPA)
Jennifer Hubbard (EPA)
Barbara Okorn-Root (EPA/BTAG)

* * * * *

Table 5-2 shows the risk-based screening and selection of COPCs for surface water. For the purposes of conservative risk-based screening, results for both seeps and surface water were evaluated similarly. The following COPCs were selected, with maximum concentrations in surface waters or seeps provided below:

- Old Base Landfill: Arsenic (552 µg/l), Beryllium (40.5 µg/l), Iron (5,280,000 µg/l), Lead (2,780 µg/l), Manganese (30,300 µg/l); Thallium (945 µg/l)
- Former Fire Training Area: Arsenic (58.3 µg/l), Iron (1,480,000 µg/l); Lead (498 µg/l)

The downstream samples were reported to be highly turbid. It is likely that the majority of the metals detected in these samples are associated with suspended sediments. Comparison to upstream samples provided little useful information because these samples were not turbid and exhibited much lower concentrations of metals.

Surface waters located adjacent to the Old Base Landfill and Former Fire Training Area are reportedly too shallow to support swimming activities. Therefore, assuming a wading scenario, dermal contact would represent the only potential exposure route. Dermal exposure to inorganic chemicals in surface water can be estimated as follows (EPA, 1992):

Dose (mg/kg/day) = (Kp x CV x t x CF x EF x ED x A)/(BW x AT)

where,

Kp = Permeability coefficient from water (cm/hr)
CV = Concentration of chemical in water (mg/l)
t = Duration of exposure event (hrs)
CF = Conversion factor (L/cm3: 1E-3)
EF = Exposure frequency (days/yr)
ED = Exposure duration (yrs)
BW = Body weight (kg)
AT = 365 days/yr x ED (noncancer)
365 days/yr x 70 yrs (cancer)

The Hazard Quotients and cancer risks are estimated using the dose as shown in Sections 5.4.4 and 5.4.5.

The following exposure parameters may be assumed:

PARAMETER	VALUE	SOURCE/RATIONALE
Kp	1E-3	EPA, 1992 (Table 5-3 or default value for metals)
CV	Max. Conc.	Estimation/screening purposes
t	2.6	EPA, 1989a (Suggested default for swimming)
EF	7	EPA, 1989a (Suggested default for swimming)
ED	24 (adult) 8 (child)	Default of adult's portion of 30-year lifetime segment (EPA, 1991) Child assumed to be ages 6-14
A	3000 (adult) 2000 (child)	Estimates from EPA, 1989b for lower legs and feet
BW	70 (adult) 35 (child)	EPA, 1991 Estimated from EPA, 1989b

Dermal RfDs and CSFs were derived from oral RfDs and CSFs. Where oral absorption factors were available, they were used to derive the dermal RfDs and CSFs in accordance with EPA, 1989a (Appendix A). Oral absorption factors of 95% for Arsenic (NCEA, 1992) and 1% for Beryllium (NCEA, 1994) were used. For thallium, an RfD of 8E-5 mg/kg/day (for various thallium compounds) was used to estimate noncancer hazard (EPA, 1996).

The following noncancer hazards and carcinogenic risks were calculated for exposure to COPCs in surface water:

Old Base Landfill

CHEMICAL	HQ-ADULT	HQ-CHILD	CA RISK-ADULT	CA RISK-CHILD
ARSENIC	0.004	0.006	6E-7	3E-7
BERYLLIUM	0.002	0.002	1E-5	6E-6
IRON	0.04	0.05	N/A	N/A
LEAD	N/A	N/A	N/A	N/A
MANGANESE	0.003	0.004	N/A	N/A
THALLIUM	0.02	0.03	N/A	N/A

Fire Training Area

CHEMICAL	HQ-ADULT	HQ-CHILD	CA RISK-ADULT	CA RISK-CHILD
ARSENIC	0.0004	0.0006	7E-8	3E-8
IRON	0.01	0.01	N/A	N/A
LEAD	N/A	N/A	N/A	N/A

Since use of maximum concentrations represents a conservative screening measure, risks are expected to be no greater than those estimated above. Nevertheless, it is apparent that even these conservative risk estimates are well within or even below target ranges outlined in the National Contingency Plan.

In the case of lead, no RfDs or CSFs have been developed. EPA Region III typically evaluates lead exposure with the Integrated Exposure Uptake Biokinetic (IEUBK) model, which estimates blood-lead levels. However, the IEUBK model is designed for young children and does not incorporate the dermal exposure route since the ingestion and inhalation routes are considered to be much more significant for lead. Therefore, the IEUBK model was inappropriate for use. For the aforementioned reasons, lead exposure was not evaluated quantitatively.

* * * * *

REFERENCES

United States Environmental Protection Agency (EPA). 1992. Issue Paper: Oral-to-Dermal Extrapolation for Arsenic. National Center for Environmental Assessment (NCEA), Cincinnati, OH. October 9, 1992.

NCEA. 1994. Issue Paper: Oral-to-Dermal Extrapolation for Beryllium. National Center for Environmental Assessment, Cincinnati, OH. May 12, 1994.

EPA. 1989a. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A). Interim Final. Office of Emergency and Remedial Response, Washington, D.C. December 1989.

EPA. 1989b. Exposure Factors Handbook. EPA/600/8-89/043. Exposure Assessment Group, Office of Health and Environmental Assessment, Washington, D.C. May.

EPA. 1991. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03. Office of Solid Waste and Emergency Response, Washington, D.C. March 25.

EPA. 1992. Dermal Exposure Assessment: Principles and Applications. Interim Report. EPA/600/8-91/011/B. Office of Health and Environmental Assessment, Washington, D.C. January.

EPA. 1996. Integrated Risk Information System (IRIS). Records for thallium compounds.

J Exposure Point Concentrations Calculation

Exposure point concentrations used in the human health risk assessments prepared for Sites 1 and 2 of the NTC were estimated from concentrations measured in the exposure media. In accordance with EPA guidance, the 95% UCL on the arithmetic mean was calculated for each COPC in each medium, assuming lognormal data distributions. In most cases, the UCL values were used as the exposure point concentrations. In a few cases where the UCL was greater than the maximum concentration in the data set, the maximum concentration was used instead.

This appendix contains two section. Section I.1 presents the results of statistical testing for normality of groundwater data from both sites and sediment data from Site 1. This analysis was not carried out for Site 2 soil or sediment because the numbers of samples collected from those media were too small for meaningful results. The results obtained indicate that the assumption of lognormality in the data distributions for the purpose of calculating UCL values is reasonable. Section I.2 presents the calculation spreadsheets for the exposure point concentrations that were used in the risk assessments.

J.1 Statistical Testing of Environmental Data for Normality

The distributions of all of the COPCs for groundwater at Sites 1 and 2, and the COPCs for sediment at Site 1 were tested using the Shapiro-Wilk's test for normality. Both the original untransformed and logtransformed datasets were tested. The results are presented in Tables 1 through 3. As shown in the tables, the vast majority of the datasets were neither normally nor lognormally distributed, however nearly all of the datasets fitted a lognormal distribution as well or better than a normal distribution (a larger W statistic indicating a better fit). The poor fits observed are probably due to a combination of factors:

- Many of the COPCs were detected in only a small fraction of the samples, which has the effect of obscuring the underlying distribution. There are statistical methods available for estimating the population characteristics of censored datasets, but they are generally limited to datasets with no more than 20 - 30 % nondetects. Application of these methods often yields very wide confidence intervals which would lead to adoption of the maximum detected concentration as the exposure point concentration in accordance with EPA guidance on estimating exposure point concentrations.

- Other datasets, in which a chemical was detected in most or all of the samples, were heterogeneous, reflecting the presence of two or more distinct populations within the dataset. Examples were groundwater datasets that included samples from wells with distinctly different COPC levels and sediment datasets that included samples from different locations and/or different sampling rounds with widely varying results.

The objective of the exposure point concentration selection process is to obtain a reasonably conservative (health protective) estimate of the average exposure point concentration a potential receptor is likely to encounter. The upper confidence limit on the arithmetic average concentration on or the maximum observed concentration, whichever is lower, is deemed to provide such an estimate. When UCLs are calculated for a population assuming both common distributions (normal and lognormal), the UCL calculated assuming the distribution that fits the data better is always smaller than the other UCL. This indicates that a UCL calculated assuming a distribution that does not fit the data well tends to overestimate, rather than underestimate, the actual UCL for the dataset. Thus a UCL calculated using an incorrect distribution assumption still provides a conservative (possibly a somewhat overly conservative) estimate of the exposure point concentration.

J.2 Calculation of Exposure Point Concentrations

The following pages present calculation spreadsheets for the exposure point concentrations that were used in the human health risk assessment to estimate potential exposures to sediment and groundwater at Site 1 and sediment, soil, and groundwater at Site 2. The spreadsheets show which samples were included, the values used in the calculations of UCLs, a comparison of the UCL and the maximum concentration detected, and finally the exposure point concentration that was used in the risk assessment.

Table 1

Shapiro-Wilk's tests for Parameter Distributions for Site 1 (Old Landfill) Groundwater, Bainbridge Naval Training Center, Port Deposit, Maryland

Chemical	Usable Samples	Detects	Normal		Lognormal		Better Fit
			W	P	W	P	
1,2-Dichloroethene	66	52	0.518752	0.000	0.895126	0.000	Lognormal
1,2-Dichloropropane	1	1					
1,4-Dichlorobenzene	66	23	0.659527	0.000	0.711832	0.000	Lognormal
Antimony	66	1	0.124513	0.000	0.124513	0.000	Lognormal
Arsenic	66	1	0.124513	0.000	0.124513	0.000	Lognormal
Beryllium	17	17	0.912566	0.112	0.880717	0.032	Normal
bis(2-ethylhexyl)phthalate	66	31	0.628966	0.000	0.852812	0.000	Lognormal
Cadmium	66	2	0.208175	0.000	0.199379	0.000	Normal
Carbon disulfide	3	3	0.75		0.75	0.000	Lognormal
Chlorobenzene	66	23	0.631309	0.000	0.648486	0.000	Lognormal
Chloroform	4	4	0.629109	0.000	0.629109	0.000	Lognormal
Chromium	66	17	0.17755	0.000	0.460002	0.000	Lognormal
Heptachlor	66	1	0.124513	0.000	0.124513	0.000	Lognormal
Iron	66	66	0.719429	0.000	0.937429	0.004	Lognormal
Manganese	66	66	0.733141	0.000	0.910341	0.000	Lognormal
Methylene chloride	66	4	0.150271	0.000	0.315039	0.000	Lognormal
Nickel	66	34	0.312326	0.000	0.805281	0.000	Lognormal
Thallium	66	1	0.124513	0.000	0.124513	0.000	Lognormal
Trichloroethene	66	37	0.733221	0.000	0.833473	0.000	Lognormal
Vinyl Chloride	26	2	0.249374	0.000	0.283184	0.000	Lognormal

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Table 2

Shapiro-Wilk's tests for Parameter Distributions for Site 2 (Fire Training Area) Groundwater, Bainbridge Naval Training Center, Port Deposit, Maryland

CHEMICAL	Usable Samples	Detects	Normal		Lognormal		Better Fit
			W	P	W	P	
1,1,2,2-Tetrachloroethane	54	6	0.330741	0.000	0.338925	0.000	Lognormal
1,4-Dichlorobenzene	1	1					
Aldrin	54	1	0.13801	0.000	0.13801	0.000	Lognormal
Aluminum	54	54	0.529492	0.000	0.872338	0.000	Lognormal
Arsenic	54	6	0.315094	0.000	0.319743	0.000	Lognormal
Benzo(a)anthracene	1	1					
Benzo(a)pyrene	2	2					
Benzo(b)fluoranthene	2	2					
Benzo(k)fluoranthene	1	1					
Beryllium	54	8	0.513767	0.000	0.487875	0.000	Normal
bis(2-ethylhexyl)phthalate	54	18	0.266938	0.000	0.681765	0.000	Lognormal
Cadmium	54	3	0.202673	0.000	0.205592	0.000	Lognormal
Chloroform	54	2	0.199527	0.000	0.199527	0.000	Lognormal
Chromium	54	19	0.499467	0.000	0.643373	0.000	Lognormal
Chrysene	2	2					
Indeno(1,2,3-cd)pyrene	2	2					
Iron	54	54	0.794994	0.000	0.875351	0.000	Lognormal
Manganese	54	54	0.810271	0.000	0.854319	0.000	Lognormal
Methylene Chloride	54	5	0.229057	0.000	0.37706	0.000	Lognormal
Thallium	54	2					
Trichloroethene	6	6	0.639916	0.000	0.639916	0.000	Lognormal
Zinc	54	51	0.229164	0.000	0.953397	0.066	Lognormal

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Table 3

Shapiro-Wilk's tests for Parameter Distributions for Site 1 (Old Landfill) Sediment, Bainbridge Naval Training Center, Port Deposit, Maryland

Chemical	Usable Samples	Detects	Normal		Lognormal		Better Fit
			W	P	W	P	
Aluminum	35	35	0.683635	0.000	0.917847	0.014	Lognormal
Arsenic	35	35	0.647892	0.000	0.888104	0.002	Lognormal
Benzo(a)anthracene	35	23	0.211187	0.000	0.792859	0.000	Lognormal
Benzo(a)pyrene	35	22	0.201813	0.000	0.741747	0.000	Lognormal
Benzo(b)fluoranthene	35	27	0.201569	0.000	0.822206	0.000	Lognormal
Benzo(k)fluoranthene	35	20	0.197033	0.000	0.740238	0.000	Lognormal
Beryllium	35	28	0.636282	0.000	0.912356	0.009	Lognormal
Chlordane	35	9	0.294098	0.000	0.657023	0.000	Lognormal
Chromium	35	35	0.758035	0.000	0.953533	0.188	Lognormal
Chrysene	35	24	0.20416	0.000	0.806165	0.000	Lognormal
Dibenzo(a,h)anthracene	35	10	0.204329	0.000	0.631399	0.000	Lognormal
Indeno(1,2,3-cd)pyrene	35	22	0.204736	0.000	0.793266	0.000	Lognormal
Iron	35	35	0.474554	0.000	0.879319	0.001	Lognormal
Manganese	35	35	0.652154	0.000	0.934389	0.048	Lognormal
Thallium	35	2	0.470681	0.000	0.435148	0.000	Normal
Vanadium	35	35	0.80336	0.000	0.944793	0.102	Lognormal

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Site 1: Old Landfill
Sediment Analytical Results

Units	Chemical	P1-SD-4	P1-SD-4	P1-SD-5	P1-SD-5	P1-SD-6	P1-SD-6	P1-SD-7	P1-SD-7	P1-SD-8
ug/kg	Benzo(a)Anthracene	410	180	1800	150	68	170	1100	130	250
ug/kg	Benzo(a)Pyrene	450	200	1800	170	71	160	1200	120	240
ug/kg	Benzo(b)Fluoranthene	510	330	2200	300	98	210	1500	220	280
ug/kg	Benzo(k)Fluoranthene	280	150	1500	140	46	130	690	60	150
ug/kg	Chrysene	460	210	1800	170	70	210	1100	140	260
ug/kg	Dibenzo(a,h)Anthracene	58	*165*	270	*165*	*165*	*165*	180	*165*	*165*
ug/kg	Indeno(1,2,3,-cd)Pyrene	290	130	1100	110	55	100	810	59	170
ug/kg	Chlordane	*1.7*	*1.7*	*1.7*	*1.7*	*1.7*	*1.7*	690	86	43
mg/kg	Aluminum	4570	5320	3070	3680	3830	2890	5450	5390	4080
mg/kg	Arsenic	2.00	1.40	1.50	0.81	0.94	0.88	1.70	0.78	1.40
mg/kg	Beryllium	*0.5*	0.78	*0.5*	0.64	*0.5*	0.45	*0.5*	0.99	*0.5*
mg/kg	Chromium	18.1	12.5	6.6	37	9	5.5	11.7	14.4	8.2
mg/kg	Iron	18200	22100	11400	15200	20900	8680	12400	13400	11900
mg/kg	Manganese	380	1320	1630	1720	882	1190	252	182	229
mg/kg	Thallium	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
mg/kg	Vanadium	21.8	25.9	23.7	22.0	22.5	13.3	22.7	37.6	20.4

*An italicized value indicates that the chemical was not detected. The reported value is 1/2 of the sample quantitation limit.

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BAINBRIDGE NAVAL TRAINING STATION

Site 1: Old Landfill
Sediment Analytical Results

Units	Chemical	P1-SD-8	P1-SD-9	P1-SD-9	P1-SD-11	P1-SD-11	1-SD-2	1-SD-3	1-SD-4	1-SD-7
ug/kg	Benzo(a)Anthracene	*165*	47000	85	*165*	*165*	3500	96	*165*	97
ug/kg	Benzo(a)Pyrene	*165*	54000	70	*165*	*165*	2800	58	*165*	93
ug/kg	Benzo(b)Fluoranthene	62	74000	120	69	340	3800	110	*165*	110
ug/kg	Benzo(k)Fluoranthene	*165*	35000	*165*	*165*	*165*	1000	*165*	*165*	49
ug/kg	Chrysene	*165*	55000	83	*165*	*165*	3100	88	*165*	93
ug/kg	Dibenzo(a,h)Anthracene	*165*	9100	*165*	*165*	*165*	530	*165*	*165*	*165*
ug/kg	Indeno(1,2,3,-cd)Pyrene	*165*	38000	*165*	*165*	*165*	2500	47	*165*	77
ug/kg	Chlordane	21.9	*1.7*	*1.7*	*1.7*	*1.7*	*1.7*	*1.7*	*1.7*	*1.7*
mg/kg	Aluminum	2590	3210	3545	9145	9680	4780	7640	4910	1455
mg/kg	Arsenic	1.00	1.40	0.72	0.56	*0.20*	0.87	1.40	1.10	1.80
mg/kg	Beryllium	0.49	*0.5*	0.61	*0.5*	3.3	0.58	1.1	0.58	0.53
mg/kg	Chromium	7.2	7.9	9.3	41.4	49.4	11.7	19.3	3.3	12
mg/kg	Iron	6280	9500	9370	17300	115000	9650	24400	30100	192000
mg/kg	Manganese	174	284	360	152	5600	456	756	2290	2725
mg/kg	Thallium	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
mg/kg	Vanadium	16.0	15.0	18.6	29.3	68.0	21.8	34.3	19.9	24.2

*An italicized value indicates that the chemical was not detected. The reported value is 1/2 of the sample quantitation limit.

BAINBRIDGE NAVAL TRAINING STATION

Site 1: Old Landfill
Sediment Analytical Results

Units	Chemical	1-SD-8	1-SD-9	1-SD-10	1-SD-11	1-SD-12	1-SD-13	1-SD-14	1-SD-15	1-SD-16
ug/kg	Benzo(a)Anthracene	430	31	61	160	170	560	*165*	*165*	750
ug/kg	Benzo(a)Pyrene	350	*165*	52	140	140	420	*165*	*165*	620
ug/kg	Benzo(b)Fluoranthene	520	43	84	190	240	550	*165*	50	880
ug/kg	Benzo(k)Fluoranthene	160	*165*	25	64	67	180	*165*	*165*	290
ug/kg	Chrysene	430	36	73	140	190	500	*165*	48	790
ug/kg	Dibenzo(a,h)Anthracene	66	*165*	*165*	*165*	35	60	*165*	*165*	110
ug/kg	Indeno(1,2,3,-cd)Pyrene	260	26	48	86	120	280	*165*	*165*	440
ug/kg	Chlordane	*1.7*	*1.7*	*1.7*	*1.7*	2.6	9.4	*1.7*	24	*1.7*
mg/kg	Aluminum	3000	1170	2210	2730	3290	2460	2610	3210	4540
mg/kg	Arsenic	0.88	*0.20*	0.62	*0.20*	0.75	*0.20*	*0.20*	0.62	1.60
mg/kg	Beryllium	0.47	0.25	0.27	0.27	0.37	0.27	0.39	0.33	0.47
mg/kg	Chromium	6.3	4.8	4.1	8.1	7.2	7.8	8.6	7.9	7.8
mg/kg	Iron	35600	7520	9380	11600	12600	7830	11600	7320	8120
mg/kg	Manganese	1510	1170	892	597	903	255	555	208	193
mg/kg	Thallium	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*
mg/kg	Vanadium	16.7	12.6	12.1	14.1	18.5	12.7	13.0	14.9	19.5

*An italicized value indicates that the chemical was not detected. The reported value is 1/2 of the sample quantitation limit.

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BAINBRIDGE NAVAL TRAINING STATION

Site 1: Old Landfill
Sediment Analytical Results

Units	Chemical	1-SD-17	1-SD-18	OHM-AC	OHM-BC	OHM-CC	OHM-DC	OHM-EC	OHM-FC
ug/kg	Benzo(a)Anthracene	400	240	*200*	*200*	*200*	*200*	*200*	*200*
ug/kg	Benzo(a)Pyrene	290	180	*200*	*200*	*200*	*200*	*200*	*200*
ug/kg	Benzo(b)Fluoranthene	410	230	*200*	*200*	*200*	*200*	*200*	*200*
ug/kg	Benzo(k)Fluoranthene	160	98	*200*	*200*	*200*	*200*	*200*	*200*
ug/kg	Chrysene	430	260	*200*	*200*	*200*	*200*	*200*	*200*
ug/kg	Dibenzo(a,h)Anthracene	55	*165*	*200*	*200*	*200*	*200*	*200*	*200*
ug/kg	Indeno(1,2,3-cd)Pyrene	220	120	*200*	*200*	*200*	*200*	*200*	*200*
ug/kg	Chlordane	19	200	*3.9*	*1*	*1*	*2*	*2*	*2.3*
mg/kg	Aluminum	3070	5650	12400	30500	18700	25000	17100	25500
mg/kg	Arsenic	0.90	1.40	0.75	*1.20*	*1.25*	5.90	1.50	0.85
mg/kg	Beryllium	0.37	0.75	0.85	2.1	1.7	0.71	0.71	0.97
mg/kg	Chromium	7.5	17.4	14.9	10	19.4	24.7	10.3	29.7
mg/kg	Iron	7310	14100	19100	32500	27300	26200	16400	40400
mg/kg	Manganese	184	357	354	227	843	228	283	448
mg/kg	Thallium	*1.00*	*1.00*	*0.28*	*0.30*	*0.32*	1.20	*0.30*	0.82
mg/kg	Vanadium	14.8	33.7	22.2	21.4	34.5	35.2	22.9	42.7

*An italicized value indicates that the chemical was not de' 'ted. The reported value is 1/2 of the sample quantitation ''nit.

Site 1: Old Landfill
Sediment Analytical Results

Summary Statistics for Log Transformed Data

Units	Chemical	No. of Values n	Average ln value	Std. Dev., s (ln)	n-1	Land "H" for 0.95	Lognormal Distrib. UCL	Max. Conc.	Max. Exceeded?	Source conc. for RME Case
ug/kg	Benzo(a)Anthracene	35	5.53	1.29	34	2.759	1.07E+03	47000.00	No	1.07E+03
ug/kg	Benzo(a)Pyrene	35	5.51	1.27	34	2.733	1.00E+03	54000.00	No	1.00E+03
ug/kg	Benzo(b)Fluoranthene	35	5.63	1.38	34	2.879	1.44E+03	74000.00	No	1.44E+03
ug/kg	Benzo(k)Fluoranthene	35	5.24	1.20	34	2.644	6.67E+02	35000.00	No	6.67E+02
ug/kg	Chrysene	35	5.53	1.32	34	2.799	1.13E+03	55000.00	No	1.13E+03
ug/kg	Dibenzo(a,h)Anthracene	35	5.13	0.85	34	2.237	3.37E+02	9100.00	No	3.37E+02
ug/kg	Indeno(1,2,3,-cd)Pyrene	35	5.28	1.27	34	2.733	7.92E+02	38000.00	No	7.92E+02
ug/kg	Chlordane	35	1.33	1.59	34	3.165	3.18E+01	690.00	No	3.18E+01
mg/kg	Aluminum	35	8.51	0.80	34	1.973	8.92E+03	30500.00	No	8.92E+03
mg/kg	Arsenic	35	-0.13	0.75	34	2.136	1.53E+00	5.90	No	1.53E+00
mg/kg	Beryllium	35	-0.54	0.57	34	1.973	8.31E-01	3.30	No	8.31E-01
mg/kg	Chromium	35	2.40	0.64	34	1.973	1.68E+01	49.40	No	1.68E+01
mg/kg	Iron	35	9.70	0.76	34	2.136	2.85E+04	192000.00	No	2.85E+04
mg/kg	Manganese	35	6.28	0.92	34	2.311	1.18E+03	5800.00	No	1.18E+03
mg/kg	Thallium	35	-0.14	0.39	34	1.841	1.06E+00	1.20	No	1.06E+00
mg/kg	Vanadium	35	3.07	0.40	34	1.847	2.64E+01	68.00	No	2.64E+01

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BAINBRIDGE NAVAL TRAINING STATION

Site 1: Old Landfill
Groundwater Analytical Results

Units	Chemical	1-GW-3	1-GW-3	1-GW-3	1-GW-3	1-GW-3	1-GW-3	1-GW-4	1-GW-4	1-GW-4	1-GW-4
ug/L	1,2-Dichloroethene	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
ug/L	1,2-Dichloropropane										
ug/L	Carbon disulfide	4									
ug/L	Chlorobenzene	300	355	160	270	260	280	*5*	*5*	*5*	*5*
ug/L	Chloroform										
ug/L	Methylene chloride	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
ug/L	Trichloroethene	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
ug/L	Vinyl chloride				*0.5*	*0.5*	*0.5*				
ug/L											
ug/L	1,4-Dichlorobenzene	28	27	25	26	21	*5*	*5*	*5*	*5*	*5*
ug/L	Bis(2-ethylhexyl)phthalate	*5*	*5*	1.5	2	2	*5*	*5*	*5*	2	4
ug/L											
ug/L	Heptachlor	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*
ug/L	Antimony	*30*	*30*	*30*	*30*	*30*	*30*	32.4	*30*	*30*	*30*
ug/L	Arsenic	*1*	*1*	*1*	*1*	2.3	*1*	*1*	*1*	*1*	*1*
ug/L	Beryllium				0.3	0.28					0.29
ug/L	Cadmium	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*
ug/L	Chromium	*5*	5.6	*5*	5.6	*5*	*5*	*5*	3.9	*5*	2.3
ug/L	Iron	36600	37350	33700	28900	23400	22600	169	57	33.3	355
ug/L	Manganese	5890	6540	6255	6970	6580	6780	301	263	93.6	181
ug/L	Nickel	*20*	11.8	7.7	7.8	*20*	10.3	*20*	*20*	*20*	*20*
ug/L	Thallium	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*

*An italicized value indicates that the chemical was not detected. The reported value is 1/2 of the sample quantitation limit.

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BAINBRIDGE NAVAL TRAINING STATION

Site 1: Old Landfill
Groundwater Analytical Results

Units	Chemical	1-GW-4	1-GW-4	1-GW-5	1-GW-5	1-GW-5	1-GW-5	1-GW-5	1-GW-5	1-GW-6	1-GW-6
ug/L	1,2-Dichloroethene	5	5	3	3	4	8	7	9	2	4
ug/L	1,2-Dichloropropane										
ug/L	Carbon disulfide										
ug/L	Chlorobenzene	5	5	97	150	130	160	150	110	5	5
ug/L	Chloroform										
ug/L	Methylene chloride	5	5	5	5	5	5	5	5	5	5
ug/L	Trichloroethene	5	5	5	5	5	2	2	2	6	12
ug/L	Vinyl chloride						0.5		0.5		
ug/L											
ug/L	1,4-Dichlorobenzene	5	5	17	14	15	17	17	13	5	5
ug/L	Bis(2-ethylhexyl)phthalate	1	5	5	5	1	2	4	5	5	5
ug/L											
ug/L	Heptachlor	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
ug/L	Antimony	30	30	30	30	30	30	30	30	30	30
ug/L	Arsenic	1	1	1	1	1	1	1	1	1	1
ug/L	Beryllium	0.28			0.17				0.26		
ug/L	Cadmium	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
ug/L	Chromium	5	5	5	5	5	3.1	5	5.1	5	3.3
ug/L	Iron	272	152	2190	2620	6360	11800	11300	11900	7230	6140
ug/L	Manganese	260	373	3250	2910	3490	3630	3890	3760	190	185
ug/L	Nickel	20	20	8.9	10.2	8.1	16.2	9.6	14.8	20	20
ug/L	Thallium	1	1	1	2.1	1	1	1	1	1	1

italicized value indicates that the chemical was not detec[illegible]. The reported value is 1/2 of the sample quantitation lim[illegible]

BAINBRIDGE NAVAL TRAINING STATION

Site 1: Old Landfill
Groundwater Analytical Results

Units	Chemical	1-GW-6	1-GW-6	1-GW-6	1-GW-6	1-GW-7	1-GW-7	1-GW-7	1-GW-7	1-GW-7	1-GW-7
ug/L	1,2-Dichloroethene	2	5	4	3	13	21	18	31	14	19
ug/L	1,2-Dichloropropane			1							
ug/L	Carbon disulfide										
ug/L	Chlorobenzene	5	5	5	5	5	5	5	5	5	5
ug/L	Chloroform									1	
ug/L	Methylene chloride	5	97	5	5	5	5	5	5	5	5
ug/L	Trichloroethene	5	11	9	5	4.5	7	3	8	3	6
ug/L	Vinyl chloride		0.5	0.5	0.5				0.5	0.5	0.5
ug/L											
ug/L	1,4-Dichlorobenzene	5	5	5	5	5	5	5	5	5	5
ug/L	Bis(2-ethylhexyl)phthalate	5	5	3	5	5	5	7	5	2	5
ug/L											
ug/L	Heptachlor	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
ug/L	Antimony	30	30	30	30	30	30	30	30	30	30
ug/L	Arsenic	1	1	1	1	1	1	1	1	1	1
ug/L	Beryllium		0.295	0.275							
ug/L	Cadmium	2.5	2.5	2.5	2.5	2.5	2	2.5	2.5	2.5	2.5
ug/L	Chromium	5	5	5	5	5	5	5	5	5	5
ug/L	Iron	1570	4010	2615	3200	1310	552	775	106	265	2850
ug/L	Manganese	132	236	296	323	102	52.5	77.3	3	21.6	54.4
ug/L	Nickel	20	20	20	11.8	7.2	20	20	6.6	20	11.4
ug/L	Thallium	1	1	1	1	1	1	1	1	1	1

*An italicized value indicates that the chemical was not detected. The reported value is 1/2 of the sample quantitation limit.

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BAINBRIDGE NAVAL TRAINING STATION

Site 1: Old Landfill
Groundwater Analytical Results

Units	Chemical	1-GW-8	1-GW-8	1-GW-8	1-GW-8	1-GW-8	1-GW-8	1-GW-9	1-GW-9	1-GW-9	1-GW-9
ug/L	1,2-Dichloroethene	5	1	5	2	2	10	19	29	16	54
ug/L	1,2-Dichloropropane										
ug/L	Carbon disulfide										
ug/L	Chlorobenzene	6.5	220	140	150	110	110	40	93	5	51
ug/L	Chloroform										
ug/L	Methylene chloride	5	5	5	9	5	5	5	5	5	5
ug/L	Trichloroethene	5	5	5	5	5	2	5	7	5	12
ug/L	Vinyl chloride				0.5	0.5	0.9				0.5
ug/L											
ug/L	1,4-Dichlorobenzene	8	21	16	10	8	15	10	10	14	4
ug/L	Bis(2-ethylhexyl)phthalate	5	5	10	2	4	20	5	5	3	4
ug/L											
ug/L	Heptachlor	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
ug/L	Antimony	30	30	30	30	30	30	30	30	30	30
ug/L	Arsenic	1	1	1	1	1	1	1	1	1	1
ug/L	Beryllium					0.2			0.13		
ug/L	Cadmium	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
ug/L	Chromium	5	2.8	5	4.1	5	5	5	5	5	5
ug/L	Iron	2305	14300	15200	15200	14200	9440	6700	4720	7090	2270
ug/L	Manganese	5355	5940	6580	6080	6280	5470	4480	3300	4100	2650
ug/L	Nickel	5.7	16.9	11.2	14.8	28.7	8.7	9.1	13	13.4	13.7
ug/L	Thallium	1	1	1	1	1	1	1	1	1	1

italicized value indicates that the chemical was not detec . The reported value is 1/2 of the sample quantitation lim

BAINBRIDGE NAVAL TRAINING STATION

Site 1: Old Landfill
Groundwater Analytical Results

Units	Chemical	1-GW-9	1-GW-9	1-GW-10	1-GW-10	1-GW-10	1-GW-10	1-GW-10	1-GW-10	1-GW-11	1-GW-11
ug/L	1,2-Dichloroethene	73	120	18	32	20	18	19	19	5	3
ug/L	1,2-Dichloropropane										
ug/L	Carbon disulfide										
ug/L	Chlorobenzene	27	15	5	5	5	5	5	5	5	5
ug/L	Chloroform						4				
ug/L	Methylene chloride	5	5	5	5	5	5	5	5	5	5
ug/L	Trichloroethene	14	24	6	9	7	5	4	6	5	5
ug/L	Vinyl chloride	0.5	2.8				0.5	0.5	0.5		
ug/L											
ug/L	1,4-Dichlorobenzene	3	4	5	5	5	5	5	5	5	5
ug/L	Bis(2-ethylhexyl)phthalate	9	9	5	5	15	1	2	25	5	5
ug/L											
ug/L	Heptachlor	0.025	0.025	0.025	0.025	0.025	0.025	0.055	0.025	0.025	0.025
ug/L	Antimony	30	30	30	30	30	30	30	30	30	30
ug/L	Arsenic	1	1	1	1	1	1	1	1	1	1
ug/L	Beryllium				0.1						0.22
ug/L	Cadmium	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.7	2.5	2.5
ug/L	Chromium	3	5	5	5	5	5	5	5	5	5
ug/L	Iron	15700	3540	118	205	169	589	48.2	140	2030	2730
ug/L	Manganese	1960	1110	41.4	5.1	5.9	60.8	3.2	6.7	40.7	66.1
ug/L	Nickel	10.2	11.6	20	20	20	10.2	20	20	20	20
ug/L	Thallium	1	1	1	1	1	1	1	1	1	1

*An italicized value indicates that the chemical was not detected. The reported value is 1/2 of the sample quantitation limit.

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BAINBRIDGE NAVAL TRAINING STATION

Site 1: Old Landfill
Groundwater Analytical Results

Units	Chemical	1-GW-11	1-GW-11	1-GW-11	1-GW-11	1-GW-12	1-GW-12	1-GW-12	1-GW-12	1-GW-12	1-GW-12
ug/L	1,2-Dichloroethene	5	5	5	4	2	4	5	4	4	4 5
ug/L	1,2-Dichloropropane										
ug/L	Carbon disulfide								1		
ug/L	Chlorobenzene	5	5	5	5	5	5	5	5	5	5
ug/L	Chloroform			1	1						
ug/L	Methylene chloride	5	1	5	5	5	5	5	1	5	5
ug/L	Trichloroethene	1	2	2	1	1	1	5	1	1	1
ug/L	Vinyl chloride		0.5		0.5				0.5		0.5
ug/L											
ug/L	1,4-Dichlorobenzene	5	5	5	5	5	5	5	5	5	5
ug/L	Bis(2-ethylhexyl)phthalate	5	5	5	3	5	5	5	5	5	3.5
ug/L											
ug/L	Heptachlor	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
ug/L	Antimony	30	30	30	30	30	30	30	30	30	30
ug/L	Arsenic	1	1	1	1	1	1	1	1	1	1
ug/L	Beryllium		0.22				0.11		0.2		
ug/L	Cadmium	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
ug/L	Chromium	5	4	5	5	5	5	5	5	5	5
ug/L	Iron	892	759	6510	375	705	179	310	550	580	148
ug/L	Manganese	24.3	16.1	109	7.5	275	135	122	196	120	106
ug/L	Nickel	20	20	6.8	20	20	20	20	9.9	20	20
ug/L	Thallium	1	1	1	1	1	1	1	1	1	1

*/ italicized value indicates that the chemical was not detec' The reported value is 1/2 of the sample quantitation lim

Site 1: Old Landfill
Groundwater Analytical Results

Units	Chemical	1-GW-13	1-GW-13	1-GW-13	1-GW-13	1-GW-13	1-GW-13
ug/L	1,2-Dichloroethene	5	5	6	5	5	5
ug/L	1,2-Dichloropropane						
ug/L	Carbon disulfide					1	
ug/L	Chlorobenzene	5	5	5	5	5	5
ug/L	Chloroform						
ug/L	Methylene chloride	5	5	5	5	5	5
ug/L	Trichloroethene	5	5	5	5	5	5
ug/L	Vinyl chloride				0.5		0.5
ug/L							
ug/L	1,4-Dichlorobenzene	5	5	5	5	5	5
ug/L	Bis(2-ethylhexyl)phthalate	5	5	9	5	22	10
ug/L							
ug/L	Heptachlor	0.025	0.025	0.025	0.025	0.025	0.025
ug/L	Antimony	30	30	30	30	30	30
ug/L	Arsenic	1	1	1	1	1	1
ug/L	Beryllium		0.14		0.22		
ug/L	Cadmium	2.5	2.5	2.5	2.5	2.5	2.5
ug/L	Chromium	241	13.2	8.5	8.1	44	13.3
ug/L	Iron	11400	7610	6220	8310	6390	4890
ug/L	Manganese	1260	869	1020	1060	934	944
ug/L	Nickel	181	12.2	20	13.2	25.2	18.1
ug/L	Thallium	1	1	1	1	1	1

*An italicized value indicates that the chemical was not detected. The reported value is 1/2 of the sample quantitation limit.

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BAINBRIDGE NAVAL TRAINING STATION

Site 1: Old Landfill
Groundwater Analytical Results

Summary Statistics for Log Transformed Data

Units	Chemical	No. of Values n	Average ln value	Std. Dev., s (ln)	n-1	Land "H" for 0.95	Lognormal UCL (ug/L)	Max. Conc. (ug/L)	Max. Exceeded?	Source conc.for RME Case (ug/L)
ug/L	1,2-Dichloroethene	66	1.93	0.92	65	2.199	1.35E+01	120.00	No	1.35E+01
ug/L	1,2-Dichloropropane	1	0.00	NA	NA	NA	NA	1.00	NA	1.00E+00
ug/L	Carbon disulfide	3	0.46	0.80	2	10.43	8.01E+02	4.00	Yes	4.00E+00
ug/L	Chlorobenzene	66	2.68	1.58	65	2.929	8.98E+01	355.00	No	8.98E+01
ug/L	Chloroform	4	0.35	0.69	3	6.307	2.24E+01	4.00	Yes	4.00E+00
ug/L	Methylene chloride	66	1.61	0.47	65	1.844	6.25E+00	97.00	No	6.25E+00
ug/L	Trichloroethene	66	1.46	0.67	65	1.983	6.40E+00	24.00	No	6.40E+00
ug/L	Vinyl chloride	26	-0.60	0.35	25	1.847	6.62E-01	2.80	No	6.62E-01
ug/L										
ug/L	1,4-Dichlorobenzene	66	1.94	0.58	65	1.923	9.41E+00	28.00	No	9.41E+00
ug/L	Bis(2-ethylhexyl)phthalate	66	1.52	0.63	65	1.952	6.46E+00	25.00	No	6.46E+00
ug/L										
ug/L	Heptachlor	66	-3.68	0.10	65	1.68	2.59E-02	0.06	No	2.59E-02
ug/L	Antimony	66	3.40	0.01	65	1.68	3.01E+01	32.40	No	3.01E+01
ug/L	Arsenic	66	0.01	0.10	65	1.68	1.04E+00	2.30	No	1.04E+00
ug/L	Beryllium	17	-1.58	0.36	16	1.87	2.59E-01	0.30	No	2.59E-01
ug/L	Cadmium	66	0.91	0.03	65	1.68	2.51E+00	2.70	No	2.51E+00
ug/L	Chromium	66	1.71	0.60	65	1.93	7.65E+00	241.00	No	7.65E+00
ug/L	Iron	66	7.58	1.87	65	3.294	2.45E+04	37350.00	No	2.45E+04
ug/L	Manganese	66	5.96	2.27	65	3.826	1.48E+04	6970.00	Yes	6.97E+03
ug/L	Nickel	66	2.74	0.49	65	1.856	1.96E+01	181.00	No	1.96E+01
ug/L	Thallium	66	0.01	0.09	65	1.68	1.04E+00	2.10	No	1.04E+00

Site 2: Fire Training Area
Sediment Analytical Results

Units	Chemical	P2-SD-8	P2-SD-8	2-SD-1	2-SD-2	2-SD-3
mg/kg	Arsenic	0.82	0.62	0.62	0.82	0.83
mg/kg	Beryllium			0.22	0.38	0.24
mg/kg	Iron	8070	3320	5450	6980	5890
mg/kg	Manganese	477	189	223	286	386

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BAINBRIDGE NAVAL TRAINING STATION

Site 2: Fire Training Area
Soil Borings Analytical Results[1]

Units	Chemical	2-GW-9-SB2	2-GW-9-SB2A	2-BH-1B	2-BH-2B	2-BH-3B	2-BH-4A	2-BH-4B
mg/kg	Aluminum	5230	4330	6650	6610	6610	15700	15300
mg/kg	Arsenic	*0.20*[2]	0.51	*0.20*[2]	*0.20*[2]	*0.20*[2]	1.10	*0.20*[2]
mg/kg	Iron	17700	16400	11600	10100	16400	16700	15900
mg/kg	Manganese	159	214	341	107	638	118	118

[1]Data from 2-BH-1C and 2-BH-4C were not used because the depth (10-15 feet bgs) from which samples were collected makes exposure highly unlikely.

[2] An italicized value indicates that the chemical was not detected. The reported value is 1/2 of the sample quantitation limit.

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Site2: Fire Training Area
Groundwater Analytical Results

Units	Chemical	2-GW-2	2-GW-2	2-GW-2	2-GW-2	2-GW-2	2-GW-2	2-GW-3	2-GW-3
ug/L	1,1,2,2-Tetrachloroethane	5	5	5	5	5	5	5	5
ug/L	Chloroform	5	5	5	5	5	5	5	5
ug/L	Methylene chloride	5	5	5	5	5	5	5	5
ug/L	Trichloroethene	1	2		1	1			
ug/L	1,4-Dichlorobenzene								
ug/L	Benzo(a)anthracene								
ug/L	Benzo(a)pyrene								
ug/L	Benzo(b)fluoranthene								
ug/L	Benzo(k)fluoranthene								
ug/L	Chrysene								
ug/L	Indeno(1,2,3-cd)pyrene								
ug/L	Bis(2-ethylhexyl)phthalate	5	5	4	1	1	5	5	5
ug/L	Aldrin	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*
ug/L	Aluminum	119	340	158	108	44.4	58.7	134	159
ug/L	Arsenic	1	*1*	2.1	*1*	*1*	*1*	*1*	*1*
ug/L	Beryllium	2.5	2.5	2.5	0.24	2.5	2.5	2.5	2.5
ug/L	Cadmium	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
ug/L	Chromium	5	6	5	5	5	5	5	5
ug/L	Iron	18900	33600	33400	26400	22700	25600	219	201
ug/L	Manganese	3970	1880	1570	1560	1420	1490	140	23
ug/L	Thallium	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
ug/L	Zinc	218	7.4	53.9	42.7	122	308	16.2	9.1

*An italicized value indicates that the chemical was not detected. The reported value is 1/2 of the sample quantitation limit.

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BAINBRIDGE NAVAL TRAINING STATION

Site2: Fire Training Area
Groundwater Analytical Results

Units	Chemical	2-GW-3	2-GW-3	2-GW-3	2-GW-3	2-GW-4	2-GW-4	2-GW-4	2-GW-4
ug/L	1,1,2,2-Tetrachloroethane	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
ug/L	Chloroform	*5*	*5*	*5*	*5*	16	*5*	*5*	*5*
ug/L	Methylene chloride	*5*	39	2	*5*	*5*	*5*	*5*	*5*
ug/L	Trichloroethene						2		
ug/L	1,4-Dichlorobenzene								
ug/L	Benzo(a)anthracene								
ug/L	Benzo(a)pyrene								
ug/L	Benzo(b)fluoranthene								
ug/L	Benzo(k)fluoranthene								
ug/L	Chrysene								
ug/L	Indeno(1,2,3-cd)pyrene								
ug/L	Bis(2-ethylhexyl)phthalate	3	*5*	2	*5*	*5*	*5*	*5*	*5*
ug/L	Aldrin	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*
ug/L	Aluminum	157	62.4	45.7	221	79	59.7	67.8	945
ug/L	Arsenic	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
ug/L	Beryllium	2.5	2.5	2.5	2.5	2.5	2.5	2.5	0.25
ug/L	Cadmium	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
ug/L	Chromium	3.9	3.2	*5*	*5*	*5*	5.2	*5*	*5*
ug/L	Iron	250	61.2	56.7	178	14600	37100	22800	16400
ug/L	Manganese	40.1	5	15.7	173	4270	4040	3910	3830
ug/L	Thallium	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
ug/L	Zinc	13.8	114	7420	12.3	9.2	9	16.5	39

.n italicized value indicates that the chemical was not dete d. The reported value is 1/2 of the sample quantitation lim

BAINBRIDGE NAVAL TRAINING STATION

Site2: Fire Training Area
Groundwater Analytical Results

Units	Chemical	2-GW-4	2-GW-4	2-GW-5	2-GW-5	2-GW-5	2-GW-5	2-GW-5	2-GW-5
ug/L	1,1,2,2-Tetrachloroethane	5	5	5	5	5	5	5	5
ug/L	Chloroform	5	5	5	5	5	5	5	5
ug/L	Methylene chloride	5	5	5	5	5	5	5	5
ug/L	Trichloroethene	1							
ug/L	1,4-Dichlorobenzene				1				
ug/L	Benzo(a)anthracene								
ug/L	Benzo(a)pyrene								
ug/L	Benzo(b)fluoranthene								
ug/L	Benzo(k)fluoranthene								
ug/L	Chrysene								
ug/L	Indeno(1,2,3-cd)pyrene								
ug/L	Bis(2-ethylhexyl)phthalate	1	2	5	5	5	5	5	5
ug/L	Aldrin	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*
ug/L	Aluminum	22.9	49.6	2010	77.1	122	770	117	66.2
ug/L	Arsenic	*1*	*1*	2	*1*	*1*	*1*	2.1	*1*
ug/L	Beryllium	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
ug/L	Cadmium	2.5	2.5	4.1	2.5	2.5	2.5	2.5	2.5
ug/L	Chromium	5	5	5	3.4	5	4	5	5
ug/L	Iron	23400	6600	79200	48600	31200	15500	12400	21300
ug/L	Manganese	3590	3830	3720	5290	3030	1530	1630	3230
ug/L	Thallium	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
ug/L	Zinc	*10*	20.8	204	*10*	97.3	47.1	*10*	66

*An italicized value indicates that the chemical was not detected. The reported value is 1/2 of the sample quantitation limit.

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Site2: Fire Training Area
Groundwater Analytical Results

Units	Chemical	2-GW-8	2-GW-8	2-GW-8	2-GW-9	2-GW-9	2-GW-9	2-GW-10	2-GW-10
ug/L	1,1,2,2-Tetrachloroethane	5	5	5	5	5	5	5	5
ug/L	Chloroform	5	5	5	5	5	5	5	5
ug/L	Methylene chloride	5	5	5	5	5	5	5	5
ug/L	Trichloroethene								
ug/L	1,4-Dichlorobenzene								
ug/L	Benzo(a)anthracene			1					
ug/L	Benzo(a)pyrene	2		2					
ug/L	Benzo(b)fluoranthene	3		3					
ug/L	Benzo(k)fluoranthene			2					
ug/L	Chrysene	2		1					
ug/L	Indeno(1,2,3-cd)pyrene	2		1					
ug/L	Bis(2-ethylhexyl)phthalate	5	52	110	5	5	2	5	5
ug/L	Aldrin	*0.025*	*0.025*	0.11	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*
ug/L	Aluminum	6670	10500	2920	2050	636	809	4880	4310
ug/L	Arsenic	*1*	*1*	*1*	1.2	2.1	*1*	*1*	*1*
ug/L	Beryllium	0.41	0.53	0.44	2.5	2.5	6.3	2.5	0.15
ug/L	Cadmium	2.5	*2.5*	*2.5*	*2.5*	*2.5*	5.6	*2.5*	*2.5*
ug/L	Chromium	23.8	28.6	9.3	5	8.3	7.7	19.7	21.3
ug/L	Iron	64500	47700	40800	24200	32300	20500	12500	10400
ug/L	Manganese	4120	5390	4990	771	527	714	174	152
ug/L	Thallium	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
ug/L	Zinc	108	24.8	262	123	1.6	383	121	33.4

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Site2: Fire Training Area
Groundwater Analytical Results

Units	Chemical	2-GW-10	2-GW-10	2-GW-10	2-GW-10	2-GW-11	2-GW-11	2-GW-11	2-GW-11
ug/L	1,1,2,2-Tetrachloroethane	5	5	5	5	5	5	5	5
ug/L	Chloroform	5	5	5	5	16	5	5	5
ug/L	Methylene chloride	5	5	5	5	5	5	5	5
ug/L	Trichloroethene								
ug/L	1,4-Dichlorobenzene								
ug/L	Benzo(a)anthracene								
ug/L	Benzo(a)pyrene								
ug/L	Benzo(b)fluoranthene								
ug/L	Benzo(k)fluoranthene								
ug/L	Chrysene								
ug/L	Indeno(1,2,3-cd)pyrene								
ug/L	Bis(2-ethylhexyl)phthalate	3.5	5	1	5	5	5	9	5
ug/L	Aldrin	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*
ug/L	Aluminum	1575	5340	3000	118	174	248	146	92.1
ug/L	Arsenic	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
ug/L	Beryllium	2.5	0.48	2.5	2.5	2.5	2.5	2.5	2.5
ug/L	Cadmium	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
ug/L	Chromium	7.8	24.4	9.6	5	5	6.8	5	5
ug/L	Iron	4105	12200	7490	266	1240	3770	2480	837
ug/L	Manganese	69.4	149	85.5	8.9	3850	5500	3280	3130
ug/L	Thallium	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
ug/L	Zinc	52.4	88.3	77.6	11.1	12.8	17	52.8	62.5

*An italicized value indicates that the chemical was not detected. The reported value is 1/2 of the sample quantitation limit.

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Site2: Fire Training Area
Groundwater Analytical Results

Units	Chemical	2-GW-11	2-GW-11	2-GW-12	2-GW-12	2-GW-12	2-GW-12	2-GW-12	2-GW-12
ug/L	1,1,2,2-Tetrachloroethane	5	5	6	6	8	7	6	5
ug/L	Chloroform	5	5	5	5	5	5	5	5
ug/L	Methylene chloride	5	5	5	5	5	5	16	5
ug/L	Trichloroethene								
ug/L	1,4-Dichlorobenzene								
ug/L	Benzo(a)anthracene								
ug/L	Benzo(a)pyrene								
ug/L	Benzo(b)fluoranthene								
ug/L	Benzo(k)fluoranthene								
ug/L	Chrysene								
ug/L	Indeno(1,2,3-cd)pyrene								
ug/L	Bis(2-ethylhexyl)phthalate	3	4	5	5	5	1	3	5
ug/L	Aldrin	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
ug/L	Aluminum	75.7	49.3	118	104	455	62.8	74.5	126
ug/L	Arsenic	1	1	1	1	1	1	1	1
ug/L	Beryllium	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
ug/L	Cadmium	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
ug/L	Chromium	5	5	5	2.9	5	5	5	5
ug/L	Iron	781	567	314	209	339	138	123	234
ug/L	Manganese	3080	2760	56.6	47	38.4	22.1	21.9	32.6
ug/L	Thallium	1	1	1	1	1	1	1	1
ug/L	Zinc	8.7	1809	25.4	15.2	43.7	88	62.9	187

n italicized value indicates that the chemical was not dete d. The reported value is 1/2 of the sample quantitation lim.

Site2: Fire Training Area
Groundwater Analytical Results

Units	Chemical	2-GW-13	2-GW-13	2-GW-13	2-GW-13	2-GW-13	2-GW-13
ug/L	1,1,2,2-Tetrachloroethane	*5*	*5*	*5*	*5*	*5*	*5*
ug/L	Chloroform	*5*	*5*	*5*	*5*	*5*	*5*
ug/L	Methylene chloride	*5*	*5*	*5*	2	100	*5*
ug/L	Trichloroethene						
ug/L	1,4-Dichlorobenzene						
ug/L	Benzo(a)anthracene						
ug/L	Benzo(a)pyrene						
ug/L	Benzo(b)fluoranthene						
ug/L	Benzo(k)fluoranthene						
ug/L	Chrysene						
ug/L	Indeno(1,2,3-cd)pyrene						
ug/L	Bis(2-ethylhexyl)phthalate	*5*	*5*	*5*	*5*	1	*5*
ug/L	Aldrin	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*	*0.025*
ug/L	Aluminum	40.1	35	130	87.4	20.4	70.4
ug/L	Arsenic	*1*	*1*	*1*	*1*	*1*	*1*
ug/L	Beryllium	2.5	2.5	2.5	2.5	2.5	2.5
ug/L	Cadmium	2.5	2.5	2.5	2.5	2.5	2.5
ug/L	Chromium	*5*	*5*	*5*	*5*	*5*	*5*
ug/L	Iron	574	39.6	126	132	21.8	166
ug/L	Manganese	4.6	1.8	3	6.3	2.9	10.8
ug/L	Thallium	*1*	*1*	*1*	*1*	*1*	*1*
ug/L	Zinc	8.1	4.4	21.5	104	*10*	174

*An italicized value indicates that the chemical was not detected. The reported value is 1/2 of the sample quantitation limit.

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K Estimation of Dermal Absorption from Water

The following procedures for estimating dermal absorption (DA) of chemicals are taken from EPA's *Dermal Exposure Assessment: Principles and Applications* (EPA 1992c).

K.1 Estimating DA for Inorganics

A steady-state approach is used to estimate the dermal absorption of inorganics from water:

$$DA = K_p C_w t_{event}$$

where

DA = Dose absorbed per unit area per event (mg/cm^2-event)

K_p = Permeability coefficient from water (cm/hr)

C_w = Concentration of chemical in water (mg/cm^3)

t_{event} = Duration of event (hr)

K_p for inorganics is assumed to be 0.001 cm/hr, a default value that is based on the dermal absorption of water. To evaluate dermal exposure from showering, the UCL concentration of the chemical was used for C_w, and t_{event} was assumed to be 0.25 hour for the reasonable maximum exposure (RME) case as recommended (EPA 1992c).

K.2 Estimating DA for Organics

DA for organics is estimated using a nonsteady-state approach, which more realistically reflects exposures for short contact times in which steady state often is not reached, and which accounts for continued exposure to chemicals stored in skin lipids after the actual exposure event.

One of two equations is used to calculate DA, depending on the time needed for the chemical's absorption to reach steady state (t^*) relative to the exposure event time (t_{event}).

If $t_{event} < t^*$, then:

where

τ = lag time at the stratum corneum (hr).

If $t_{event} > t^*$, then:

$$DA = K_p C_w \left[\frac{t_{event}}{1 + B} + 2\pi \left(\frac{1 + 3B}{1 + B} \right) \right]$$

where

B = a parameter which describes the relative contribution of the permeability coefficients of the chemical in the stratum corneum and viable epidermis to its flux through the skin (unitless).

B, τ, and K_p are chemical-specific parameters. The dermal guidance describes their calculation and lists chemical-specific values in Table 5-8 in EPA 1992c. Table K-1 of this appendix summarizes the B, τ, K_p, and t* values from Table 5-8 and other chemical-specific values used in the calculation of DA (MW and $\log K_{ow}$ from Table K-7 in EPA 1992c) along with the final DA results for the COPCs in groundwater at the Bainbridge NTC sites.

Table K-1

CALCULATION OF DERMAL ABSORPTION FROM WATER

	MW	$\log K_{ow}$	K_p (cm/hr)	B	τ (hr)	t* (hr)	Site 1 C_w (mg/cm^3)	Site 1 DA (mg/cm^2-event)	Site 2 C_w (mg/cm^3)	Site 2 DA (mg/cm^2-event)
Inorganics										
Aluminum	—	—	0.001	—	—	—	N	NC	1.5E-3	3.75E-7
Antimony	—	—	0.001	—	—	—	3.01E-5	7.52E-9	N	NC
Arsenic	—	—	0.001	—	—	—	1.04E-6	2.60E-10	1.13E-6	2.82E-10
Beryllium	—	—	0.001	—	—	—	2.59E-7	6.48E-11	3.10E-6	7.75E-10
Cadmium	—	—	0.001	—	—	—	2.51E-6	6.27E-10	2.66E-6	6.65E-10
Chromium	—	—	0.001	—	—	—	7.65E-6	1.91E-9	7.57E-6	1.89E-9
Iron	—	—	0.001	—	—	—	2.45E-2	6.12E-6	7.92E-2	1.98E-5
Manganese	—	—	0.001	—	—	—	6.97E-3	1.74E-6	5.5E-3	1.37E-6
Nickel	—	—	0.001	—	—	—	1.96E-5	4.90E-9	N	NC
Thallium	—	—	0.001	—	—	—	1.04E-6	2.60E-10	1.00E-6	2.50E-10
Zinc	—	—	0.001	—	—	—	N	NC	2.41E-2	6.02E-6
Organics										
Aldrin	365	3.01	0.0016	0.10	15	36	N	NC	2.75E-8	2.35E-10
Heptachlor	373.5	4.27	0.011	1.9	17	94	2.59E-8	1.62E-9	N	NC
1,4-Dichlorobenzene	147	3.39	0.062	0.25	0.69	3.3	9.75E-6	6.94E-7	1.0E-6	7.12E-8
Benzo(a)anthracene	228.3	5.66	0.81	46	2.2	10	N	NC	1.0E-6	1.66E-6
Benzo(a)pyrene	250	6.10	1.2	130	2.9	14	N	NC	2.0E-6	5.65E-6

Key at end of table.

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Table K-1

CALCULATION OF DERMAL ABSORPTION FROM WATER

	MW	$\log K_{ow}$	K_p (cm/hr)	B	τ (hr)	t* (hr)	Site 1		Site 2	
							C_w (mg/cm^3)	DA (mg/cm^2-event)	C_w (mg/cm^3)	DA (mg/cm^2-event)
Benzo(b)fluoranthene	252.3	6.12	1.2	130	3.0	14	N	NC	3.0E-6	8.62E-6
Benzo(k)fluoranthene	252.3	6.12	1.2	130	3.0	14	N	NC	2.0E-6	5.74E-6
Chrysene	228.3	5.66	0.81	46	2.2	10	N	NC	2.0E-6	3.32E-6
Indeno(1,2,3-cd)pyrene	276.3	6.58	1.9	380	4.2	20	N	NC	2.0E-6	1.08E-5
Bis(2-ethylhexyl)phthalate	390.6	5.11	0.033	13	21	100	6.46E-6	1.35E-6	6.39E-6	1.33E-6
1,1,2,2-Tetrachloroethane	167.9	2.39	0.009	0.025	0.93	2.2	N	NC	5.25E-6	6.3E-8
1,2-Dichloroethene	96.9	1.86	0.01	0.0072	0.34	0.82	1.35E-5	1.09E-7	N	NC
1,2-Dichloropropane	113	2.00	0.01	0.01	0.43	1.0	1.0E-6	9.06E-9	N	NC
Carbon disulfide	80	2.24	0.024	0.017	0.27	0.65	4.0E-6	6.89E-8	N	NC
Chlorobenzene	112.6	2.84	0.041	0.069	0.43	1.0	8.98E-5	3.34E-6	N	NC
Chloroform	119.4	1.97	0.0089	0.0093	0.47	1.1	4.0E-6	3.37E-8	5.64E-6	4.76E-8
Methylene chloride	84.9	1.25	0.0045	0.0018	0.29	0.70	6.25E-6	2.09E-8	7.98E-6	2.67E-8
Trichloroethene	131.4	2.42	0.016	0.026	0.55	1.3	6.40E-6	1.05E-7	1.97E-6	3.23E-8
Vinyl chloride	62.5	1.36	0.0073	0.0023	0.21	0.50	6.62E-7	3.06E-9	N	NC

Key:

N = Not a COPC.
NC = Not calculated.

L Shower Volatilization Model

This appendix includes a copy of "Inhalation Exposure to Volatile Organic Contaminants in the Shower" (Foster and Chrostowski 1987), which describes the shower volatilization model. A spreadsheet version of the model, supplied by EPA Region III, was used to do the volatilization modeling for the risk assessment of the Bainbridge NTC sites. Printouts from the spreadsheets showing the equations, input values, and results for Site 1 (Old Landfill) and Site 2 (Fire Training Area) have also been included in this appendix. Note that the variable "D" in the spreadsheet corresponds to the variable "E_{inh}" in the inhalation exposure equation presented in Table 5-20 of the Human Health Risk Assessment.

87-42.6

INHALATION EXPOSURES TO VOLATILE ORGANIC CONTAMINANTS IN THE SHOWER

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INTRODUCTION

Over the past few years, the potential importance of inhalation exposures to volatile organic chemicals (VOCs) through the use of contaminated household water supplies has been recognized. Due to their strong tendency to volatilize, VOCs present in tap water may be readily released into indoor air as a result of showering, bathing, dishwashing, laundering, and cooking.[1,2,3] Several researchers have already concluded that inhalation exposures to volatile compounds released during typical water uses in the home may be as large as or larger than exposures from water ingestion.[1,3,4,5,6] Of particular concern to human health is the potential for elevated VOC exposures to occur in the confined space of the shower. Detailed empirical data on the levels of VOCs released into shower room air are, however, scarce.[1,7] Andelman and his colleagues, relying on experiments conducted using trichloroethylene and chloroform in a scaled-down model shower, are responsible for the bulk of the data that are currently available.

Exposure modeling may provide the best means of estimating inhalation exposures to VOCs while showering. Such modeling can be validated to a limited extent at present using Andelman's data and will be further validated in the future with whatever reliable data become available.

The purpose of this paper is to expand on previous work in which we developed a dynamic model for the behavior of VOCs in shower water.[8] In this paper we present a model that estimates exposures to VOCs in the shower, both while showering and after the shower has been turned off. The model has been programmed using Microsoft C and is run on an IBM PC. Typically a model run, including data input, takes less than one minute.

Previous efforts to estimate exposures to VOCs in the shower have relied upon the simple assumption that a certain percentage of VOC in water is released into air (e.g., 40-100%).[2,4,5] Our model, unlike the previous approaches, takes into account many of the variable factors that influence the release of VOCs from water and their subsequent buildup in shower room air. The kinetic model presented in this paper estimates VOC air concentrations and the magnitude of chemical exposures for the duration of exposure.

METHODOLOGY

Inhalation exposures to VOCs are modeled by estimating the rate of chemical release into the air (generation rate), the buildup (shower on) and decay (shower off) of VOCs in shower room air, and the quantity of airborne VOCs inhaled while the shower is both on and off.

Estimation of the rate of VOC release into the air is based upon Liss and Slater's[9] adaptation of the two-film gas-liquid mass transfer theory which has been described in our previous paper.[8] The two-film boundary theory provides the basis for estimating the overall mass transfer coefficient (K_L) for each VOC of interest according to the following equation:

$$K_L = (1/k_l + RT/Hk_g)^{-1} \qquad (1)$$

where

K_L = overall mass transfer coefficient (cm/hr),
H = Henry's Law Constant (atm-m^3/mol-K),
RT = 2.4×10^{-2} atm-m^3/mole (gas constant of 8.2×10^{-5} atm-m^3/mol-K times absolute temperature of 293 K),
k_g = gas-film mass transfer coefficient (cm/hr), and
k_l = liquid-film mass transfer coefficient (cm/hr).

Equation 1 describes the mass transfer rate of a compound at an air-water interface where diffusion may be limited by both liquid- and gas-phase resistances. For most VOCs, however, with Henry's Law Constants greater than 1×10^{-3} atm-m^3/mol-K, mass transfer is limited by only liquid-phase resistance.[10]

Typical values of k_l (20 cm/hr) and k_g (3,000 cm/hr), which have been measured for CO_2 and H_2O, respectively,[9] may be used to estimate VOC-specific values for these parameters:

$$k_g(VOC) = k_g(H_2O)(18/MW_{VOC})^{0.5} \qquad (2)$$

$$k_l(VOC) = k_l(CO_2)(44/MW_{VOC})^{0.5} \qquad (3)$$

where

MW = molecular weight (g/mol).

The mass transfer coefficient, K_L, is adjusted to the shower water temperature, T_s, according to a semi-empirical equation developed to estimate the effect of temperature on oxygen mass-transfer rate:[11]

$$K_{aL} = K_L(T_l\mu_s/T_s\mu_l)^{-0.5} \qquad (4)$$

where

K_{aL} = adjusted overall mass transfer coefficient (cm/hr),
T_l = calibration water temperature of K_L (K),
T_s = shower water temperature (K),
μ_l = water viscosity at T_l (cp), and
μ_s = water viscosity at T_s (cp).

The concentration leaving the shower droplet, C_{wd}, is obtained from an integrated rate equation based on a mass-balance approach:

$$C_{wd} = C_{w0}(1-\exp[-K_{aL}t_s/60d]) \qquad (5)$$

where

C_{wd} - concentration leaving shower droplet after time t_s (μg/l),
C_{w0} - shower water concentration (μg/l),
d - shower droplet diameter (mm), and
t_s - shower droplet drop time (sec).

The term $K_{al}/60d$ combines both the rate of transfer and the available interfacial area across which volatilization can occur. The value 1/60d equals the specific interfacial area, 6/d, for a spherical shower droplet of diameter d multiplied by conversion factors (hr/3600 sec and 10 mm/cm).

Inherent in equation 5 is the assumption that the shower water is immediately disaggregated into droplets of equal size and that volatilization occurs from each droplet only between the time it is released from the shower head until it impacts the shower bottom. In reality, the shower water will disaggregate into droplets of different diameters and will also agglomerate into layers as it runs over the showering individual and impacts nearby surfaces. The model presented in this paper does not take into account volatilization from these "non-droplet" air-water surfaces, many of which increase the residence time during which volatilization could occur (relative to an unimpeded droplet). In addition, this model does not estimate the additional volatilization from water as it drains from the shower bottom. Volatilization from water running over a showering individual and draining from the shower bottom may, however, contribute significantly to overall VOC air concentrations in the shower.[12] By not taking into account volatilization from water running down nearby surfaces and the showering individual and draining from the shower bottom, our model is more likely to underestimate than overestimate indoor VOC air concentrations and exposures.

The VOC generation rate in the shower room, S, can then be calculated by the equation:

$$S = C_{wd}(FR)/SV \qquad (6)$$

where

S - indoor VOC generation rate (μg/m³-min),
FR - shower water flow rate (l/min), and
SV - shower room air volume (m³).

A simple one-box indoor air pollution model was used to estimate VOC air concentrations in the shower room. This model can be expressed as a differential equation describing the rate of change of the indoor pollutant concentration with time:

$$dC_a/dt = -RC_a + S \qquad (7)$$

where

C_a - indoor VOC air concentration (μg/m³), and
R - air exchange rate (min⁻¹).

This indoor air model assumes instantaneous mixing of the shower room air and no chemical decay of VOCs once they are released into the indoor air. It is likely, however, that air concentrations of VOCs will be higher immediately adjacent to the shower spray (i.e., within the individual's breathing zone) than in the rest of the shower room. As a result, the model may underestimate inhalation exposures during showering by assuming a completely mixed indoor environment. Because modeling the incremental exposure due to showering only is the focus of this paper, it is also assumed that the initial VOC air concentration indoors before the shower is turned on is zero (i.e., there are no other sources of VOCs contributing to indoor air pollutant levels).

In the model, the air exchange rate is kept constant throughout the exposure period. The generation rate is allowed only two values, off (i.e. zero) and on. In general, both the air exchange rate and the generation rate may vary over time; however, for the short periods modeled in this paper (more than one or two hours), we consider that the assumptions of constant exchange and generation rates are likely to be valid.

When equation 7 is integrated, the time-dependent indoor concentration can be estimated as follows:

$$C_a(t) = (S/R)(1 - \exp[-Rt]) \text{ for } t \le D_s$$

and

$$C_a(t) = (S/R)(\exp[RD_s] - 1)\exp(-Rt) \quad \text{for } t > D_s$$

where

$C_a(t)$ - indoor air VOC concentration at time t (μg/m³),
D_s - shower duration (min), and
t - time (min).

The inhalation exposure per shower can then be calculated according to the equation:

$$E_{inh} = (Vr/(BW)(10^6)) \int_0^{D_t} C_a(t)dt$$

where

E_{inh} - inhalation exposure per shower (mg/kg/shower),
VR - ventilation rate (l/min),
BW - body weight (kg), and
D_t - total duration in shower room (min).

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this equation can be solved as:

$$C_{inh} = (Vr)(S)/[(BH)(R)(10^6)]\{D_1 - 1/R + \exp(-RD_1)/R\}$$

for the duration of the shower, and as:

$$C_{inh} = (Vr)(S)/[(BH)(R)(10^6)]\cdot$$

$$(D_1 + \exp(-RD_1)/R - \exp[R(D_1 - D_L)]/R)$$

for both the duration of the shower and the duration in the room after the shower is turned off.

MODEL APPLICATION I. COMPARISON WITH EXPERIMENTAL RESULTS

The only experimental data currently available and sufficiently detailed to apply in our model have been developed by Andelman et al.[1] Experimental data presented by these researchers for trichloroethylene (TCE) were input into our model (Table I) to predict indoor air concentrations and to compare these with the measured levels. Figure I shows that our model's estimates of air concentrations compare favorably with Andelman's results for both the buildup and decay of concentrations in shower room air. The model only slightly underpredicts indoor air concentrations. This difference is not surprising since the model does not, as has been described, take into account volatilization from water after it has impacted on nearby surfaces or as it drains from the shower bottom. This comparison also indicates that for short exposure periods (e.g., less than 20 minutes), the modeled air concentrations may approximate actual concentrations quite well.

MODEL APPLICATION II. SENSITIVITY OF AIR CONCENTRATIONS TO INPUT PARAMETERS

To determine the sensitivity of our model to several important input parameters, we examined the changes in estimated air concentrations associated with different air exchange rates, shower water concentrations, and water temperatures. We focused on only one VOC, TCE, in this model application. Cothern et al.[4] estimate that as many as 212,000 and 128,000 individuals in the United States may be using public water supplies containing >10-20 µg/l and >70-80 µg/l TCE, respectively. To make our results comparable with these estimates, we assumed two shower water concentrations of 35 µg/l and 75 µg/l. Three air exchange rates, 0.5, 1.0, and 1.5 hr^{-1}, were used to simulate leaky, average, and tight homes, respectively.[13] The changes in air concentrations associated with four shower water temperatures, 35°, 40°, 45°, and 50°C, were also evaluated. Table II lists the values of the input parameters used to develop the information presented in this sensitivity analysis (Figures II and III).

Figure II illustrates the effects of changing air exchange rates and TCE water concentrations on TCE air concentrations in the shower room. As expected, predicted indoor air concentrations are highly sensitive to water concentrations. Figure II shows that as the water concentration increases from 15 µg/l to 75 µg/l (a factor of five), air concentrations also increase by about a factor of five or more. As the air exchange rate increases from 0.5 hr^{-1} to 1.5 hr^{-1}, indoor air concentrations are

predicted to decrease, and the differences between air levels become increasingly large with time.

Figure III shows the impact that different shower water temperatures have on indoor air concentrations. As water temperature increases, predicted air concentrations increase. After the shower has been on for 60 minutes, every 5°C increase in water temperature increases indoor TCE air levels by approximately 0.08 mg/m^3. For shorter shower durations, however, the effect of changing temperature is less pronounced, with every 5°C increase in water temperature increasing indoor air concentrations by approximately 0.03 mg/m at 20 minutes and 0.02 mg/m^3 at 10 minutes.

These results indicate that the model presented in this paper behaves as expected; it predicts that indoor air levels increase as water concentrations increase, air exchange rates decrease, and water temperatures increase. The effects of changing these variables become increasingly important with time after the shower has been turned on. However, for short shower durations (e.g., less than 20 minutes), water concentration appears to have a greater impact on indoor air levels than air exchange rate or water temperature. In addition, the increase in air concentration with time appears to be approximately linear for short shower durations.

MODEL APPLICATION III. COMPARATIVE RISK ASSESSMENT

In order to estimate potential human VOC inhalation exposures and risk from showering, we applied our model to five VOCs that have been found in U.S. public water supplies;[4,14] TCE, chloroform, tetrachloroethylene, vinyl chloride, and benzene. Benzene and vinyl chloride have been classified by EPA as Group A carcinogens—human carcinogens based on adequate evidence from human studies. The remaining three chemicals have been classified as Group B carcinogens—probable human carcinogens based on inadequate evidence from human studies and adequate evidence from animal studies. Two plausible exposure scenarios were evaluated. The two scenarios differ with respect to three variables: water concentration, shower duration, and air exchange rate. For the lower bound exposure scenario, the water concentration, shower duration, and air exchange rate were assumed to be 15 µg/l, 10 minutes, and 1.5 hr^{-1}, respectively. For the upper bound exposure scenario, the values for these three variables were assumed to be 75 µg/l, 15 minutes, and 0.5 hr^{-1}, respectively. Table III summarizes the input parameters used in this comparative risk assessment. These exposure scenarios are clearly not applicable to all homes and individuals, but they are probably representative of conditions that may exist in some homes in the United States.

Figure IV compares the estimated exposures for the five VOCs. The predicted exposures for the upper bound exposure scenario are approximately one order of magnitude larger than the exposures for the lower bound exposure scenario. The largest exposures are predicted for vinyl chloride, the VOC with the largest Henry's Law Constant and lowest molecular weight. The next largest exposures are predicted for benzene, a chemical with the next smallest molecular weight but the second smallest Henry's Law Constant. Both of the chemical-specific parameters are important factors affecting exposure. The figure also shows that exposures received over an assumed five minute period in the shower room after the shower has been turned off are almost as large as exposures received while showering for 10 or 15 minutes.

The potential excess upper bound lifetime cancer risks associated with these estimated exposures are shown in Table IV. These calculations assume that an individual takes one 10- or 15-minute shower per day for a 70-year lifetime. The excess lifetime risks are highest for chloroform, 2×10^{-5} and 2×10^{-4} for the lower bound and upper bound exposure scenarios, respectively. The predicted risks are lowest for tetrachloroethylene, 3×10^{-7} and 3×10^{-6}, respectively.

The risks associated with inhaling VOCs in the shower for the two exposure scenarios are compared in Table V to the risks associated with ingestion of tap water at the same water concentrations (15 µg/l and 75 µg/l). It is important to recognize that all the VOCs evaluated except chloroform are more potent by ingestion than by inhalation. In calculating ingestion exposures, it was assumed that an individual drinks 2 liters of water per day for a 70-year lifetime. Table V shows that the ingestion cancer risks range from the same order of magnitude as the inhalation risks to approximately two orders of magnitude greater than the inhalation risks. For example, the risks associated with ingestion of chloroform in drinking water are essentially the same as the risks associated with chloroform inhalation in the shower room. For vinyl chloride, the ingestion risks are about two orders of magnitude greater than the inhalation risks. Thus, for the specific shower exposure scenarios evaluated in this comparative risk assessment, the estimated risks associated with the inhalation of VOCs in the shower room may be as large as the risks associated with VOC ingestion, depending on the particular chemical.

SUMMARY AND CONCLUSIONS

A kinetic model which can be used to estimate inhalation exposures to VOCs in the shower, both while showering and after the shower has been turned off, has been presented in this paper. Inhalation exposures to VOCs are modeled by estimating the rate of VOC release from water into air, the buildup (shower on) and decay (shower off) of VOCs in shower room air, and the quantity of airborne VOCs inhaled while the shower is both on and off.

The model was validated with one set of experimental data for TCE presented by Andelman et al.[1] The predicted air concentrations compared very favorably with the experimental results. In subsequent model runs, the predicted air concentrations were observed to be particularly sensitive to changes in shower water concentration and air exchange rate, but, in comparison, less sensitive to changes in water temperature.

Potential risks associated with inhalation in shower room air of five VOCs that have been measured in U.S. drinking water supplies were estimated for two plausible exposure scenarios. The lower bound exposure scenario assumed a 15 µg/l water concentration, a 10 minute shower, and an air exchange rate of $1.5\ hr^{-1}$. The upper bound exposure scenario assumed a 75 µg/l water concentration, a 15 minute shower, and an air exchange rate of $0.5\ hr^{-1}$. All other input variables, except those that are chemical specific, were held constant. The exposures and excess lifetime cancer risks estimated for the upper bound exposure scenario were approximately one order of magnitude greater than the exposures and risks estimated for the lower bound exposure scenario. Excess upper bound lifetime cancer risks were highest for chloroform, ranging from 2×10^{-5} to 2×10^{-4} for the lower bound and upper bound exposure scenarios, respectively.

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These inhalation risks were compared to the risks associated with dail ingestion of 2 liters of water per day at the same concentrations, 15 µg/l and 75 µg/l. For the specific shower exposure scenarios evaluated, the estimated inhalation risks in the shower room were equivalent to the risks associated with ingestion for chloroform, but were two orders of magnitude lower than the ingestion risks for vinyl chloride.

Based on this analysis, our model can be applied to estimate inhalati exposures to VOCs in shower room air. The model has been validated with on set of experimental laboratory data in this paper, but additional data, particularly collected in the home, is required to conduct a more thorough validation. Further research is also needed to characterize more accurate the model's input parameters.

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NOTE TO EDITORS

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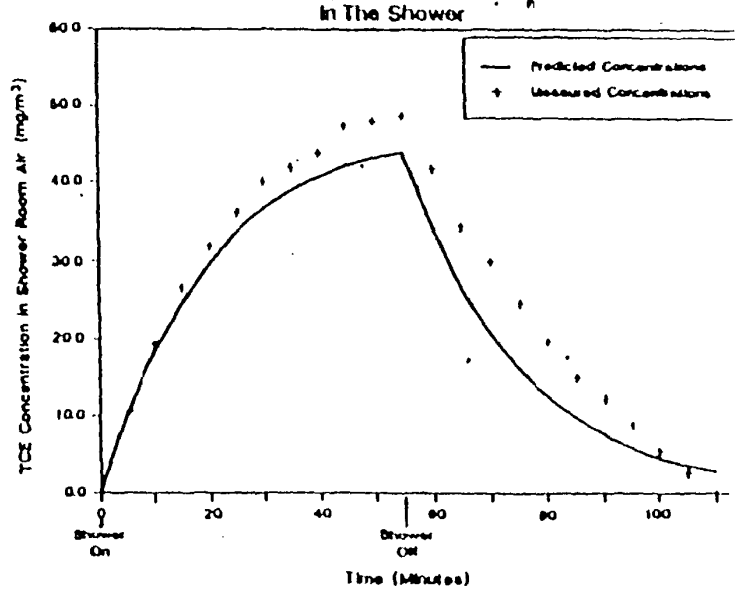
Table I. Model Application Using Experimental Data from Andelman et al.[1]

Input Parameter	Value
Andelman's data:	
Chemical	Trichloroethylene
Shower water concentration	2,000 μg/l[a]
Shower water temperature	43°C (316 K)
Shower water flow rate	0.3 l/min
Droplet diameter	0.25 mm
Droplet drop time	0.5 sec[b]
Air flow rate	0.005 m^3/min
Shower chamber volume	0.1 m^3
Shower duration	55 min
Duration after shower	55 min
Other model input data:	
Molecular weight	131 g/mol
Henry's Law Constant	1.0×10^{-2} atm-m^3/mol-K
Water viscosity	0.6178 cp

[a]Measured range 1,500-2,900 μg/l.
[b]Measured range 0.25-0.75 sec.

Figure 1
Comparison Of Predicted And Measured*
Trichloroethylene Air Concentrations
In The Shower



*Source Of Measured Data: Andelman et al.[1]

Table II. Input Parameters for Sensitivity Analysis of Shower Room Air Concentrations

Input Parameter	Value: Figure II	Value: Figure III
Chemical	TCE	TCE
Molecular weight	131 g/mol	131 g/mol
Henry's Law Constant	1.0×10^{-2} atm-m^3/mol-K	1.0×10^{-2} atm-m^3/mol-K
Shower water concentration	15, 75 µg/l	15 µg/l
Shower water temperature	45°C	35°, 40°, 45°, 50°C
Water viscosity	0.596 cp	0.7194, 0.6529, 0.5996, 0.5468 cp
Shower water flow rate	10 l/min	10 l/min
Droplet diameter	1 mm	1 mm
Droplet drop time	2 sec	2 sec
Air exchange rate	0.5, 1.0, 1.5 hr^{-1}	1.0 hr^{-1}
Shower room air volume	6 m^3	6 m^3
Shower duration	60 min	60 min
Duration in room after shower turned off	60 min	60 min

Figure 8
Effect Of Different Air Exchange Rates And TCE Water Concentrations On TCE Air Concentrations In The Shower

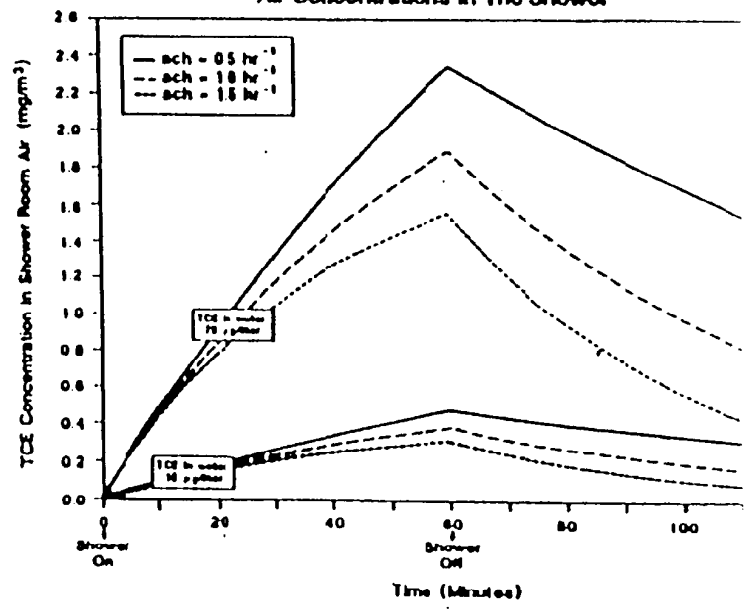


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Figure III

Effect Of Different Water Temperatures On Trichloroethylene Air Concentrations In The Shower

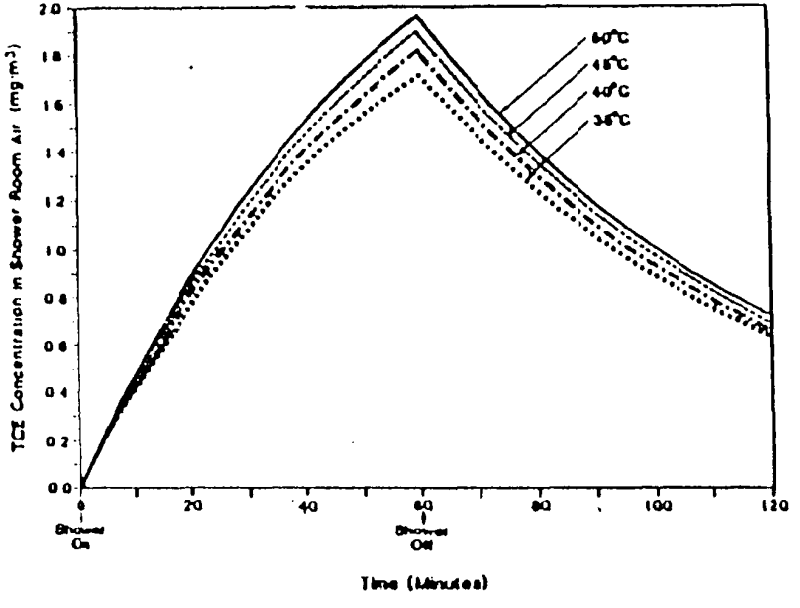

Table III. Input Parameters for Comparative Risk Assessment of Exposure to Five Volatile Organic Chemicals In Shower Room Air

Input Parameter	Value
Chemical (Henry's Law Constant, molecular weight)	Benzene (78 g/mol, 5.5×10^{-3} atm-m³/mol-K) Chloroform (119 g/mol, 2.87×10^{-3} atm-m³/mol-K) Tetrachloroethylene (166 g/mol, 2.6×10^{-2} atm-m³/mol-K) Trichloroethylene (131 g/mol, 1.0×10^{-2} atm-m³/mol-K) Vinyl chloride (63 g/mol, (8.2×10^{-2} atm-m³/mol-K)
Shower water concentration	75 µg/l (upper bound scenario) 15 µg/l (lower bound scenario)
Shower water temperature	45°C (318 K)
Water viscosity	0.596 cp
Shower water flow rate	10 l/min
Droplet diameter	1 mm
Droplet drop time	2 sec
Air exchange rate	0.5 hr^{-1} (upper bound scenario) 1.5 hr^{-1} (lower bound scenario)
Shower room air volume	6 m³
Shower duration	15 min (upper bound scenario) 10 min (lower bound scenario)
Duration in room after shower is turned off	5 min
Ventilation rate	15 l/min
Inhalation absorption factor	1.0
Body weight	70 kg
Cancer potency factor for inhalation [EPA weight of evidence classification for carcinogenic effects][a]	Benzene-2.6×10^{-2} (mg/kg/day)$^{-1}$ [A] Chloroform-8.1×10^{-2} (mg/kg/day)$^{-1}$ [Tetrachloroethylene-1.7×10^{-3} (mg/kg/day)$^{-1}$ [B2] Trichloroethylene-4.6×10^{-3} (mg/kg/day)$^{-1}$ [B2] Vinyl chloride-2.5×10^{-2} (mg/kg/day)$^{-1}$ [A]

[a] [A] - human carcinogen based on adequate evidence from human studies; [B2] - probable human carcinogen based on inadequate evidence from human studies and adequate evidence from animal studies.

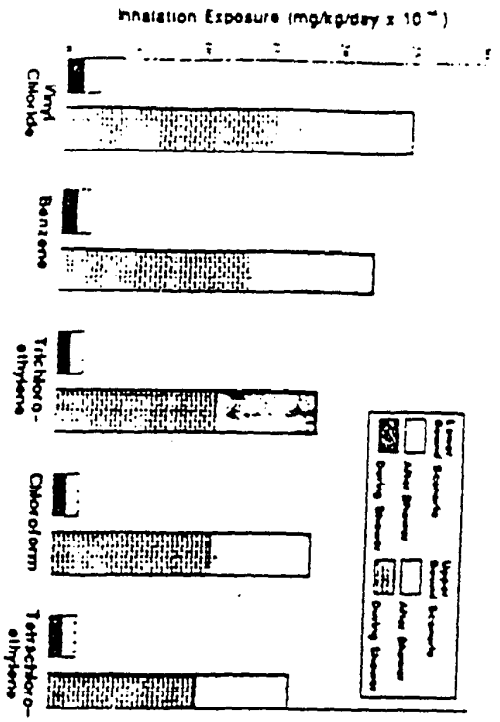

Figure IV
Comparison of Inhalation Exposures to Five Volatile Organic Compounds in the Shower

Table IV. Comparative Risk Assessment for Inhalation of Five Volatile Organic Compounds in Shower Room Air

Chemical	Exposure (mg/kg/day)[a]		Cancer Potency Factor for Inhalation $(mg/kg/day)^{-1}$	Excess Lifetime Cancer Risk	
	Lower Bound Scenario[b]	Upper Bound Scenario[c]		Lower Bound Scenario[b]	Upper Bound Scenario[c]
Benzene	2.24×10^{-4}	2.26×10^{-3}	2.6×10^{-2} [A][d]	6×10^{-6}	6×10^{-5}
Chloroform	1.86×10^{-4}	1.88×10^{-3}	8.1×10^{-2} [B2][d]	2×10^{-5}	2×10^{-4}
Tetrachloroethylene	1.73×10^{-4}	1.75×10^{-3}	1.7×10^{-3} [B2][d]	3×10^{-7}	3×10^{-6}
Trichloroethylene	1.87×10^{-4}	1.89×10^{-3}	4.6×10^{-3} [B2][d]	9×10^{-7}	9×10^{-6}
Vinyl chloride	2.48×10^{-4}	2.50×10^{-3}	2.5×10^{-2} [A][d]	6×10^{-6}	6×10^{-5}

[a]Assumes one shower per day over a 70-year lifetime.

[b]*Lower-case scenario:* Water concentration = 15 µg/l, ach = 1.5 hr^{-1}, 10-minute shower, and 5 minutes in shower room after shower off. See Table III for all input parameter values.

[c]Upper-case scenario: Water concentration = 75 µg/l, ach = 0.5 hr^{-1}, 15-minute shower, and 5 minutes in shower room after shower off. See Table III for all input parameter values.

[d]EPA weight of evidence classification for carcinogenic effects (see Table III).

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Table V. Comparison of Excess Lifetime Cancer Risks Associated With Inhalation of VOCs in Shower Room Air and Ingestion of VOCs in Tap Water

Chemical	Range of Excess Lifetime Cancer Risks[a]	
	Inhalation[b]	Ingestion[c]
Benzene	6×10^{-6} - 6×10^{-5}	2×10^{-5} - 1×10^{-4}
Chloroform	2×10^{-5} - 2×10^{-4}	3×10^{-5} - 2×10^{-4}
Tetrachloroethylene	3×10^{-7} - 3×10^{-6}	2×10^{-5} - 1×10^{-4}
Trichloroethylene	9×10^{-7} - 9×10^{-6}	5×10^{-6} - 2×10^{-5}
Vinyl Chloride	6×10^{-6} - 6×10^{-5}	1×10^{-3} - 5×10^{-3}

[a]Lower value in range assumes water concentration = 15 µg/l; upper value in range assumes water concentration = 75 µg/l.

[b]Assumes one 10- or 15-minute shower per day for a 70-year lifetime. Detailed exposure conditions are shown in Table III.

[c]Assumes ingestion of 2 liters of water per day over a 70-year lifetime.

L-14

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DRINKING WATER EXPOSURE
SITE: Bainbridge Naval Training Center - Old Landfill

INHALATION EXPOSURE: FOSTER AND CHROSTOWSKI SHOWER MODEL

EQUATIONS:

kg = kH x SQRT (MW H / MW)

kg = GAS-FILM MASS TRANSFER COEFFICIENT (CM/HR)
kH = kg FOR WATER (CM/HR: 3000)
MW H = MOLEC. WT. FOR WATER (G/MOL: 18)
MW = MOLECULAR WT. (G/MOL)

kl = kC x SQRT (MW C / MW)

kl = LIQUID-FILM MASS TRANSFER COEFFICIENT (CM/HR)
kC = kl FOR CARBON DIOXIDE (CM/HR: 20)
MW C = MOLEC. WT. FOR CARB. DIOXIDE (G/MOL: 44)

KL = 1 / [(1 / kl) + ((R x T) / (H x kg))]

KL = MASS TRANSFER COEFFICIENT (CM/HR)
R = GAS CONSTANT (ATM M3/MOL K: 8.2E-5)
T = ABSOLUTE TEMP. (K: 293)
H = HENRY'S LAW CONSTANT (ATM M3/MOL)

KaL = KL / SQRT [(T1 x US) / (TS x U1)]

KaL = ADJUSTED OVERALL MASS TRANS. COEFF. (CM/HR)
T1 = CALIB. WATER TEMP OF KL (K)
TS = SHOWER WATER TEMP. (K)
U1 = WATER VISCOSITY AT T1 (CP)
US = WATER VISCOSITY AT TS (CP)

CWD = C x CF x (1 - EXP [(-KaL x ts) / (60 x d)])

CWD = CONC LEAVING SHOWER DROPLET AFTER TIME ts (UG/L)
C = CONCENTRATION IN WATER (MG/L)
CF = CONVERSION FACTOR (UG/MG: 1E3)
ts = SHOWER DROPLET TIME (SEC)
d = SHOWER DROPLET DIAMETER (MM)

S = CWD x FR / SV

S = INDOOR VOC GENERATION RATE (UG/M3/MIN)
FR = SHOWER FLOW RATE (L/MIN)
SV = SHOWER ROOM AIR VOLUME (M3)

D = [(VR x S) / (BW x Ra x 1E6)] x Q

D = INHALATION DOSE (MG/KG/SHOWER)
VR = VENTILATION RATE (L/MIN)
BW = BODY WEIGHT (KG)
Dt = TOTAL DURATION IN SHOWER ROOM (MIN)
Ra = RATE OF AIR EXCHANGE (1/MIN)

Q = Ds + [(EXP(-Ra x Dt)) / Ra] - [(EXP(Ra x (Ds-Dt))) / Ra]

Ds = DURATION OF SHOWER (MIN)

DRINKING WATER EXPOSURE
SITE: Bainbridge Naval Training Center - Old Landfill

INPUTS:

T1	293	VR	14
TS	318	BW	70
U1	1.002	EF	350
US	0.596	ED	30
d	1	AT-NC	10950
ts	2	AT-C	25550
FR	20		
SV	6		
Ds	15	Q	2.78071
Dt	20		
Ra	0.01667		

CHEMICAL	C (MG/L)	MW	H	kg	kl	KL	KaL	CWD	S	D
Antimony	3.00E-02	122	0.00E+00	1152.332	12.01092	N/A	0	0	0	0
Arsenic	1E-03	74.9	0.00E+00	1470.675	15.32906	N/A	0	0	0	0
Beryllium	2.59E-04	9.01	0.00E+00	4240.286	44.19712	N/A	0	0	0	0
Chlorobenzene	8.98E-02	112.6	3.77E-03	1199.467	12.50222	11.72347	15.83605	36.83048	122.7683	0.004109
Chloroform	4E-03	119.4	3.67E-03	1164.811	12.14099	11.36546	15.35244	1.602213	5.340709	0.000179
Chromium VI	7.65E-03	52	0.00E+00	1765.045	18.39732	N/A	0	0	0	0
Di(2-ethylhexyl)phthalat	6.46E-03	391	1.47E-05	643.6787	6.709157	0.371991	0.502484	0.107301	0.357668	0.000012
Dichlorobenzene, 1,4	9.75E-03	147	2.40E-03	1049.781	10.94202	9.908163	13.38393	3.509026	11.69675	0.000391
Dichloroethene, 1,2-	1.35E-02	96.9	4.08E-03	1292.991	13.47704	12.69767	17.15199	5.878625	19.59542	0.000656
Dichloropropane, 1,2-	1E-03	113	2.80E-03	1197.342	12.48007	11.45551	15.47409	0.402979	1.343263	0.000045
Heptachlor	2.59E-05	373.5	1.09E-03	658.5856	6.864534	5.58206	7.540237	0.005756	0.019187	6.4E-07
Iron	2.45E+01		0.00E+00	N/A	N/A	N/A	0	0	0	0
Manganese	6.97E+00	54.9	0.00E+00	1717.795	17.90483	N/A	0	0	0	0
Methylene Chloride	6.25E-03	84.9	2.19E-03	1381.35	14.39801	12.92055	17.45305	2.756818	9.189393	0.000308
Nickel	1.96E-02	58.7	0.00E+00	1661.263	17.31559	N/A	0	0	0	0
Thallium	1E-03			N/A	N/A	N/A	0	0	0	0
Trichloroethene	6.4E-03	131.4	1.03E-02	1110.35	11.57334	11.29863	15.26217	2.551979	8.506597	0.000285
Vinyl Chloride	6.62E-04	62.5	2.70E-02	1609.969	16.78094	16.62673	22.45935	0.348869	1.162898	0.000039
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0

DRINKING WATER EXPOSURE
SITE: Bainbridge Naval Training Center - Old Landfill

RISKS

CHEMICAL	D	RFD	CSF	HQ	CR
Antimony	0.00E+00			N/A	0.0E+00
Arsenic	0.00E+00		1.50E+01	N/A	0.0E+00
Beryllium	0.00E+00		8.40E+00	N/A	0.0E+00
Chlorobenzene	4.11E-03	5.70E-03		6.9E-01	0.0E+00
Chloroform	1.79E-04	1.10E-02	8.00E-02	1.6E-02	5.9E-06
Chromium VI	0.00E+00			N/A	0.0E+00
Di(2-ethylhexyl)phthalat	1.20E-05	2.90E-03		4.0E-03	0.0E+00
Dichlorobenzene, 1,4-	3.91E-04	2.30E-01		1.6E-03	0.0E+00
Dichloroethene, 1,2-	6.56E-04			N/A	0.0E+00
Dichloropropane, 1,2-	4.50E-05	1.10E-03		3.9E-02	0.0E+00
Heptachlor	6.42E-07		4.50E+00	N/A	1.2E-06
Iron	0.00E+00			N/A	0.0E+00
Manganese	0.00E+00			N/A	0.0E+00
Methylene Chloride	3.08E-04	8.60E-01	1.60E-03	3.4E-04	2.0E-07
Nickel	0.00E+00			N/A	0.0E+00
Thallium	0.00E+00			N/A	0.0E+00
Trichloroethene	2.85E-04		6.00E-03	N/A	7.0E-07
Vinyl Chloride	3.89E-05		3.00E-01	N/A	4.8E-06
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
TOTALS/INHALATION				**7.5E-01**	**1.3E-05**

DRINKING WATER EXPOSURE
SITE: Bainbridge Naval Training Center - Fire Training Area

INHALATION EXPOSURE: FOSTER AND CHROSTOWSKI SHOWER MODEL

EQUATIONS:

kg = kH x SQRT (MW H / MW)

kg = GAS-FILM MASS TRANSFER COEFFICIENT (CM/HR)
kH = kg FOR WATER (CM/HR: 3000)
MW H = MOLEC. WT. FOR WATER (G/MOL: 18)
MW = MOLECULAR WT. (G/MOL)

kl = kC x SQRT (MW C / MW)

kl = LIQUID-FILM MASS TRANSFER COEFFICIENT (CM/HR)
kC = kl FOR CARBON DIOXIDE (CM/HR: 20)
MW C = MOLEC. WT. FOR CARB. DIOXIDE (G/MOL: 44)

KL = 1 / [(1 / kl) + ((R x T) / (H x kg))]

KL = MASS TRANSFER COEFFICIENT (CM/HR)
R = GAS CONSTANT (ATM M3/MOL K: 8.2E-5)
T = ABSOLUTE TEMP. (K: 293)
H = HENRY'S LAW CONSTANT (ATM M3/MOL)

KaL = KL / SQRT [(T1 x US) / (TS x U1)]

KaL = ADJUSTED OVERALL MASS TRANS. COEFF. (CM/HR)
T1 = CALIB. WATER TEMP OF KL (K)
TS = SHOWER WATER TEMP. (K)
U1 = WATER VISCOSITY AT T1 (CP)
US = WATER VISCOSITY AT TS (CP)

CWD = C x CF x (1 - EXP [(-KaL x ts) / (60 x d)])

CWD = CONC LEAVING SHOWER DROPLET AFTER TIME ts (UG/L)
C = CONCENTRATION IN WATER (MG/L)
CF = CONVERSION FACTOR (UG/MG: 1E3)
ts = SHOWER DROPLET TIME (SEC)
d = SHOWER DROPLET DIAMETER (MM)

S = CWD x FR / SV

S = INDOOR VOC GENERATION RATE (UG/M3/MIN)
FR = SHOWER FLOW RATE (L/MIN)
SV = SHOWER ROOM AIR VOLUME (M3)

D = [(VR x S) / (BW x Ra x 1E6)] x Q

D = INHALATION DOSE (MG/KG/SHOWER)
VR = VENTILATION RATE (L/MIN)
BW = BODY WEIGHT (KG)
Dt = TOTAL DURATION IN SHOWER ROOM (MIN)
Ra = RATE OF AIR EXCHANGE (1/MIN)

Q = Ds + [(EXP(-Ra x Dt)) / Ra] - [(EXP(Ra x (Ds-Dt))) / Ra]

Ds = DURATION OF SHOWER (MIN)

DRINKING WATER EXPOSURE
SITE: Bainbridge Naval Training Center - Fire Training Area
INPUTS:

T1	293	VR	14
TS	318	BW	70
U1	1.002	EF	350
US	0.596	ED	30
d	1	AT-NC	10950
te	2	AT-C	25550
FR	20		
SV	6		
Ds	15	Q	2.78971
Dt	20		
Ra	0.01667		

CHEMICAL	C (MG/L)	MW	H	kg	kl	KL	KaL	CWD	S	D
Aldrin	0.000028	365	3.20E-04	666.2099	6.944003	3.895473	5.261998	0.004424	0.014747	4.9E-07
Aluminum	1.5			N/A	N/A	N/A	0	0	0	0
Arsenic	0.00113			N/A	N/A	N/A	0	0	0	0
Benzo(a)anthracene	0.001	228	6.60E-07	842.9272	8.785954	0.023095	0.031196	0.001039	0.003464	1.2E-07
Benzo(a)pyrene	0.002	252	2.40E-06	801.7837	8.357109	0.079331	0.107161	0.007131	0.023771	8.0E-07
Benzo(b)fluoranthene	0.003	252	1.20E-05	801.7837	8.357109	0.382146	0.516202	0.051179	0.170596	5.7E-06
Benzo(k)fluoranthene	0.002	252	3.87E-05	801.7837	8.357109	1.118611	1.511018	0.09824	0.327466	0.000011
Beryllium	0.0031			N/A	N/A	N/A	0	0	0	0
Cadmium	0.00266			N/A	N/A	N/A	0	0	0	0
Chloroform	0.00564	119	3.67E-03	1166.767	12.16138	11.38454	15.37822	2.262024	7.54008	0.000252
Chromium VI	0.00757			N/A	N/A	N/A	0	0	0	0
Chrysene	0.002	228	1.05E-06	842.9272	8.785954	0.036684	0.049553	0.003301	0.011003	3.7E-07
Di(2-ethylhexyl)phthalate	0.00639	390	1.47E-05	644.5034	6.717753	0.372467	0.503128	0.106273	0.354242	0.000012
Dichlorobenzene 1.4	0.001	147	2.40E-03	1049.781	10.94202	9.908163	13.38393	0.3599	1.199667	0.00004
Indeno(1,2,3-cd)pyrene	0.002	276	6.95E-08	766.1309	7.985494	0.002216	0.002993	0.0002	0.000665	2.2E-08
Iron	79.2			N/A	N/A	N/A	0	0	0	0
Manganese	5.5			N/A	N/A	N/A	0	0	0	0
Methylene Chloride	0.00798	84.9	2.19E-03	1381.35	14.39801	12.92055	17.45305	3.519905	11.73302	0.000393
Tetrachloroethane, 1,1,2,	0.00525	168	4.55E-04	981.9805	10.23533	6.601784	8.917678	1.350017	4.500057	0.000151
Thallium	0.001			N/A	N/A	N/A	0	0	0	0
Trichloroethene	0.00197	131	1.03E-02	1112.044	11.59099	11.31587	15.28546	0.78645	2.6215	0.000088
Zinc	0.241			N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0
				N/A	N/A	N/A	0	0	0	0

recycled paper

ecology and environment

DRINKING WATER EXPOSURE
SITE: Bainbridge Naval Training Center - Fire Training Area
RISKS

CHEMICAL	D	RFD	CSF	HQ	CR
Aldrin	4.94E-07		1.70E+01	N/A	3.4E-06
Aluminum	0.00E+00			N/A	0.0E+00
Arsenic	0.00E+00		1.50E+01	N/A	0.0E+00
Benzo(a)anthracene	1.16E-07		6.10E+00	N/A	2.9E-07
Benzo(a)pyrene	7.96E-07		6.10E+00	N/A	2.0E-06
Benzo (b)fluoranthene	5.71E-06		6.10E+00	N/A	1.4E-05
Benzo (k)fluoranthene	1.10E-05		6.10E+00	N/A	2.7E-05
Beryllium	0.00E+00		8.40E+00	N/A	0.0E+00
Cadmium	0.00E+00		6.30E+00	N/A	0.0E+00
Chloroform	2.52E-04	1.10E-02	8.00E-02	2.2E-02	8.3E-06
Chromium VI	0.00E+00		4.20E+01	N/A	0.0E+00
Chrysene	3.68E-07		6.10E+00	N/A	9.2E-07
Di(2-ethylhexyl)phthalate	1.19E-05	2.90E-03		3.9E-03	0.0E+00
Dichlorobenzene 1,4	4.02E-05	2.30E-01		1.7E-04	0.0E+00
Indeno(1,2,3-cd)pyrene	2.23E-08		6.10E+00	N/A	5.6E-08
Iron	0.00E+00			N/A	0.0E+00
Manganese	0.00E+00			N/A	0.0E+00
Methylene Chloride	3.93E-04	8.60E-01	1.60E-03	4.4E-04	2.6E-07
Tetrachloroethane, 1,1,2,	1.51E-04		2.00E-01	N/A	1.2E-05
Thallium	0.00E+00			N/A	0.0E+00
Trichloroethene	8.77E-05		6.00E-03	N/A	2.2E-07
Zinc	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
	0.00E+00			N/A	0.0E+00
TOTALS/INHALATION				2.7E-02	7.0E-05

M Health Effects Summaries

This appendix contains health effects summaries for chemicals of potential concern (COPCs) at the Bainbridge NTC Sites. These summaries provide information on:

- The occurrence and behavior of the COPCs in the environment;
- Potential exposure mechanisms and adverse health effects that could result from exposure; and
- The basis and reliability of the quantitative toxicological indices for the COPCs.

In most cases, the information in the summaries is drawn from the Public Health Statement in the Toxicological Profile or the Fact Sheet for the chemical, prepared by the Agency for Toxic Substances and Disease Registry (ATSDR). Information on the basis and reliability of the toxicological indices for the COPCs generally is from the chemicals' IRIS files, from the HEAST, or from EPA's National Center for Environmental Assessment (NCEA), which was formerly called Environmental Criteria and Assessment Office (ECAO).

Aldrin

Aldrin is a structured man-made chemical that was used extensively as an agricultural pesticide for over 20 years until its use was suspended by the United States Department of Agriculture (USDA) in 1970. Use of aldrin to control termites continued until 1987, when the manufacturer voluntarily canceled the registration.

Although some aldrin could be found in environmental media, most previously released aldrin has probably been degraded to dieldrin. Dieldrin persists in the environment and can be found tightly bound to soils and sediment. It is not expected to leach to groundwaters. Plants can take up dieldrin from soil, and fish and livestock can accumulate high concentrations through the food chain.

The health effects associated with aldrin and dieldrin are similar. Both can be absorbed into the body through skin contact, ingestion, and inhalation. The most likely route of human exposure is through eating contaminated food. Foods most likely to be contaminated include fish, shellfish, root crops, meat, and dairy products.

Human poisoning from aldrin is characterized by major involuntary muscle convulsions or kidney damage that can be fatal. Other effects include lack of coordination, headache, dizziness, and gastrointestinal disturbances.

Animal studies show effects of aldrin on the nervous system and kidneys to be similar to the effects in humans. In addition, exposure to aldrin has resulted in increases in liver

enzymes and liver weight, decreased immune response, and high mortality in nursing rat pups. It is unknown whether exposed humans have similar health effects. Liver damage is the critical or most sensitive effect in animals according to EPA. The oral RfD for aldrin, 36.05 mg/kg-day, as derived from the LOAEL from a rat chronic feeding study of applying an uncertainty factor of 1,000 to account for use of a LOAEL rather than a NOAEL, interspecies extrapolation, and human variability. Confidence in the RfD is rated medium.

Aldrin is a carcinogen in mice, with the liver being the site of increased tumor incidence. However, it is not known if aldrin is human carcinogens. Aldrin is classified under Group B2, probable human carcinogens, by EPA. An oral SF and inhalation unit risk have been derived for aldrin based on liver tumors in mice exposed to aldrin in their diet. Confidence in the data is good as adequate numbers of animals were exposed for a large proportion of their lifetime. Slope factors calculated from three data sets from two independent assays were within a factor of 2.

Aluminum

Aluminum is a naturally occurring, silver-white, flexible metal that is always found in the earth in combination with other elements. Aluminum is used in cooking utensils, appliances, and building materials. In combination with other substances, aluminum is an ingredient in such everyday items as antacids and antiperspirants.

Limited amounts of aluminum can be found in natural waters, drinking water, and air. It makes up approximately 8 percent of the earth's crust; however, higher concentrations may exist in soil surrounding waste sites associated with industries such as coal combustion and aluminum mining and smelting.

Very little aluminum enters the body through the skin or the lungs, and the small amount that might enter the bloodstream through the stomach is quickly eliminated. Some people may get skin rashes from aluminum in antiperspirants, and factory workers who breathe in large amounts of aluminum dust can have lung problems such as coughing or changes that show up in chest x-rays. Because it is minimally absorbed through the gastrointestinal tract (GI), aluminum has long been regarded as nontoxic. Human and animal studies have shown that elevated levels of aluminum in the body may be toxic to the central nervous, skeletal, and hematological systems; however, these effects have been observed mainly under conditions in which the GI tract has been bypassed (e.g., intravenously). People with Alzheimer's disease have higher than normal levels of aluminum associated with lesions in their brain tissue, but

there is insufficient evidence to conclude that aluminum causes this disease. In general, exposure to aluminum is usually not considered harmful to humans.

Oral doses of aluminum have been shown to induce neurobehavioral effects in adult mice and in their developing offspring. Developmental effects (neurobehavioral deficits, decreased body weight, and possibly skeletal abnormalities) in the offspring of mice were identified as the most sensitive toxicity endpoint. A provisional oral RfD for aluminum of 1 mg/kg-day is derived by applying to the LOAEL a total uncertainty factor of 100 to account for use of a LOAEL rather than a NOAEL, interspecies extrapolation, and human population variability. Confidence in the RfD is low because of limitations in the data base. The RfD is based on conservative data (i.e., ingestion of soluble aluminum compounds).

No cases of cancer have been attributed to aluminum exposure. The EPA has placed aluminum in Group D (not classifiable as to carcinogenicity in humans).

Antimony

Antimony is a naturally occurring element that can be found at very low levels in air, soil, food, and water. Much of the antimony in the environment is bound tightly to dust, soil, and rocks. Antimony is used industrially in metal alloys and for producing fireproofing chemicals, ceramics, glassware, and pigments. It also has been used medicinally as an anti-parasitic agent.

Antimony can enter the body by absorption from the gastrointestinal tract following ingestion of food or water containing it, or by absorption from the lungs after inhalation. People may be exposed to high levels of antimony in dust if they live near antimony mines or processing companies. Ingestion of high doses of antimony can result in burning stomach pains, colic, nausea, and vomiting. Long-term occupational inhalation exposure has been shown to cause heart problems, stomach ulcers, and irritation of the lungs, eyes, and skin. It is not known whether antimony can enter the body through the skin.

The critical or most sensitive noncarcinogenic effects of antimony exposure, based on chronic oral exposure of rats to antimony, are shortened life span, reduced blood glucose levels, and altered cholesterol levels. The oral reference dose (RfD) for antimony, 4E-04 mg/kg-day, is based on a chronic oral bioassay in which 5 ppm of potassium antimony tartrate was administered to rats in their drinking water. The primary study, Schroeder *et al.* 1970, included 100 rats. Confidence in the principal study is considered low because only one species and one dose level were used; a "no observed adverse effects level" (NOAEL) was not determined; and gross pathology and histopathology were not well described. Confidence in

the data base, and consequently the RfD, is low due to lack of adequate oral exposure investigations.

Existing data suggest that antimony may be an animal carcinogen; however, the data are not sufficient to justify a quantitative cancer potency estimate at this time. In laboratory rats, inhalation of antimony dust can increase the risk of lung cancer. However, there is no evidence of increased risk of cancer to animals from eating food or drinking water containing antimony. It is not known whether antimony can cause cancer in humans. Antimony has not yet received a weight-of-evidence classification from the EPA.

Arsenic

Arsenic, a naturally occurring element, is present at low levels in soil, water, and air. It is usually found in combination with one or more elements such as oxygen, chlorine, or sulfur; these compounds are called inorganic arsenic. Arsenic is also found in plants, animals, fish, and shellfish, usually in combination with carbon and hydrogen; these compounds, called organic arsenic, are generally less toxic than inorganic arsenic. Arsenic is widely distributed in the environment from natural sources, but higher concentrations have been found to occur in association with chemical waste, smelting of copper and other metals, fossil fuel combustion, and pesticide use. The primary use of arsenic is as a wood preservative, but it is also used to make insect and weed killers and pharmaceuticals.

Arsenic does not break down in the environment, but it can change from one form to another. Most arsenic compounds are soluble in water but do not evaporate. Arsenic can be released into the air when minerals containing arsenic are processed or smelted, or when materials containing arsenic are burned. Airborne particles containing arsenic can settle on the ground, surface water, and plants. Fish and shellfish accumulate arsenic in their tissues, but most of the arsenic in fish is the less- toxic organic arsenic.

Most people are routinely exposed to low levels of arsenic because it is naturally occurring and low levels are present in food, water, soil, and air. Workers in several industries (nonferrous smelting, wood preservation, arsenical pharmaceutical production, and production and application of arsenical pesticides) may be exposed to significantly higher levels. Higher exposures also can result from breathing sawdust or smoke from wood treated with arsenic.

Inorganic arsenic is a human poison; organic arsenic is less harmful. Ingestion of food or water with high levels of inorganic arsenic (60 mg/kg in food or 60 mg/L in water) can be fatal. Chronic arsenic overexposure may cause many health effects, including body weight

changes, changes in the blood, and liver and kidney damage. Arsenic damages many tissues, including nerves, stomach, intestines, liver, kidneys, and skin. Breathing high levels can irritate the throat and lungs. Lower levels of exposure to inorganic arsenic may cause nausea, vomiting, and diarrhea; decreased production of red and white blood cells; abnormal heart rhythm; blood vessel damage, and a "pins and needles" sensation in the hands and feet. Long-term exposure to inorganic arsenic may lead to a darkening of the skin (hyperpigmentation), and the appearance of small "corns" or "warts" (keratosis) on the palms, soles, and torso. Direct skin contact may cause redness and swelling.

The critical or most sensitive effects of arsenic exposure, based on chronic oral exposure to humans, are hyperpigmentation of the skin, keratosis, and possible vascular complications. The oral RfD for arsenic, 3E-04 mg/kg-day, is based on chronic human exposure to elevated levels of inorganic arsenic in drinking water. The principal study upon which the reference dose is based included more than 40,000 individuals, and there are a number of supporting studies. Confidence in the principal study is considered medium. An extremely large number of people were included in the study, but the doses were not well-characterized and other contaminants were present. The supporting human toxicity database is extensive but somewhat flawed. Problems exist with all of the epidemiological studies; however, the database does support the choice of a NOAEL. Confidence in the database as a whole and in the RfD is considered medium.

Arsenic is classified as a Group A human carcinogen by EPA. Epidemiologic studies and case reports have shown that ingesting inorganic arsenic increases the risk of cancer of the skin, lungs, bladder, and kidneys. Breathing inorganic arsenic increases the risk of lung cancer.

An oral slope factor and inhalation unit risk have been derived for inorganic arsenic. The oral slope factor of 1.5 $(mg/kg\text{-}day)^{-1}$, which is based on increased incidence of skin cancer in humans who consumed drinking water with high arsenic concentrations, was derived from the same principal study as the oral RfD. Although the study included a large number of people, uncertainties about the dosages of arsenic led the EPA administrator to conclude that the slope factor estimates based on that study could be modified downward by as much as an order of magnitude relative to estimates for most other carcinogens.

The inhalation unit risk, 0.0043 $(\mu g/m^3)^{-1}$, is derived from observations of increased lung cancer mortality in occupationally exposed males. Data from several studies were combined to obtain the final unit risk estimates. Overall, a large study population was observed. Exposure assessments included both work place air and urinary arsenic measure-

ments. The unit risk estimated from the individual studies that were combined to obtain the final estimate all fell within a factor of 6 of one another. All of these factors lead to medium confidence in the final inhalation unit risk estimate.

Beryllium

Pure beryllium is a hard, gray metal. It occurs as a chemical component of certain rocks. The minerals bertrandite and beryl are mined commercially for the recovery of beryllium. Most beryllium ore is purified for use in electronics, aerospace industry, X-ray machines, nuclear weapons, nuclear reactors, and mirrors. Beryllium oxide is used in the manufacture of specialty ceramics.

Beryllium compounds are naturally present in soils, where they are generally immobile, but deposition of atmospheric beryllium and disposal of beryllium-containing wastes can increase the levels in localized areas. Beryllium is released into the air by natural sources such as volcanic dust; however, the major emission source to the environment is the burning of coal and oil. Beryllium occurs naturally in tobacco and can be inhaled in cigarette smoke. Some beryllium compounds dissolve in water.

In general, the primary route of exposure to beryllium is inhalation, because relatively little beryllium is absorbed from the gastrointestinal (GI) tract or through the skin. Industrial workers involved in the mining, milling, and processing of beryllium to alloys or beryllium oxide have the highest exposure to beryllium.

The respiratory tract is the major target organ for damage due to inhalation exposure to beryllium. Exposure to high levels of beryllium in air can cause lung damage and a disease that is similar to pneumonia. The resulting lung damage may be reversible once inhalation of air containing beryllium ceases. It also is possible that people exposed to low levels of beryllium will develop an inflammatory reaction called berylliosis, an immune reaction characterized by noncancerous growths on the lungs. The disease, which occurs in individuals who are hypersensitive or allergic to beryllium, can occur long after exposure to small amounts of beryllium. Both the short-term, pneumonia-like disease and the berylliosis can cause death.

Ingestion of beryllium has not been reported to cause effects in humans because very little beryllium can move from the stomach and intestines into the bloodstream. Beryllium contact with scraped or cut skin can cause rashes or ulcers.

The oral RfD for beryllium, 5E-03 mg/kg-day, is derived from a NOAEL of 5 ppm in drinking water administered to rats for their entire lifetime. Confidence in the principal study is considered low because only one dose level was administered. In addition, confidence in the

entire database from which the RfD is derived also is low; although numerous supporting studies exist, the studies are considered of low to medium quality and thus the database is given a low confidence rating. In addition, the work of another researcher indicates that a higher dose level might be a NOAEL. The overall confidence in the RfD is low, reflecting the need for more oral route toxicity data.

Epidemiological studies have indicated that an increased risk of lung cancer may result from exposure to beryllium in industrial settings. In addition, laboratory studies have shown that breathing beryllium causes lung cancer in animals. However, it is not clear whether excess cancer risk is associated with ingestion of beryllium.

The EPA has classified beryllium as a Group B2, probable human carcinogen, based on limited human evidence and animal data. The International Agency for Research on Cancer (IARC) has concluded that there is sufficient evidence that beryllium is an animal carcinogen, but there is limited human evidence. Consequently, IARC concludes that beryllium should be considered a suspected human carcinogen.

An oral slope factor and inhalation unit risk have been derived for beryllium. The oral slope factor, 4.3 $(mg/kg\text{-}day)^{-1}$, is based on tumors observed in gross examination of male rats exposed to beryllium in their drinking water. Slight increases in cancer incidence (not statistically significant in comparison with controls) were reported in these rats. The authors reported a slight excess of grossly observed tumors in the cohort group (9/33) over the control group (4/26). However, the ability to detect a carcinogenic effect was reduced by high mortality (approximately 60% survived a pneumonia epidemic at 20 months). This study is limited because only one non-zero dose group was used and the rate of mortality was very high. Oral risk estimates derived by extrapolation from other studies (also highly uncertain) are within an order of magnitude.

The inhalation unit risk, 0.0024 $(\mu g/m^{3})$-1, is derived from human occupational exposure studies. Inhalation risk estimates were based on the data provided in one study in which the smoking-adjusted expected lung cancer deaths ranged from 13.91 to 14.67 in comparison to 20 observed deaths. Relative risk estimates of 1.36 and 1.44 were derived, and the 95% confidence limits of these estimates were used to derive the lifetime cancer risk. Because of uncertainties regarding occupational beryllium concentrations and exposure duration, unit risks were derived using two estimates each of concentration, fraction of lifetime exposed, and relative risk. The recommended value is the arithmetic mean of the eight derived unit risks. A low degree of confidence is placed in the unit risk because the quality of the available studies, which were conducted at single-dose levels or lacked control groups, is poor.

Cadmium

Cadmium is a naturally occurring element present in trace amounts in the earth's crust. It is usually found as a mineral combined with other elements such as oxygen (cadmium oxide), chlorine (cadmium chloride), or sulfur (cadmium sulfate, cadmium sulfide). Because cadmium does not corrode easily, it has several industrial applications, including metal plating and the manufacture of pigments, batteries, and plastics.

Cadmium enters the air from mining and industrial processes, and from the burning of coal and household wastes, eventually depositing on land and water surfaces. It also can be released to water and soil by waste disposal processes and spills or leaks at hazardous waste sites. Cadmium can bind to soil particles; however, some cadmium dissolves in water. Cadmium does not break down in the environment, but can change from one form to another.

Plants and animals take up cadmium from the environment, and cadmium accumulates in body tissues even as a result of prolonged exposure to low levels. Humans are exposed to small quantities of cadmium because it is widely distributed in air, water, soil, and food. Cadmium can enter the body by absorption from the stomach or intestines after ingestion of food or water containing cadmium, or by absorption from the lungs after inhalation of cadmium-containing dust, mists, or fumes. Food and cigarette smoke are probably the largest sources of cadmium exposure for the general public. Very little cadmium enters the body through the skin.

Cadmium can cause a number of adverse health effects. Ingestion of very high levels of cadmium causes severe irritation to the stomach, leading to vomiting and diarrhea. Breathing high levels of cadmium severely damages the lungs and can cause death. There is very strong evidence that long-term exposure to lower levels of cadmium in air, food, or water leads to a build up of cadmium in the kidneys and possible kidney disease. Long-term human exposure by the inhalation route may cause kidney damage and lung disease such as emphysema.

Studies of animals given cadmium in food or water indicate that high blood pressure, iron-poor blood, liver disease, and nerve or brain damage may result. It is not known if humans get any of these diseases from eating or drinking cadmium. Skin contact with cadmium is not known to cause health effects in humans or animals.

The most sensitive or critical effect of cadmium exposure is abnormal kidney function as indicated by significant proteinuria. Oral RfDs (5E-04 mg/kg-day [water] and 1E-03 mg/kg-day [food]) have been derived for cadmium based on a toxicokinetic model that predicts NOAELs for chronic cadmium exposure in water (5E-03 mg/kg-day) and food (0.01 mg/kg-

day). An uncertainty factor of 10 was applied to each NOAEL to obtain the RfDs. The toxicokinetic model was used to identify the level of chronic human oral exposure that results in a concentration of 200 μg cadmium/gm human renal cortex (wet), the highest renal level not associated with significant proteinuria. Confidence in the RfDs is high because the NOAEL reflects data obtained from many studies on cadmium toxicity in both humans and animals. These data also permit calculation of pharmacokinetic parameters of cadmium absorption, distribution, metabolism, and elimination. Taken together, this information gives a high level of confidence in the database and, as a result, a high level of confidence in each of the RfDs.

Studies of humans or animals have not demonstrated increased cancer rates from ingestion of cadmium. However, there is evidence that long-term inhalation of cadmium by workers may be associated with an increased risk of lung cancer. Laboratory rats that inhaled cadmium also have shown increased cancer rates. EPA classifies cadmium as a Group B1, probable human carcinogen, based on the occupational studies. The inhalation unit risk, 0.0018 ($\mu g/m^{3)}$-1, is based on increased incidence of cancer from lung, tracheal, and bronchial cancers among occupationally exposed males (for example, a 2-fold excess risk of lung cancer observed in cadmium smelter workers). The cohort consisted of 602 white males who had been employed in production work for a minimum of 6 months during the years 1940-1969. An excess lung cancer risk also was observed in three other occupational studies; however, those studies were compromised by the presence of other carcinogens (e.g., arsenic, smoking) or by a small population. Although, the inhalation unit risk for cadmium in one animal study was higher (i.e., more conservative) than that used to derive the unit risk, the use of available human data was considered to be more reliable because of species response variations and differences in the forms of cadmium used in the animal studies.

Chlordane/Heptachlor

Chlordane and heptachlor are man-made pesticides that were once widely used on more than 20 types of crops and in household applications to eliminate termites. Most uses were banned in the United States by 1988 because of concerns about carcinogenicity and the persistence of these compounds in the environment. Commercial chlordane is a mixture of more than 50 different compounds composed primarily of cis-chlordane, trans-chlordane, and heptachlor. Similarly, technical-grade heptachlor contains chlordane, trans-chlordane, and heptachlor.

Both chlordane and heptachlor degrade slowly in the environment. Heptachlor is converted by chemical and microbial reactions to heptachlor epoxide, which is more persistent

and more toxic than the parent compound. Because chlordane and heptachlor were used on food crops and in homes, there are residual levels in soils, ambient air, and indoor air in many parts of the United States. These compounds are taken up by plants and can biomagnify in the food chain.

Chlordane and heptachlor can be absorbed by the body through dermal contact, inhalation of vapors in ambient air, and ingestion of contaminated soil or food. These chemicals and their metabolites, including heptachlor epoxide, may remain stored for months or years in the blood plasma or the body fat of the liver, spleen, brain, and kidneys.

Little data are available on the adverse health effects of chlordane and heptachlor exposure in humans. Symptoms associated with human overexposure to chlordane and heptachlor include headache, dizziness, lack of coordination, irritability, weakness, and convulsions. In humans, an acute oral lethal dose of chlordane was estimated by the World Health Organization (WHO) (1984) to be between 25 and 50 milligrams per kilogram (mg/kg).

Experimental studies exploring the health effects on animals exposed to levels of chlordane between 5 and 1,000 ppm showed an association between exposure and immunologic dysfunction, reproductive dysfunction, nervous system damage, liver damage, convulsions, liver cancer, and death.

The oral RfD for chlordane, 6E-05 mg/kg-day, is derived from a 30-month rat feeding study in which liver lesions occurred in female rats. The NOAEL was adjusted by an uncertainty factor of 100 to account for interspecies and intraspecies differences, and an additional factor of 10 to account for limitations in the principle study and the overall data base including inadequate reproductive and chronic studies. Because of low confidence in the database, confidence in the RfD is also low.

The oral RfD for heptachlor, 5E-4 mg/kg-day, is derived from a 2-year rat feeding study in which increased liver weight was reported in males only. The NOAEL was adjusted by an uncertainty factor of 100 to account for interspecies and intraspecies differences, and an additional factor of 3 to account for lack of chronic toxicity data in a second species. Confidence in the RfD is low because of the low quality of the principle study and inadequate chronic toxicity data in the database.

Some occupational epidemiology research supports an increased cancer risk associated with human exposure to chlordane. Chronic oral treatment with chlordane and heptachlor has resulted in significant increases in hepatocellular carcinomas in mice. The EPA has classified chlordane and heptachlor under Group B2, probable human carcinogens, and has developed

oral Sfs and inhalation unit risk for both chemicals based on multiple studies that reported increased incidences of hepatocellular carcinomas in mice following dietary exposures.

Chlorobenzene

Chlorobenzene is used primarily as a solvent for pesticide formulations, diisocyanate manufacture, degreasing automobile parts, and in the production of nitrochlorobenzene.

The major use of chlorobenzene in the past was as an intermediate in phenol and DDT production. These processes released chlorobenzene to the environment in water and air discharges. Chlorobenzene is volatile and only moderately soluble in water, and it has a moderate tendency to adsorb to soil. It evaporates readily to the atmosphere where it quickly degrades. In water and soil, chlorobenzene biodegrades rapidly under aerobic conditions.

Chlorobenzene can enter the body via inhalation, ingestion, or dermal contact. However, inhalation is the primary route of exposure. Most absorbed chlorobenzene does not remain in the body, but is metabolized and the metabolites are excreted in urine and through exhalation.

Data on toxic effects of chlorobenzene in humans are sparse. Humans occupationally exposed to chlorobenzene displayed signs of neurotoxicity, including numbness, cyanosis, and muscle spasms. It is not clear that chlorobenzene caused these effects, however, because other chemicals were also present.

Acute exposure of animals to chlorobenzene has resulted in unconsciousness, tremors, and restlessness. Liver function impairment and kidney damage have been observed following long-term exposures. Birth defects and reproductive effects have not been observed. The oral RfD for chlorobenzene, 2E-02 mg/kg-day, is based on histopathological changes in the livers of dogs exposed to chlorobenzene in capsules for a 13-week period. This subchronic study is given a medium confidence rating because it provides a NOAEL and a LOAEL. In addition, it incorporates several biochemical and biological endpoints. Overall confidence in the database is medium because several toxicity studies provide supportive data. A medium level of confidence in the RfD follows. The inhalation RfD, 5.71E-03 mg/kg-day, is based on a RfC of 2E-02 mg/m^3. The RfC is derived from a rat study in which liver and kidney effects were observed following intermittent inhalation exposure for 120 days. The production of liver nodules in animal studies provides some, but not clear, evidence of carcinogenesis. EPA has placed chlorobenzene in Group D, not classifiable as to human carcinogenicity.

Chloroform

Chloroform, also know as trichloromethane, is a colorless liquid with a pleasant, non-irritating odor and a slightly sweet taste. Chloroform is used primarily to synthesize other chemicals. Most chloroform found in the environment comes from chemical manufacturing plants, pulp and paper mills, chlorinated drinking water supplies, and chlorination of waste water from sewage treatment plants. Chloroform is highly soluble in water, and it readily evaporates into air where it is ultimately degraded by photochemical reactions. Background levels of chloroform range from 0.02 to 0.05 ppb in air and 2-44 ppb in water.

The most likely source of exposure to chloroform is through drinking water and/or breathing air containing chloroform. It also can be absorbed through the skin. Inside the body, chloroform can be transported throughout the body, concentrating mainly in fat tissue, brain, liver, and kidney. In humans, chloroform has been found to adversely affect the central nervous system (CNS), liver, kidneys, digestive system, heart, and circulatory system after exposure through inhalation or ingestion. CNS effects associated with human exposure to chloroform include dizziness, vertigo, headache, and in some cases death. When used as an anesthetic in the past, chloroform caused irregular heartbeat and low blood pressure. Anesthetic use was discontinued because of liver and kidney damage. Exposure to very high levels of chloroform (8,000 to 10,000 ppm) likely will result in unconsciousness and death. Breathing high levels (900 ppm) for a short time may cause tiredness, dizziness, or headaches. Long-term exposure to low concentrations of chloroform also causes liver and kidney damage in humans and animals. Dermal contact with chloroform may cause sores. It is unclear whether chloroform affects reproduction or causes birth defects in humans. However, in animal studies, moderate amounts (300 ppm) of chloroform affected reproduction in mice and rats. Male mice had abnormal sperm while female rats and mice experienced miscarriages or had higher numbers of offspring with birth defects.

The oral RfD of 1E-02 mg/kg-day was derived from a study involving beagle dogs who were administered chloroform in a toothpaste base in gelatin capsules. The critical effect identified in this study is fatty cyst formation in the liver. The principal study was of chronic duration, used a fairly large number of dogs, and measured multiple endpoints; however only two treatment doses were used and no NOAEL was determined. Therefore, confidence in the study is rated medium. Confidence in the database is considered medium to low because several studies support the choice of a LOAEL, but a NOAEL was not identified, therefore medium to low confidence in the RfD follows. The inhalation RfD of 1E-03 mg/kg-day was extrapolated from the oral RfD.

Although it is unknown whether long-term exposure contributes to the development of cancer in humans, liver and kidney tumors have been associated with oral exposure in mice and rats. Chloroform is classified as a Group B2, probable human carcinogen, by EPA based on animal studies. The oral slope factor for chloroform, 6.1E-03 mg/kg-day^{-1}, is based on kidney tumors in male rats exposed to chloroform in their drinking water. The inhalation slope factor, 8.05E-02 mg/kg-day^{-1}, is based on an inhalation unit risk of 2.3E-05 μg/m^3. The unit risk is derived from a gavage study on female mice in which an increased incidence of hepatocellular carcinomas was observed.

Chromium

Chromium is a naturally occurring element used in the manufacture of steel and other alloys. Its compounds are used in refractory brick for the metallurgical industry, and in metal plating (chromium VI), the manufacture of pigments (chromium III and chromium VI), leather tanning (chromium III), and other processes. Exposure to chromium can result from inhalation of air containing chromium-bearing particles and ingestion of water or food contaminated with chromium. Chromium III is considered an essential nutrient that helps to maintain normal glucose, cholesterol, and fat metabolism. The minimum daily requirement of chromium for optimal health has not been established, but ingestion of 20 to 500 μg/day has been estimated to be safe and adequate.

The two major forms of chromium—chromium III and chromium VI—can be toxic at high levels, but chromium VI is more toxic than chromium III. Inhaling very high levels of chromium VI can damage and irritate the nose, lungs, stomach, and intestines. Individuals who are allergic to chromium also may experience asthma attacks after breathing high levels of either chromium III or VI. Long-term exposures to high or moderate levels of chromium VI cause damage to the nose (bleeding, itching, sores) and lungs, and can increase the risk of non-cancer lung diseases. Minor to severe damage to the mucous membranes of the respiratory tract and to the skin have resulted from occupational exposure to as little as 0.1 mg/m^3 chromium VI compounds. Chromium VI also may cause adverse effects in the kidney and liver. Ingestion of large amounts of chromium may result in upset stomachs and ulcers, convulsions, kidney and liver damage, and even death. It is not known whether chromium affects human reproduction or harms the fetus; however, mice that ingested large amounts of chromium had reproductive problems and offspring with birth defects. Skin contact with liquids or solids containing chromium VI may lead to skin ulcers, and some people also may experience allergic reactions, including severe redness and swelling. Chromium III does not

cause these effects. The only effects observed in toxicological studies of chromium III were decreased liver and spleen weights in rats.

Oral RfDs have been developed by EPA for chromium III, insoluble salts, and chromium VI. The oral RfD for chromium III, 1E+00 mg/kg-day, is based on a chronic rat feeding study in which rats were fed chromic oxide baked in bread at dietary levels of 0, 1, 2, or 5%, 5 days/week for 600 feedings. Confidence in the principal study used in deriving the RfD is considered low because of the lack of detail on study protocol and results. Low confidence in the database reflects the lack of high-dose supporting data. The overall confidence in the RfD is low, reflecting the study and database limitations as well as the lack of an observed effect level. The oral RfD for chromium VI, 5E-03 mg/kg-day, is based on a 1-year drinking study during which rats were supplied with drinking water containing 0 to 11 ppm chromium for 1 year. Confidence in this study is low because of the small number of animals tested, the small number of parameters measured, and the lack of toxic effects at the highest dose tested. Confidence in the database is low because the supporting studies are of equally low quality, and teratogenic and reproductive endpoints are not well documented. Consequently, confidence in the chromium VI RfD also is low.

A provisional inhalation reference concentration (RfC) for chromium VI of 0.0004 mg/m^3 was based a NOAEL of 0.001 mg/m^3 and a LOAEL of 0.002 mg/m^3 for diffuse nasal symptoms from occupational exposure to chromic acid fumes. Confidence in the study is medium because the sample size was adequate and because nasal effects appear to be the most sensitive endpoint in humans. However, because the data from the supporting animal studies, which show respiratory effects from chromium, are inadequate with respect to developmental and reproductive effects, confidence in both the database and the RfC are considered low.

Epidemiologic studies of chromate production facilities in the United States have identified an association between chromium exposure and lung cancer. The majority of these studies did not attempt to determine whether chromium III or chromium VI compounds were the etiologic agents. However, because only chromium VI compounds were carcinogenic in animal assays, the EPA has classified chromium VI as a Group A, human carcinogen. An inhalation unit risk for chromium VI of 0.012 $(\mu g/m^{3)}$-1 has been derived based on the incidence of lung cancer among occupationally exposed individuals in the United States and West Germany. These studies are supported by three additional studies of the chrome pigment industry in which an association between occupational chromium exposure (predominantly to chromium VI) and lung cancer was identified. The results of the principal and supporting studies used to establish the dose-response relationship for lung tumors are consistent across

investigators and countries. However, there are uncertainties associated with several assumptions that were made in deriving the unit risk for chromium VI. The assumption that no less than one-seventh of total chromium exposure was chromium VI may lead to an underestimation of risk. The use of occupational data that may have underestimated worker exposure may result in an overestimation of risk. Further overestimation of risk may be due to the implicit assumption that the smoking habits of chromate workers were similar to those of the general white male population, because it is generally accepted that the proportion of smokers is higher for industrial workers than for the general population.

1,4-Dichlorobenzene

1,4-dichlorobenzene, or p-DCB, is a colorless solid with a characteristic penetrating odor. It is used mainly as a deodorizer and as a fumigant for control of moths, molds, and mildew. It is also used in the production of polyphenylene sulfide resin and other chemicals.

Because p-DCB is a highly volatile substance which sublimes at room temperature, most environmental releases are to the atmosphere. Industrial releases contribute only a small fraction of total environmental loading of p-DCB. The major sources of environmental release are the use of space deodorants and moth repellents.

Volatilization is the most likely fate of p-DCB released to soil. However, p-DCB is slightly soluble in water and may leach to groundwater. Biodegradation occurs in water under aerobic, but not aerobic, conditions. p-DCB may bioconcentrate in aquatic organisms.

Human exposure is most likely to occur through inhalation of air and ingestion of food and drinking water containing p-DCB. Animal studies indicate that it is absorbed relatively quickly through the lungs and gastrointestinal tract. It is not known if p-DCB is absorbed through the skin.

Target organs of p-DCB's toxic effects are the liver, the blood forming tissue, and the central nervous system. In humans who were exposed to high levels of p-DCB for long periods through household use, headaches, dizziness, and liver damage were reported. Individuals who ingested p-DCB for long periods developed anemia. However, there is no evidence that moderate use of common household products containing p-DCB leads to adverse health effects in humans.

In animal studies, long-term exposure to p-DCB has caused toxic effects in the liver, kidneys, and lungs. The inhalation RfC (8E-01 mg/m^3) is based on a rate multigeneration reproductive study which reported increased liver weights in males from inhalation of p-DCB. The RfC was derived from the NOAEL by applying an uncertainty factor of 100 to account for

use of a subchronic rather than a chronic study, interspecies differences, and sensitive subpopulations among humans. Confidence in the RfC is medium.

Although there is no evidence that p-DCB causes cancer in humans, an increased incidence of cancer has been observed in laboratory animals exposed in lifetime studies. At present, p-DCB is classified as a Group C, possible human carcinogen. The provisional oral SF is based on an increased incidence of liver tumors in mice who were exposed by gavage to p-DCB.

1,2-Dichloroethene (1,2-DCE)

1,2-DCE is a man-made flammable liquid with a sharp, harsh odor. 1,2-DCE is primarily used in the production of solvents and as an additive to dyes, lacquer solutions, perfumes, and thermoplastics. There are two forms of 1,2-DCE, cis-1,2-DCE and trans-1,2-DCE, which may occur separately or as a mixture.

In the environment, 1,2-DCE evaporates rapidly. When 1,2-DCE is released to either surface soil or surface water, almost all of the chemical will evaporate into air. When 1,2-DCE occurs underground, such as in landfills and chemical waste sites, 1,2-DCE can dissolve in water and migrate into groundwater. In groundwater, 1,2-DCE breaks down to vinyl chloride, which ultimately breaks down to water, carbon dioxide, and chloride ions. Vinyl chloride, the initial breakdown product, is more toxic than 1,2-DCE.

1,2-DCE can enter the body by drinking water, eating food, or breathing air that contains 1,2-DCE. Because 1,2-DCE evaporates readily, inhalation is the most likely route of human exposure. Inhalation of high levels of 1,2-DCE can cause nausea, drowsiness, dizziness, and death. Liver, heart, and lung damage were observed in laboratory animals after short- or long-term exposure to 1,2-DCE in air. Liver and lung damage was reported in animals fed 1,2-DCE. Death can also occur in animals fed large amounts of 1,2-DCE. A provisional oral RfD of 9E-03 mg/kg-day for mixed isomers of 1,2-DCE was adopted based on analogy on the RfD for 1,1-DCE which was derived from a 2-year rat drinking water study which reported liver lesions as the critical effect.

The long-term health effects resulting from exposure to 1,2-DCE are unknown. Increased risk of cancer has not been reported in humans or animals exposed to 1,2-DCE. EPA has not assigned 1,2-DCE a weight-of-evidence classification for carcinogenicity.

1,2-Dichloropropane

1,2-Dichloropropane is a man-made colorless liquid that has a chloroform-like odor and evaporates quickly at room temperature. Prior to the early 1980s, 1,2-dichloropropane was used in farming as a soil fumigant and was found in some paint strippers, varnishes, and furniture finish removers. Its only current uses in the United States are in research and industrial applications. Process and fugitive emissions from its production and use as a chemical intermediate and industrial solvent are now the main sources of 1,2-DCE releases to the environment.

1,2-DCE is volatile and soluble in water. When released to soil, part will volatilize and the remainder will leach to subsurface soil and groundwater. Chemical and biological degradation in groundwater is very slow, therefore, 1,2-DCE may remain in groundwater for a long time.

1,2-dichloropropane enters the body primarily through ingestion (eating, drinking) or inhalation. The amount able to enter the body following skin contact is unknown. Ingestion of high levels of 1,2-dichloropropane can produce poisoning, with effects including dizziness, headache, nausea, damage to liver and kidneys, anemia, coma, and ultimately, death. The health effects of both short- and long-term low-level exposure to 1,2-dichloropropane in humans are unknown, as are the dosages that could result in adverse effects. In animals, inhalation of low doses over short- and long-term periods results in damage to the liver, kidney, and respiratory system.

The inhalation RfC for 1,2-DCE, 4E-03 mg/m^3, is based on 13-week rat inhalation study in which hyperplasia of the nasal mucosa was reported as the critical effect. The study LOAEL was adjusted by an uncertainty factor of 300 to account for extrapolation from a subchronic study, use of a LOAEL rather than a NOAEL, interspecies differences, and intraspecies variability. While confidence in the principal study is high, the database is rated medium because there are no chronic inhalation studies. A medium confidence in the RfC follows.

Based on increased liver cancer rates seen in long-term oral-ingestion studies in mice, EPA has classified 1,2-dichloropropane as a group B2 probable human carcinogen and developed a provisional oral SF.

Iron

Iron is a naturally occurring metallic element. It is commonly used to produce steel, special-purpose alloys with magnetic properties, and heat, corrosion and electrical resistances. In combination with other substances, iron is used to make pigments, polishing compounds, catalysts, feeds, disinfectants, and sewage and industrial wastewater treatment chemicals.

Iron is an essential nutrient; required for maintenance of good health. Available data indicate that to protect against the adverse health effects associated with iron deficiency, the RDA (recommended dietary allowance) should be at least 30 mg/day for pregnant women. If ingested in larger quantities iron can be toxic, causing effects such as irritability, seizures, abdominal pain, vomiting, diarrhea, lethargy, and coma. However, apart from accidental or deliberate poisoning, ingestion of sufficient iron to cause these effects is unlikely in most individuals.

Approximately 0.01% of the body burden of iron is excreted daily and the elimination half-time of iron from the body is 10 to 20 years. Humans do not have a mechanism to increase the excretion of absorbed iron in response to elevated body levels. Chronic ingestion of high levels of iron causes an increase in tissue iron levels. During iron overload, excess iron is stored in the liver and other organs. Massive iron overload can lead to liver cirrhosis and damage to other organs including the heart, endocrine glands, and pancreas.

A provisional oral RfD has been developed for iron based on typical dietary intake. The average intakes of iron, which range from 0.15 to 0.27 mg/kg-day do not cause iron overload, yet are sufficient to protect against iron deficiency. Dividing the NOAEL of 0.27 mg/kg-day by an uncertainty factor of 1 yields a provisional chronic oral RfD of 0.3 mg/kg-day. While confidence in the critical study is high, overall confidence in the overall database is medium because the data are insufficient to determine the chronic dose level that is associated with adverse effects in health individuals. This RfD may not be protective of people with disorders of iron metabolism and could be conservative if applied to forms of iron with low bioavailability.

There is no evidence that iron can cause cancer. Iron has not been assigned a carcinogenicity weight-of-evidence classification by EPA.

Manganese

Manganese, a naturally occurring element, is usually found combined with other elements such as oxygen, sulfur, and chlorine. Manganese is used in the steel industry; metallurgical processing; the production of dry cell batteries; as a component of some ceram-

ics, pesticides, and fertilizers; and in nutritional supplements. Manganese is an essential element for humans and is a cofactor for a number of enzymatic reactions. The United States National Research Council recommends a provisional daily dietary intake of manganese of 2.0 to 5.0 gram for adults.

Manganese enters the air primarily through the burning of fossil fuels and emissions from factories where metallic manganese is produced from ores. It can be released to water and soil from factories or spills and leaks at hazardous waste sites. Some manganese compounds are soluble in water, and low levels of these compounds are normally present in lakes, streams, and the ocean. Manganese does not break down in the environment, but can change from one form to another.

Because manganese occurs naturally in the environment, humans are exposed to low levels of manganese in water, air, soil, and food. Food is the primary source of manganese for most people. There are few reports of negative health effects in humans exposed to manganese in drinking water or food. Laboratory studies of animals exposed to manganese in water or food have demonstrated adverse health effects, including changes in brain chemical levels, low birth weights in rats when mothers were exposed during pregnancy, slower than usual testes development, decreased body weight gain, and weakness and muscle rigidity in monkeys.

Inhalation of manganese dust at mining or ore processing plants and inhalation of welding fumes may be significant sources of occupational exposure. Following inhalation of manganese dust, absorption into the bloodstream occurs only if particles are sufficiently small to be able to penetrate deeply into the lungs. Long-term inhalation of manganese dust may result in a neurological disorder characterized by irritability, difficulty in walking, and speech disturbances. Impotence and loss of libido also have been reported in men exposed to high levels of manganese in air. Short-term inhalation exposure has been associated with respiratory disease.

Several studies were used to derive the oral RfD for dietary manganese, 1.4E-01 mg/kg-day. While those studies report average levels of manganese in various diets, no quantitative information is available to indicate toxic levels of manganese in the diet. Because humans maintain homeostatic control of manganese uptake and elimination, there is a wide range of dietary intakes considered to be safe. The determination of a single acceptable intake of manganese in the diet does not reflect the considerable variability in its absorption and elimination by humans, which are influenced by both environmental and biological factors. Confidence in the database and in the dietary RfD for manganese is medium.

For assessments of exposure to manganese is soil or drinking water, EPA recommends that the oral RfD should be adjusted by subtracting the amount of manganese that would be consumed in a normal diet (assuming 5 mg/day for a 70 kg adult, or 0.071 mg/kg-day) and dividing by an uncertainty factor of 3. The resulting oral RfD for soil or water is 2×10^{-2} mg/kg-day.

The inhalation RfC for manganese, 0.00005 mg/m^3, is based on a study in which impairment of neurobehavioral function in occupationally exposed individuals was identified as the critical effect. The principal study included 92 male workers exposed to manganese dioxide dust in a Belgian alkaline battery plant for an average of 5.3 years and a control group of 101 male workers. The study did not identify a NOAEL for neurobehavioral effects, nor did it measure particle size directly or provide information on particle size distribution. These limitations are mitigated by the fact that the principal study found similar indications of neurobehavioral dysfunction, and these findings were consistent with the results of other human studies. In all of the principal and supporting studies, the exposure duration was relatively limited and the workers were relatively young. These temporal limitations raise concerns that longer exposure durations and/or interactions with aging might result in the detection of effects at lower concentrations. There also is insufficient information on the developmental and reproductive effects of manganese inhalation. Medium confidence in the inhalation RfC follows medium confidence in the principal studies and the database.

There are no human carcinogenicity data for manganese exposure. The data from some animal studies have shown increases in tumors in a small number of animals at high doses of manganese, but the data are inadequate to judge whether manganese can cause cancer. The EPA has placed manganese in Group D (not classifiable as to human carcinogenicity).

Methylene Chloride (Dichloromethane, MC)

MC is a man-made liquid chemical that is widely used as an industrial solvent and as a paint stripper. Because MC evaporates easily, most MC released into the environment will end up in the air. Small amounts of MC may be found in some drinking water. Absorption into the body occurs readily following exposure by breathing vapors or accidental ingestion. Occupational worker exposure to MC in air has resulted in drowsiness, fatigue, lack of appetite, and light-headedness. Other effects include impaired reaction time and coordination, numbness or tingling of fingers and toes, and intoxication.

Oral and inhalation RfDs have been derived for MC. The oral RfD, 6E-02 mg/kg-day, is based on a 2-year rant drinking water study in which liver toxicity was identified as the

critical effect. Confidence in the principal study is considered high because a large number of animals of both sexes were tested in four dose groups, which a large number of controls. Many effects were monitored and a dose-related increase in severity was observed. The database is rated medium to low because only a few studies support the NOAEL. Medium confidence in the RfD follows. The inhalation RfD, 8.57E-01 mg/kg-day, is derived from an RfC of 3 mg/m^3. The RfC is based on a two year intermittent inhalation study in rats in which liver toxicity was identified as the critical effect.

Chronic exposure of laboratory animals to high concentrations of MC by inhalation resulted in an increased incidence of liver and lung cancer in mice and rats. MC has not been shown to cause cancer in occupationally exposed humans. Based on results from animal studies, MC is classified as a Group B2, probable human carcinogen. Oral and inhalation slope factors also have been derived for MC. The oral slope factor, 7.5E-03 mg/kg-day, is based on hepatocellular adenomas or carcinomas in a NTP study and hepatocellular cancer and neoplastic nodules in a National Coffee Association study. The slope factor is the arithmetic mean of slope factors derived from these two studies. Adequate numbers of animals were used in both studies. Risk estimates were based on the more sensitive sex in each study. The two risk estimates were within a factor of 5. The inhalation slope factor, 1.6E-03 $(mg/kg\text{-}day)^{7}$, is based on a unit risk of 4.7E-07 $\mu g/m^3$. The unit risk is derived from an inhalation study involving female mice in which an increased incidence of combined adenomas and carcinomas was identified. Adequate numbers of animals were observed and tumor incidences were significantly increased in a dose-dependent fashion. Uncertainty still remains in the estimates of internal dose generated by the model. Important uncertainties remain regarding the pharmacokinetics, pharmacodynamics, and mechanisms of carcinogenicity for MC.

Nickel

Nickel is a naturally occurring metal found in small quantities in the earth's crust. Nickel is used industrially in making various steels and alloys and in electroplating. Exposure to nickel and nickel compounds may occur through inhalation of dust and particles, ingestion of food and drinking water containing nickel, and by absorption through the skin. Nickel has been shown to be essential nutrients for some species of animals and may be essential to humans.

Inhalation exposure to high levels of nickel and nickel compounds may have adverse effects on the lungs. Exposure by oral and inhalation routes may also affect the immune system, kidneys, and blood. Inhalation of nickel at concentrations greater than 0.001 mg/m^3 in

air may cause immune system depression, lung irritation, and pulmonary disease. Death may result from inhalation of concentrations greater than 0.1 mg/m^3.

An oral RfD for soluble salts of nickel, 0.02 mg/kg-day, is based on decreased organ and body weights in rats who ingested nickel in their diet. The NOAEL of 5 mg/kg-day was multiplied by an uncertainty factor of 300 to account for interspecies extrapolation, protection of sensitive populations, and inadequacies in the reproductive studies. Confidence in the oral RfD is medium.

Inhalation of nickel refinery dust has caused cancer of the lung, nasal cavity, and voice box in humans. Nickel refinery dust and nickel subsulfide have been classified as Group A human carcinogens. It is not known if other nickel compounds are carcinogenic.

Polynuclear Aromatic Hydrocarbons (PAHs)

PAHs contain only carbon and hydrogen and consist of two or more fused benzene rings in linear, angular, or cluster arrangements. PAHs are formed during the incomplete burning of fossil fuel, garbage, or any organic matter. PAHs produced by burning may be carried into the air on dust particles and distributed into water and soil. In general, PAHs do not evaporate easily and do not dissolve in water.

Exposure to PAHs may occur by inhaling airborne particles, drinking water, or accidentally ingesting soil or dust containing PAHs. In addition, smoking tobacco or eating charcoal-broiled food are common routes of exposure to PAHs.

Some PAHs are known carcinogens, and potential health effects caused by PAHs are usually discussed in terms of an individual PAH compound's carcinogenic or noncarcinogenic effects. Little attention has been paid to noncarcinogenic effects of PAHs. Rapidly growing tissues, such as the intestinal lining, bone marrow, lymphoid organs, blood cells, and testes seem to be especially susceptible targets to noncarcinogenic effects. Concentrations of 150 mg/kg or more administered to laboratory animals have been shown to inhibit body growth.

Exposure to benzo(a)pyrene (B(a)P) and other carcinogenic PAHs can cause cancer at the point of exposure. However, only B(a)P has been assigned a slope factor (SF) by EPA. The oral SF for B(a)P, 7.3 mg/kg-day, is based on the geometric mean of four slope factors derived using differing modelling procedures from two different studies of mice and rats in which increased incidences of cancers of the forestomach were caused by dietary exposures.

In the past, other Group B2 carcinogenic PAHs were assumed to be equipotent to B(a)P; however, it has been shown in animal studies that some are less carcinogenic than B(a)P. EPA has recently adopted relative potency factors (RPFs) that account for differences

in the carcinogenic potencies of individual PAHs relative to that of B(a)P (EPA 1993). The RPFs are to be used only for the oral route. In this risk assessment, the oral SF for each carcinogenic PAH has been estimated by combining its RPF with the oral SF of B(a)P.

Animals exposed to high levels of B(a)P in air develop lung tumors; when exposed via the dietary route they develop stomach tumors; and when B(a)P is painted on skin, animals develop skin tumors. Although RfDs and SFs for dermal exposure to other chemicals are routinely extrapolated from oral-route values, it is inappropriate to use the oral SF of B(a)P to evaluate carcinogenic risks from dermal exposure because direct dermal exposure to B(a)P directly causes skin cancer.

Thallium

Thallium is a naturally occurring element that is widely distributed in trace amounts in the earth's crust. It is usually found combined with other elements (primarily oxygen, sulfur, and halogens) in inorganic compounds. Thallium is used mainly in the semiconductor industry for the production of switches and closures. It is also used in the manufacture of specialty glasses and for certain medical procedures. Thallium was once widely used as a pesticide for rodents and insects, but that use was banned by the EPA in 1972.

The major sources of thallium releases to the environment are emissions from coal burning or smelting operations. Thallium compounds are generally soluble in water, and the element is found in water mainly as the monovalent ion (Tl^+). Thallium tends to be sorbed to soils and sediments and bioaccumulates in aquatic plants, invertebrates, and fish. Terrestrial plants can also take up thallium from the soil.

Humans may be exposed to thallium by ingestion, inhalation, or dermal absorption. The main route of exposure for the general population is ingestion of thallium-containing foods, especially home-grown fruits and vegetables. Cigarette smoking is another common source of exposure. Inhalation of contaminated air may be a significant route of exposure for people who live or work near emission sources such as power plants or smelters.

Most thallium that is ingested is absorbed through the gastrointestinal tract and rapidly distributed to various parts of the body, especially the kidney and liver. Thallium is slowly eliminated in the urine and feces; its half-life within the body is approximately three days. Ingestion of large amounts over a short period can affect the liver and kidneys and the nervous, respiratory, and cardiovascular systems. Animal studies indicate that high doses damaged the nervous and cardiovascular systems and that lower doses over a longer period caused damage to the male reproductive system. Reproductive effects have not been reported in humans.

Oral studies in humans suggest that the liver is susceptible to thallium toxicity; necrosis, fatty changes, and altered serum enzyme levels have been reported. EPA has identified increased levels of serum glutamic oxaloacetic transaminase (SGOT) and lactate dihydrogenase (LDH) as the critical effect for deriving oral RfDs for several thallium compounds, including thallium acetate, carbonate, chloride, nitrite, and sulfate. The RfDs for all of these compounds are all based on a subchronic study in which rats that had been exposed by gavage to thallium sulfate in water showed increased levels of SGOT and LDH, and other effects. The RfD for thallium sulfate, $8x10^{-5}$, was obtained by multiplying the NOAEL from the critical study by an uncertainty factor of 3,000 to account for extrapolation from subchronic to chronic, interspecies extrapolation, interspecies variability, and lack of reproductive and chronic toxicity data. (RfDs for the other compounds were obtained similarly, with an additional adjustment to account for molecular weight differences.) Confidence in the critical study is low because of uncertainties in the results, and confidence in the database is low because it includes just one subchronic study and some anecdotal human data. Low confidence in the RfD follows.

There is no evidence that thallium causes cancer in humans or animals. The EPA has placed thallium in Group D (not classifiable as to carcinogenicity in humans).

Trichloroethene (TCE)

TCE is a man-made chemical widely used as a cleaning agent and solvent for degreasing operations. Most TCE released into surface water or surficial soil will rapidly evaporate into the air. In the subsurface, TCE is moderately to highly mobile and can migrate to groundwater. TCE biodegrades very slowly in subsurface soils and groundwater. Microbial degradation products include dichloroethene and vinyl chloride.

Humans are most likely to be exposed to TCE in air. TCE also may occur in drinking water supplies and consumer products, including metal cleaners, spot removers, rug cleaning fluids, paints, and paint removers. TCE may cause adverse health effects following exposure via inhalation, ingestion, or skin or eye contact. Exposure to high levels of TCE can cause CNS effects, including drowsiness, dizziness, headache, blurred vision, lack of coordination, mental confusion, flushed skin, tremors, nausea, vomiting, fatigue, irregular heartbeat, and in some cases death. In the past, TCE was used as an anesthetic, but that use was discontinued when it was found to cause irregular heartbeats. Chronic exposure to TCE can cause liver damage and skin reactions, as well as CNS effects.

Exposure of laboratory animals to TCE has been associated with an increased incidence of a variety of tumors, including kidney, liver, and lung cancers. However, it is uncertain whether people exposed to TCE have a higher risk of cancer. EPA has not adopted a current position on the weight-of-evidence classification for TCE. In 1988, the Agency's Science Advisory Board offered the opinion that TCE was on a "C-B2 continuum © = possible human carcinogen, B2 = probable human carcinogen). Provisional SFs are based on increase incidences of liver cancer in mice exposed to TCE.

1,1,2,2-Tetrachloroethane

1,1,2,2-Tetrachloroethane is a man-made, colorless, dense liquid with a penetrating, sweet, chloroform-like odor. In the past, it was used in large amounts as a chemical intermediate and as an industrial solvent. It was also used to clean and degrease metals and as an ingredient in varnishes. In the United States, present use of 1,1,2,2-tetrachloroethane is limited to closed industrial systems in order to prevent most worker contact.

The major sources of 1,1,2,2-tetrachloroethane in the environment are atmospheric emissions, wastewater discharges, and landfills. Most of the chemical released to surface soil or surface water would be expected to volatilize, with the remainder leaching to groundwater. In groundwater, it slowly breaks down to more toxic chemicals including trichloroethene, 1,1,2-trichloroethane, dichloroethene, and vinyl chloride.

1,1,2,2-Tetrachloroethane can enter the body through ingestion, inhalation, or skin contact. The most likely route of exposure is by inhalation of air containing 1,1,2,2-tetrachloroethane. Exposure to large amounts by ingestion, inhalation, or dermal contact can cause fatigue, vomiting, dizziness, and possibly unconsciousness. The concentrations required to produce adverse effects via inhalation are high enough that the sickeningly sweet smell would be noticeable. Most people recover from these effects after exposure ends. The human health effects from long-term exposure to small amounts of the chemical are not known. Chronic oral exposures to 1,1,2,2-tetrachloroethane have caused liver and kidney lesions in rats.

Oral exposure to 1,1,2,2-tetrachloroethane was found to cause liver cancer in mice but not in rats. Based on the increased incidence of hepatocellular carcinomas in mice, EPA has classified 1,1,2,2-tetrachloroethane as a Group C, possible human carcinogen and has derived oral and inhalation slope factors. The oral and inhalation slope factors, 0.2 $(mg/kg\text{-}day)^{-1}$, are based on increased incidence of hepatocellular carcinomas in mice administered 1,1,2,2-tetrachloroethane by gavage. A adequate number of animals were treated. Malignancies

increased as a function of treatment dose, and their incidence was significantly increased at both doses.

Vanadium

Vanadium is a naturally occurring gray metal. In the environment, vanadium is usually combined with elements such as oxygen and sulfur. Vanadium compounds, primarily vanadium pentoxide, are used extensively in industry. The largest industrial use of vanadium oxide is in steel manufacturing, but vanadium compounds also are used in plastic, rubber, ceramic, and other chemical manufacturing.

Burning of fuel oil is the largest source of vanadium releases to the atmosphere, which are generally in the form of vanadium oxides. Deposition of atmospheric vanadium is an important source of vanadium in soil and water; however, natural releases from weathering of rocks and soil erosion are far greater than anthropogenic sources to the atmosphere.

Vanadium is not generally very soluble in water, but it can be carried with small particles in surface water and groundwater. Because vanadium occurs naturally, people are likely to be exposed to low concentrations of vanadium in food and drinking water. People can be exposed to vanadium in air near industries that use vanadium, waste disposal areas of these industries, or downwind of fuel oil or coal burning areas. Most inhaled or ingested vanadium is not absorbed from the respiratory or digestive tract. Only a small amount is absorbed into the bloodstream, and most of that leaves the body quickly in the urine. Vanadium is not believed to be absorbed through skin. Humans exposed to large amounts of vanadium in air have experienced coughs, and eye and throat irritation. However, these effects stop soon after exposure ceases. Long-term oral exposure of rats to vanadium causes minor cell changes in the kidney and lungs. Female rats exposed to vanadium have offspring of decreased body weights. It is unknown whether humans experience effects similar to vanadium-exposed rats. The oral RfD for vanadium is currently under review by the EPA. The provisional oral RfD for vanadium, 7E-03 mg/kg-day, is based on a study in which rats were administered vanadium in their drinking water. A critical effect was not reported, but a NOAEL of 5 ppm was provided.

There have been no specific studies of the carcinogenicity of vanadium. No increased incidence of cancer has been noticed in studies of long-term oral exposure of rats, but these studies are less sensitive than specific cancer studies. Vanadium has not yet received a weight-of-evidence classification from the EPA.

Vinyl Chloride (VC)

VC, which is a gas or pressurized liquid at ambient temperature, is a man-made chemical that does not occur naturally in the environment. It is used primarily in the production of polyvinyl chloride (PVC) which is in turn used to manufacture a variety of plastic products, including pipes, wire coatings, automotive parts, wallcoverings, and packaging materials. Most of the VC in the environment comes from the plastic industry's releases to air or water. In addition, VC is a known degradation product of many chlorinated solvents including tetra-, tri-, and dichloroethenes. VC evaporates readily from surface water or surface soil to the air, where it breaks down rapidly to nonhazardous chemicals. VC is soluble in water and can migrate to groundwater before evaporation can occur. Once in the groundwater, VC can persist for many years.

People are most likely to be exposed to VC in the air, although it is also possible to be exposed to VC in drinking water. VC has been detected in the outdoor air near some plastics factories, landfills, and chemical waste sites, however, the levels are usually hundreds of times lower than the levels found in occupational settings. VC has also been detected in tobacco smoke.

VC may cause adverse health effects following exposure by inhalation or ingestion. Short-term exposures to very high levels of VC in air can cause dizziness, stumbling and lack of muscle coordination, headache, unconsciousness, and death. Long-term exposure to lower but unmeasured amounts in factories where VC is made or processed has caused "vinyl chloride disease" which is characterized by severe damage to the liver, effects on the lungs, poor circulation in the fingers, changes in the bones at the end of the fingers, thickening of the skin, and changes in the blood. Some of the same effects have been seen in laboratory animals.

VC has been shown to cause liver and lung cancer in rats, and liver cancer in workers occupationally exposed to air concentrations in the range of 25 ppm to greater than 200 ppm. Based on this evidence, VC is classified as a Group A, human carcinogen.

The provisional oral slope factor for VC, 1.9 $(mg/kg\text{-}day)^{-1}$, is based on lung and liver tumors in rats following dietary exposure to VC. The inhalation slope factor, 0.3 $(mg/kg\text{-}day)^{-1}$, is based on liver tumors in rats following one-year intermittent inhalation exposure to vinyl chloride. These values, which were established in 1984 and 1985, are currently under review and are subject to change based on more recent toxicological studies.

Zinc

Zinc is a naturally occurring element that can be found in a variety of compounds. Zinc has many industrial uses, including the production of galvanized steel and the manufacture of zinc-containing alloys such as brass. Zinc is an essential nutrient, and an inadequate amount of zinc in the diet will lead to adverse health effects such as loss of appetite, decreased sense of taste and smell, slow wound healing, and skin sores.

Although zinc occurs naturally, releases from anthropogenic sources are greater than from natural sources. The primary sources are releases from mining and metallurgical operations and the use of commercial products containing zinc, such as fertilizers. The mobility of zinc in soil depends on its chemical form and on soil properties, which affect zinc adsorption. Mobility is greater at lower pH under oxidizing conditions in soils with low cation exchange capacity and high organic content. Migration to groundwater is usually slow; however, the rate would be faster under favorable soil conditions or if zinc was applied in a soluble form or with corrosive substances (such as mine tailings).

People are exposed to low concentrations of zinc in air, water, soil, and food. Sources of zinc exposure include drinking water containing elevated levels of zinc and breathing air containing elevated levels of zinc from galvanizing, smelting, welding, or brass foundry operations. Drinking water is thought to be the most significant exposure route to zinc at hazardous waste sites.

Zinc appears to be toxic only at levels at least 10 times higher than the recommended daily allowance (15 mg/day for men and 12 mg/day for women). Symptoms of overexposure may include severe diarrhea, stomach cramping, nausea, and vomiting. Serious damage to the digestive system can occur if too much zinc is ingested over a long period of time. Ingesting excess amounts of zinc can cause deficiency in other nutrients such as iron (anemia) and copper. Anemia is the critical, or most sensitive, effect caused by zinc overexposure. Inhalation of zinc fumes or dusts has been associated with a condition called "metal fume fever" characterized by flu-like symptoms, including throat irritation, body aches, weakness, and fatigue. Zinc is not thought to cause cancer or birth defects. The EPA has place zinc in Group D (not classifiable as to carcinogenicity in humans).

The oral RfD for zinc, 3E-01 mg/kg-day, is based on decreased erythrocyte superoxide dismutase (a blood enzyme) activity in a 10-week study of 18 healthy women who were given zinc as a dietary supplement. By 10 weeks, the blood enzyme activity had decreased to 53% of pretreatment levels. The principal study is supported by several other studies that indicate that zinc supplementation can alter copper balance. The level of confidence in the studies is

medium. The clinical studies were well-conducted, with many biochemical parameters investigated; however, only a small number of subjects were tested. The confidence in the overall data base is medium because these studies were all of short duration. Medium confidence in the RfD follows.

N Source Papers from the National Center Environmental Assessment (NCEA)

This appendix contains the following risk assessment issue papers used as supporting data for the human health risk assessments at Sites 1 and 2, and supplied by the National Center for Environmental Assessment.

1. Provisional Inhalation RfC for Antimony (CASRN 7440-36-0)

2. Subchronic RfC for Chloroform (CASRN 67-66-3)

3. Subchronic RfC for Chromium (various CASRN)

4. Derivation of a Provisional Subchronic RfC for Bis (2-ethylhexyl) phthalate (CASRN 117-81-7)

5. Derivation of a Provisional RfD for Iron (CASRN 7439-89-6)

6. Oral Absorption for Arsenic (CARSN 7440-38-2)

7. Oral Absorption for Chloroform (CASRN 67-66-3)

8. Oral Absorption for 1, 2-Dichloroethene

9. Oral Absorption for Nickel (CASRN 7440-02-0)

10. Oral Absorption for Vinyl Chloride (CASRN 75-01-4)

11. Oral Absorption for Zinc (CASRN 7440-66-6)

Attachment

Risk Assessment Issue Paper for:
Provisional Inhalation RfC for Antimony (CASRN 7440-36-0)

Bio/dynamics (1990) exposed groups of male and female Fisher 344 rats (65/sex/group) to 0, 0.055, 0.511 or 4.5 mg/cu.m antimony trioxide (0, 0.046, 0.426, 3.76 mg Sb/cu.m) 6 hours/day, 5 days/week for 52 weeks. The MMAD and geometric standard deviation were 3.8 um and 1.8, respectively. The animals were monitored for 1 year after exposure termination. The following parameters were used to assess toxicity: clinical observation, body and organ weight, hematology and gross and histopathologic examination.

Ocular irritation was observed at the 6 month-interim kill; however, these effects were not observed at month 12 or 18. A dose-related increased incidence of cataracts was observed in the rats killed 12 months after exposure termination. Minimal to moderate increases in the number of alveolar/intraalveolar macrophages were observed in treated rats. The severity was dose related. A significant increase in the incidence of increased number of alveolar/intraalveolar macrophages, characteristic of occupational pneumoconiosis was observed in the exposed rats killed 6 or 12 months after exposure termination. No other histopathologic alterations were observed.

A variety of respiratory effects have been reported in humans and animals exposed to antimony. Most of these effects are associated with the physiologic response to dust accumulation in the lungs. Antimony pneumoconiosis is the most frequently reported health effect reported in workers exposed to antimony trioxide and/or pentoxide (Cooper et al., 1968; Potkonjak and Pavlovich, 1983; Renes, 1953). Other respiratory effects reported in workers include chronic bronchitis, chronic emphysema and irritation (Potkonjak and Pavlovich, 1983). A relationship between exposure levels and effect cannot be established from these data because the workers were also exposed to other compounds including arsenic oxide, hydrogen chloride and hydrogen sulfide.

The respiratory effects observed in animals include increased number of dust-laden alveolar macrophages, interstitial fibrosis, hypertrophy and hyperplasia of alveolar wall cells and cholesterol clefts (Bio/dynamics, 1985, 1990; Watt, 1980, 1983; Groth et al., 1986; Gross et al., 1952). The effects of dust overloading of the lungs may progress from the accumulation of dust-laden macrophages to fibrosis (Morrow, 1988). Because of the integral role the macrophages have in the

progression to fibrosis, nonreversible proliferation of macrophages was considered a serious health effect and, thus, classified as a LOAEL.

In addition to the observed respiratory tract effects, cardiac effects (altered EKG readings) have been observed in humans and animals exposed to airborne antimony (Brieger et al., 1954). Degenerative changes in the myocardium have also been observed in animals exposed to antimony (Brieger et al., 1954).

Cooper et al. (1968) examined 28 workers exposed to airborne antimony trioxide or antimony ore for 1-15 years. Airborne antimony levels were measured at numerous locations. The range was 0.081-138 mg/cu.m. Roentgenographic examinations were conducted in 13 of the workers. Based on this examination, three of the workers were diagnosed as having antimony pneumoconiosis and five were suspected as having pneumoconiosis. No consistent pattern of abnormalities of lung function were observed although lung function changes were observed in some of the workers. Electrocardiogram readings were taken on 7 of the 28 workers. Six had normal readings, the readings for the seventh worker were indicative of slight bradycardia.

Workers (n=51) employed in an antimony smelting plant for 9-13 years (mean 17.91) were examined (Potkonjak and Pavlovich, 1983). The workers were examined 2-5 times over a 25-year period. The dust concentration ranged from 17-88 mg/cu.m. The percentage of antimony in the dust was 38.7-88.9% antimony trioxide and 2.11-7.82% antimony pentoxide. Contaminants present included silicon oxide (0.82-4.72%), arsenic trioxide (0.21-6.48%) and ferric trioxide (0.9-3.8%). Using the midpoint percentage of the antimony trioxide and pentoxide range (63.8 and 5%, respectively), the range of antimony in the dust was 9.64-50.2 mg Sb/cu.m. The authors reported that over 80% of the dust had a particle size of less than 5 um. The workers predominantly exposed to antimony oxide exhibited definitive signs of pneumoconiosis, as assessed by chest X-rays. The pneumonoconiosis observed in the workers was characterized as sporadic pinhead lesions. The authors noted that pneumoconiotic changes were not observed in workers exposed to antimony oxide dust for less than 9 years. Chronic coughing was noted in 60.8% of the workers. Other respiratory symptoms included breathlessness in effort, wheezing and whistling bronchi. Pulmonary function changes did not have a characteristic pattern. However, airway obstruction, bronchospasm and hyperinflation have been reported. In addition to the parenchymal changes caused by pneumoconiosis, chronic bronchitis (37.7%), chronic emphysema with pulmonary function changes with evidence of hyperinflation (34.5%), inactive tuberculosis (18.2%) and pleural adhesions (27.5%) were also observed. Upper airway inflammation was

observed in 35.3% of the subjects. Antimony dermatosis, characterized by vesicular or pustular lesions with residual hyperpigmentation, was observed in 32 of the workers, especially during the summer.

Renes (1953) examined 78 antimony smelter workers employed for 2 weeks or longer. The fumes from the smelter contained 68% antimony, 4.1% arsenic, 0.4% lead and 0.4% copper. It is possible that the workers were also exposed to hydrogen sulfide and sodium hydroxide. The average concentrations of antimony were 10.07 and 11.81 mg/cu.m in two work areas. Soreness and bleeding of the nose were reported in 70% of the workers. Laryngitis, erosions or ulcerations on the vocal cord was also observed. The severity of these respiratory effects was duration related. Abdominal cramps, diarrhea, vomiting and dizziness were observed. Dermatitis and nodular ulcerative lesions, occurring in sweaty friction areas, were reported during a brief period of high exposure to fumes. Pneumonitis was diagnosed by X-rays in six of six subjects. Peripheral parenchymal pulmonary damage was not observed. Altered EKG readings, indicative of bradycardia, were observed in one out of seven workers.

Factory workers (n=113) exposed to antimony trisulfide for 8 months to 2 years were examined (Brieger et al., 1954). Air concentrations of antimony trisulfide ranged from 0.58-5.5 mg/cu.m (0.4-3.9 mg Sb/cu.m), with the majority over 3.0 mg/cu.m (2.2 mg Sb/cu.m); the particle size was not reported. The workers also may have been exposed to phenol formaldehyde. Blood pressure of over 150/90 was observed in 14 of the workers; 24 workers had a blood pressure of under 110/70. Altered EKG readings (mostly of the T-waves) were observed in 37 out of 75 of the workers. EKG changes were detected in 12 out of 56 workers reexamined after antimony trisulfide use was discontinued. A large number of workers complained of gastrointestinal disturbances (details not provided). Gastrointestinal ulcers were detected in 7 out of the 111 workers examined per 1000) as compared to the incidence for the total plant population (59/3912, 15 per 1000). Respiratory irritation was not reported. Swallowing of the antimony-containing dust may have contributed to the gastrointestinal effects.

Women (number of individuals not reported) working at an antimony metallurgical plant who were exposed to a mixture of antimony trioxide, antimony pentasulfide and metallic antimony were examined over a 2-year period (Belyaeva, 1967). A control group was also examined; however, a description of the control group was not provided in the report. The level of airborne antimony and the presence or absence of other compounds were not reported. Disturbances of menstrual cycle and inflammatory and other ailments of sexual organs were reported in 77.5% of the

workers as compared to 56% in the control group. Disturbances of menstrual cycle were the most frequently reported effect. No details or description of the effects were reported. An increased number of spontaneous abortions (12.5%) was observed in the workers as compared to controls (4.1%). Because it is not known if the controls had comparable jobs to the exposed group or what type of work the exposed group did, it is difficult to determine if these effects were exposure related. No difference in birth weight was observed among infants born to women exposed during pregnancy. Starting at 6 months of age, there was a lag in body weight among infancts from exposed mothers compared to the control group, and was more severe at the end of 1 year.

Groups of male and female Wistar rats (90/sex/group) were exposed to either 45 mg/cu.m (TWA) antimony trioxide or antimony ore 38 mg/cu.m (TWA) for 7 hours/day, 5 days/week for 52 weeks (Groth et al., 1986). The MMADs for the antimony trioxide and antimony ore test atmospheres were 2.8 and 4.8 um, respectively. The sigma g values were not reported. The test atmospheres for the antimony trioxide and antimony ore exposures contained 80% antimony (36 mg Sb/cu.m) and 46% antimony (17.5 mg/Sb/cu.m), respectively. A slight decrease in body weight was observed in the treated animals. Interstitial fibrosis, alveolar-wall cell hypertrophy and hyperplasia and cuboidal and columnar cell metaplasia of the lungs were observed in the antimony-exposed rats after 6 months of exposure. An increase in the size of the affected area was observed after 12 months of exposure. In addition, cholesterol clefts in the lungs were seen. An increase in the extent of the interstitial fibrosis of the lungs was observed in the rats 4-5 months postexposure. No significant histopathologic lesions were observed in the controls. An increase in the incidence of lung tumors (squamous-cell carcinomas, bronchioloalveolar adenomas, bronchioloalveolar carcinomas and scirrhous carcinomas) were observed in the female rats exposed to antimony trioxide (27%) and antimony ore (25%). Lung tumors were not observed in the exposed male rats or the male or female control rats.

Fifty male Sprague-Dawley rats were exposed to 100-125 mg/cu.m antimony trioxide dust (84-105 mg Sb/cu.m) 25 hours/week (daily exposure duration was not reported) for 14.5 months (Gross et al., 1952). Mean particle size was 0.6 um. A control group (n=50) was exposed to dust (25 mg/cu.m) containing 1% antimony trioxide. Mottling of the lung surface was observed beginning after 9 months of exposure; the severity was duration-related. Fatty degeneration and necrosis of alveolar macrophages and lipoid crystals within alveolar walls and interstitial tissue were observed. These changes were not observed in the control group.

Groups of female Fisher rats and Sinclair S-1 miniature swine (n=50/species/group) were exposed to 0, 1.6 or 4.2 mg Sb/cu.m as antimony trioxide dust 6 hours/day, 5 days/week for 1 year (Watt, 1980, 1983). The Ferret's diameter of the particles was 0.4 um and the standard deviation was 2.2. No alterations in hematologic parameters were observed in either species. EKG readings were taken on the pigs, no alterations were detected. In the exposed rats, focal fibrosis, adenomateous hyperplasia, multinucleated giant cells, cholesterol clefts and pneumonocyte hyperplasia were observed in the lungs. The severity was dose- and duration-related. A significant increase in lung weight was also observed in the exposed rats. A statistically significant increase in the incidence of lung neoplasms (scirrhous carcinomas, squamous cell carcinomas or bronchioalveolar adenomas) was observed in the rats exposed to 4.2 mg/cu.m. No difference between the control group and the 1.6 mg/cu.m exposure group for the incidence of lung neoplasms was observed. No other histologic alterations were observed in the rats (Watt, 1980). No histopathologic abnormalities were observed in the pigs.

The 4.2 mg/cu.m exposure level used in the Watt (1980, 1983) study was similar to the highest exposure level used in the Bio/dynamics (1990) study (3.76 mg/cu.m). The experimental protocol was similar for the two studies; however, fibrosis was not observed in the Bio/dynamics (1990) study. Differences in the method of assessing particle size (Ferret's diameter as compared to the mass median aerodynamic diameter (MMAD)) precludes a comparison of the studies. However, if the studies used different particles, then a difference in the particle size of the antimony aerosol used in the studies might explain the discrepancy in the severity of lung effects. The deposition and clearance of antimony from the lung is dependent on particle size (Felicetti et al., 1974; Thomas et al., 1973). Smaller particles are deposited in the lower respiratory tract and are slowly cleared from the lungs. Larger particles are deposited in the upper airways and are cleared more efficiently from the respiratory tract. Thus, an antimony aerosol with a smaller particle size would come into contact with the lung for a longer period of time as compared to an aerosol made up of larger particles. The lung antimony burden was not measured in the Watt (1980, 1983) study, thereby making it difficult to determine if lung antimony burden was the contributing factor to the difference in the severity of effects between the two studies.

Groups of male and female (50/sex/group) Fisher 344 rats were exposed to 0, 0.25, 1.08, 4.92 or 23.46 mg/cu.m antimony trioxide dust (0, 0.21, 0.92, 4.11 or 19.61 mg Sb/cu.m) 6 hours/day, 5 days/week for 13 weeks (Bio/dynamics, 1985). The MMADs and geometric standard deviations were 2.9 um 1.6, 3.0 um 1.5, 2.9 um 1.6 and 3.4 um 1.6, for the four exposure levels,

respectively. Corneal irregularities were observed in treated rats and control females; however, the incidence was higher in treated females. Alopecia was observed in all groups with the highest incidence in the 0.92 mg/cu.m group. A slight decrease (less than 10%) in body weight was observed in the rats exposed to 19.6 mg/cu.m of antimony. No consistant changes in hematologic parameters were observed. A slight increase in SGOT activity was observed in the males exposed at 4.1 mg/cu.m or greater. After 13 weeks of exposure, a significant increase in the number of alveolar-intraalveolar macrophages was observed in rats exposed at 4.11 mg/cu.m or greater. Rats exposed to 0.9 mg/cu.m and killed 1 week after termination of exposure exhibited an increase in the number of alveolar/intraalveolar macrophages. A separate review of this data by the Experimental Pathology Laboratories, Inc., showed an increased incidence of pneumocyte hyperplasia in the 4.1 (4/5) and 19.6 mg/cu.m (5/5) groups. This was not observed at lower concentrations or in the controls.

Six rabbits (strain not specified) were exposed to 5.6 mg/cu.m antimony trisulfide (4 mg Sb/cu.m) for 7 hours/day, 5 days/week for 6 weeks (Brieger et al., 1954). The particle size was 2 um or less. Altered EKG readings, indicative of slight to moderate myocardial damage, were observed. In addition, the myocardium appeared to be very flabby, and swelling of myocardial fibers and cytoplasmic granules was observed.

Ten male Wistar rats were exposed to 3.07 mg/cu.m antimony trisulfide (2.2 mg Sb/cu.m) 7 hours/day, 5 days/week for 6 weeks (Brieger et al., 1954). The particle size was 2 um or less. Altered EKG readings (elevations of RS-T segment, T-waves frequently flattened) were detected. Slight to moderate hyperemia of the heart and degenerative parenchymatous changes in the heart were observed in 90% of the rats. A mild degree of congestion and focal areas of hemorrhages were observed in the lung. The authors noted that the congestion was probably secondary to the heart damage.

Groups of two female dogs (strain not specified) were exposed to antimony trisulfide (particle size of 2 um or less) at levels of 5.32 mg/cu.m (3.8 mg Sb/cu.m) for 7 weeks or 5.55 mg/cu.m (4 mg Sb/cu.m) for 10 weeks (Brieger et al., 1954). The dogs were exposed for 7 hours/day, 5 days/week. No definite or consistant EKG changes were observed in the dogs exposed for 7 weeks. EKG changes indicative of myocardial injury were observed in the dogs exposed for 10 weeks.

Five rabbits (strain not specified) were exposed to 27.8 mg/cu.m antimony trisulfide aerosol (19.9 mg Sb/cu.m), with a particle size of 2 um or less (Brieger et al., 1954). It is assumed that the rabbits were exposed for 7 hours/day. Altered

EKG readings, indicative of myocardial damage or coronary inadequacy, were observed in three rabbits. Slight to moderate parenchymatous changes of the myocardium were observed. Slight parenchymatous degeneration of the liver (five of five) and of tubular epithelium of kidney (three of five) were observed. Inflammatory processes, with and without pigment deposits, were present in the lung.

Derivation of a Provisional Inhalation RfC:

A LOAEL of 0.055 mg/m³ was determined for increased number of alveolar macrophages from a chronic inhalation rat study by Bio/dynamics (1990). Therefore, this study was used to derive the provisional chronic RfC. Calculation of the $LOAEL_{HEC}$ is as follows:

a. LOAEL of 0.055 mg/m³ for antimony trioxide (Sb_2O_3) is converted to LOAEL of antimony (Sb):

Sb molecular weight = 121.8 and Sb_2O_3 molecular formula weight = 291.5

LOAEL (mg Sb/m³) = 0.055 mg Sb_2O_3 x [(121.8 x 2)/291.5] = 0.046.

b. LOAEL of 0.046 mg/m³ is adjusted for intermediate exposure:

$LOAEL_{ADJ}$ = 0.046 mg/m³ x 6 hours/24 hours x 5 days/7 days = 0.008 mg/m³

c. $LOAEL_{HEC}$ = $LOAEL_{ADJ}$ x RDDR

where: the $LOAEL_{HEC}$ is the human equivalent concentration for the LOAEL and was calculated for an aerosol:respiratory effect in the pulmonary region and

RDDR is the regional deposited dose ratio,

RDDR = 0.7869 for MMAD of 3.8 µm and sigma g of 1.8

$LOAEL_{HEC}$ = 0.008 mg/m³ x 0.7869 = 0.006 mg/m³

Calculation of the provisional chronic RfC is:

$$RfC = LOAEL_{HEC}/(UF \times MF)$$
$$= 0.006\ mg/m^3\ /\ (1000 \times 1)$$
$$= 6E\text{-}6\ mg/m^3$$

An uncertainty factor of 1000 reflects 10 to extrapolate from a LOAEL to a NOAEL, 10 to protect sensitive human subpopulations, and 3 for lack of developmental and reproductive toxicity studies. An additional factor of 3 is used for species-to-species extrapolation since a dosimetric adjustment was utilized.

High confidence is placed in the principal study (Bio/dynamics, 1990). It is a well designed chronic inhalation study in which an adequate sample size was used. There is low confidence in the data base on the toxicity of airborne antimony. The Bio/dynamics (1990) and Watt (1980, 1983) studies exposed rats to approximately 4 mg/cu.m for 1 year. Fibrosis of the lung was observed in the Watt (1980, 1983) studies. This effect was not observed in the Bio/dynamics study (1990). As discussed above, this difference is probably a reflection of the difference in particle size of the antimony in the test atmospheres generated in the two studies. A comparison of the differences in the toxicity of various antimony particle sizes was not located. No reproductive or developmental toxicity studies were located. Although there are several limitations to the Belyaeva (1967) study, this study does suggest that exposure to airborne antimony may cause developmental and reproductive toxicity in humans. Reflecting high confidence in the key study and low confidence in the data base, confidence in the inhalation RfC for antimony is medium.

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$$D_{inhal} = \frac{6 \times 10^{-6}\ \frac{mg}{m^3} \times 20\ m^3/day}{70\ kg} = 1.71 \times 10^{-6}\ mg/kg/day$$

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Enclosure III.

(8/25/93)

Risk Assessment Issue Paper for:
Subchronic RfC for Chloroform (CASRN 67-66-3)

The presented data in Torkelson et al. (1976) are a compilation of several smaller studies that were conducted prior to 1965. Groups of rats (n=10-12/sex/dose), guinea pigs (n=8-12/sex/dose), and rabbits (n=2-3/sex/dose) were exposed to air or chloroform at target concentrations of 25, 50, or 85 ppm for 7 hours/day, 5 days/week for 195-203 days. The average actual concentrations were 23.1, 47.5, and 84.4 ppm (113, 232, and 412 mg/m^3). The duration-adjusted concentrations were 23.4, 48.3, and 85.8 mg/m^3. One male and one female dog were exposed to an actual concentration of 23.1 ppm (duration-adjusted value 23.4 mg/m^3.) for the same exposure period. Male rats (10/group) were also exposed to an actual concentration of 23.1 ppm for 1, 2, or 4 hours/day, 5 days/week, for the same period (duration-adjusted concentrations 3.36, 6.72, and 13.4 mg/m^3.). Strains were not reported for any species. Actual concentrations were generally within 10% of target. All animals were sacrificed the day after the last exposure, except that half of the rats exposed to 23.1 ppm 7 hours/day were kept for 6 weeks before being sacrificed. Unexposed control groups were also used.

Survival of many of the control groups was very low. Survival of unexposed male rats in one set of experiments was 67%, and survival of air-exposed male guinea pigs in one set of experiments was 50%. Too few rabbits were tested to derive meaningful survival figures, but in some rabbit control groups only 1/3 or 2/3 animals survived. No mention was made in the report of the high control mortality rates, and no mention was made of any possible cause (e.g. bacterial or viral infections). The high mortality in the controls compromises the study and makes it difficult to interpret the survival data from the treatment groups. For example, although only 40% of the rats exposed to 23.1 ppm for 4 hours/day survived, the effect was not concentration-related. In addition, no adverse effects on organ weight or histomorphology were reported for this group or the rats exposed to 23.1 ppm for 1 or 2 hours/day. An infection in the animal colonies could account for both the high mortality and the inconsistent results in guinea pigs and rabbits discussed below.

Excess mortality (40%, compared with a high of 17% for the concurrent controls) was reported in male rats exposed to 84.4 ppm. The mortality was reported to be generally attributable to

pneumonia. Marked interstitial pneumonitis was seen in males at this level. Pneumonitis was also reported in female guinea pigs and male rabbits at this level ($_{HEC}$ for guinea pigs based on thoracic surface area = 77 mg/m^3.) and in female rabbits at 23.1 ppm ($_{HEC}$ = 15 mg/m^3), but not at higher concentrations.

Relative liver weight was significantly elevated in male rats exposed to 84.4 ppm, but not in either gender of any other species. Marked central lobular granular degeneration of the liver was reported in rats of both sexes that were exposed to 84.4 ppm. Similar degeneration was noted at 47.5 ppm, and some degeneration, along with focal areas of necrosis, occurred in male rats only at 23.1 ppm. Liver enzymes (serum glutamic-pyruvic transaminase (SGPT) and alkaline phosphatase (AP)) were normal for all exposure groups. No histopathology was reported in rats that were allowed to recover for 6 weeks prior to sacrifice. Inconsistent results were obtained with guinea pigs and rabbits. Central lobular granular degeneration with foamy vacuolization was observed in male guinea pigs exposed to the low concentra-tion (23.1 ppm), and female guinea pigs at this exposure level had light-colored livers with central foamy vacuolization. No liver effects were seen in guinea pigs at higher exposure levels. In rabbits, liver effects were observed in high exposure males (foamy vacuolization and necrosis) and females (central lobular granular degeneration and necrosis), and low exposure females (central lobular granular degeneration and necrosis with slight fibrosis in the portal area). No effects were seen in rabbits of either sex exposed to 47.5 ppm, or in male rabbits exposed to the low concentration.

Kidney weights of male rats in the two higher-exposure groups were significantly increased; increases in female rats at these levels were not statistically significant. Cloudy swelling of the renal tubular epithelium occurred in rats of both sexes and at all exposure concentrations. There was no effect on serum urea nitrogen (SUN). Male guinea pigs in the low-concentration group had increased tubular and interstitial nephritis; the absolute and relative kidney weights of female guinea pigs exposed at this level were elevated without accompanying histopathology. No kidney effects were seen at higher levels. Similarly, interstitial and tubular nephritis was reported in male and female rabbits at the low concentration, but no kidney effects were seen in rabbits at 47.5 ppm, and the only kidney effects reported at the high concentration was cloudy swelling in females. Female rabbits at 23.1 ppm also exhibited glomerular nephritis. The only pathological effect in the dogs was an increase in capsular space in the glomeruli and marked cloudy swelling of the renal tubular epithelium observed in the female.

This study suggests a $LOAEL_{HEC}$ of 23.4 mg/m^3 and a $NOAEL_{HEC}$ of 13.4 mg/m^3 for rats. Inconsistent results preclude the designation of a NOAEL or LOAEL for the other species in this study.

Plummer et al. (1990) exposed male black-hooded Wistar rats (n=12/group) to air or 50 ppm (244 mg/m^3) chloroform continuously for 4 weeks, except for two 1½ hour periods/week. An additional group was exposed discontinuously (6 h/d, 5 d/wk) to 275 ppm (1343 mg/m^3), for the same total exposure (duration-adjusted concentration of 240 mg/m^3). Within each group, rats received either plain drinking water, 0.05% w/v sodium phenobarbitone, or 5% v/v 1,3-butanediol (n=4/subgroup). Only the liver was examined histological-ly. The most prominent effect was microvesicular fatty change, seen through-out zone 2, often in zone 1, and usually not in zone 3. There was also some focal necrosis throughout the acini; quantitation revealed a significant difference from the control ($p<0.01$). Adverse effects were smaller in the discontinuous-exposure group. Injury in this group was characterized as minor to mild, with scattered hepatocytes containing small fat droplets and a few foci of liver cell necrosis. The smaller adverse effect of discontinuous exposure was attributed to saturation of the metabolic processes that convert chloroform to toxic intermediates. In this study 240 mg/m^3 is the LOAEL, but only one concentration was tested.

Murray et al. (1979) exposed 34-40 bred CF-1 mice to filtered air or 100 ppm spectral grade chloroform (488 mg/m^3) for 7 hr/day on gestation days (gd) 1-7, 6-15, or 8-15. Maternal body weight gain was significantly reduced in the groups exposed on gd 1-7 and gd 8-15, and slightly reduced in the group exposed from gd 6 to gd 15; food consumption was slightly reduced in all treatment groups. One exposed mouse in the latter group died of gastric ulceration, but the etiology of this effect was unknown. The ability to maintain pregnancy (percentage of animals that had implantation sites at sacrifice) was significantly reduced ($p<0.05$) in the groups exposed on gesta-tion days 1-7 or 6-15. The number of resorptions/litter was significantly increased in the group exposed on gd 1-7, but not in the other exposed groups. Mean fetal body weight and crown-to-rump length was significantly reduced ($p<0.05$) in the groups exposed on gestation days 1-7 or 8-15, but not in the group exposed on gestation days 6-15. The incidence of cleft palate was significantly increased ($p<0.05$) only in the group exposed on gd 8-15. The effect occurred largely in fetuses with retarded growth. All exposed groups exhibited an increased incidence of delayed ossification of the skull. Liver toxicity was observed in the dams. Absolute and relative liver weights were significantly increased ($p<0.05$) in the groups exposed on gestation days 6-15 or 8-15, and SGPT

activity was significantly increased in the only group in which it was measured (those exposed on gestation days 6-15).

Schwetz et al. (1974) also found that chloroform increased the incidence of resorptions and structural defects. They exposed bred Sprague-Dawley (Spartan) rats (n=20-31 for treated groups; n=77 for the control) for 7 hr/day on gestation days 6-15 to filtered air or 30, 95, or 291 ppm reagent grade chloroform (0, 146, 464, or 1421 mg/m^3). An additional control group was fed only 3.7 g food/day to control for the marked anorexia observed in the high-exposure group. In the high-exposure group, the apparent conception rate was only 15% (compared to 88% in the control), and the percent resorptions was significantly increased ($p<0.05$). Since the only evidence of implantation was a focal increase in the vascularity of the mesometrium, chloroform exerted its toxic effect early in gestation. Both the fetal body weight and fetal crown-to-rump length were significantly reduced ($p<0.05$) in the offspring of the high-exposure group. Gross abnormalities (acaudia or short tail and imperforate anus) were significantly ($p<0.05$) elevated in the 95 ppm exposure group. Additional significant effects in the 95 ppm group were increases ($p<0.05$) in the incidence of delayed sternebra ossification, wavy ribs and soft tissue edema. The only effects observed in the "starved" control group were reduced fetal size, showing that the effects at 291 ppm were largely chemical-related, rather than secondary to weight loss. Relative maternal liver weight was significantly increased at 95 and 291 ppm. This study suggests a NOAEL for developmental effects of 146 mg/m^3.

In an oral study, Munson et al. (1982) administered 0, 50, 125, or 250 mg/kg-day chloroform by gavage to CD-1 mice (n=7-12/sex/dose). A dose-dependent increase in relative liver weight that was statistically significant only at the high dose was observed in males. In females, absolute and relative liver weight was significantly increased at all three doses. A dose-dependent increase in SGPT and serum glutamic-oxalacetic transaminase (SGOT) levels was observed in males, but the effect was not statistically significant. Slight histopathology was observed in the kidneys and livers of males and females. Generalized hydropic degeneration of hepatocytes and occasional small focal collections of lymphocytes were observed in the liver. The kidney showed small intertubular collections of chronic inflammatory cells. The report did not state at which doses histopathology was observed. Humoral immunity was affected, as by decreased antibody-forming cells in the spleen. The effect was statistically significant only in males at the high dose. Cell-mediated immunity (delayed-type hypersensitivity) was impaired in females at the high dose. No histopathology was observed in the spleen. Based on the liver effects, the LOAEL is 50 mg/kg-day.

In an experiment conducted by Heywood et al. (1979), beagle dogs (8/sex/dose) received 15 or 30 mg/kg-day in a toothpaste vehicle by gelatin capsule, vehicle alone, or were untreated. Statistically significant increases in SGPT levels were found at 30 mg/kg throughout the treatment period. A smaller but statistically significant increase was found at 15 mg/kg from weeks 130 through 364. Levels declined in the posttreatment recovery period. Apparent dose-related increases were also observed in gamma glutamyl transferase (GGT) and glutamic dehydrogenase (GDH), additional markers of liver injury. Relative liver weight was only slightly increased in both treatment groups. The only treatment-related histopathological changes was an increase in the size and number of fatty liver cysts in both treatment groups and animals of both sexes. The incidence of haemosiderin occurrence was also increased in the treated animals. This study suggests a LOAEL of 15 mg/kg-day.

Palmer et al. (1979) treated Sprague-Dawley rats (10/sex/dose) with chloroform in toothpaste or toothpaste only by oral gavage. No primary data were presented. Increased liver weight with fatty change and necrosis were reported at 410 mm/kg/day, along with gonadal atrophy and bone marrow proliferation. There were "less pronounced" changes, along with changes in liver and kidney weight at 150 mg/kg-day. Study details are insufficient to establish a NOAEL or LOAEL. In a followup study, Sprague-Dawley rats (50/sex/dose) received 60 mg/kg-day or vehicle only by gavage for 95 weeks. Animals of both sexes exhibited a small but consistent and progressive reduction in weight gain. The study authors did not report if the change was statistically significant. Plasma cholinesterase was significantly lowered in treated females at weeks 29, 34, and 52 ($p<0.001$) and at week 80 ($p<0.01$). The decrease was not significant at week 95. Relative liver weight was significantly reduced in treated females, but only "minor" histological changes were noted. Because only one dose was tested, no NOAEL can be determined.

Thompson et al. (1974) observed mild fetotoxicity at oral doses that were maternally toxic in rats. They administered 20, 50, or 126 mg/kg-day chloroform (twice-daily) in corn oil or vehicle alone to bred Sprague-Dawley rats (25/dose) on gestation days 6-15. Maternal toxicity (alopecia, rough appearance, and weight loss) was observed in the high-dose group. Reduced body weight gain was also seen at 50 mg/kg-day. The only evidence of fetal toxicity was reduced fetal weight at 126 mg/kg-day ($p<0.05$). The incidence of bilateral extra lumbar ribs was significantly increased at the high dose. Dutch-Belted rabbits (15/dose) were given daily gavage doses of chloroform in corn oil or vehicle alone. There was no treatment-related maternal toxicity. Fetal toxicity, as evidenced by reduced fetal weight

($p<0.05$) was observed at 20 and 50 mg/kg-day. Fetal weight at 35 mg/kg-day was also reduced, but the effect was not statistically significant. There were no treatment-related major anomalies. Incomplete ossification of skull bones was significantly elevated in the two lower dosing groups.

DERIVATION OF A PROVISIONAL SUBCHRONIC RfC Chloroform

A NOAEL of 113 mg/m^3 (23.1 ppm) was determined based on focal areas of liver necrosis and cloudy swelling of the renal tubular epithelium from subchronic rat inhalation studies by Torkelson et al. (1976). Calculation of the human equivalent concentration (HEC) for the NOAEL is as follows:

a. NOAEL of 113 mg/m^3 is adjusted for intermediate exposure:

$NOAEL^{ADJ}$ = 113 mg/m^3 x 4 hours/24 hours x 5 days/7 days
= 13.4 mg/m^3

b. Derivation of the $NOAEL_{HEC}$:

$NOAEL_{HEC}$ = $NOAEL_{ADJ}$ x (b:a lambda(a)/lambda(h))
= 13.4 mg/m^3

where: $NOAEL_{HEC}$ was calculated for a gas:extrarespiratory effect, assuming periodicity was attained.
b:a lambda(a) = 20.8, b:a lambda(h) = 20.8, (Gargas et al., 1989). Since b:a lambda(a) is greater than b:a lambda(h), a default value of 1.0 was used for this ratio.

Calculation of the provisional subchronic RfC follows:

Subchronic RfC = $NOAEL_{HEC}$ / UF x MF
= 13.4 mg/m^3 / 300 x 1
= 4E-2 mg/m^3 RfD = 1E-02

The uncertainty factor of 300 includes a 10 for protection of sensitive human subjects, 3 for interspecies extrapolation, and 10 for lack of a complete database including reproductive toxicity endpoints not being fully addressed and poor quality of the studies (consistently high mortality even in control groups). The resulting provisional subchronic RfC is 4E-2 mg/m^3.

The study by Torkelson et al. (1976) looked at three species (rat, rabbit and guinea pig) at several dose levels and found liver and kidney effects in all three species using established

histopathological and hematological methods. However, high mortality in some control groups and some treatment groups, as well as inconsistent results with rabbits and guinea pigs, reduce the confidence in this study. The finding of liver effects is supported by the results of Plummer et al. (1990), who compared the effects on the liver of continuous and discontinuous exposure to equivalent concentrations of chloroform. Liver and kidney histopathology were also found in rats following oral dosing with chloroform (Munson et al., 1982). Increased liver weight and liver enzymes levels, and slight liver histo-pathology was found in beagles after 7.5 years of oral dosing (LOAEL = 15 mg/kg-day; Heywood et al., 1979). Species differences in metabolism following oral dosing have been noted (Davidson et al., 1982). Davidson et al. (1982) noted that there are important differences between humans and animals in the pharmacokinetics and metabolism of orally-administered chloroform. It is not known whether similar differences exist in metabolism of inhaled chloroform. The most common effect of acute human exposure to chloroform has been reported to be hepatic damage (U.S. EPA, 1985). Confidence in the database is medium. The resulting confidence in the subchronic RfC is medium.

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Risk Assessment Issue Paper for:
Subchronic RfC for Chromium (various CASRN)

Respiratory symptoms, lung function, and nasal septum changes were evaluated in 100 individuals exposed to chrome plating in a study by Lindberg and Hedenstierna (1983). The exposed group were divided into 3 subgroups: low exposure (0.001-0.0019 mg/m^3 Cr(VI) as chromic acid) (16 men, 5 women), high exposure (>0.002 mg/m^3 Cr(VI)) (21 men, 1 woman), and mixed exposure (<0.002 mg/m^3 Cr(VI) and other acids and metallic salts) (28 men, 13 women). Exposure levels were measured with personal air samplers and stationary equipment with a limit of detection of 0.2 μg/m^3 Cr(VI)/filter. The average exposure duration was 2.5 years (0.2-23.6 years). The control group consisted of 120 unexposed individuals. A transient decrease in forced vital capacity (FVC), forced expired volume in 1 second (FEV_1), and forced mid-expiratory flow (FEF_{25-75}) was found in the high-concentration group. No effect on lung function was observed in the workers exposed to <0.002 mg/m^3. No nasal ulcerations or perforations or abnormal lung function were found in the low-exposure group, although 4 of 19 individuals complained of diffuse nasal symptoms. Within this group, no one exposed to concentrations below 1 μg/m^3 complained of symptoms (N=9). In the workers exposed to ≥0.002 mg/m^3 or those whose peak exposure level was 0.02 mg/m^3 or above, nasal ulcerations and/or perforations were observed. Therefore, because the nasal effects in the low-concentration exposure (<0.002 mg/m^3 Cr(VI)) were mild and no effects were observed at 1 μg/m^3, a NOAEL of 0.001 mg/m^3 was determined for diffuse nasal symptoms.

In the study by Cohen et al. (1974), 37 chromeplaters were exposed to total chromium ranging from not detectable to 49.3 μg/m^3 (mean=7.1 μg/m^3) and hexavalent chromium ranging from not detectable to 9.1 μg/m^3 (mean=2.9 μg/m^3). The nasal system and skin were examined in workers, but no pulmonary function test was given. Nasal sores were reported by 62% of the exposed workers. Pathological changes occurred in 95% of the workers (11% had septal perforations) compared to 7% in the unexposed controls. Because air chromium levels were measured only once, little information on previous exposure is known. A LOAEL of 2.9 μg/m^3 Cr(VI) was determined for nasal effects.

Clinical examination was conducted on 303 workers exposed to chromic acid (Gomes, 1972). The exposure concentration ranged from <0.1 mg/m^3 Cr(VI) to >1 mg/m^3. About 73% of the workers were

exposed to <0.1-0.2 mg/m^3 Cr(VI). Nasal septum ulcers and perforation of nasal septum were reported in 38.4% and 24% of exposed workers, respectively. Many of the workers also exhibited coughing and expectoration, probably due to the irritation of the bronchi. Exposure duration to chromium in the workers were not reported in the study.

Male Wistar rats (20/group) inhaled 0.025, 0.05, 0.1, or 0.2 mg/m^3 chromium (VI) whole-body, 22 hours/day, 7 days/week, for 90 days (Glaser et al., 1985). The aerosol was generated from sodium dichromate. Particles of the chromium VI aerosol had a mean average mass median diameter (MMAD) of 0.20 μm and a geometric standard deviation of 1.5. Exposed animals showed no treatment-related clinical signs or hematological changes and had normal histologic findings in lungs, kidney, liver, stomach, and gonad. A significant increase in lung and spleen weights was found in the 0.05-mg/m^3 group and higher. A significant increase in kidney weight occurred in the high-concentration group only. The mean total immunoglobulin levels in the serum were significantly increased between control and 0.05-mg/m^3 group but became depressed in the 0.1- and 0.2-mg/m^3 groups. Primary antibody response to B-cell-dependent antigen sheep red blood cell (SRBC) was evaluated in animals. Immune stimulating effect occurred with 0.05 and 0.1 mg/m^3 Cr, but responses were lower in the 0.2-mg/m^3 group. Therefore, results suggest a depression of humoral immune stimulating effect at higher chromium exposures. Spleen T-lymphocytes were also stimulated by chromium exposure. Macrophage cell counts were significantly decreased with exposure to greater than 0.025 mg/m^3. The number of macrophages in telophase had increased significantly in the 0.025-mg/m^3 group, but numbers were lower in the 0.2-mg/m^3 group. The number of lymphocytes and granulocytes were also slightly, but significantly, increased, corresponding to increased phagocytic activity at 0.025 and 0.5 mg/m^3 Cr(VI). However, after exposure to 0.2 mg/m^3, phagocytic function had decreased significantly in the alveolar macrophages. The authors concluded that low-level exposure to Cr(VI) aerosols increased the respiratory defense and all measured immunological functions in an adaptive manner while high-level exposure resulted in inhibition of alveolar macrophages and immunological functions. Therefore, a LOAEL of 0.025 mg/m^3 Cr(VI) was determined for immunological effects.

Rabbits were exposed to Na_2CrO_4 aerosols at concentrations of 0.9 mg/m^3 Cr(VI) or to $Cr(NO_3)_3$ at concentrations of 0.6 mg/m^3 Cr(III), 6 hours/day, 5 days/week, for 4-6 weeks (Johansson et al., 1986). The MMAD of both aerosols were about 1 μm. There was a significant increase in intraalveolar or intrabronchiolar accumulation of macrophages in animals exposed to Cr(III) and Cr(VI). Therefore, a LOAEL of 0.6 mg/m^3 Cr(III) was determined for increased accumulation of macrophages in the lungs.

DERIVATION OF A PROVISIONAL SUBCHRONIC RfC:

Lindberg and Hedenstierna (1983) identified a NOAEL of 0.001 mg Cr(VI)/m^3 (as chromic acid) and a LOAEL of 0.002 mg/m^3 for diffuse nasal symptoms. Therefore, this occupational study was used to derive the subchronic RfC. Calculation of the human equivalent concentration for the NOAEL is as follows:

a. NOAEL of 0.001 mg/m^3 is adjusted for intermediate exposure:

$$NOAEL_{ADJ} = 0.001\ mg/m^3 \times 10\ m^3/20\ m^3 \times 5\ days/7\ days$$
$$= 0.0004\ mg/m^3$$

b. Derivation of the $NOAEL_{HEC}$:

$$NOAEL_{HEC} = NOAEL_{ADJ} \text{ in humans}$$

$$NOAEL_{HEC} = 0.0004\ mg/m^3$$

The $NOAEL_{HEC}$ of 0.0004 mg/m^3 was divided by an uncertainty factor of 100 (10 to protect sensitive human subpopulations and 10 for lack of completeness of database) to yield a subchronic RfC of 4E-6 mg/m^3 Cr(VI).

Chromium (VI) is used to derive the subchronic RfC for chromium because this hexavalent form is more toxic to humans than trivalent chromium. The critical study (Lindberg and Hedenstierna, 1983) is given medium confidence because there are adequate sample size and exposure groups and nasal effects appears to be the most sensitive endpoint in humans exposed to chromium (VI). This critical endpoint is supported by other occupational studies that reported similar effects in the workers (Cohen et al., 1974; Gomes et al., 1972). Animal studies also suggest that there are respiratory effects (macrophage accumulation in pulmonary region) occurring following exposure to chromium (VI) (Glaser et al., 1985; Johansson et al., 1986). However, there is inadequate data for developmental and reproductive effects resulting in low confidence for both the database and the RfC.

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Attachment 2

(96-013a / 03-18-96)

Risk Assessment Issue Paper for:
Derivation of a Provisional Subchronic RfC for
Bis(2-ethylhexyl)phthalate (CASRN 117-81-7)

INTRODUCTION

A subchronic RfC for bis(2-ethylhexyl)phthalate is not available on HEAST (U.S. EPA, 1995a). A chronic RfC for bis(2-ethylhexyl)phthalate is not listed on IRIS (U.S. EPA, 1996) or HEAST (U.S. EPA, 1995a), and was not discussed by the RfD/RfC Work Group as of September 1995 (U.S. EPA, 1995b). Documents listed on the CARA database (U.S. EPA, 1991a, 1994) include a HEA for selected phthalic acid esters (U.S. EPA, 1987a), a HEEP for phthalic acid (alkyl, aryl, and alkyl/aryl esters) (U.S. EPA, 1987b), and a DWCD for phthalic acid esters (U.S. EPA, 1991b). Bis(2-ethylhexyl)phthalate has been the subject of an ATSDR toxicological profile (ATSDR, 1993); ATSDR did not derive inhalation MRLs for bis(2-ethylhexyl)phthalate.

In preparation of this issue paper, computer literature searches of TOXLINE (January 1992 to February 1996), RTECS, DART, and TSCATS databases were conducted for bis(2-ethylhexyl)phthalate in February 1996. The above listed documents and literature search were used to identify relevant studies.

REVIEW OF PERTINENT INFORMATION

No studies were located regarding the toxicity of bis(2-ethylhexyl)phthalate in humans after inhalation exposure under controlled experimental conditions. ACGIH (1991) summarized several occupational studies; however, in all of these studies the workers were also exposed to other chemicals. No association was found between exposure of workers to up to 0.7 mg/m^3 of a phthalate mixture for an unspecified period of time and the presence of signs and symptoms of peripheral nervous system disease or the presence of obstructive lung disease. Adverse neurological signs and symptoms were reported in a group of 147 workers in the artificial leather industry exposed to 1.7-766 mg/m^3 of mixed phthalate esters of 0.5-19 years. However, tri-o-cresyl phosphate, a potent neurotoxicant, was also a component of the mixture.

In a study of mechanically ventilated premature infants intubated with PVC nasotracheal tubes, bis(2-ethylhexyl)phthalate was detected in the condensate from the respiratory tubes from 5 out of 6 infants, in the urine of 2 of 2 infants who developed lung disorders, and in the lungs but not liver of a third infant who died of pneumothorax (Roth et al., 1988). The lung disorders resembled those observed in hyaline membrane disease and were observed during the fourth

week of life, following an initial improvement in respiratory condition. After ruling out other possible causes for the worsening respiratory condition of the infants, the investigators concluded that inhalation exposure to bis(2-ethylhexyl)phthalate may have been a factor.

The database on the toxicity of inhaled bis(2-ethylhexyl)phthalate in animals consists of several acute exposure studies (General Motors Corporation, 1982; Eastman Kodak Corporation, 1978; Shaffer et al., 1945; Union Carbide Corporation, 1943; Anonymous, 1978), a 4-week study (Klimisch et al., 1992), chronic studies with limited reporting of methods and/or results (Lawrence et al., 1975; Schmezer et al., 1988), and a developmental toxicity study (Merkle et al., 1988).

General Motors Corporation (1982) reported that no deaths occurred in a group of 8 rats exposed to 600 mg/m^3 of an aerosol of bis(2-ethylhexyl)phthalate for 6 hours or in a group of 16 rats exposed repeatedly to 100 mg/m^3, 6 hours/day, 5 days/week for 2 weeks. The authors also indicated that repeated exposure did not affect body weight gain or pulmonary morphology, but that slight non-specific irritation of the respiratory epithelium was evident; no further details were provided. Eastman Kodak Company (1978) reported that no deaths occurred in rats exposed to 128 mg/m^3 bis(2-ethylhexyl)phthalate for 6 hours; no additional information was provided.

Shaffer et al. (1945) exposed a group of 6 rats (sex and strain not reported) to a mist of bis(2-ethylhexyl)phthalate formed by bubbling a stream of air through the test material at 170°C. The resulting concentration of bis(2-ethylhexyl)phthalate in air was not reported. No deaths occurred in a 2 hour exposure period, but all rats died after 2-4 hours of exposure. No mortality was observed in a group of 6 guinea pigs similarly exposed for 2 hours, but all died after 4 hours of exposure (Union Carbide Corporation, 1943).

Groups of 5 albino rats (sex and strain not reported) were exposed to bis(2-ethylhexyl)phthalate by inhalation in concentrations of 0 or 0.0463 mg/L (46.3 mg/m^3) on 5 days/week for 2 weeks (number of hours per day not reported) (Anonymous, 1978). Hematology (hemoglobin, hematocrit, and total and differential leukocyte levels), clinical chemistry (SGOT, lactate dehydrogenase, alkaline phosphatase, BUN) and histology (24 tissues) were evaluated three day following the end of the exposure period. No compound-related adverse effects were observed. Some minor histological changes were found in treated animals only, consisting of localized fibrosis of the splenic capsule (1 rat) and foci of hypospermatogenesis (2 rats), but these were not regarded as toxicologically significant.

Klimisch et al. (1992) exposed groups of 27 male and 17 female Wistar rats to 0, 0.011, 0.049, or 0.94 mg/L (0, 11, 49, or 94 mg/m^3) bis(2-ethylhexyl)phthalate 6 hours/day, 5 days/week for 4 weeks. The animals received a head-nose exposure to an aerosol with a MMAD of ≥ 1.2 µm and a geometric standard deviation of 2.9, 9.5, or 6.6 for the 11, 49, or 94 mg/m^3 concentration, respectively. At the end of the exposure period, 12 male and 12 female rats were

sacrificed and the following parameters were used to assess toxicity: clinical observations, body weight, hematology, clinical chemistry, organ weights (liver, kidney, testes, adrenal, heart, lung, and brain), and gross and histopathology of major tissues, including the respiratory tract and male reproductive tissues. The remaining 15 males and 5 females per group were observed for an 8- week recovery period. During the recovery period, the male rats were mated with non-exposed females (2 and 6 weeks after exposure termination). No deaths or significant alterations in body weight or body weight gain were observed. The levels of hematological parameters were similar in the bis(2-ethylhexyl)phthalate-exposed rats and in the controls. Alterations in serum chemistry parameters were limited to an increase in plasma albumin levels in the male and female rats exposed to 94 mg/m^3 and an increase in inorganic phosphate levels in the male rats exposed to 94 mg/m^3. The alterations in plasma albumin levels were not observed in the rats allowed to recover for 8 weeks. In the 94 mg/m^3 group, significant increases in absolute and relative liver weights and relative lung weight (males only) were observed. Histological alterations were limited to a slight increase in foam-cell (alveolar macrophage) proliferation and alveolar septal thickening in the lungs of the 94 mg/m^3 group; these alterations were not observed in the rats allowed to recover for 8 weeks. In addition, no evidence of peroxisome proliferation was observed in the livers (livers of 2 rats/sex/group examined by electron microscopy). No alterations in fertility were observed in the male rats mated with unexposed females. Thus, this study identifies a NOAEL of 49 mg/m^3 and LOAEL of 94 mg/m^3 for alterations in serum albumin and inorganic phosphate levels, increased liver and lung weights, and histological alterations in the lungs of rats exposed 6 hours/day, 5 days/week for 4 weeks. This study also identifies a NOAEL of 94 mg/m^3 for reproductive effects in male rats.

In the chronic toxicity study conducted by Schmezer et al. (1988), a group of Syrian golden hamsters (65/sex) was continuously exposed to an atmosphere containing 15 µg/m^3 bis(2-ethylhexyl)phthalate vapors from the twelfth week of age until natural death (about 23 months). The exposures were interrupted twice a week for animal handling and care. The control group consisted of 80 male and 80 female hamsters exposed to air. Gross necropsy and histological examination of unspecified organs and tissues were performed. This study was intended to examine the carcinogenicity of inhaled bis(2-ethylhexyl)phthalate; the only information regarding potential noncarcinogenic effects is that no difference in survival was found between the treated and control groups. No further details were provided.

Lawrence et al. (1975) exposed male ICR mice (20/group) to air or to an atmosphere saturated with bis(2-ethylhexyl)phthalate vapors 2 hours/day, 3 days/week for 4-16 weeks. Five mice from each group were sacrificed at 4, 8, 12, and 16 weeks and the lungs and other tissues (unspecified) were processed for histopathological examination. No consistent alterations were observed that could be attributed to exposure to the test material. No further information was provided.

In the developmental toxicity study conducted by Merkle et al. (1988), groups of 25 pregnant Wistar rats received head/nose exposure to aerosol concentrations of 0, 0.011, 0.048, or

0.3 mg/L bis(2-ethylhexyl)phthalate (0, 11, 48, and 300 mg/m^3) 6 hours/day on gestational days 6–15. An "MMAD 50% of <1.2 µm and slope factors of 7.3, 16.8, and 5.8" were determined for 11, 48, and 300 mg/m^3 concentrations, respectively. These animals were acclimatized by sham exposure to air without bis(2-ethylhexyl)phthalate during gestational days 0–6. Five rats per group were allowed to deliver and rear the pups until weaning (postnatal day 21); the remaining rats were subjected to cesarean section on gestational day 20. No differences in maternal body weight gain or behavior were seen between controls and exposed groups during the exposure period; at postnatal day 21, a significant reduction in body weight (9%) was observed in the dams exposed to 300 mg/m^3 bis(2-ethylhexyl)phthalate. This effect on body weight did not appear to be concentration-related. No bis(2-ethylhexyl)phthalate-related macroscopic alterations were observed.

The conception rate was 90%, 95%, 85%, and 80% with increasing exposure to bis(2-ethylhexyl)phthalate, but there was no significant difference among the groups. The number of corpora lutea and mean uterine weights among groups were similar. Early resorptions were reportedly seen throughout all groups, but there was no concentration-related response trend. In the 48 mg/m^3 group, statistically significant decreases in the number of mean live fetuses per dam (12.00, 11.68, 10.59, 13.19 in the 0, 11, 48, and 300 mg/m^3 groups, respectively) and live implantations per dam (92.37, 94.74, 80.02, 91.11%, respectively) and an increase in the number of dead implantations per dam (7.63, 5.26, 19.98, 8.89%, respectively) were observed. The authors did not consider these effects to be related to the bis(2-ethylhexyl)phthalate exposure because the incidences were not concentration-related. No significant alterations in the number of fetuses or litters with anomalies or variations were observed. The percentages of fetuses per litter with delays in development (primarily due to renal pelvis dilatations) were 18.83%, 23.22%, 26.46%, and 32.63% with increasing concentration, but no statistically significant alterations were observed. The percentages of litters with gross delays in development (also primarily renal pelvis dilatations) were 16.67%, 33.33%, 31.25%, and 56.25% for the 0, 11, 48, and 300 mg/m^3 groups, respectively; this finding was statistically significant in the 300 mg/m^3 group. The authors considered the renal pelvic dilatations unrelated to bis(2-ethylhexyl)phthalate exposure; they state that it is a common effect for this strain of rat and was observed at a high incidence in historical controls, however no data were presented to support this statement. No significant alterations in survival rate, viability and lactation indices, righting test (administered on postnatal day 6), pupillar reflex (postnatal day 20), hearing test (postnatal day 21), eye/ear auricle, incisivi, fur development, or body weight gain were observed in offspring of the 5 rats/group allowed to litter.

Because the decreased incidence of live fetuses observed at 48 mg/m^3 was not observed in the 300 mg/m^3 group, and the overall incidence of this effect does not appear to be concentration-related, this effect was not considered to be related to bis(2-ethylhexyl)phthalate exposure. The increased incidence of gross delays in development

observed in the litters from the 300 mg/m^3 group was considered to be related to bis(2-ethylhexyl)phthalate exposure. The incidence of litters with gross delays in development was also increased in the 11 and 48 mg/m^3 groups, although the increases were not statistically significant. The authors noted that historical controls have a high incidence of renal pelvis dilatations, however no data were provided to support this statement and it is not known if the incidence in the 300 mg/m^3 group would be higher than the historical control incidence. Thus, the 300 mg/m^3 concentration is considered a LOAEL for developmental effects in rats, and the NOAEL is 48 mg/m^3 in rats exposed 6 hours/day during gestational days 6-15.

DERIVATION OF A PROVISIONAL RfC FOR BIS(2-ETHYLHEXYL)PHTHALATE

Although several studies have examined the toxicity of inhaled bis(2-ethylhexyl)phthalate in animals, only the Klimisch et al. (1992) and the Merkle et al. (1988) studies can be used to derive a subchronic RfC. The lack of reported details on the study design or the results precludes using other studies in the database to derive a subchronic RfC. In the Klimisch et al. (1992) study, a NOAEL of 49 mg/m^3 and LOAEL of 94 mg/m^3 for alterations in serum chemistry parameters, increased liver and lung weight, and histological alterations in the lung (increased macrophage proliferation and alveolar septal thickening) were identified in rats exposed to bis(2-ethylhexyl)phthalate aerosols for 4 weeks (6 hours/day, 5 days/week). In the Merkle et al. (1988) study, a NOAEL of 48 mg/m^3 and LOAEL of 300 mg/m^3 were identified for developmental effects [increased incidence of litters with delays in development (primarily renal pelvis dilatations)] in rats exposed *in utero* (6 hours/day, gestational days 6-15). Thus, derivation of a provisional subchronic RfC based on the NOAEL identified in the Klimisch et al. (1992) study is recommended. The $NOAEL_{HEC}$ for systemic effects and the $NOAEL_{HEC}$ for pulmonary effects were compared to identify the most sensitive effect. The $NOAEL_{HEC}$ values were calculated using the following equations:

$$NOAEL_{HEC} = NOAEL_{ADJ} \times RDDR$$

where: $NOAEL_{ADJ}$ is the duration-adjusted NOAEL

$$NOAEL_{ADJ} = 49\ mg/m^3 \times 6\ hours/24\ hours \times 5\ days/7\ days$$

$$NOAEL_{ADJ} = 8.8\ mg/m^3$$

RDDR is the ratio of regional deposited doses for rats and humans inhaling an aerosol with a MMAD of 1.0 µm and a sigma g of 2.4, based on dosimetric modeling as described in U.S. EPA (1990). The RDDR is specific for the region of concern in the respiratory tract (the thoracic region, TH) or for extrarespiratory effects (ER).

$$RDDR_{ER} = 0.0089 \times (BW_H/BW_R)$$

$$RDDR_{TH} = 1.4942$$

For extrarespiratory effects (using U.S. EPA. 1988 reference body weights):

$$NOAEL_{HEC} = 8.8\ mg/m^3 \times RDDR_{ER}$$

$$RDDR_{ER} = 0.0089 \times (70\ kg/0.217\ kg)$$

$$RDDR_{ER} = 2.87$$

$$NOAEL_{HEC} = 8.8\ mg/m^3 \times 2.87$$

$$NOAEL_{HEC} = 25\ mg/m^3$$

For lung effects:

$$NOAEL_{HEC} = 8.8\ mg/m^3 \times RDDR_{TH}$$

$$NOAEL_{HEC} = 8.8\ mg/m^3 \times 1.4942$$

$$NOAEL_{HEC} = 13\ mg/m^3$$

Based on a comparison of the $NOAEL_{HEC}$ values, the lung effects are the most sensitive effect. A provisional subchronic RfC of 1E-2 mg/m^3 is calculated by dividing the $NOAEL_{HEC}$ of 13 mg/m^3 by an uncertainty factor of 1000 (10 to account for extrapolation from a less than subchronic study, 3 for interspecies extrapolation using dosimetric adjustments, 10 for human variability, and 3 for database deficiencies). The database deficiencies consist of a lack of a subchronic study and developmental toxicity study in a second species and the lack of a multigeneration reproduction study; a partial uncertainty factor was used because male fertility (an endpoint of concern following oral exposure) was assessed in the Klimisch et al. (1992) study and no effects were observed at the highest concentration (94 mg/m^3). Confidence in the principal study is medium. It is a well-designed study examining a number of relevant endpoints, however, no incidence data were reported for the histological effects. Confidence in the database is medium to low; the limitations in the database include the lack of 90-day subchronic study, a subchronic study in a second animal species, a developmental toxicity study in a second species, and a multigeneration reproductive toxicity study. Reflecting the medium to low confidence in the database, confidence in this provisional subchronic RfC is medium to low.

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Attachment III

(93-24/07-07-93)

Risk Assessment Issue Paper for:
Derivation of a Provisional RfD for Iron (CASRN 7439-89-6)

INTRODUCTION

Review documents available for iron and compounds include a Health Effects Assessment (U.S. EPA, 1984) and reviews by Jacobs (1977), Bothwell et al. (1979), and Lauffer (1991). The following computer searches, performed in April, 1993, were screened to identify additional pertinent studies not discussed in review documents: TOXLINE (oral and inhalation toxicity and cancer from 1983-April, 1993), CANCERLINE (1990 - April, 1993), MEDLINE (1991 - April, 1993), TSCATS, RTECS, and HSDB.

Iron is not listed on IRIS (U.S. EPA, 1994a), the RfD/RfC Work Group Status Report (U.S. EPA, 1994b), or Drinking Water Regulations and Health Advisories (U.S. EPA, 1994c). The HEAST (U.S. EPA, 1994d) reported that data regarding iron were inadequate for quantitative risk assessment. Iron was not listed on the NTP Chemical Status Report (NTP, 1993a). An NTP Results Report (NTP, 1993b) indicates a gavage study has been completed on iron and compounds, but the study does not meet minimum standards (as per telephone conversation with NTP, April, 1993).

Iron is an essential element, and deriving a risk assessment value for such chemicals poses a special problem in that the dose adversity curve is "U-shaped". Thus, the risk value must be protective against deficiency as well as toxicity. The NAS (1989) has determined that the Recommended Dietary Allowance (RDA) for iron is 10 mg/day (0.13 mg/kg-day) for adult men and 15 mg/day (0.24-0.33 mg/kg-day) for females aged 11-50 years. The RDA is 6 mg/day (1 mg/kg-day) for non-breastfed infants aged 0-6 months; 10 mg/day (0.36-1.11 mg/kg-day) for children aged 6 months to 10 years; and 12 mg/day (0.18-0.27 mg/kg-day) for males aged 11-14 years. Note that breastfed infants typically receive only 0.15 to 0.3 mg Fe/day, about 20- to 40-fold lower than the RDA. The RDA is 30 mg/day (0.443 mg/kg-day) for pregnant women and 15 mg/day (0.25 mg/kg-day) for women who are lactating.

In humans and other animals, levels in the body are regulated primarily through changes in the amount of iron absorbed by the gastrointestinal mucosa. The absorption of dietary iron is influenced by body stores, by the amount and chemical nature of iron in ingested food, and by a variety of dietary factors that increase or decrease the availability of iron for absorption. However, excessive accumulation of iron in the body resulting from chronic ingestion of high levels of iron cannot be prevented by intestinal regulation of absorption, nor do humans have a mechanism to increase excretion of absorbed iron in response to elevated body levels (NAS, 1989). Below are summaries of selected

epidemiological and medical studies, and of available toxicity studies in animals exposed to iron and inorganic compounds.

REVIEW OF PERTINENT LITERATURE

While chronic iron toxicity occurs in people with genetic metabolic disorders resulting in excessive iron absorption, with abnormal hemoglobin synthesis, or who receive frequent blood transfusions (Jacobs, 1977; Bothwell et al., 1979), there is a long-standing controversy as to whether a chronic overload due to oral intake is possible in individuals with a normal ability to control iron absorption (Hillman and Finch, 1985). Nevertheless, "the cumulative experience in human subjects suffering from iron overload of various etiologies strongly suggests that iron is noxious to tissues [when]...present in parenchymal cells...for a sufficiently long period of time" (Bothwell et al., 1979).

Looker et al. (1988) made comparisons of dietary iron intake and biochemical indices of iron status based on values taken from the second National Health and Nutrition Examination Survey (NHANES II) data base. NHANES II was a probability sample of the noninstitutionalized U.S. population aged 6 months to 74 years, conducted between 1976 and 1980 by the National Center for Health Statistics. These data suggest that normal intake of iron by men 16-74 years old exceeds the RDAs, and that iron intake is somewhat lower than the RDA for women younger than 51 years. Concomitant with the study of dietary intake, the NHANES II measured the iron status of these populations. The serum ferritin levels, which index total body iron stores, ranged from 23.8 μg/L, for premenopausal women not using iron supplements, to 105.6 μg/L for 45- to 64-year-old supplement users. These values are well within the normal range of 12-300 μg/L (Cook, 1991). (From Taber's Medical Dictionary, ferritin is the form in which iron is stored in the tissues, principally in the reticuloendothelial cells of the liver, spleen, and bone marrow. [It is] an iron-phosphorus-protein complex containing about 23% iron.) The percent serum transferrin saturation, a measure of the residual capacity of the iron transport system to process potential variations in iron from dietary intake or catabolized body stores, ranged from 23.9% saturation for pre- and post-menopausal women not using iron supplements, to 28.9% saturation for male supplement users in the 25- to 44- and 65- to 75-year-old groups. These values are also within the normal range (20-40%), establishing that the intake levels of 0.15-0.27 mg/kg-day consumed by these groups are both sufficient to protect against iron deficiency and insufficient to cause the toxic effects of iron overload (Elinder, 1986; Cook, 1991; Hillman and Finch, 1985). Therefore, 0.15-0.27 mg/kg-day represents a NOEL for chronic dietary iron intake.

Hemosiderosis (or siderosis) and iron overload are increases in tissue iron or a general increase in iron stores without associated tissue damage (Bothwell et al., 1979; Jacobs, 1977). Hemochromatosis describes massive iron overload (15 g of body iron stores or greater) together with cirrhosis and/or other tissue damage attributable to iron. Although focal deposits of iron may occur in any part of the body where red cells are extravasated, the clinical syndrome of hemochromatosis typically involves damage to the hepatic parenchyma (particularly fibrosis), heart (cardiac dysfunction including failure) and endocrine glands

(particularly hypogonadism). Pancreatic iron deposition is common, and massive deposits may be associated with fibrosis and diabetes. A number of studies involving chronic oral administration of iron to animals have been designed in an attempt to identify an animal model for hemochromatosis. Most of these studies have been negative (Bothwell et al., 1979; NRC, 1979). Animal studies involving parenteral administration of iron have been generally negative as well, even though parenteral routes bypass the mechanisms that regulate absorption of iron from the gastrointestinal tract.

Chronic iron toxicity has been observed in people with idiopathic hemochromatosis (a genetic metabolic disorder resulting in excessive iron absorption), abnormalities of hemoglobin synthesis (e.g., thalassemia) or various anemic states (e.g., sideroblastic anemia), frequent blood transfusions or a combination of these conditions (Jacobs, 1977; Bothwell et al., 1979). Chronic hemochromatosis has also occurred among the South African Bantu population from an excessive intake of absorbable iron in an alcoholic beverage.

Habitual excessive intake of iron by the Bantus is attributed to consumption of home-brewed Kaffir beer, which was contaminated by iron vessels during brewing (Bothwell and Bradlow, 1960; Bothwell et al., 1964). The beer's high acidity (pH 3-3.5) enhanced iron leaching from the vessels. The iron in the beer is readily assimilable (i.e., ionizable) due to the acidity and presence of iron-complexing ligands such as fructose, and is absorbed to approximately the same degree as ferric chloride. The alcohol content of the beer is also believed to contribute to the bioavailability of the iron (Jacobs, 1977; Finch and Monsen, 1972). Based primarily on drinking habits and analyses of beer samples, the estimated average dietary iron intake of the Bantu men ranged from 50-100 mg/day from beer alone (Bothwell et al., 1964). Using a reference body weight of 70 kg (U.S. EPA, 1987), this range corresponds to 0.7-1.4 mg/kg-day. Histological examinations of the liver of 147 Bantus (129 male, 18 female), ranging in age from 11-70 years (most were between 20 and 50 years old) that died from acute traumatic causes, were performed (Bothwell and Bradlow, 1960). Varying degrees of hepatic siderosis were observed in 89% of the cases; the degree tended to increase with age 40-50 years or less. The siderosis was mild in 59%, and severe in 19% of the cases, respectively. There was a close correlation between hepatic iron concentration and portal fibrosis and cirrhosis. Although the overall prevalence was low (15.6% fibrosis and 1.4% cirrhosis), all 11 subjects with the highest iron concentrations (>2.0% dry weight of liver) showed either fibrosis or cirrhosis. Histological examination of the spleen (50 subjects) also showed siderosis and unspecified histological changes. Malnutrition and alcoholism could have played a role in the etiology of the hepatic and splenic siderosis in the Bantus.

Hemosiderosis of the skin and liver with cirrhotic changes, accompanied by a serum iron level of 246 μg/100 mL and 100% saturation of transferrin, also developed in a 60-year-old female patient who ingested approximately 12,000 g of elemental iron (as 12 g ferrous carbonate/day or 2 g ferrous gluconate/day) for 27 years (Turnberg, 1965). Assuming a mean body weight of 64 kg for a woman 33-60 years old, 12 kg iron 365 days/year for 27 years averages to approximately 19 mg/kg-day. Using an estimated intake of 0.17 mg

iron/kg-day for dietary iron, the total intake of iron was approximately 19.2 mg/kg-day. The author noted that the patient was not anemic during the treatment period, was absorbing iron at a normal rate, had no history of hepatitis (a potential complication in people with iron overload following repeated transfusion) and did not consume alcohol. It was concluded that the prolonged high iron intake was the sole origin of the clinical picture of hemochromatosis.

Ethiopia reportedly has the highest per capita iron intake in the world, with an average daily intake of 471 mg iron/day (range 98-1418 mg/day; 1.4-20.3 mg iron/kg-day assuming 70 kg body weight) (Roe, 1966; Hofvander, 1968). Increased stored iron in the liver and adverse health effects have not been observed due to low bioavailability of the iron in Ethiopian food.

A recent study in Eastern Finnish men suggests that high serum ferritin concentration and high dietary iron intake are risk factors for myocardial infarction (Salonen et al., 1992). Of the 1,931 randomly selected men aged 42-60 years who had no history of coronary heart disease upon entry to the study, 51 experienced an acute myocardial infarction during the average 3-year follow-up. After adjusting via Cox proportional hazards model for age and examination year, cigarette-pack years, ischemic ECG in exercise test, oxygen uptake, systolic blood pressure, blood glucose, serum copper, blood leukocyte count, and concentrations of serum high density lipoprotein cholesterol, apolipoprotein B, and triglyceride, those having serum ferritin at levels $\geq$ 200 μg/L (median value for healthy adult men is 69-140 μg/L) showed increased risk ($p<0.01$) of myocardial infarction compared to those with lower serum ferritin. Use of the same model and covariates indicated dietary iron intake was also significantly ($p<0.05$) associated with disease risk; consumption of red meat had the strongest correlation of all foods with serum ferritin concentration ($r=0.059$). High serum low density lipoprotein (LDL) cholesterol concentrations ($\geq$5.0 mmol/L) associated with elevated serum ferritin was also a strong risk factor for acute myocardial infarction; this lends support to the theory that iron overload elevates risk of acute myocardial infarction by promoting oxidation of LDL (Lauffer, 1991; Sullivan, 1992).

The effects of acute oral exposure to iron in humans are well characterized. Acute iron toxicity has most often been observed in small children who accidentally ingested iron supplements, usually in the form of ferrous sulfate, but also as ferrous gluconate, ferrous chloride, ferric chloride or ferric ammonium citrate (Bothwell et al., 1979). The pathogenesis of acute oral iron toxicity consists primarily of gastrointestinal, cardiovascular, metabolic, neurological and hepatic alterations caused by direct corrosive action or the presence of unbound iron in the circulation (Bothwell et al., 1979; Banner and Tong, 1986; Engle et al., 1987; Mann et al., 1989). Gastrointestinal toxicity is due to the direct caustic effect of iron on the mucosa, particularly in the stomach and small intestine, and is characterized initially by vomiting, diarrhea and abdominal pain. These symptoms can progress to gastric and intestinal hemorrhage and/or necrosis and, rarely, 4-6 weeks after ingestion, scarring that may result in stenosis in the stomach outlet and small intestine. Cardiovascular toxicity of iron results from severe hemodynamic alterations characterized by loss of vascular integrity, decreased circulating plasma volume, decreased cardiac output and

acidosis, leading to shock and cardiac failure. Neurological effects ranging from lethargy and mild obtundation to coma may occur. Hepatic damage, which can range from cloudy swelling of hepatocytes to necrosis, is a rare complication after ingestion of large quantities of iron in acute overexposure.

Determinations of serum iron concentration and total iron binding capacity (TIBC) in blood 2-4 hours after ingestion may provide reliable laboratory indices of the bioavailability of iron resulting from an acute ingestion (Mann et al., 1989), but are impractical for assessments of environmental exposures because they may be difficult to obtain rapidly. Since iron is rapidly cleared from the plasma and taken up by hepatocytes, samples drawn 4-6 hours after exposure may be low and not indicative of the quantity of iron bioaccumulated following ingestion. Clinically serious acute iron toxicity generally occurs when free unbound iron circulates (i.e., when serum iron exceeds the TIBC of transferrin and the serum transferrin is 100% saturated). Serum levels of iron are normally in the range of 65-165 μg/100 mL; concentrations of 150-350 μg/100 mL may be associated with mild symptoms, and concentrations >350 μg/dL are generally considered toxic if the TIBC or the percent saturation of serum transferrin is not available (Engle et al., 1987; Mann et al., 1989). Except for the case reported by Turnberg (1965), in which a chronically exposed patient suffering iron overload had 246 μg/100 mL iron in her serum with 100% saturation of her serum transferrin, data on serum levels of iron following repeated exposures were not located.

Information on acute oral toxic doses of iron in humans is available from numerous case reports of ingestions by children, but values vary because it is difficult to obtain accurate estimates of the amount taken in most overdose situations. It may be unclear whether amounts of elemental iron or iron compound are reported, and serum iron levels may peak at different times depending upon the type of product ingested (Engle et al., 1987). Reviews of these case reports indicate that doses in the range of 200-300 mg iron/kg are generally considered lethal (Arena, 1970; Krenzelok and Hoff, 1979; NRC, 1979; Engle et al., 1987; Mann et al., 1989; Klein-Schwartz et al., 1990), although doses as low as 40-60 mg iron/kg have been regarded as potentially fatal (NRC, 1979; Krenzelok and Hoff, 1979).

Minimum acute toxic doses of iron in humans are poorly defined because most of the cases of poisoning were overdose situations that relied on clinical histories (information from the patient or parent) for determination of dose. Additionally, toxicity mitigation procedures may complicate determining actual severity of effects. Management of acute iron poisoning typically includes gastrointestinal decontamination (e.g., emesis with syrup of ipecac, gastric lavage) and/or chelation therapy with deferoxamine performed at varying times after ingestion (Mann et al., 1989). Based on reviews of case reports and consensus opinions, treatment protocols generally consider ingestions of <20 mg iron/kg minimally toxic and ingestions of >40 mg iron/kg potentially serious (Engle et al., 1987; Mann et al., 1989; Elinder 1986). Klein-Schwartz et al. (1990) analyzed 339 iron ingestion cases to validate the treatment protocol of a regional poison control center. According to the protocol of this center, ingestions of 20-40 mg iron/kg required only home treatment if there were no symptoms other than mild gastrointestinal symptoms, and ingestions 40 mg iron/kg or higher

required hospital referral. The median age of the subjects was 3 years (range, 9 months to 33 years). The amount of iron ingestion was known in 199 subjects, ranging from 20-301 mg/kg (mean, 39.5 mg/kg). Of the 199 subjects, 144 ingested 20-40 mg/kg, 31 ingested 40-60 mg/kg, and 24 ingested 60 mg/kg and higher. There was no statistically significant difference in the mean dose ingested by patients with symptoms (abdominal pain, vomiting and/or diarrhea), compared with asymptomatic patients [42.2 mg/kg versus 38.5 mg/kg ($p=0.33$)]. The overall prevalence of the gastrointestinal symptoms was higher in the 40-60 mg/kg and 60 mg/kg or higher groups (41.9 and 33.3%, respectively), than in the 20-40 mg/kg group (22.2%), but the differences among the three groups were not statistically significant ($p=0.058$). Also, there was no statistically significant difference ($p>0.05$) in the development of any of the specific symptoms in any of the groups. The prevalence of symptoms generally increased with increasing serum iron levels, but only 20 of the patients had serum iron levels higher than the concentration of 350 μg/dL, generally considered toxic. Symptoms more serious than gastrointestinal ones (e.g., metabolic, cardiovascular, central nervous system or hepatic effects) did not develop in any of the patients. The results of this study suggest that acute iron ingestions in the range of 20-60 mg/kg are unlikely to be serious in children. Based on this study, the poison center protocol was changed to home management (i.e., ipecac syrup), for iron ingestions of 20-60 mg/kg unless significant symptoms developed, and hospital referral for ingestions 60 mg/kg or greater.

- Effects of iron therapy on the upper gastrointestinal tract were evaluated in 14 healthy volunteers [13 women, 1 man; mean age 29 years (range, 24-48 years)] who were instructed to ingest 325 mg tablets of ferrous sulfate (65 mg iron) 3 times/day (before meals) for 2 weeks (Laine et al., 1988). This study was performed to ascertain whether there is a basis for implications that iron therapy may cause false-positive fecal occult blood testing. Evaluation consisted of gastrointestinal symptom survey, qualitative (Hemoccult) and quantitative (HemoQuant; mg mercury/g stool) testing for fecal blood loss, endoscopy of the upper gastrointestinal tract and histological examination of pinch biopsies of the gastric body, antrum and duodenum. In a separate portion of the study, Hemoccult testing was performed on 13 other subjects [12 men, 1 woman; mean age 33 years (range 23-50 years)] who were similarly treated with ferrous sulfate for 1 week. All subjects served as their own controls and ingested no other substances that could potentially damage the upper gastrointestinal tract during their participation in the study. Based on actual average ingestion of 2.5 tablets/day (2-week study) and 2.6 tablets/day (1-week study) and a reference human body weight of 70 kg (U.S. EPA, 1987), the estimated doses consumed by the subjects were 2.3 and 2.4 mg iron/kg-day, respectively, in addition to dietary iron. All subjects had significantly increased ($p<0.05$) dark brown-black stools and symptoms of nausea and vomiting during the treatment period, but not abdominal pain, compared to the 2 weeks prior to treatment. The stool samples of all 27 subjects were Hemoccult-negative prior to iron treatment. Only 1 of 27 stool samples was questionably trace positive after treatment. Hemoglobin levels in stool did not change significantly after iron treatment. Endoscopic examination showed a significant ($p=0.003$) increase in abnormalities in the stomach, but not duodenum, after therapy. These changes consisted of erythema, small areas of subepithelial hemorrhage and solitary antral erosions in nine, six and two subjects, respectively, and were considered only minimally abnormal. Linear regression analysis showed that there was a significant

correlation between endoscopy scores and abdominal pain scores ($r=0.64$, $p=0.01$), but not with vomiting ($r=0.5$, $p=0.07$), diarrhea ($r=0.46$, $p=0.1$) or nausea ($r=0.4$, $p=0.16$). No treatment-related histological changes were observed and there was no correlation between the endoscopic and histologic findings, although the investigators noted that the correlation between endoscopic findings and histologic changes in small mucosal pinch biopsies is "notoriously" poor. Although it was speculated that the changes in the stomach could represent a mild form of iron poisoning, the investigators concluded that the treatment caused mild endoscopic abnormalities of uncertain clinical significance in the stomach. Evidence for iron overload (tissue biopsies or hematologic iron status indices) was not examined.

Adverse developmental effects in humans have not been associated with the ingestion of supplemental iron during pregnancy. As indicated above, NAS (1989) recommended that pregnant women supplement their diets with 30 mg iron/day (0.43 mg/kg-day). McElhatton et al. (1991) reported on 49 women who took an overdose of a simple iron preparation (53%) or iron with folate preparation (47%). For 48 of the women, the amount of iron ingested was known; 28 took > 1.2 g and the remainder took ≤ 1.2 g. Twenty-five of the women received chelation treatment with desferrioxamine (DFO) and 12 received an emetic. Maternal toxicity, consisting of nausea, vomiting, hematoemesis, abdominal pain and diarrhea, was observed in 35 of the women. Two spontaneous abortions occurred and there were 3 premature deliveries. One of the spontaneous abortions and the premature deliveries were not related to the iron overdose. It is not known if the other spontaneous abortion occurring at 22 weeks (3 weeks after the overdose) was caused by the iron overdose. A LOAEL for maternal toxicity or NOAEL for developmental toxicity could not be identified due to inexact exposure data, variation in type of mitigation used, and time elapsed prior to its administration.

Animal studies have shown that rats administered 2.7 mg iron/kg-day as ferric chloride on gestation days 6-15 (Nolen et al., 1972) or rats and mice administered 24-76 mg iron/kg-day as ferrous sulfate for 6 days (gestation days unspecified) (Tadokoro et al., 1979) had no treatment-related teratogenic or embryotoxic effects. Some (numbers and species not reported) embryonic mortality occurred in the latter study at 240 mg iron/kg-day.

DERIVATION OF THE PROVISIONAL CHRONIC ORAL RfD

Most of the quantitative chronic oral toxicity data for iron have been obtained from studies of the Bantu population of South Africa. These data indicate that intakes in the range of 0.7-1.4 mg iron/kg-day in home-brewed beer are associated with hemosiderosis and liver cirrhosis (Bothwell and Bradlow, 1960; Bothwell et al., 1964). However, confounding factors such as malnutrition and unusually high iron bioavailability, due to the high acidity and ethanol in the beer, preclude use of these data for risk assessment. Much higher dietary intakes (average 6.7 mg/kg-day) of less soluble forms of iron are tolerated in nonwestern diets as indicated by studies of populations in Ethiopia. Therapeutic oral doses of 2.3 mg iron/kg-day as ferrous sulfate for 2 weeks were minimally toxic to the gastrointestinal tract, causing nausea, vomiting and endoscopic abnormalities in the stomach (e.g., erythema and

small areas of hemorrhage), but no gastric histological changes were found, and evidence for iron overload (tissue biopsies or hematologic iron status indices) was not examined (Laine et al., 1988). One case of hemochromatosis was reported in a woman who ingested 19.2 mg/kg-day of iron for 27 years; treatment was not accompanied by alcohol- or transfusion-induced hepatitis, anemia, malnutrition or abnormal intestinal absorption (Turnberg, 1965). Thus, although toxicity associated with iron overload due to chronic oral intake can be demonstrated qualitatively or even semiquantitatively, assignment of a precise LOAEL for normal individuals consuming western diets is compromised by studies containing confounding factors, inadequate endpoint assessment, too short a duration of exposure or too few subjects.

Nonetheless, it is possible to establish a NOEL for chronic iron overload using the values for dietary intake and iron status indices taken from the second National Health and Nutrition Examination Survey (NHANES II) data base. Looker et al. (1988) made comparisons of dietary iron intake and biochemical indices of iron status using data from NHANES II. The average intakes of iron ranged from 0.15 to 0.27 mg/kg-day. The serum ferritin levels and percent serum transferrin saturation were within the normal range. Thus, intake levels of 0.15-0.27 mg/kg-day consumed are both sufficient to protect against iron deficiency and insufficient to cause the toxic effects of iron overload.

Using the NOAEL of 0.27 (representing the upperbound value in the range of mean dietary iron intakes, dietary plus supplemental, taken from the NHANES II data base) and dividing by an uncertainty factor of 1 yields the provisional chronic oral RfD of 0.3 mg/kg-day. An uncertainty factor of 1 is supported by the fact that iron is an essential element. In addition, the information used to derive the oral RfD for iron was derived from intake data from over 20,000 individuals aged 6 months to 74 years and humans exert an efficient homeostatic control over iron such that body burdens are kept constant with variations in diet.

Confidence in the critical study is high; the NHANES II data are derived from a very large sampling of the U.S. population ranging in age from 6 months to 74 years. Overall confidence in the data base is medium; there are insufficient data to determine what chronic dose level is associated with adverse effects in healthy individuals. While a point estimate has been derived in this risk assessment, individual variations in diet, nutritional status, physiology, etc. suggest that a range of values may be more appropriate. Reflecting the high confidence in the critical study and medium confidence in the data base, confidence in the RfD is medium.

NOTE: This RfD supplies adequate levels of iron to meet the nutritional requirements of adults and adolescents over a lifetime. It does not supply the recommended dietary allowance (RDA) to those members of the population that have greater requirements for a short, less-than-lifetime duration such as infants, pre-adolescent children, and pregnant women. For shorter term requirements for these subpopulations, refer to the RDAs (NAS, 1989). Further, this RfD may not be protective of people with inherited disorders of iron metabolism and could be conservative if applied to exposure scenarios involving forms of iron with low bioavailability.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
ENVIRONMENTAL CRITERIA AND ASSESSMENT OFFICE
CINCINNATI, OHIO 45268

MEMORANDUM

DATE: November 1, 1993

SUBJECT: Oral and Inhalation Absorption Factors for Multiple Chemicals (Berkley Products Co. Dump/Denver, PA)

FROM: Joan S. Dollarhide
Director
Superfund Health Risk Technical Support Center
Chemical Mixtures Assessment Branch

TO: Jennifer Hubbard
U.S. EPA
Region III

This memorandum responds to your request for oral and inhalation absorption factors for multiple chemicals for use at the Berkley Products Co. Dump, Denver, PA.

Attached please find the following **Risk Assessment Issue Papers:**

- **Attachment I.** Oral Absorption for Arsenic (CASRN 7440-38-2)
- **Attachment II.** Provisional Oral Absorption Factors for Barium (CASRN 7440-39-3)
- **Attachment III.** Oral Absorption for Chloroform (CASRN 67-66-5)
- **Attachment IV.** Oral Absorption for Copper (CASRN 7440-50-8)
- **Attachment V.** Oral Absorption for 1,2-Dichloroethene
- **Attachment VI.** Oral Absorption for Ethylbenzene (CASRN 100-41-4)
- **Attachment VII.** Oral Absorption for Mercury (CASRN 7439-97-6)
- **Attachment VIII.** Oral Absorption for Nickel (CASRN 7440-02-0)
- **Attachment IX.** Oral Absorption for Tetrachloroethylene (CASRN 127-18-4)
- **Attachment X.** Oral Absorption for Toluene (CASRN 108-88-3)
- **Attachment XI.** Oral Absorption for Vinyl Chloride (CASRN 75-01-4)
- **Attachment XII.** Oral Absorption for Xylene (CASRN 1330-20-7)

· Attachment XIII. Oral Absorption for Zinc (CASRN 7440-66-6)

We do not have any oral RfD information available for delta-hexachlorocyclohexane. A weight-of-evidence classification of "D" for this chemical is available on IRIS (U.S. EPA, 1993).

Please feel free to contact the Superfund Technical Support Center at (513) 569-7300 if you have further questions.

Attachments

cc: R. Harris (Region III)

Reference:

U.S. EPA. 1993. Integrated Risk Information System (IRIS). Online. Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH.

Attachment I.

(10-09-92)

Risk Assessment Issue Paper for:
Oral Absorption for Arsenic (CASRN 7440-38-2)

Available EPA documents (U.S. EPA, 1980, 1984) and the ATSDR Toxicological Profile on Arsenic (ATSDR, 1993) reviewed data for humans indicating that greater than 95% of ingested, water-soluble arsenic is absorbed by the gastrointestinal tract; data for animals indicate that poorly soluble arsenic compounds are absorbed less efficiently. These data indicate that the assumption of a value of 95% for oral absorption of inorganic arsenic compounds is reasonable.

References:

ATSDR (Agency for Toxic Substances and Disease Registry). 1993. Toxicological Profile for Arsenic. ATSDR, U.S. Public Health Service, Atlanta, GA.

U.S. EPA. 1980. Water Quality Criteria Document for Arsenic. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Drinking Water, Washington, DC. EPA 440/5-80/021. NTIS PB81-117327/AS

U.S. EPA. 1984. Health Effects Assessment for Arsenic. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Emergency and Remedial Response, Washington, DC. EPA 540/1-86/020. NTIS PB86-134319/AS.

Attachment III.

(2/91)

Risk Assessment Issue Paper for:
Oral Absorption for Chloroform (CASRN 67-66-5)

As reviewed by U.S. EPA (1980, 1985, 1988) and ATSDR (1993), oral absorption of chloroform is nearly complete in both animals and humans. In rats, mice and monkeys 93-98% of the administered dose of radioactivity was recovered in exhaled air, urine and carcass (U.S. EPA, 1985, 1988). According to ATSDR (1993) approximately 100% of chloroform is absorbed rapidly in humans.

References:

ATSDR. 1993. Toxicological Profile for Chloroform. Agency for Toxic Substances and Disease Registry. U.S. Public Health Service. Atlanta, GA.

U.S. EPA. 1980. Ambient Water Quality Criteria for Chloroform. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Water Regulations and Standards, Washington, DC.

U.S. EPA. 1985. Health Assessment Document for Chloroform. Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for Office of Air Quality Planning and Standards, Washington, DC.

U.S. EPA. 1988. Updated Health Effects Assessment for Chloroform. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Emergency and Remedial Response, Washington, DC.

Attachment V.

Risk Assessment Issue Paper for: Oral Absorption for 1,2-Dichloroethene

Review documents for 1,2-dichloroethene (ATSDR, 1990; U.S. EPA, 1980, 1984a, 1984b, 1986, 1990) did not find any data regarding oral absorption in humans or animals. However, based on analogy to related compounds (e.g., tetrachloroethene), U.S. EPA (1980) estimated that virtually 100% of ingested dichloroethenes might be absorbed by the gut, and subsequent studies found this to be the case for the 1,1-isomer in animals (U.S. EPA, 1986). Therefore, a value of 100% is a reasonable assumed value for gastrointestinal absorption of 1,2-dichloroethene.

References:

ATSDR (Agency for Toxic Substances and Disease Registry). 1990. Toxicological Profile for 1,2-Dichloroethenes. ATSDR, U.S. Public Health Service, Atlanta, GA.

U.S. EPA. 1980. Ambient Water Quality Criteria Document for Dichloroethylenes. Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH. EPA 440/5-80/041. PB81-117525.

U.S. EPA. 1984a. Health Effects Assessment for cis-1,2-Dichloroethylene. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH. for the Office of Emergency and Remedial Response, Washington, D.C. EPA 540/1-86/015. PB86-134269.

U.S. EPA. 1984b. Health Effects Assessment for 1,2-t-Dichloroethylene. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH. for the Office of Emergency and Remedial Response, Washington, D.C. EPA 540/1-86/041. PB86-134525.

U.S. EPA. 1986. Health and Environmental Effects Profile for Dichloroethenes. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH. for the Office of Solid Waste and Emergency Response, Washington, D.C. ECAO-CIN-P191. PB88-218995.

U.S. EPA. 1990. Health and Environmental Effects Document for cis-1,2-Dichloroethylene. Prepared by the Office of Health and

Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH. for the Office of Solid Waste and Emergency Response, Washington, D.C. ECAO-CIN-G098.

Attachment VIII.

(92/51?/05-22-92)

Risk Assessment Issue Paper for:
Oral Absorption for Nickel (CASRN 7440-02-0)

Absorption data for humans and animals indicate that the percentage oral absorption of soluble nickel salts is influenced by (*i.e., decreased by*) adsorption to dietary components and soil (U.S. EPA, 1986 and the ATSDR, 1993). In general, the values in the reviewed studies ranged from approximately 1 to 10%; values at the high end of this range were identified in fasted individuals, while values at the low end were for absorption in the presence of food or soil.

According to U.S. EPA (1986), the data by Horak and Sunderman (1973), Nodiya (1972), Nomoto and Sunderman (1970), Perry and Perry (1959), and Tedeschi and Sunderman (1957) show that 1 to 10 percent of dietary nickel is absorbed. As noted in ATSDR (1993), nickel was reportedly absorbed in the gastrointestinal tract 40 times more when nickel sulfate was given to human subjects in drinking water (27%) than when it was given in food (0.7%) (Sunderman et al., 1989). The study by Christensen and Lagesson (1981) estimated an absorption rate of 4.3% of the given dose of nickel in eight human subjects consuming a normal diet. Thus, the presence of food profoundly reduced nickel absorption.

References:

ATSDR. 1993. Toxicological Profile for Nickel. Agency for Toxic Substances and Disease Registry, U.S. Public Health Service.

Christensen, O.B. and V. Lagesson. 1981. Nickel concentrations of blood and urine after oral administration. Ann. Clin. Lab. Sci. 11: 119-125.

Horak, E. and F.W. Sunderman, Jr. 1973. Fecal nickel excretion by healthy adults. Clin. Chem. (Winston-Salem, NC) 19: 429-430.

Nodiya, P.I. 1972. Cobalt and nickel balance in students of an occupational technical school. Gig. Sanit. 37: 108-109.

Nomoto, S. and F.W. Sunderman, Jr. 1970. Atomic absorption spectrometry of nickel in serum, urine, and other biological materials. Clin. Chem. (Winston-Salem, NC) 16: 477-485.

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Perry, H.M., Jr. and E.F. Perry. 1959. Normal concentrations of some trace metals in human urine: changes produced by ethylenediaminetetraacetate. J. Clin. Invest. 38: 1452-1463.

Sunderman, F.W., Jr., Hopfer, S.M., Sweeney, K.R. et al. 1989. Nickel absorption and kinetics in human volunteers. Proc. Soc. Exp. Biol. Med. 191: 5-11.

Tedeschi, R.E. and F.W. Sunderman, Jr. 1957. Nickel poisoning. V. The metabolism of nickel under normal conditions and after expsoure to nickel carbonyl. Arch. Ind. Health 16: 486-488.

U.S. EPA. 1986. Health Assessment Document for Nickel and Nickel Compounds. Office of Health and Environmental Assessment, Washington, DC. EPA/600/8-83/012FF.

Attachment XI.

Risk Assesssment Issue Paper for:
Oral Absorption for Vinyl Chloride (CASRN 75-01-4)

Review documents from U.S. EPA (1980, 1984, 1985) and ATSDR (1991) summarize the oral absorption data for vinyl chloride. Human data were not located, but animal data show that vinyl chloride is rapidly, and nearly completely, absorbed from the gastrointestinal tract. In rats given gavage doses ranging from 0.05 to 100 mg/kg, only 0.47-2.39% was recovered in the feces after 72 hours. Total recovery was 82.3-91.3%, so roughly 97.1-99.5% of the recovered dose was absorbed in this study. Fecal excretion was higher (8-17%) in a second study in which rats were given powdered PVC containing a high level of the monomer, but this was attributed by the researchers to encapsulation of vinyl chloride monomer by PVC, making the monomer unavailable for absorption. Therefore, an oral absorption factor of 100% is supported by the available data.

References:

ATSDR (Agency for Toxic Substances and Disease Registry). 1993. Toxicological Profile for Vinyl Chloride. ATSDR, U.S. Public Health Service, Atlanta, GA.

U.S. EPA. 1980. Ambient Water Quality Criteria Document for Vinyl Chloride. Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH. EPA 440/5-80/078. PB81-117889.

U.S. EPA. 1984. Health Effects Assessment for Vinyl Chloride. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH. for the Office of Emergency and Remedial Response, Washington, D.C. EPA 540/1-86/036. PB86-134475.

U.S. EPA. 1985. Health and Environmental Effects Profile for Chloroethene. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH. for the Office of Solid Waste and Emergency Response, Washington, D.C. ECAO-CIN-P155. PB88-174529.

Attachment XIII.

(10-09-92)

Risk Assessment Issue Paper for:
Oral Absorption for Zinc (CASRN 7440-66-6)

As reviewed by the U.S. EPA (1980; 1984) and the ATSDR (1989), the absorption of zinc from the gastrointestinal tract is dependent on several factors including the chemical form of zinc, the presence of other chemicals and the zinc status of the organism. A high concentration of phytate and dietary fiber will decrease the absorption of zinc; zinc associated with animal protein in the diet (meat, milk, eggs) is thought to be more efficiently absorbed than zinc in vegetable tissue. ATSDR (1989) reported that approximately 20-30% of all ingested zinc is absorbed. NAS (1989) used an absorption factor of 20% for its calculation of the recommended dietary allowance (RDA) for zinc. The 20% absorption factor was used to take into account the lower absorption of zinc from fiber rich diets as compared to the higher absorption in meat-containing meals. Based on this information, an oral absorption efficiency value within the reported range of 20% to 30% is recommended for adjustment of the oral RfD to an absorbed-dose basis. A value of 25% appears consistent with this recommendation and the data reviewed in Agency documents (U.S. EPA, 1980; 1984) and the ATSDR Toxicological Profile on Zinc.

References:

ATSDR. 1989. Toxicological Profile for Zinc. Agency for Toxic Substances and Disease Registry, U.S. Public Health Service. PB/90/171414/AS.

NAS. 1989. Recommended Dietary Allowances, 10th ed. National Academy of Science, National Research Council, Food and Nutrition Board. Washington DC: National Academy Press.

U.S. EPA. 1980. Ambient Water Quality Criteria Document for Zinc and Compounds. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH for the Office of Water Regulations and Standards, Washington, D.C. EPA 440/5-80/079.

U.S. EPA. 1984. Health Effects Assessment for Zinc and Compounds. Prepared by the Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH. For the Office of Solid Waste and Emergency Response, Washington, D.C. EPA 540/1-86/048.

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O Human Health Risk Tables

DIRECTORY OF RISK TABLES			
Table Number	Location	Exposure Scenario	Receptors
O-1	Site 1	Recreational sediment exposure	Adolescent
O-2	Site 1	Future residential groundwater use	Adult Child
O-3	Site 2	Recreational sediment exposure	Adolescent
O-4	Site 2	Future residential soil exposure	Adult/child Child
O-5	Site 2	Future residential groundwater use	Adult Child

Table 0-1

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 1 - Recreational Exposure to Sediment

Location	Chemical	Exposure Point Concentration (mg/kg)	Noncarcinogenic Effects			Carcinogenic Effects		
			Oral RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Oral SF $(mg/kg\text{-}day)^{-1}$	LADI (mg/kg-day)	Cancer Risk
Adolescent Visitor; RME Case								
Site 1: Old Landfill								
	Pathway 1A: Ingestion of Soil/Sediment		SIF - Noncancer = 1.63E-07			SIF - Cancer = 2.33E-08		
	Arsenic	1.5E+00	3.0E-04	2.5E-07	8.3E-04	1.5E+00	3.6E-08	5.3E-08
	Benzo[a]anthracene	1.1E+00	NA	1.7E-07	--	7.3E-01	2.5E-08	1.8E-08
	Benzo[a]pyrene	1.0E+00	NA	1.6E-07	--	7.3E+00	2.3E-08	1.7E-07
	Benzo[b]fluoranthene	1.4E+00	NA	2.3E-07	--	7.3E-01	3.4E-08	2.4E-08
	Benzo[k]fluoranthene	6.7E-01	NA	1.1E-07	--	7.3E-02	1.6E-08	1.1E-09
	Beryllium	8.3E-01	5.0E-03	1.4E-07	2.7E-05	4.3E+00	1.9E-08	8.3E-08
	Chlordane	3.2E-02	6.0E-05	5.2E-09	8.6E-05	1.3E+00	7.4E-10	9.6E-10
	Chrysene	1.1E+00	NA	1.8E-07	--	7.3E-03	2.6E-08	1.9E-10
	Di(2-ethylhexyl)phthalate	2.5E-01	2.0E-02	4.1E-08	2.1E-06	1.4E-02	5.9E-09	8.3E-11
	Dibenz[a,h]anthracene	3.4E-01	NA	5.5E-08	--	7.3E+00	7.9E-09	5.7E-08
	Indeno[1,2,3-cd]pyrene	7.9E-01	NA	1.3E-07	--	7.3E-01	1.8E-08	1.3E-08
	Iron	2.9E+04	3.0E-01	4.6E-03	1.5E-02	NA	--	--
	Manganese	1.2E+03	2.0E-02	1.9E-04	9.6E-03	NA	--	--
	Thallium	1.1E+00	7.0E-05	1.7E-07	2.5E-03	NA	--	--
	Vanadium	2.6E+01	7.0E-03	4.3E-06	6.2E-04	NA	--	--
	Zinc	5.6E+01	3.0E-01	9.1E-06	3.0E-05	NA	--	--
	Totals for Ingestion of Soil/Sediment				2.9E-02			4.2E-07

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Table 0-1

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 1 - Recreational Exposure to Sediment

Location	Chemical	Exposure Point Concentration (mg/kg)	Noncarcinogenic Effects			Carcinogenic Effects		
			Oral RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Oral SF $(mg/kg\text{-}day)^{-1}$	LADI (mg/kg-day)	Cancer Risk
Site 1: Old Landfill								
	Pathway 1B: Dermal Absorption from Soil/Sediment		SIF - Noncancer = 5.06E-06			SIF - Cancer = 7.22E-07		
	Arsenic	1.5E+00	3.0E-04	2.5E-07	8.7E-04	1.5E+00	3.5E-08	5.6E-08
	Beryllium	8.3E-01	5.0E-03	4.2E-08	8.4E-04	4.3E+00	6.0E-09	2.6E-06
	Chlordane	3.2E-02	6.0E-05	1.6E-08	3.3E-04	1.3E+00	2.3E-09	3.7E-09
	Di(2-ethylhexyl)phthalate	2.5E-01	2.0E-02	1.3E-07	1.3E-05	1.4E-02	1.8E-08	5.1E-10
	Iron	2.9E+04	3.0E-01	1.4E-03	4.8E-02	NA	--	--
	Manganese	1.2E+03	2.0E-02	6.0E-05	3.0E-02	NA	--	--
	Thallium	1.1E+00	7.0E-05	5.4E-08	8.1E-04	NA	--	--
	Vanadium	2.6E+01	7.0E-03	1.3E-06	1.9E-02	NA	--	--
	Zinc	5.6E+01	3.0E-01	2.8E-06	3.7E-05	NA	--	--
	Totals for Dermal Absorption from Soil/Sediment				**1.0E-01**			**2.6E-06**

Table 0-1

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 1 - Recreational Exposure to Sediment

Location	Chemical	Exposure Point Concentration N/A	Noncarcinogenic Effects			Carcinogenic Effects		
			Oral RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Oral SF $(mg/kg\text{-}day)^{-1}$	LADI (mg/kg-day)	Cancer Risk
Site 1: Old Landfill								
	Totals by Chemical		SIF - Noncancer = 5.22E-06			SIF - Cancer = 7.46E-07		
	Arsenic	--	--	5.0E-07	1.7E-03	--	7.1E-08	1.1E-07
	Benzo[a]anthracene	--	--	1.7E-07	--	--	2.5E-08	1.8E-08
	Benzo[a]pyrene	--	--	1.6E-07	--	--	2.3E-08	1.7E-07
	Benzo[b]fluoranthene	--	--	2.3E-07	--	--	3.4E-08	2.4E-08
	Benzo[k]fluoranthene	--	--	1.1E-07	--	--	1.6E-08	1.1E-09
	Beryllium	--	--	1.8E-07	8.7E-04	--	2.5E-08	2.7E-06
	Chlordane	--	--	2.1E-08	4.2E-04	--	3.0E-09	4.7E-09
	Chrysene	--	--	1.8E-07	--	--	2.6E-08	1.9E-10
	Di(2-ethylhexyl)phthalate	--	--	1.7E-07	1.5E-05	--	2.4E-08	5.9E-10
	Dibenz[a,h]anthracene	--	--	5.5E-08	--	--	7.9E-09	5.7E-08
	Indeno[1,2,3-cd]pyrene	--	--	1.3E-07	--	--	1.8E-08	1.3E-08
	Iron	--	--	6.1E-03	6.4E-02	--	--	--
	Manganese	--	--	2.5E-04	3.9E-02	--	--	--
	Thallium	--	--	2.3E-07	3.3E-03	--	--	--
	Vanadium	--	--	5.6E-06	2.0E-02	--	--	--
	Zinc	--	--	1.2E-05	6.8E-05	--	--	--
	Totals for Adolescent Visitor at Site 1: Old Landfill; RMECase:				1.3E-01			3.1E-06

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Table 0-2

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 3 - Future Residential Groundwater Usage

Location	Chemical	Exposure Point Concentration (mg/L)	Noncarcinogenic Effects			Carcinogenic Effects		
			Oral RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Oral SF (mg/kg-day)$^{-1}$	LADI (mg/kg-day)	Cancer Risk
Future Adult Resident; RME Case								
Site 1: Old Landfill								
	Pathway 3A: Ingestion of Water		SIF - Noncancer = 2.74E-02			SIF - Cancer = 1.17E-02		
	Antimony	3.0E-02	4.0E-04	8.2E-04	2.1E+00	NA	--	--
	Arsenic	1.0E-03	3.0E-04	2.8E-05	9.5E-02	1.5E+00	1.2E-05	1.8E-05
	Beryllium	2.6E-04	5.0E-03	7.1E-06	1.4E-03	4.3E+00	3.0E-06	1.3E-05
	Cadmium	2.5E-03	5.0E-04	6.9E-05	1.4E-01	NA	2.9E-05	--
	Chlorobenzene	9.0E-02	2.0E-02	2.5E-03	1.2E-01	NA	--	--
	Chloroform	4.0E-03	1.0E-02	1.1E-04	1.1E-02	6.1E-03	4.7E-05	2.9E-07
	Chromium(VI)	7.7E-03	5.0E-03	2.1E-04	4.2E-02	NA	9.0E-05	--
	Di(2-ethylhexyl)phthalate	6.5E-03	2.0E-02	1.8E-04	8.8E-03	1.4E-02	7.6E-05	1.1E-06
	Dichlorobenzene, 1,4-	9.8E-03	NA	2.7E-04	--	2.4E-02	1.1E-04	2.7E-06
	Dichloroethene, 1,2- (Mixed isomers)	1.4E-02	9.0E-03	3.7E-04	4.1E-02	NA	--	--
	Dichloropropane, 1,2-	1.0E-03	NA	2.7E-05	--	6.8E-02	1.2E-05	8.0E-07
	Heptachlor	2.6E-05	5.0E-04	7.1E-07	1.4E-03	4.5E+00	3.0E-07	1.4E-06
	Iron	2.5E+01	3.0E-01	6.7E-01	2.2E+00	NA	--	--
	Manganese	7.0E+00	2.0E-02	1.9E-01	9.5E+00	NA	--	--
	Methylene chloride	6.3E-03	6.0E-02	1.7E-04	2.9E-03	7.5E-03	7.3E-05	5.5E-07
	Nickel, soluble salts	2.0E-02	2.0E-02	5.4E-04	2.7E-02	NA	--	--
	Thallium	1.0E-03	7.0E-05	2.8E-05	4.1E-01	NA	--	--
	Trichloroethene	6.4E-03	NA	1.8E-04	--	1.1E-02	7.5E-05	8.3E-07
	Vinyl chloride	6.6E-04	NA	1.8E-05	--	1.9E+00	7.8E-06	1.5E-05
	Totals for Ingestion of Water				**1.5E+01**			**5.4E-05**

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Table D-2

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 3 - Future Residential Groundwater Usage

Location	Chemical	Exposure Point Concentration (mg/L)	Noncarcinogenic Effects			Carcinogenic Effects		
			Oral RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Oral SF (mg/kg-day)$^{-1}$	LADI (mg/kg-day)	Cancer Risk
Site 1: Old Landfill								
	Pathway 3B: Dermal Absorption from Water		SIF - Noncancer = 2.74E-01			SIF - Cancer = 1.17E-01		
	Antimony	3.0E-02	4.0E-04	2.1E-06	5.2E-02	NA	--	--
	Arsenic	1.0E-03	3.0E-04	7.1E-08	2.5E-04	1.5E+00	3.1E-08	4.8E-08
	Beryllium	2.6E-04	5.0E-03	1.8E-08	3.5E-04	4.3E+00	7.6E-09	3.3E-06
	Cadmium	2.5E-03	5.0E-04	1.7E-07	6.9E-03	NA	7.4E-08	--
	Chlorobenzene	9.0E-02	2.0E-02	9.0E-04	9.0E-02	NA	--	--
	Chloroform	4.0E-03	1.0E-02	9.2E-06	9.2E-04	6.1E-03	4.0E-06	2.4E-08
	Chromium(VI)	7.7E-03	5.0E-03	5.2E-07	1.0E-03	NA	2.2E-07	--
	Di(2-ethylhexyl)phthalate	5.5E-03	2.0E-02	3.8E-04	3.8E-02	1.4E-02	1.6E-04	4.5E-06
	Dichlorobenzene, 1,4-	9.8E-03	NA	1.9E-04	--	2.4E-02	8.1E-05	1.9E-06
	Dichloroethene, 1,2- (Mixed isomers)	1.4E-02	9.0E-03	3.1E-05	3.4E-03	NA	--	--
	Dichloropropane, 1,2-	1.0E-03	NA	2.5E-06	--	6.8E-02	1.1E-06	7.4E-08
	Heptachlor	2.6E-05	5.0E-04	4.3E-07	8.6E-04	4.5E+00	1.8E-07	8.3E-07
	Iron	2.5E+01	3.0E-01	1.7E-03	5.6E-02	NA	--	--
	Manganese	7.0E+00	2.0E-02	4.8E-04	2.4E-01	NA	--	--
	Methylene chloride	6.3E-03	6.0E-02	5.7E-06	9.4E-05	7.5E-03	2.4E-06	1.8E-08
	Nickel, soluble salts	2.0E-02	2.0E-02	1.3E-06	1.3E-03	NA	--	--
	Thallium	1.0E-03	7.0E-05	7.1E-08	1.1E-03	NA	--	--
	Trichloroethene	6.4E-03	NA	2.8E-05	--	1.1E-02	1.2E-05	1.3E-07
	Vinyl chloride	6.6E-04	NA	8.4E-07	--	1.9E+00	3.6E-07	6.9E-07
	Totals for Dermal Absorption from Water				4.9E-01			1.2E-05

Table 0-2

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 3 - Future Residential Groundwater Usage

Location	Chemical	Exposure Point Concentration (mg/L)	Noncarcinogenic Effects			Carcinogenic Effects		
			Inh RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Inh SF (mg/kg-day)$^{-1}$	LADI (mg/kg-day)	Cancer Risk
Site 1: Old Landfill								
	Pathway 3C: Inhalation of Vapors while Showering (Foster & Chrostowski)		SIF - Noncancer = ---			SIF - Cancer = ---		
	Chlorobenzere	9.0E-02	5.7E-03	3.9E-03	6.9E-01	NA	--	--
	Chloroform	4.0E-03	1.1E-02	1.7E-04	1.6E-02	8.0E-02	7.3E-05	5.9E-06
	Di(2-ethylhexyl)phthalate	6.5E-03	2.9E-03	1.2E-05	4.0E-03	NA	4.9E-06	--
	Dichlorobenzene, 1,4-	9.8E-03	2.3E-01	3.8E-04	1.6E-03	NA	1.6E-04	--
	Dichloropropane, 1,2-	1.0E-03	1.1E-03	4.3E-05	3.8E-02	NA	1.8E-05	--
	Heptachlor	2.6E-05	NA	6.2E-07	--	4.5E+00	2.6E-07	1.2E-06
	Methylene chloride	6.3E-03	8.6E-01	2.9E-04	3.4E-04	1.6E-03	1.3E-04	2.1E-07
	Trichloroethene	6.4E-03	NA	2.7E-04	--	6.0E-03	1.2E-04	7.0E-07
	Vinyl chloride	6.6E-04	NA	3.7E-05	--	3.0E-01	1.6E-05	4.8E-06
	Totals for Inhalation of Vapors while Showering (Foster & Chrostowski)				**7.5E-01**			**1.3E-05**

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0-11

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Table 0-2

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 3 - Future Residential Groundwater Usage

Location	Chemical	Exposure Point Concentration N/A	Noncarcinogenic Effects			Carcinogenic Effects		
			Oral RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Oral SF $(mg/kg\text{-}day)^{-1}$	LADI (mg/kg-day)	Cancer Risk
Site 1: Old Landfill								
	Totals by Chemical		SIF - Noncancer = 3.01E-01			SIF - Cancer = 1.29E-01		
	Antimony	--	--	8.3E-04	2.1E+00	--	--	--
	Arsenic	--	--	2.9E-05	9.5E-02	--	1.2E-05	1.8E-05
	Beryllium	--	--	7.1E-06	1.8E-03	--	3.0E-06	1.6E-05
	Cadmium	--	--	6.9E-05	1.4E-01	--	3.0E-05	--
	Chlorobenzene	--	--	7.3E-03	9.0E-01	--	--	--
	Chloroform	--	--	2.9E-04	2.7E-02	--	1.2E-04	6.2E-06
	Chromium(VI)	--	--	2.1E-04	4.3E-02	--	9.0E-05	--
	Di(2-ethylhexyl)phthalate	--	--	5.6E-04	5.0E-02	--	2.4E-04	5.6E-06
	Dichlorobenzene, 1,4-	--	--	8.3E-04	1.6E-03	--	3.6E-04	4.7E-06
	Dichloroethene, 1,2- (Mixed isomers)	--	--	4.0E-04	4.4E-02	--	--	--
	Dichloropropane, 1,2-	--	--	7.3E-05	3.8E-02	--	3.1E-05	8.7E-07
	Heptachlor	--	--	1.8E-06	2.3E-03	--	7.5E-07	3.4E-06
	Iron	--	--	6.7E-01	2.3E+00	--	--	--
	Manganese	--	--	1.9E-01	9.8E+00	--	--	--
	Methylene chloride	--	--	4.7E-04	3.3E-03	--	2.0E-04	7.3E-07
	Nickel, soluble salts	--	--	5.4E-04	2.8E-02	--	--	--
	Thallium	--	--	2.9E-05	4.1E-01	--	--	--
	Trichloroethene	--	--	4.8E-04	--	--	2.0E-04	1.7E-06
	Vinyl chloride	--	--	5.6E-05	--	--	2.4E-05	2.0E-05
	Totals for Future Adult Resident at Site 1: Old Landfill; RMECase:				**1.6E+01**			**7.8E-05**

Table 0-2

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 3 - Future Residential Groundwater Usage

Location	Chemical	Exposure Point Concentration (mg/L)	Noncarcinogenic Effects			Carcinogenic Effects		
			Oral RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Oral SF $(mg/kg\text{-}day)^{-1}$	LADI (mg/kg-day)	Cancer Risk
Future Child Resident; RME Case								
Site 1: Ole Landfill								
	Pathway 3A: Ingestion of Water		SIF - Noncancer = 6.39E-02			SIF - Cancer = 5.48E-03		
	Antimony	3.0E-02	4.0E-04	1.9E-03	4.8E+00	NA	--	--
	Arsenic	1.0E-03	3.0E-04	6.6E-05	2.2E-01	1.5E+00	5.7E-06	8.5E-06
	Beryllium	2.6E-04	5.0E-03	1.7E-05	3.3E-03	4.3E+00	1.4E-06	6.1E-06
	Cadmium	2.5E-03	5.0E-04	1.6E-04	3.2E-01	NA	1.4E-05	--
	Chlorobenzene	9.0E-02	2.0E-02	5.7E-03	2.9E-01	NA	--	--
	Chloroform	4.0E-03	1.0E-02	2.6E-04	2.6E-02	6.1E-03	2.2E-05	1.3E-07
	Chromium(VI)	7.7E-03	5.0E-03	4.9E-04	9.8E-02	NA	4.2E-05	--
	Di(2-ethylhexyl)phthalate	6.5E-03	2.0E-02	4.1E-04	2.1E-02	1.4E-02	3.5E-05	5.0E-07
	Dichlorobenzene, 1,4-	9.8E-03	NA	6.2E-04	--	2.4E-02	5.3E-05	1.3E-06
	Dichloroethene, 1,2- (Mixed isomers)	1.4E-02	9.0E-03	8.6E-04	9.6E-02	NA	--	--
	Dichloropropane, 1,2-	1.0E-03	NA	6.4E-05	--	6.8E-02	5.5E-06	3.7E-07
	Heptachlor	2.6E-05	5.0E-04	1.7E-06	3.3E-03	4.5E+00	1.4E-07	6.4E-07
	Iron	2.5E+01	3.0E-01	1.6E+00	5.2E+00	NA	--	--
	Manganese	7.0E+00	2.0E-02	4.5E-01	2.2E+01	NA	--	--
	Methylene chloride	6.3E-03	6.0E-02	4.0E-04	6.7E-03	7.5E-03	3.4E-05	2.6E-07
	Nickel, soluble salts	2.0E-02	2.0E-02	1.3E-03	6.3E-02	NA	--	--
	Thallium	1.0E-03	7.0E-05	6.6E-05	9.5E-01	NA	--	--
	Trichloroethene	6.4E-03	NA	4.1E-04	--	1.1E-02	3.5E-05	3.9E-07
	Vinyl chloride	6.6E-04	NA	4.2E-05	--	1.9E+00	3.6E-06	6.9E-06
	Totals for Ingestion of Water				3.4E+01			2.5E-05

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Table 0-2

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 3 - Future Residential Groundwater Usage

Location	Chemical	Exposure Point Concentration (mg/L)	Noncarcinogenic Effects			Carcinogenic Effects		
			Oral RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Oral SF $(mg/kg\text{-}day)^{-1}$	LADI (mg/kg-day)	Cancer Risk
Site 1: Old Landfill								
	Pathway 3B: Dermal Absorption from Water		SIF - Noncancer = 4.22E-01			SIF - Cancer = 3.62E-02		
	Antimony	3.0E-02	4.0E-04	3.2E-06	7.9E-02	NA	--	--
	Arsenic	1.0E-03	3.0E-04	1.1E-07	3.8E-04	1.5E+00	9.4E-09	1.5E-08
	Beryllium	2.6E-04	5.0E-03	2.7E-08	5.5E-04	4.3E+00	2.3E-09	1.0E-06
	Cadmium	2.5E-03	5.0E-04	2.6E-07	1.1E-02	NA	2.3E-08	--
	Chlorobenzene	9.0E-02	2.0E-02	1.4E-03	1.4E-01	NA	--	--
	Chloroform	4.0E-03	1.0E-02	1.4E-05	1.4E-03	6.1E-03	1.2E-06	7.4E-09
	Chromium(V.)	7.7E-03	5.0E-03	8.1E-07	1.6E-03	NA	6.9E-08	--
	Di(2-ethylhexyl)phthalate	6.5E-03	2.0E-02	5.8E-04	5.8E-02	1.4E-02	5.0E-05	1.4E-06
	Dichlorobenzene, 1,4-	9.8E-03	NA	2.9E-04	--	2.4E-02	2.5E-05	6.0E-07
	Dichloroethene, 1,2- (Mixed isomers)	1.4E-02	9.0E-03	4.7E-05	5.2E-03	NA	--	--
	Dichloropropane, 1,2-	1.0E-03	NA	3.9E-06	--	6.8E-02	3.4E-07	2.3E-08
	Heptachlor	2.6E-05	5.0E-04	6.6E-07	1.3E-03	4.5E+00	5.7E-08	2.5E-07
	Iron	2.5E+01	3.0E-01	2.6E-03	8.6E-02	NA	--	--
	Manganese	7.0E+00	2.0E-02	7.4E-04	3.7E-01	NA	--	--
	Methylene chloride	6.3E-03	6.0E-02	8.7E-06	1.5E-04	7.5E-03	7.5E-07	5.6E-09
	Nickel, soluble salts	2.0E-02	2.0E-02	2.1E-06	2.1E-03	NA	--	--
	Thallium	1.0E-03	7.0E-05	1.1E-07	1.6E-03	NA	--	--
	Trichloroethene	6.4E-03	NA	4.4E-05	--	1.1E-02	3.7E-06	4.1E-08
	Vinyl chloride	6.6E-04	NA	1.3E-06	--	1.9E+00	1.1E-07	2.1E-07
	Totals for Dermal Absorption from Water				7.5E-01			3.6E-06

Table 0-2

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 3 - Future Residential Groundwater Usage

Location	Chemical	Exposure Point Concentration N/A	Noncarcinogenic Effects: Oral RfD (mg/kg-day)	Noncarcinogenic Effects: ADI (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient	Carcinogenic Effects: Oral SF (mg/kg-day)$^{-1}$	Carcinogenic Effects: LADI (mg/kg-day)	Carcinogenic Effects: Cancer Risk
Site 1: Old Landfill								
	Totals by Chemical		SIF - Noncancer = 4.86E-01			SIF - Cancer = 4.16E-02		
	Antimony	--	--	1.9E-03	4.9E+00	--	--	--
	Arsenic	--	--	6.7E-05	2.2E-01	--	5.7E-06	8.6E-06
	Beryllium	--	--	1.7E-05	3.9E-03	--	1.4E-06	7.1E-06
	Cadmium	--	--	1.6E-04	3.3E-01	--	1.4E-05	--
	Chlorobenzene	--	--	7.1E-03	4.3E-01	--	--	--
	Chloroform	--	--	2.7E-04	2.7E-02	--	2.3E-05	1.4E-07
	Chromium(VI)	--	--	4.9E-04	9.9E-02	--	4.2E-05	--
	Di(2-ethylhexyl)phthalate	--	--	9.9E-04	7.9E-02	--	8.5E-05	1.9E-06
	Dichlorobenzene, 1,4-	--	--	9.1E-04	--	--	7.8E-05	1.9E-06
	Dichloroethene, 1,2- (Mixed isomers)	--	--	9.1E-04	1.0E-01	--	--	--
	Dichloropropane, 1,2-	--	--	6.8E-05	--	--	5.8E-06	4.0E-07
	Heptachlor	--	--	2.3E-06	4.6E-03	--	2.0E-07	8.9E-07
	Iron	--	--	1.6E+00	5.3E+00	--	--	--
	Manganese	--	--	4.5E-01	2.3E+01	--	--	--
	Methylene chloride	--	--	4.1E-04	6.8E-03	--	3.5E-05	2.6E-07
	Nickel, soluble salts	--	--	1.3E-03	6.5E-02	--	--	--
	Thallium	--	--	6.7E-05	9.5E-01	--	--	--
	Trichloroethene	--	--	4.5E-04	--	--	3.9E-05	4.3E-07
	Vinyl chloride	--	--	4.4E-05	--	--	3.7E-06	7.1E-06
	Totals for Future Child Resident at Site 1: Old Landfill; RMECase:				**3.5E+01**			**2.9E-05**

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Table 0-3

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 1 - Recreational Exposure to Sediment

Location	Chemical	Exposure Point Concentration (mg/kg)	Noncarcinogenic Effects: Oral RfD (mg/kg-day)	Noncarcinogenic Effects: ADI (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient	Carcinogenic Effects: Oral SF (mg/kg-day)$^{-1}$	Carcinogenic Effects: LADI (mg/kg-day)	Carcinogenic Effects: Cancer Risk
Adolescent Visitor; RME Case								
Site 2: Fire Trng. Area								
	Pathway 1A: Ingestion of Soil/Sediment		SIF - Noncancer = 1.63E-07			SIF - Cancer = 2.33E-08		
	Arsenic	8.3E-01	3.0E-04	1.4E-07	4.5E-04	1.5E+00	1.9E-08	2.9E-08
	Beryllium	3.8E-01	5.0E-03	6.2E-08	1.2E-05	4.3E+00	8.9E-09	3.8E-08
	Iron	8.1E+03	3.0E-01	1.3E-03	4.4E-03	NA	--	--
	Manganese	4.8E+02	2.0E-02	7.8E-05	3.9E-03	NA	--	--
	Totals for Ingestion of Soil/Sediment				8.7E-03			6.7E-08
Site 2: Fire Trng. Area								
	Pathway 1B: Dermal Absorption from Soil/Sediment		SIF - Noncancer = 5.06E-06			SIF - Cancer = 7.22E-07		
	Arsenic	8.3E-01	3.0E-04	1.3E-07	4.7E-04	1.5E+00	1.9E-08	3.0E-08
	Beryllium	3.8E-01	5.0E-03	1.9E-08	3.8E-04	4.3E+00	2.7E-09	1.2E-06
	Iron	8.1E+03	3.0E-01	4.1E-04	1.4E-02	NA	--	--
	Manganese	4.8E+02	2.0E-02	2.4E-05	1.2E-02	NA	--	--
	Totals for Dermal Absorption from Soil/Sediment				2.7E-02			1.2E-06
Site 2: Fire Trng. Area								
	Totals by Chemical		SIF - Noncancer = 5.22E-06			SIF - Cancer = 7.46E-07		
	Arsenic	--	--	2.7E-07	9.2E-04	--	3.9E-08	5.9E-08
	Beryllium	--	--	8.1E-08	4.0E-04	--	1.2E-08	1.2E-06
	Iron	--	--	1.7E-03	1.8E-02	--	--	--
	Manganese	--	--	1.0E-04	1.6E-02	--	--	--
	Totals for Adolescent Visitor at Site 2: Fire Trng. Area; RMECase:				3.5E-02			1.3E-06

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Table 0-4

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 2 - Residential Soil Exposure

Location	Chemical	Exposure Point Concentration (mg/kg)	Noncarcinogenic Effects: Oral RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Carcinogenic Effects: Oral SF $(mg/kg\text{-}day)^{-1}$	LADI (mg/kg-day)	Cancer Risk
Adult/Child (Int) Resident; RME Case								
Site 2: Fire Trng. Area								
	Pathway 2A: Ingestion of Soil/Sediment		SIF - Noncancer = 3.65E-06			SIF - Cancer = 1.57E-06		
	Aluminum	1.5E+04	1.0E+00	5.3E-02	5.3E-02	NA	--	--
	Arsenic	8.1E-01	3.0E-04	3.0E-06	9.9E-03	1.5E+00	1.3E-06	1.9E-06
	Iron	1.8E+04	3.0E-01	6.5E-02	2.2E-01	NA	--	--
	Manganese	5.4E+02	2.0E-02	2.0E-03	9.9E-02	NA	--	--
	Totals for Ingestion of Soil/Sediment				3.8E-01			1.9E-06
Site 2: Fire Trng. Area								
	Pathway 2B: Dermal Absorption from Soil/Sediment		SIF - Noncancer = 8.04E-05			SIF - Cancer = 3.44E-05		
	Aluminum	1.5E+04	1.0E+00	1.2E-02	2.3E-01	NA	--	--
	Arsenic	8.1E-01	3.0E-04	2.1E-06	7.4E-03	1.5E+00	9.0E-07	1.4E-06
	Iron	1.8E+04	3.0E-01	1.4E-02	4.7E-01	NA	--	--
	Manganese	5.4E+02	2.0E-02	4.4E-04	2.2E-01	NA	--	--
	Totals for Dermal Absorption from Soil/Sediment				9.3E-01			1.4E-06
Site 2: Fire Trng. Area								
	Totals by Chemical		SIF - Noncancer = 8.40E-05			SIF - Cancer = 3.60E-05		
	Aluminum	--	--	6.5E-02	2.9E-01	--	--	--
	Arsenic	--	--	5.1E-06	1.7E-02	--	2.2E-06	3.3E-06
	Iron	--	--	7.9E-02	6.9E-01	--	--	--
	Manganese	--	--	2.4E-03	3.2E-01	--	--	--
	Totals for Adult/Child (Int) Resident at Site 2: Fire Trng. Area; RMECase:				1.3E+00			3.3E-06

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Table 0-4

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 2 - Residential Soil Exposure

Location	Chemical	Exposure Point Concentration (mg/kg)	Noncarcinogenic Effects: Oral RfD (mg/kg-day)	Noncarcinogenic Effects: ADI (mg/kg-day)	Noncarcinogenic Effects: Hazard Quotient	Carcinogenic Effects: Oral SF (mg/kg-day)$^{-1}$	Carcinogenic Effects: LADI (mg/kg-day)	Carcinogenic Effects: Cancer Risk
Child Resident; RME Case								
Site 2: Fire Trng. Area								
	Pathway 2A: Ingestion of Soil/Sediment		SIF - Noncancer = 1.28E-05			SIF - Cancer = 1.10E-06		
	Aluminum	1.5E+04	1.0E+00	1.9E-01	1.9E-01	NA	--	--
	Arsenic	8.1E-01	3.0E-04	1.0E-05	3.5E-02	1.5E+00	8.9E-07	1.3E-06
	Iron	1.8E+04	3.0E-01	2.3E-01	7.5E-01	NA	--	--
	Manganese	5.4E+02	2.0E-02	7.0E-03	3.5E-01	NA	--	--
	Totals for Ingestion of Soil/Sediment				**1.3E+00**			**1.3E-06**
Site 2: Fire Trng. Area								
	Pathway 2B: Dermal Absorption from Soil/Sediment		SIF - Noncancer = 1.28E-04			SIF - Cancer = 1.10E-05		
	Aluminum	1.5E+04	1.0E+00	1.9E-02	3.7E-01	NA	--	--
	Arsenic	8.1E-01	3.0E-04	3.3E-06	1.2E-02	1.5E+00	2.9E-07	4.5E-07
	Iron	1.8E+04	3.0E-01	2.3E-02	7.5E-01	NA	--	--
	Manganese	5.4E+02	2.0E-02	7.0E-04	3.5E-01	NA	--	--
	Totals for Dermal Absorption from Soil/Sediment				**1.5E+00**			**4.5E-07**
Site 2: Fire Trng. Area								
	Totals by Chemical		SIF - Noncancer = 1.41E-04			SIF - Cancer = 1.21E-05		
	Aluminum	--	--	2.0E-01	5.6E-01	--	--	--
	Arsenic	--	--	1.4E-05	4.6E-02	--	1.2E-06	1.8E-06
	Iron	--	--	2.5E-01	1.5E+00	--	--	--
	Manganese	--	--	7.7E-03	7.0E-01	--	--	--
	Totals for Child Resident at Site 2: Fire Trng. Area; RMECase:				**2.8E+00**			**1.8E-06**

Table 0-5

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 3 - Future Residential Groundwater Usage

Location	Chemical	Exposure Point Concentration (mg/L)	Noncarcinogenic Effects			Carcinogenic Effects		
			Oral RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Oral SF $(mg/kg\text{-}day)^{-1}$	LADI (mg/kg-day)	Cancer Risk
Future Adult Resident; RME Case								
Site 2: Fire Trng. Area								
	Pathway 3A: Ingestion of Water		SIF - Noncancer = 2.74E-02			SIF - Cancer = 1.17E-02		
	Aldrin	2.8E-05	3.0E-05	7.5E-07	2.5E-02	1.7E+01	3.2E-07	5.5E-06
	Aluminum	1.5E+00	1.0E+00	4.1E-02	4.1E-02	NA	--	--
	Arsenic	1.1E-03	3.0E-04	3.1E-05	1.0E-01	1.5E+00	1.3E-05	2.0E-05
	Benzo[a]anthracene	1.0E-03	NA	2.7E-05	--	7.3E-01	1.2E-05	8.6E-06
	Benzo[a]pyrene	2.0E-03	NA	5.5E-05	--	7.3E+00	2.3E-05	1.7E-04
	Benzo[b]fluoranthene	3.0E-03	NA	8.2E-05	--	7.3E-01	3.5E-05	2.6E-05
	Benzo[k]fluoranthene	2.0E-03	NA	5.5E-05	--	7.3E-02	2.3E-05	1.7E-06
	Beryllium	3.1E-03	5.0E-03	8.5E-05	1.7E-02	4.3E+00	3.6E-05	1.6E-04
	Cadmium	2.7E-03	5.0E-04	7.3E-05	1.5E-01	NA	3.1E-05	--
	Chloroform	5.6E-03	1.0E-02	1.5E-04	1.5E-02	6.1E-03	6.6E-05	4.0E-07
	Chromium(VI)	7.6E-03	5.0E-03	2.1E-04	4.1E-02	NA	8.9E-05	--
	Chrysene	2.0E-03	NA	5.5E-05	--	7.3E-03	2.3E-05	1.7E-07
	Di(2-ethylhexyl)phthalate	6.4E-03	2.0E-02	1.8E-04	8.8E-03	1.4E-02	7.5E-05	1.1E-06
	Dichlorobenzene, 1,4-	1.0E-03	NA	2.7E-05	--	2.4E-02	1.2E-05	2.8E-07
	Indeno[1,2,3-cd]pyrene	2.0E-03	NA	5.5E-05	--	7.3E-01	2.3E-05	1.7E-05
	Iron	7.9E+01	3.0E-01	2.2E+00	7.2E+00	NA	--	--
	Manganese	5.5E+00	2.0E-02	1.5E-01	7.5E+00	NA	--	--
	Methylene chloride	8.0E-03	6.0E-02	2.2E-04	3.6E-03	7.5E-03	9.4E-05	7.0E-07
	Tetrachloroethane, 1,1,2,2-	5.2E-03	NA	1.4E-04	--	2.0E-01	6.2E-05	1.2E-05
	Thallium	1.0E-03	7.0E-05	2.7E-05	3.9E-01	NA	--	--
	Trichloroethene	2.0E-03	NA	5.4E-05	--	1.1E-02	2.3E-05	2.5E-07
	Zinc	2.4E-01	3.0E-01	6.6E-03	2.2E-02	NA	--	--

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Table 0-5

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 3 - Future Residential Groundwater Usage

Location	Chemical	Exposure Point Concentration (mg/L)	Noncarcinogenic Effects			Carcinogenic Effects		
			Oral RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Oral SF $(mg/kg\text{-}day)^{-1}$	LADI (mg/kg-day)	Cancer Risk
	Totals for Ingestion of Water				1.6E+01			4.2E-04
Site 2: Fire Trng. Area								
	Pathway 3B: Dermal Absorption from Water		SIF - Noncancer = 2.74E-01			SIF - Cancer = 1.17E-01		
	Aldrin	2.8E-05	3.0E-05	6.2E-08	2.1E-03	1.7E+01	2.7E-08	4.5E-07
	Aluminum	1.5E+00	1.0E+00	1.0E-04	2.1E-03	NA	--	--
	Arsenic	1.1E-03	3.0E-04	7.7E-08	2.7E-04	1.5E+00	3.3E-08	5.2E-08
	Beryllium	3.1E-03	5.0E-03	2.1E-07	4.2E-03	4.3E+00	9.1E-08	3.9E-05
	Cadmium	2.7E-03	5.0E-04	1.8E-07	7.3E-03	NA	7.8E-08	--
	Chloroform	5.6E-03	1.0E-02	1.3E-05	1.3E-03	6.1E-03	5.6E-06	3.4E-08
	Chromium(VI)	7.6E-03	5.0E-03	5.2E-07	1.0E-03	NA	2.2E-07	--
	Di(2-ethylhexyl)phthalate	6.4E-03	2.0E-02	3.7E-04	3.7E-02	1.4E-02	1.6E-04	4.5E-06
	Dichlorobenzene, 1,4-	1.0E-03	NA	1.9E-05	--	2.4E-02	8.3E-06	2.0E-07
	Iron	7.9E+01	3.0E-01	5.4E-03	1.8E-01	NA	--	--
	Manganese	5.5E+00	2.0E-02	3.8E-04	1.9E-01	NA	--	--
	Methylene chloride	8.0E-03	6.0E-02	7.2E-06	1.2E-04	7.5E-03	3.1E-06	2.3E-08
	Tetrachloroethane, 1,1,2,2-	5.2E-03	NA	1.7E-05	--	2.0E-01	7.3E-06	1.5E-06
	Thallium	1.0E-03	7.0E-05	6.8E-08	1.0E-03	NA	--	--
	Trichloroethene	2.0E-03	NA	8.7E-06	--	1.1E-02	3.7E-06	4.1E-08
	Zinc	2.4E-01	3.0E-01	1.7E-05	2.2E-04	NA	--	--
	Totals for Dermal Absorption from Water				4.3E-01			4.6E-05

Table0-5

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 3 - Future Residential Groundwater Usage

Location	Chemical	Exposure Point Concentration (mg/L)	Noncarcinogenic Effects			Carcinogenic Effects		
			Inh RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Inh SF $(mg/kg\text{-}day)^{-1}$	LADI (mg/kg-day)	Cancer Risk
Site 2: Fire Trng. Area								
	Pathway 3C: Inhalation of Vapors while Showering (Foster & Chrostowski)		SIF - Noncancer = ---			SIF - Cancer = ---		
	Aldrin	2.8E-05	NA	4.7E-07	--	1.7E+01	2.0E-07	3.5E-06
	Benzo[a]anthracene	1.0E-03	NA	1.1E-07	--	6.1E+00	4.8E-08	2.9E-07
	Benzo[a]pyrene	2.0E-03	NA	7.6E-07	--	6.1E+00	3.3E-07	2.0E-06
	Benzo[b]fluoranthene	3.0E-03	NA	5.5E-06	--	6.1E+00	2.3E-06	1.4E-05
	Benzo[k]fluoranthene	2.0E-03	NA	1.1E-05	--	6.1E+00	4.5E-06	2.7E-05
	Chloroform	5.6E-03	1.1E-02	2.4E-04	2.2E-02	8.0E-02	1.0E-04	8.3E-06
	Chrysene	2.0E-03	NA	3.5E-07	--	6.1E+00	1.5E-07	9.2E-07
	Di(2-ethylhexyl)phthalate	6.4E-03	2.9E-03	1.1E-05	3.9E-03	NA	4.9E-06	--
	Dichlorobenzene, 1,4-	1.0E-03	2.3E-01	3.9E-05	1.7E-04	NA	1.7E-05	--
	Indeno[1,2,3-cd]pyrene	2.0E-03	NA	2.1E-08	--	6.1E+00	9.2E-09	5.6E-08
	Methylene chloride	8.0E-03	8.6E-01	3.8E-04	4.4E-04	1.6E-03	1.6E-04	2.7E-07
	Tetrachloroethane, 1,1,2,2-	5.2E-03	NA	1.4E-04	--	2.0E-01	6.2E-05	1.2E-05
	Trichloroethene	2.0E-03	NA	8.4E-05	--	6.0E-03	3.6E-05	2.2E-07
	Totals for Inhalation of Vapors while Showering (Foster & Chrostowski)				2.7E-02			7.0E-05

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Table 0-5

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 3 - Future Residential Groundwater Usage

Location	Chemical	Exposure Point Concentration N/A	Noncarcinogenic Effects			Carcinogenic Effects		
			Oral RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Oral SF $(mg/kg\text{-}day)^{-1}$	LADI (mg/kg-day)	Cancer Risk
Site 2: Fire Trng. Area								
	Totals by Chemical		SIF - Noncancer = 3.01E-01			SIF - Cancer = 1.29E-01		
	Aldrin	--	--	1.3E-06	2.7E-02	--	5.5E-07	9.4E-06
	Aluminum	--	--	4.1E-02	4.3E-02	--	--	--
	Arsenic	--	--	3.1E-05	1.0E-01	--	1.3E-05	2.0E-05
	Benzo[a]anthracene	--	--	2.8E-05	--	--	1.2E-05	8.9E-06
	Benzo[a]pyrene	--	--	5.6E-05	--	--	2.4E-05	1.7E-04
	Benzo[b]fluoranthene	--	--	8.8E-05	--	--	3.8E-05	4.0E-05
	Benzo[k]fluoranthene	--	--	6.5E-05	--	--	2.8E-05	2.9E-05
	Beryllium	--	--	8.5E-05	2.1E-02	--	3.6E-05	2.0E-04
	Cadmium	--	--	7.3E-05	1.5E-01	--	3.1E-05	--
	Chloroform	--	--	4.1E-04	3.9E-02	--	1.8E-04	8.8E-06
	Chromium(VI)	--	--	2.1E-04	4.3E-02	--	8.9E-05	--
	Chrysene	--	--	5.5E-05	--	--	2.4E-05	1.1E-06
	Di(2-ethylhexyl)phthalate	--	--	5.6E-04	5.0E-02	--	2.4E-04	5.5E-06
	Dichlorobenzene, 1,4-	--	--	8.5E-05	1.7E-04	--	3.7E-05	4.8E-07
	Indeno[1,2,3-cd]pyrene	--	--	5.5E-05	--	--	2.3E-05	1.7E-05
	Iron	--	--	2.2E+00	7.4E+00	--	--	--
	Manganese	--	--	1.5E-01	7.7E+00	--	--	--
	Methylene chloride	--	--	6.0E-04	4.2E-03	--	2.6E-04	9.9E-07
	Tetrachloroethane, 1,1,2,2-	--	--	3.1E-04	--	--	1.3E-04	2.6E-05
	Thallium	--	--	2.7E-05	3.9E-01	--	--	--
	Trichloroethene	--	--	1.5E-04	--	--	6.3E-05	5.1E-07
	Zinc	--	--	6.6E-03	2.2E-02	--	--	--
	Totals for Future Adult Resident at Site 2: Fire Trng. Area; RMECase:				**1.6E+01**			**5.4E-04**

Table 0-5

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 3 - Future Residential Groundwater Usage

Location	Chemical	Exposure Point Concentration (mg/L)	Noncarcinogenic Effects			Carcinogenic Effects		
			Oral RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Oral SF (mg/kg-day)$^{-1}$	LADI (mg/kg-day)	Cancer Risk
Future Child Resident; RME Case								
Site 2: Fire Trng. Area								
	Pathway 3A: Ingestion of Water		SIF - Noncancer = 6.39E-02			SIF - Cancer = 5.48E-03		
	Aldrin	2.8E-05	3.0E-05	1.8E-06	5.9E-02	1.7E+01	1.5E-07	2.6E-06
	Aluminum	1.5E+00	1.0E+00	9.6E-02	9.6E-02	NA	--	--
	Arsenic	1.1E-03	3.0E-04	7.2E-05	2.4E-01	1.5E+00	6.2E-06	9.3E-06
	Benzo[a]anthracene	1.0E-03	NA	6.4E-05	--	7.3E-01	5.5E-06	4.0E-06
	Benzo[a]pyrene	2.0E-03	NA	1.3E-04	--	7.3E+00	1.1E-05	8.0E-05
	Benzo[b]fluoranthene	3.0E-03	NA	1.9E-04	--	7.3E-01	1.6E-05	1.2E-05
	Benzo[k]fluoranthene	2.0E-03	NA	1.3E-04	--	7.3E-02	1.1E-05	8.0E-07
	Beryllium	3.1E-03	5.0E-03	2.0E-04	4.0E-02	4.3E+00	1.7E-05	7.3E-05
	Cadmium	2.7E-03	5.0E-04	1.7E-04	3.4E-01	NA	1.5E-05	--
	Chloroform	5.6E-03	1.0E-02	3.6E-04	3.6E-02	6.1E-03	3.1E-05	1.9E-07
	Chromium(VI)	7.6E-03	5.0E-03	4.8E-04	9.7E-02	NA	4.1E-05	--
	Chrysene	2.0E-03	NA	1.3E-04	--	7.3E-03	1.1E-05	8.0E-08
	Di(2-ethylhexyl)phthalate	6.4E-03	2.0E-02	4.1E-04	2.0E-02	1.4E-02	3.5E-05	4.9E-07
	Dichlorobenzene, 1,4-	1.0E-03	NA	6.4E-05	--	2.4E-02	5.5E-06	1.3E-07
	Indeno[1,2,3-cd]pyrene	2.0E-03	NA	1.3E-04	--	7.3E-01	1.1E-05	8.0E-06
	Iron	7.9E+01	3.0E-01	5.1E+00	1.7E+01	NA	--	--
	Manganese	5.5E+00	2.0E-02	3.5E-01	1.8E+01	NA	--	--
	Methylene chloride	8.0E-03	6.0E-02	5.1E-04	8.5E-03	7.5E-03	4.4E-05	3.3E-07
	Tetrachloroethane, 1,1,2,2-	5.2E-03	NA	3.4E-04	--	2.0E-01	2.9E-05	5.8E-06
	Thallium	1.0E-03	7.0E-05	6.4E-05	9.1E-01	NA	--	--
	Trichloroethene	2.0E-03	NA	1.3E-04	--	1.1E-02	1.1E-05	1.2E-07
	Zinc	2.4E-01	3.0E-01	1.5E-02	5.1E-02	NA	--	--

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Table 0-5
Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland
Scenario 3 - Future Residential Groundwater Usage

Location	Chemical	Exposure Point Concentration (mg/L)	Noncarcinogenic Effects			Carcinogenic Effects		
			Oral RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Oral SF (mg/kg-day)$^{-1}$	LADI (mg/kg-day)	Cancer Risk
	Totals for Ingestion of Water				**3.6E+01**			**2.0E-04**
Site 2: Fire Trng. Area								
	Pathway 3B: Dermal Absorption from Water		SIF - Noncancer = 4.22E-01			SIF - Cancer = 3.62E-02		
	Aldrin	2.8E-05	3.0E-05	9.5E-08	3.2E-03	1.7E+01	8.2E-09	1.4E-07
	Aluminum	1.5E+00	1.0E+00	1.6E-04	3.2E-03	NA	--	--
	Arsenic	1.1E-03	3.0E-04	1.2E-07	4.2E-04	1.5E+00	1.0E-08	1.6E-08
	Beryllium	3.1E-03	5.0E-03	3.3E-07	6.5E-03	4.3E+00	2.8E-08	1.2E-05
	Cadmium	2.7E-03	5.0E-04	2.8E-07	1.1E-02	NA	2.4E-08	--
	Chloroform	5.6E-03	1.0E-02	2.0E-05	2.0E-03	6.1E-03	1.7E-06	1.0E-08
	Chromium(VI)	7.6E-03	5.0E-03	8.0E-07	1.6E-03	NA	6.8E-08	--
	Di(2-ethylhexyl)phthalate	6.4E-03	2.0E-02	5.7E-04	5.7E-02	1.4E-02	4.9E-05	1.4E-06
	Dichlorobenzene, 1,4-	1.0E-03	NA	3.0E-05	--	2.4E-02	2.6E-06	6.1E-08
	Iron	7.9E+01	3.0E-01	8.4E-03	2.8E-01	NA	--	--
	Manganese	5.5E+00	2.0E-02	5.8E-04	2.9E-01	NA	--	--
	Methylene chloride	8.0E-03	6.0E-02	1.1E-05	1.9E-04	7.5E-03	9.6E-07	7.2E-09
	Tetrachloroethane, 1,1,2,2-	5.2E-03	NA	2.6E-05	--	2.0E-01	2.3E-06	4.5E-07
	Thallium	1.0E-03	7.0E-05	1.1E-07	1.6E-03	NA	--	--
	Trichloroethene	2.0E-03	NA	1.3E-05	--	1.1E-02	1.2E-06	1.3E-08
	Zinc	2.4E-01	3.0E-01	2.5E-05	3.4E-04	NA	--	--
	Totals for Dermal Absorption from Water				**6.6E-01**			**1.4E-05**

Table 0-5

Estimates of Potential Exposures and Risks for the Bainbridge Naval Training Center, Port Deposit, Maryland

Scenario 3 - Future Residential Groundwater Usage

Location	Chemical	Exposure Point Concentration N/A	Noncarcinogenic Effects Oral RfD (mg/kg-day)	ADI (mg/kg-day)	Hazard Quotient	Carcinogenic Effects Oral SF (mg/kg-day)$^{-1}$	LADI (mg/kg-day)	Cancer Risk
Site 2: Fire Trng. Area								
	Totals by Chemical		SIF - Noncancer = 4.86E-01			SIF - Cancer = 4.16E-02		
	Aldrin	--	--	1.9E-06	6.2E-02	--	1.6E-07	2.7E-06
	Aluminum	--	--	9.6E-02	9.9E-02	--	--	--
	Arsenic	--	--	7.2E-05	2.4E-01	--	6.2E-06	9.3E-06
	Benzo[a]anthracene	--	--	6.4E-05	--	--	5.5E-06	4.0E-06
	Benzo[a]pyrene	--	--	1.3E-04	--	--	1.1E-05	8.0E-05
	Benzo[b]fluoranthene	--	--	1.9E-04	--	--	1.6E-05	1.2E-05
	Benzo[k]fluoranthene	--	--	1.3E-04	--	--	1.1E-05	8.0E-07
	Beryllium	--	--	2.0E-04	4.6E-02	--	1.7E-05	8.5E-05
	Cadmium	--	--	1.7E-04	3.5E-01	--	1.5E-05	--
	Chloroform	--	--	3.8E-04	3.8E-02	--	3.3E-05	2.0E-07
	Chromium(VI)	--	--	4.8E-04	9.8E-02	--	4.2E-05	--
	Chrysene	--	--	1.3E-04	--	--	1.1E-05	8.0E-08
	Di(2-ethylhexyl)phthalate	--	--	9.8E-04	7.8E-02	--	8.4E-05	1.9E-06
	Dichlorobenzene, 1,4-	--	--	9.4E-05	--	--	8.0E-06	1.9E-07
	Indeno[1,2,3-cd]pyrene	--	--	1.3E-04	--	--	1.1E-05	8.0E-06
	Iron	--	--	5.1E+00	1.7E+01	--	--	--
	Manganese	--	--	3.5E-01	1.8E+01	--	--	--
	Methylene chloride	--	--	5.2E-04	8.7E-03	--	4.5E-05	3.4E-07
	Tetrachloroethane, 1,1,2,2-	--	--	3.6E-04	--	--	3.1E-05	6.2E-06
	Thallium	--	--	6.4E-05	9.1E-01	--	--	--
	Trichloroethene	--	--	1.4E-04	--	--	1.2E-05	1.3E-07
	Zinc	--	--	1.5E-02	5.2E-02	--	--	--
	Totals for Future Child Resident at Site 2: Fire Trng. Area; RMECase:				3.7E+01			2.1E-04

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P Desktop Ecological Risk Assessment

CBFO-C98-04

DESKTOP ECOLOGICAL RISK ASSESSMENT BAINBRIDGE NAVAL TRAINING CENTER, PORT DEPOSIT, MARYLAND

U.S. Fish and Wildlife Service

OCTOBER 1998

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TABLE OF CONTENTS

Page

ACKNOWLEDGMENTS i
TABLE OF CONTENTS ii
LIST OF TABLES iv
LIST OF FIGURES v
1.0 INTRODUCTION 1
1.1 Objective 1
1.2 Site History and Background 1

2.0 PROBLEM FORMULATION 1
2.1 Summary of the Screening Level Risk Assessment 2
2.2 Identification of Contaminants of Potential Concern 3
2.3 Exposure Characterization 3
2.4 Hazard Characterization/Toxicity Assessment 3
2.5 Selection of Assessment Endpoints 3
2.6 Production of Testable Hypotheses 4
2.7 Conceptual Model 5
2.8 Linkage Between Assessment and Measurement Endpoints 6
2.9 Life History/Exposure Profile Information 7

3.0 ASSUMPTIONS OF THE DESKTOP ERA 7

4.0 FOOD CHAIN SCREENING ANALYSIS 8

5.0 RISK CHARACTERIZATION 9
5.1 Risks to Benthic Invertebrates 9
5.1.1 Old Landfill 9
5.1.2 Fire Training Area 10
5.2 Risks to Fish 11
5.2.1 Old Landfill 11
5.2.2 Fire Training Area 11
5.3 Risks to Piscivorous Birds 11
5.3.1 Old Landfill 11
5.3.2 Fire Training Area 11
5.4 Risks to Omnivorous Mammals 12
5.4.1 Old Landfill 12
5.4.2 Fire Training Area 12

6.0 UNCERTAINTY ANALYSIS 12

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7.0 CONCLUSIONS....13
7.1 Risks to Benthic Life....13
7.1.1 Old Landfill....13
7.1.2 Fire Training Area....14
7.2 Risks to Fish....14
7.2.1 Old Landfill....14
7.2.2 Fire Training Area....14
7.3 Risks to Piscivorous Birds....14
7.3.1 Old Landfill....14
7.3.2 Fire Training Area....15
7.4 Risks to Omnivorous Mammals....15
7.4.1 Old Landfill....15
7.4.2 Fire Training Area....15

8.0 REFERENCES....15

APPENDIX A: TOXICOLOGICAL PROFILES

APPENDIX B: LIFE HISTORY AND EXPOSURE PROFILES

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LIST OF TABLES

Table 1. Chemistry data for the Old Landfill: (a) sediments, (b) surface water.
Table 2. Chemistry data for the Fire Training Area: (a) sediments, (b) surface water, (c) soil.
Table 3. Comparison of maximum concentrations with EPA Region III BTAG screening levels: Old Landfill.
Table 4. Comparison of maximum concentrations with EPA Region III BTAG screening levels: Fire Training Area.
Table 5. Conservative food chain screening analysis for the Old Landfill: kingfisher.
Table 6. Conservative food chain screening analysis for the Old Landfill: raccoon.
Table 7. Conservative food chain screening analysis for the Fire Training Area: kingfisher.
Table 8. Conservative food chain screening analysis for the Fire Training Area: raccoon.
Table 9. Comparison of sediment contaminant concentrations with guidance values.
Table 10. Chemicals detected in exceedance of water quality criteria.

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LIST OF FIGURES

Figure 1. Surface water/sediment sample locations
Site 1 - Old Landfill area
Naval Training Center - Bainbridge
Figure 2. Surface water/sediment sample locations
Site 2 - Fire Training area
Naval Training Center - Bainbridge

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1.0 INTRODUCTION

1.1 Objective

The objective of this project was to prepare a desktop ecological risk assessment (ERA) for the Bainbridge Naval Training Center (BNTC). A desktop ERA relies on existing contaminant data obtained during the site investigation in contrast to a complete ERA which will frequently include data developed specifically for the assessment. The desktop ERA relies on data obtained by U.S. Navy contractors and summarized by Ecology and Environment, Inc. (1997). The desktop ERA was conducted according to the Ecological Risk Assessment Guidance for Superfund (EPA 1997a).

1.2 Site History and Background

BNTC was an active Navy training facility from 1941 to 1949, 1951 to 1957, and 1972 to 1976 (Ecology and Environment 1997). Part of the facility was used as a Job Corps Center by the Department of Labor between 1978 and 1990. The site has been largely unused since 1990 and will be transferred to the State of Maryland in the near future.

Through the Installation Restoration Program (IRP), the Navy identified two primary areas of concern--the Old Landfill and the Fire Training Area. The Old Landfill was used for disposal of pesticides, asbestos, and other contaminants from the early 1940s through 1976. The Fire Training Area contained several brick buildings, an oil separator pit, underground vaults and underground storage tanks. For both sites, risks to human health and the environment are being investigated, according to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) process. Sampling was conducted in 1991 and 1994 and Interim Remedial Actions were performed in 1994-95 to remove the sources of contamination. The primary site-related documents used in this environmental risk assessment (ERA) are the Ecology and Environment (1997) Draft Final Remedial Investigation Report, and the OHM (1996) Contractor Close-Out Report for the Interim Remedial Action.

2.0 PROBLEM FORMULATION

The desktop ERA was designed to evaluate the potential ecological threats from exposure to site contaminants and, to the extent possible, provide technical support for any site-specific cleanup levels for contaminants of potential concern (COPC). The problem formulation process includes the identification of COPCs, determination of exposure pathways, formulation of testable hypotheses, development of a conceptual model, determination of assessment and measurement endpoints, and analysis of uncertainties associated with the risk assessment.

2.1 Summary of the Screening Level Risk Assessment

The first step of the preliminary risk assessment process compared all chemicals analyzed from sampling described in Ecology and Environment, Inc. (1997) with benchmark values. Prior to conducting the preliminary assessment, maps for the sites were evaluated against the remediation maps included in the OHM (1996) Close-Out Report. All sampling locations that have been remediated were removed from the risk analysis. For the Old Landfill site, the following sample locations are from areas that were capped, so both sediment and surface water data were removed from the analysis: 1-SD-1, 1-SD-2, 1-SD-3, 1-SD-4, 1-SD-5, P1-SD-10, P1-SW-10, and 1-SW-4. Chemical data are provided in Table 1, using one-half the detection limit for all non-detected COPCs. For the Fire Training Area, sediments from swales were removed. Since water still may exist in these areas, only the sediment samples (1-2-SD-6, P2-SD-6, 2-SD-7, 2-SD-8, 2-SD-4, and P2-SD-7) were removed from the analysis. Chemical data are provided in Table 2. The benchmarks for sediment, soil, and water used to identify potential contaminants of concern for the protection of site biota were those developed by EPA Region III (EPA 1995). Maps with the sediment and surface water sampling locations from the Ecology and Environment, Inc. (1997) report are provided as Figures 1 and 2.

The hazard quotient (HQ) method was used to estimate the potential risk for each contaminant detected. To be conservative, the maximum concentrations for each contaminant in each medium were used in the screening level ERA. The HQ is defined as the maximum exposure concentration divided by the benchmark value. An HQ of greater than one indicates that exposure to the contaminant may cause an adverse effect. These compounds, and those for which there are no specific benchmarks, are identified in Table 3 (Old Landfill) and Table 4 (Fire Training Area) and discussed below.

For the Old Landfill, the following chemicals were detected in sediments with an HQ$\geq$1: 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-c,d)pyrene, pyrene, dibenzofuran, diethylphthalate, 4,4'-DDD, 4,4'DDE, 4,4'-DDT, aldrin, alpha-chlordane, gamma-chlordane, cadmium, chromium, copper, lead, manganese, mercury, nickel, and zinc. The following chemicals were detected in water with an HQ$\geq$1: diethylphthalate, carbon disulfide, 4,4'-DDD, 4,4'-DDT, methoxychlor, aluminum, antimony, beryllium, cadmium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, silver, and zinc. The following chemicals, which were detected in sediment, have no benchmarks: benzo(k)fluoranthene, carbazole, carbon disulfide, chloroform, tetrachloroethene, trichloroethene, heptachlor, aluminum, barium, beryllium, calcium, cobalt, cyanide, iron, magnesium, potassium, sodium, and vanadium. There is no available benchmark for trichloroethene, which was detected in water.

For the Fire Training Area, the following chemicals were detected in sediment with an HQ≥1: phenanthrene, butylbenzylphthalate, 4,4'DDE, 4,4'-DDT, cadmium, chromium, manganese, and zinc. The following chemicals were detected in water with an HQ≥1: carbon disulfide, 4,4'-DDD, 4,4'-DDT, aluminum, cadmium, calcium, copper, iron, lead, mercury, and zinc. The following chemicals, which were detected in sediment, have no benchmarks: benzo(k)fluoranthene, toluene, aluminum, barium, beryllium, calcium, cobalt, iron, magnesium, potassium, sodium, and vanadium. There were no chemicals detected in surface water that do not have benchmarks.

2.2 Identification of Contaminants of Potential Concern

The results of the screening level ERA were used to identify COPCs for the desktop ERA. All chemicals with HQ≥1 and those chemicals for which there are no benchmarks were retained for further analysis in the desktop ERA.

2.3 Exposure Characterization

The objective of the exposure assessment is to determine the pathways and media through which receptors may be exposed to site contaminants. Potential exposure pathways are dependant on habitats and receptors present on site, extent and magnitude of contamination, and environmental fate and transport of COPCs.

For the Old Landfill site, the areas of concern are the two unnamed streams that run along the landfill and connect downstream of the landfill. For the Fire Training Area, the areas of concern are the forested wetland known as the pesticide area where pesticides were removed, the swales leading to Happy Valley Branch, and Happy Valley Branch itself. Exposure will be characterized through evaluation of effects on ecological receptors that are found in the streams, wetlands, and riparian areas. In this desktop ERA, it will be concluded that "a potential risk" exists if the HQ calculated from the maximum medium concentrations and the No Observed Apparent Effect Level (NOAEL) equals or exceeds 1.

2.4 Hazard Characterization/Toxicity Assessment

Brief toxicological profiles, describing the chemical fate, bioaccumulation potential, and toxic mechanisms of action are provided for each of the COPCs in Appendix A.

2.5 Selection of Assessment Endpoints

Previous data collected at the site, the preliminary risk assessment, and a site reconnaissance allowed for the selection of assessment endpoints that corresponded to the habitat types present at Bainbridge. The site is composed of a variety of habitats including forested and old-field uplands, forested and emergent wetlands, and streams. A variety of birds and mammals may use the site for feeding and nesting. Therefore, the assessment endpoints focused toward these faunal

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groups. Since chemical sampling of media has focused on sediment and water, the assessment has focused on wetland, stream, and swale samples. Viability of avian, mammalian, and aquatic populations were selected as assessment endpoints for this risk assessment. Listed next are the specific assessment endpoints selected for this ecological risk assessment.

Four assessment endpoints were chosen to evaluate the risk of contaminants at the Bainbridge site:

(1) Protection of benthic invertebrate communities from toxic effects of contaminants in sediments and surface waters to maintain species diversity, biomass, and nutrient cycling (trophic structure), to provide a food source for higher level consumers, and to insure that contaminant levels in benthic invertebrate tissues are low enough to minimize the risk of bioaccumulation and/or toxic effects in higher trophic levels.

(2) Protection of fish communities from toxic effects of contaminants in sediments and surface waters to maintain species diversity. Also, to insure that ingestion of contaminants in fish and invertebrates does not have a negative impact on growth, survival, and reproduction. Additionally, to insure that contaminant levels accumulated in fish tissues are low enough to minimize risk of accumulation and toxic effects in higher trophic levels.

(3) Protection of birds that feed on aquatic life to insure that ingestion of contaminants in sediments and prey does not have a negative impact on growth, survival and reproduction.

(4) Protection of omnivorous mammals to insure that contaminants in food items and soils do not have a negative impact on growth, survival, and reproduction, to provide a food source for higher level consumers, and to insure that contaminant levels in omnivore tissues are low enough to minimize the risk of bioaccumulation.

2.6 Production of Testable Hypotheses

The testable hypotheses are specific risk questions that are based on the assessment endpoints. Based on the mechanism of contaminant toxicity, the number of exposure pathways that may exist for an assessment endpoint, or other factors, there may be more than one question for each assessment endpoint.

(1) Are concentrations of site contaminants in sediments from the Old Landfill streams and Fire Training Area streams and wetlands sufficient to cause adverse alterations to the structure and/or function of the benthic community, at either the population or community level?

(2) Are concentrations of site contaminants in water and/or sediments sufficient to cause adverse alterations to the structure and/or function of the fish community?

(3) Are concentrations of site contaminants in sediments and prey sufficient to cause adverse effects on the long-term health and reproductive capacity of piscivorous birds that utilize the site?

(4) Are concentrations of site contaminants in sediments and prey sufficient to cause adverse effects on the long-term health and reproductive capacity of omnivorous mammals that utilize the site?

2.7 Conceptual Model

The conceptual model is based on contaminant and habitat characteristics to identify critical exposure pathways to the selected assessment endpoints. Contaminants in water and sediment may come in contact with the aquatic, benthic, and terrestrial receptors inhabiting the wetland and neighboring areas of the site. Benthic invertebrates may be exposed to site contaminants through direct contact with and/or ingestion of the sediment and overlying water. Mammals and birds may be exposed to site contaminants via ingestion of contaminated food, incidental ingestion of sediment, and ingestion of surface water.

Based on this conceptual model, and depending on the availability of information, the following pathways will be evaluated in this assessment:

(1) Benthic invertebrates
- Direct contact with water
- Direct contact with sediment
- Ingestion of sediment

(2) Fish
- Direct contact with water
- Direct contact with sediment
- Ingestion of sediment

(3) Piscivorous birds (kingfisher)
- Ingestion of water
- Ingestion of sediment
- Ingestion of fish and invertebrates

(4) Omnivorous mammals (raccoon)
- Ingestion of water
- Ingestion of sediment
- Ingestion of fish and invertebrates

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2.8 Linkage Between Assessment and Measurement Endpoints

Assessment endpoint 1, protection of the benthic invertebrate community structure and function:

Measurement endpoint: The most direct method for assessing the toxicity of sediment-bound contaminants is to perform sediment toxicity tests. Since such tests have not been performed at BNTC, chemical concentrations in sediments will be compared against benchmarks used for association of concentrations with adverse impacts to benthos. The benchmarks consist of effects range-low (ER-L) and effects range-median (ER-M) concentrations developed by Long and Morgan (1990) and threshold effect levels (TEL), and probable effect levels (PEL) (Smith et al. 1996). The Long and Morgan (1990) values were used rather than the Long et al. (1995) values because the older values are based on freshwater as well as estuarine-marine data. The Smith et al. (1996) values are based on freshwater data only. The lower set of values (ER-L and PEL) can be considered screening values in that sediment concentrations below these thresholds are rarely associated with adverse biological effects. When the higher set of values (ER-M and PEL) is exceeded in sediments, adverse biological effects may occur more frequently (Long et al. 1995). For this desktop ERA, potential risk to benthic invertebrates will be considered to exist if the maximum sediment concentration exceeds the lower of the Smith et al. (1996) PEL and the Long and Morgan (1990) ER-M.

To evaluate the effects of chemicals in surface water, toxicity tests are the method of choice. Since such tests were not performed at BNTC, the water concentrations will be compared against state and federal ambient water quality criteria (AWQC). For this desktop ERA, potential risk to benthic invertebrates will be considered to exist if the maximum water concentration exceeds the chronic AWQC.

Assessment endpoint 2, protection of the fish populations and communities from direct toxicity and reproductive impairment:

Measurement endpoint: The most direct method for assessing the toxicity of contaminants in the water column is to perform aquatic toxicity tests. Since such tests have not been performed at BNTC, chemical concentrations in the water column will be compared against state and federal acute and chronic AWQC. For this desktop ERA, potential risk to fish will be considered to exist if the maximum water concentration exceeds the chronic AWQC.

Assessment endpoint 3, protection from direct toxicity effects and reproductive impairment of piscivorous birds utilizing the site:

Measurement endpoint: A food chain model will be constructed based on ingestion of surface water and consumption of sediment. As a conservative assumption, the highest ingestion rate and the lowest body weight will be used. It will also be assumed that the birds are consuming a diet consisting of 100% sediment (with 100% bioavailability), which for the purposes of the model, is in the form of whole body fish. The kingfisher will be used as an example of a

piscivorous bird. Estimated concentrations will be compared with literature-derived NOAELs and Lowest Observable Adverse Effect Levels (LOAELs).

Assessment endpoint 4, protection from direct toxicity effects and reproductive impairment of omnivorous mammals utilizing the site:

Measurement endpoint: A food chain model will be constructed based on ingestion of surface water and consumption of sediment. As a conservative assumption, the highest ingestion rate and the lowest body weight will be used. It will also be assumed that omnivorous mammals are consuming a diet consisting of 100% sediment (with 100% bioavailability), which for the purposes of the model is in the form of whole body fish. The raccoon will be used as an example of an omnivorous mammal. Estimated concentrations will be compared with literature-derived NOAELs and LOAELs.

2.9 Life History/Exposure Profile Information

Information on the life history of the receptor species is provided in Appendix B. These profiles are provided to support the use of these receptor species as valid measurement endpoints.

According to Andy Moser, Senior Endangered Species Biologist, Chesapeake Bay Field Office, there are no federally proposed/listed endangered or threatened species known to exist within the BNTC. The following is a list of endangered or threatened species which occur within a 3-mile radius of BNTC: bald eagle (*Haliaeetus leucocephalus*), bog turtle (*Clemmys muhlenbergii*), and shortnose sturgeon (*Acipenser brevirostrum*).

The Maryland Wildlife and Heritage Division Natural Heritage Data Base indicates that there are two state-endangered species known to occur on the BNTC. They are the halberd-leaved green brier (*Smilax pseudochina*), and the other is a slender blue flag (*Iris prismatica*). In addition there are 43 plant species and 11 animal species that are classified by the State of Maryland as rare, threatened or endangered species that can be found outside the site boundaries in the vicinity and on adjacent quads maps. The 11 animals identified are the following: bog turtle (*Clemmys muhlenbergii*), hellbender (*Cryptobranchus alleganiensis*), Maryland darter (*Etheostoma sellare*), map turtle (*Graptemys geographica*), bald eagle (*Haliaeetus leucocephalus*), eastern lampmussel (*Lampsilis radiata*), tidewater mucket (*Leptodea ochracea*), logperch (*Percina caprodes*), trout-perch (*Percopsis omiscomaycus*), regal fritillary (*Speyeria idalia*), and tenuis amphipod (*Stygobromus tenuis tenuis*).

3.0 ASSUMPTIONS OF THE DESKTOP ERA

The following assumptions were made:

(1) Maximum contaminant concentrations measured in water, sediments, and soil were used in the risk calculations.

(2) Contaminants in media were assumed to be 100% bioavailable.

(3) Dietary composition information was obtained from the literature for each receptor species. However, for the purposes of this screening model the receptors were presumed to consume 100% sediment.

(4) 100% area use factor was assumed for all food chain models.

(5) For food chain models, the lowest reported body weight and the highest reported ingestion rates were assumed.

(6) A literature search was conducted to determine the chronic toxicity of contaminants of concern evaluated in the food chain models. If no toxicity values could be identified for the receptor species, values reported for a closely related species were used. Studies were critically reviewed to determine whether the study design and methods were appropriate. If chronic toxicity values were not available, median lethal dose (LD50) data were used. A factor of 100 was used to convert the reported LD50 to a NOAEL. A factor of 10 was used to convert a LOAEL to a NOAEL. If several toxicity values were reported for a receptor species, the lowest (most conservative) value was used in the risk calculations, assuming the study design and methods were appropriate. For the chronic toxicity endpoints, values obtained from long-term feeding studies were preferred over those from single dose exposures.

(7) In cases where toxicity values in the literature were reported as part per million (ppm) contaminant in the diet, the values were converted to a daily intake (mg per kg body weight per day) by the following formula:
Daily intake (mg/kg/day) = Dose (mg/kg diet) x ingestion rate (kg/day) x 1/body weight (kg)

(8) Chemicals in surface water for which there are no ambient water quality criteria are discussed in the Uncertainty Analysis portion of the desktop ERA. Chemicals in sediment for which there are no ER-L, ER-M, TEL, or PEL are discussed in the Uncertainty Analysis.

4.0 FOOD CHAIN SCREENING ANALYSIS

The two food chain analyses were performed with the assumption that the predators (kingfisher and raccoon) are consuming 100% sediment at the maximum concentration (i.e., the hypothetical whole body fish concentration is equal to the maximum sediment concentration). All of the chemicals that exceeded benchmarks in the preliminary analysis (Tables 3 and 4) were included in the food chain screening analysis. Based on these food chain models, for the following chemicals and pathways the HQs were equal to or greater than one: (See Tables 5-8 for HQ values).

Old Landfill:

Kingfisher: phenanthrene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, fluoranthene, indeno(1,2,3,c,d)pyrene, pyrene, alpha-chlordane, gamma-chlordane, aluminum, cadmium, copper, lead, mercury, and zinc (Table 5).

Raccoon: acenaphthylene, anthracene, fluorene, phenanthrene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno(1,2,3,c,d)pyrene, pyrene, aluminum, chromium, copper, lead, manganese, and mercury (Table 6).

Fire Training Area:

Kingfisher: 4,4-DDE, aluminum, cadmium, copper, and lead (Table 7).

Raccoon: aluminum, chromium, copper, lead, and manganese (Table 8).

5.0 RISK CHARACTERIZATION

The COPCs identified in the screening level risk assessment are evaluated in the characterization of risks to benthic invertebrates and fish (endpoints 1 and 2) and mammalian and avian receptors (endpoints 3 and 4). For endpoints 1 and 2, maximum sediment concentrations are compared with sediment guidance values and maximum water concentrations with AWQC. For the food chains (endpoints 3 and 4), whole body fish were considered to have the same concentrations as the maximum sediment concentration. Maximum water concentrations were used for the drinking water portion of the dose. The HQs were determined based on the maximum concentrations compared with the NOAELs.

5.1 Risks to Benthic Invertebrates

5.1.1 Old Landfill

Exceedances of guidance values occurred in a number of sediment samples (Table 9). Chemicals that were measured in excess of the higher set of guidance values (ER-M or PEL) were: total chlordane, total DDT, total PAHs, lead, and nickel. In addition to these chemicals, chromium, mercury, and zinc were detected at concentrations above the lower set of guidance values (ER-L or TEL).

When sediment concentrations of multiple chemicals exceed the higher set of guidance values, it is frequently the case that adverse biological effects are observed (Long et al. 1998). At BNTC, the highest concentrations and greatest exceedances occurred with samples P1-SD-7, which had

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high levels of total DDT (0.86 mg/kg) and total chlordane (0.69 mg/kg); P1-SD-9, which had a high concentration of total PAHs (679 mg/kg); P1-SD-11, which had a high concentration of lead (387 mg/kg), and 1-SD-18 which had a high concentration of total DDT (0.50 mg/kg) and total chlordane (0.20 mg/kg). All of these samples are in the east branch of the unnamed tributary.

Comparisons with state and federal AWQC indicate a number of exceedances (Table 10). Surface water concentrations of 4,4'-DDD, aluminum, cadmium, chromium, copper, lead, selenium, and zinc were greater than the 1-hour average (acute) criteria. In addition to these analytes, methoxychlor, antimony, beryllium, iron, manganese, mercury, and nickel were detected at concentrations greater than the 4-day average (chronic) criteria (Table 10). The greatest exceedances occurred in samples 1-SW-8 (August 1994) which had a cadmium concentration of 21.1 µg/L, a chromium concentration of 532 µg/L, a copper concentration of 950 µg/L and a lead concentration of 1360 µg/L, and P1-SW-11(August 1991), which had a chromium concentration of 201 µg/L, a copper concentration of 216 µg/L, and a lead concentration of 656 µg/L (Table 1). Samples 1-SW-8 and P1-SW-11 were collected near seeps. The age of both of these samples in relation to removal actions, and the use of unfiltered samples is discussed in the Uncertainty Analysis.

5.1.2 Fire Training Area

There were no samples with sediment concentrations exceeding the higher set of guidance values (Table 9). Total DDT concentrations in all of the samples, lead in sample P2-SD-8 (February 1991), and nickel in P2-SD-5 (August 1991) exceeded the lower set of guidance values. All of these samples are in Happy Valley Branch.

There were several exceedances of state and federal ambient quality criteria (Table 10). Surface water concentrations of 4,4'-DDD, 4,4'-DDT, aluminum, cadmium, chromium, copper, lead, and zinc were greater than the 1-hour average (acute) criteria. In addition to these analytes, iron and mercury were detected at concentrations greater than the 4-day average (chronic) criteria (Table 10). The greatest exceedances occurred in swale water samples (P2-SW7, 2-SW-4, and P2-SW-6) rather than in Happy Valley Branch samples (P2-SW-5, P2-SW-8, and 2-SW-1). Sample P2-SW-6 (February 1991) had a 4,4'-DDD concentration of 14.0 µg/L, a 4,4'-DDT concentration of 16.0 µg/L, a cadmium concentration of 234 µg/L, a chromium concentration of 80.9 µg/L, a copper concentration of 435 µg/L, a lead concentration of 498 µg/L, and a zinc concentration of 379 µg/L (Table 2). This sample was collected from a swale where sediment was removed in 1994-95. It was included in the desktop ERA because, although swale sediments were removed, there was no active remediation of the water. It is likely, however, that the water concentrations measured in 1991 reflect conditions that no longer exist.

For the surface water samples collected from Happy Valley Branch, exceedance of water quality criteria occurred at P2-SW-8 in which aluminum was detected at 335 and 98.7 µg/L, exceeding the EPA chronic criterion of 87 µg/L, and lead at 3.4 and 4.7 µg/L which exceeds the Maryland chronic criterion of 3.2 µg/L. In sample 2-SW-1, zinc was detected at 144 µg/L which exceeds

the Maryland acute criterion of 120 µg/L and aluminum was detected at 122 µg/L, which exceeds the EPA chronic criterion of 87 µg/L. The use of unfiltered samples is discussed in the Uncertainty Analysis.

5.2 Risks to Fish

5.2.1 Old Landfill

The AWQC comparisons in Section 5.1.1 (Table 10) apply to the protection of aquatic life, including fish. The age of these samples in relation to removal actions, and the use of unfiltered samples is discussed in the Uncertainty Analysis.

5.2.2 Fire Training Area

For protection of fish, the surface water samples collected in Happy Valley Branch are the only relevant samples. Fish are unlikely to be present in the swales leading to Happy Valley Branch and the sediment remediation conducted in the swales in 1994-95 has probably reduced the measured water column contaminant concentrations. In this stream, exceedance of water quality criteria occurred at P2-SW-8 in which aluminum was detected at 335 and 98.7 µg/L, exceeding the EPA chronic criterion of 87 µg/L, and lead at 3.4 and 4.7 µg/L which exceeds the Maryland chronic criterion of 3.2 µg/L. In sample 2-SW-1, zinc was detected at 144 µg/L which exceeds the Maryland acute criterion of 120 µg/L and aluminum was detected at 122 µg/L, which exceeds the EPA chronic criterion of 87 µg/L (Table 10). The use of unfiltered samples is discussed in the Uncertainty Analysis.

5.3 Risks to Piscivorous Birds

5.3.1 Old Landfill

Based on maximum sediment and water concentrations compared to NOAELs, the following chemicals had HQ values greater than one (Table 5): phenanthrene (3.2), benzo(a)anthracene (1.2), benzo(a)pyrene (1.4), benzo(b)fluoranthene (2.0), benzo(g,h,i)perylene (1.0), chrysene (1.5), fluoranthene (3.2), fluoranthene (1.0), pyrene (2.4), alpha-chlordane (3.9), gamma-chlordane (5.7), aluminum (31), cadmium (2.5), copper (59), lead (343), mercury (4.2), and zinc (3.6).

5.3.2 Fire Training Area

Based on maximum sediment and water concentrations compared to NOAELs, the following chemicals had HQ values equal to or greater than one (Table 7): 4,4'-DDE (1.0), aluminum (12), copper (10), and lead (32).

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5.4 Risks to Omnivorous Mammals

5.4.1 Old Landfill

Based on maximum sediment and water concentrations compared to NOAELs, the following chemicals had HQ values greater than one (Table 6): acenaphthylene (1.4), anthracene (2.6), fluorene (1.3), phenanthrene (12), benzo(a)anthracene (4.5), benzo(a)pyrene (5.2), benzo(b)fluoranthene (7.1), benzo(g,h,i)perylene (3.5), benzo(k)fluoranthene (3.4), chrysene (5.3), fluoranthene (12), indeno(1,2,3,c,d)pyrene (3.7), pyrene (8.6), aluminum (221), chromium (36), copper (6.5), lead (323), manganese (539), and mercury (2.4).

5.4.2 Fire Training Area

Based on maximum sediment and water concentrations compared to NOAELs, the following chemicals had HQ values greater than one (Table 8): aluminum (84), chromium (6.7), copper (1.1), lead (30), and manganese (69).

6.0 UNCERTAINTY ANALYSIS

Because toxicity tests were not performed, risks to benthos and fish were estimated by comparing guidance values with sediment concentrations and AWQC with surface water data. Reliance on a comparison to guidance values and criteria lends considerable uncertainty to the estimation of risk to these receptors because site-specific factors which modify toxicity (i.e., exposure to a mixture of chemicals in water and sediments under unique water quality conditions) are not taken into account. In addition, there are uncertainties associated with the measurement of chemicals in surface water (and to a lesser extent, sediments), where concentrations can fluctuate considerably with flow and precipitation. In addition, all of the surface water data was measured without filtering and removing the particles. EPA (1993) recommends the measurement of dissolved metals in ambient waters for comparison to standards and criteria and stated that dissolved metals more closely approximates the bioavailable fraction. For example, aluminum is found in high concentrations in soils and sediments and is bound to clays in forms which are not likely to become toxic (EPA 1988); the use of total rather than dissolved concentration could greatly overestimate risks.

Chemical data used in this assessment were collected in 1991 and 1994, prior to remediation at both sites. While sediment samples in remediated areas were excluded from the analysis, it is possible that the remediation has also lowered chemical concentrations in downgradient areas. At the Fire Training Area, water samples from an area where sediment was remediated were used in the risk assessment because active remediation of the water did not occur. Sediments can serve as a source of contaminants to the surface water (Burgess and Scott 1992) and it is likely that the 1994-95 sediment remediation has resulted in lowered surface water concentrations.

Many factors in the food chain analyses lead to uncertainty in the results and need to be discussed. In general, conservative assumptions were used which minimize the possibility of concluding that there is no risk when a threat actually exists. These conservative assumptions maximize exposure by using the maximum reported sediment concentration, the smallest body weight and largest ingestion rate, and 100% area use. Toxicological reference values are made conservative by the use of the lowest available NOAEL found in the literature. For a number of chemicals detected in water and sediment, no benchmarks, LOAELs, or NOAELs exist and the potential risks of these compounds were not evaluated. For some chemicals in surface water that exceeded benchmarks, no ambient water quality criteria exist. The potential risks of these chemicals were not evaluated.

Other assumptions in the food chain analyses contribute uncertainty to the analysis. Since literature values were not available for all receptor species, the value used for a related species may overestimate or underestimate the risk to the receptor. Laboratory toxicology studies control exposures to other contaminants which may have additive, antagonistic, or synergistic interactions with the tested chemical. Thus, it is uncertain how realistic the NOAELs and LOAELs are in situations where the receptors are exposed to multiple contaminants, which is the case at BNTC where PAHs, chlorinated pesticides, and metals are the chemicals of potential concern. In addition, receptor species may differ from the laboratory test animals in terms of overall health and exposure to other stressors such as weather or predators. These factors may make a particular species more or less susceptible to chemical exposure. Some of the studies detected either an LD_{50} or an LOAEL and the NOAEL was estimated by dividing by a factor of 100 (LD_{50} to NOAEL) or 10 (LOAEL to NOAEL). These calculations add uncertainty to the analysis. Finally, there is little data on the amount of sediments ingested by wildlife. Thus, the sediment exposure may be overestimated or underestimated, again adding uncertainty to the analysis.

7.0 CONCLUSIONS

A separate risk management memorandum will be drafted and used to facilitate discussions among the regulators.

7.1 Risks to Benthic Life

7.1.1 Old Landfill

Several sediment samples in the east branch of the unnamed tributary had multiple chemicals at concentrations that are frequently associated with adverse biological effects. In addition, surface water concentrations at several locations exceeded state and federal criteria. Thus, based on the 1991 and 1994 sampling data, it is likely that the sediment and surface water chemical concentrations pose risks to benthic organisms. As stated above, however, present sediment and

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surface water concentrations in at least some of the sampling locations may have been reduced by the remedial actions conducted in 1994-95.

7.1.2 Fire Training Area

In general, chemicals were not detected at concentrations in sediments that are frequently associated with adverse biological effects on benthos. Chemicals in several surface water samples from Happy Valley Branch slightly exceed state and federal criteria but the comparisons are highly conservative due to the use of total rather than dissolved samples. Thus, it is unlikely that surface water and sediment chemicals in Happy Valley Branch pose risks to benthos. Greater exceedances of ambient water quality occurred in swales but the samples were collected prior to the remediation of sediments.

7.2 Risks to Fish

7.2.1 Old Landfill

Based on the 1991 and 1994 surface water data, there are several sample locations where 1-hour (acute) criteria were exceeded for multiple chemicals. However, the chemical data are based on unfiltered samples, which may overestimate the bioavailable fraction. In addition, it is possible that the concentrations measured in 1991 and 1994 have been reduced by the remedial actions. Nonetheless, application of conservative assumptions suggests that exposure of aquatic life, including fish, to these chemical concentrations is likely to pose risks.

7.2.2 Fire Training Area

There were few exceedances of AWQC in Happy Valley Branch. In view of the measurement of whole rather than filtered samples and the possibility that concentrations may have been reduced by the interim remedial actions, it is unlikely that fish are at risk.

7.3 Risks to Piscivorous Birds

7.3.1 Old Landfill

Based on the food chain modeling, which includes considerable uncertainties, there appears to be some potential for risks to piscivorous birds. HQ values, based on the food chain screening analysis with maximum sediment and water concentrations, were less than four for nine PAHs, and approximately 4-6 for two chlordane isomers. HQ values for six metals were greater than one, ranging from 2.5 (cadmium) to 343 (lead).

7.3.2 Fire Training Area

Based on the food chain modeling, which includes considerable uncertainties, there appears to be some potential for risks to piscivorous birds. HQ values, based on the food chain screening analysis with maximum sediment and water concentrations, were 1.0 for 4,4'-DDE, 12 for aluminum, 10 for copper, and 32 for lead.

7.4 Risks to Omnivorous Mammals

7.4.1 Old Landfill

Based on the food chain modeling, which includes considerable uncertainties, there appears to be some potential for risks to omnivorous mammals. HQ values, based on the maximum sediment and water concentrations, were 1.3-12 for thirteen PAHs, 221 for aluminum, 36 for chromium, 6.5 for copper, 323 for lead, 539 for manganese, and 2.4 for mercury.

7.4.2 Fire Training Area

Based on the food chain modeling, which includes considerable uncertainties, there appears to be some potential for risks to omnivorous mammals. HQ values, based on the maximum sediment and water concentrations, were greater than one for aluminum (84), chromium (6.7), copper (1.1), lead (30), and manganese (69).

8.0 REFERENCES

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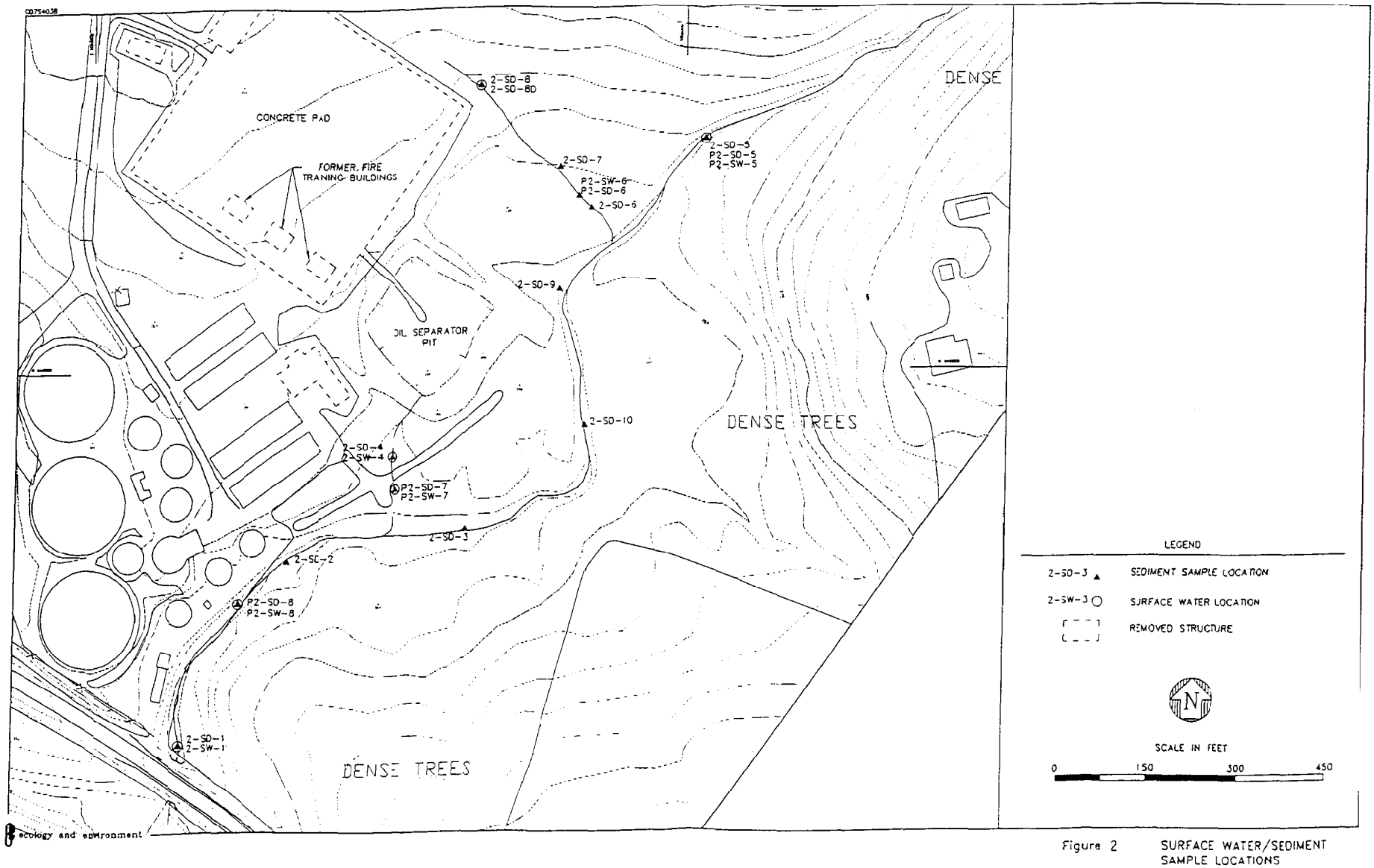

Figure provided by U.S.Navy Engineering Field Activity-Chesapeake from Ecology and Environment, Inc. (1997)

Figure 2 SURFACE WATER/SEDIMENT SAMPLE LOCATIONS
SITE 2 - FIRE TRANING AREA
NAVAL TRAINING CENTER - BAINBRIDGE

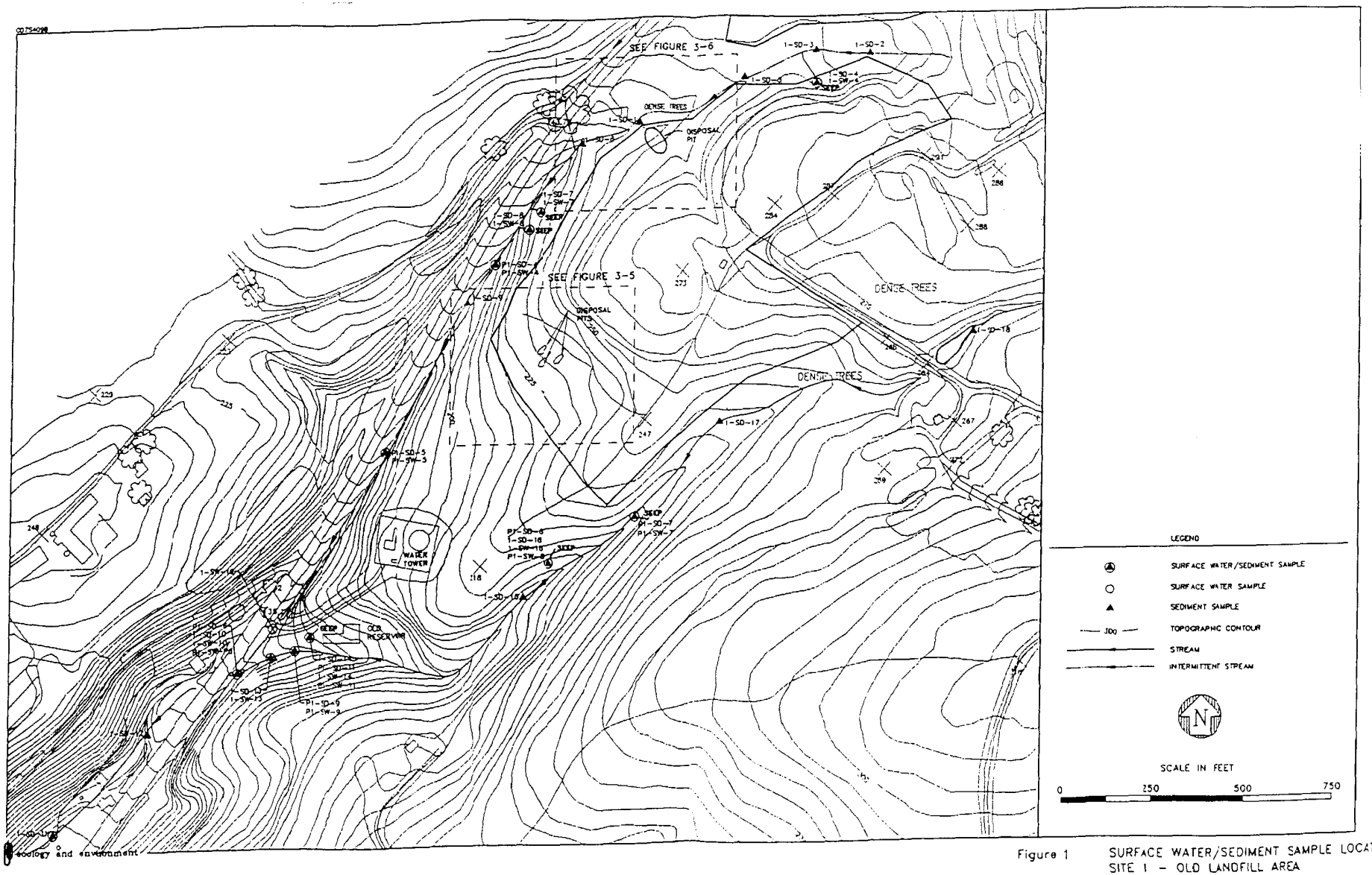

Figure 1 SURFACE WATER/SEDIMENT SAMPLE LOCATIONS
SITE 1 - OLD LANDFILL AREA
NAVAL TRAINING CENTER
BAINBRIDGE

Figure provided by U.S. Navy Engineering Field Activity-Chesapeake from Ecology and Environment, Inc. (1997)

Table 1. Chemistry data for the Old Landfill: (a) Sediments.

Duplicates	Sample Date	2-butanone	2-hexanone	acetone	carbon disulfide	chloroform	ethylbenzene	tetrachloroethene	toluene	trichlororethene	xylenes (total)
P1-SD-9	Aug-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
P1-SD-9D	Aug-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
P1-SD-11	Feb-91	ND	ND	ND	4.00	ND	ND	ND	ND	ND	ND
P1-SD-11D	Feb-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-SD-7	Feb-94	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-SD-7D	Feb-94	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Samples											
P1-SD-3	Feb-91	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
P1-SD-3	Aug-91	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
P1-SD-4	Feb-91	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
P1-SD-4	Aug-91	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
P1-SD-5	Feb-91	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
P1-SD-5	Aug-91	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
P1-SD-6	Feb-91	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
P1-SD-6	Aug-91	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
P1-SD-7	Feb-91	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
P1-SD-7	Aug-91	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
P1-SD-8	Feb-91	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
P1-SD-8	Aug-91	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
P1-SD-9	Feb-91	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
P1-SD-9	Aug-91	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
P1-SD-11	Feb-91	5.00	5.00	5.00	4.00	ND	5.00	5.00	5.00	5.00	5.00
P1-SD-11	Aug-91	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
1-SD-7	Feb-94	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
1-SD-8	Feb-94	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
1-SD-9	Feb-94	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
1-SD-10	Feb-94	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
1-SD-11	Feb-94	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
1-SD-12	Feb-94	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
1-SD-13	Feb-94	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
1-SD-14	Feb-94	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	8.00	5.00
1-SD-15	Feb-94	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
1-SD-16	Feb-94	5.00	5.00	5.00	5.00	ND	5.00	3.00	ND	9.00	5.00
1-SD-17	Feb-94	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
1-SD-18	Feb-94	5.00	5.00	5.00	5.00	ND	5.00	5.00	5.00	5.00	5.00
Freq		0/28	0/28	0/28	1/28	1/28	0/28	1/28	0/28	2/28	0/28
Min					4.00	5.00		3.00		5.00	
Max					5.00	5.00		5.00		9.00	
Mean					4.96	5.00		4.93		5.25	
StDev					0.19					0.93	
Note: Organics	in ug/kg; inorganics	in mg/kg									

Table 1. Chemistry data for the Old Landfill: (a) Sediments.

Duplicates	Sample Date	1,4-dichlorobenzene	2-methylnaphthalene	acenaphthene	acenaphthylene	anthracene	benzo(a)anthracene	benzo(a)pyrene	benzo(b)fluoranthene
P1-SD-9	Aug-91	ND	ND	ND	ND	ND	ND	ND	ND
P1-SD-9D	Aug-91	ND	ND	ND	ND	ND	85.00	70.00	120.00
P1-SD-11	Feb-91	ND	ND	ND	ND	ND	ND	ND	69.00
P1-SD-11D	Feb-91	ND	ND	ND	ND	ND	ND	ND	ND
1-SD-7	Feb-94	100.00	ND	ND	ND	ND	130.00	93.00	150.00
1-SD-7D	Feb-94	44.00	ND	ND	ND	ND	64.00	ND	70.00
Samples									
P1-SD-3	Feb-91	5.00	165.00	165.00	165.00	165.00	81.00	69.00	83.00
P1-SD-3	Aug-91	5.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00
P1-SD-4	Feb-91	5.00	165.00	165.00	165.00	91.00	410.00	450.00	510.00
P1-SD-4	Aug-91	5.00	165.00	165.00	165.00	165.00	180.00	200.00	330.00
P1-SD-5	Feb-91	5.00	63.00	165.00	650.00	910	1800	1800	2200
P1-SD-5	Aug-91	5.00	165.00	165.00	165.00	165.00	150.00	170.00	300.00
P1-SD-6	Feb-91	5.00	165.00	165.00	165.00	165.00	68.00	71.00	98.00
P1-SD-6	Aug-91	5.00	165.00	46.00	165.00	93.00	170.00	160.00	210.00
P1-SD-7	Feb-91	5.00	165.00	165.00	210.00	350.00	1100.00	1200.00	1500.00
P1-SD-7	Aug-91	5.00	165.00	165.00	165.00	165.00	130.00	120.00	220.00
P1-SD-8	Feb-91	5.00	165.00	165.00	165.00	98.00	250.00	240.00	280.00
P1-SD-8	Aug-91	5.00	165.00	165.00	165.00	165.00	165.00	165.00	62.00
P1-SD-9	Feb-91	5.00	500.00	165.00	15000.00	27000	47000	54000	74000
P1-SD-9	Aug-91	5.00	165.00	165.00	165.00	165.00	85.00	70.00	120.00
P1-SD-11	Feb-91	5.00	165.00	165.00	165.00	165.00	165.00	165.00	69.00
P1-SD-11	Aug-91	5.00	165.00	165.00	165.00	165.00	165.00	165.00	340.00
1-SD-7	Feb-94	100.00	165.00	165.00	165.00	165.00	130.00	93.00	150.00
1-SD-8	Feb-94	93.00	165.00	110.00	165.00	150.00	430.00	350.00	520.00
1-SD-9	Feb-94	5.00	165.00	165.00	165.00	165.00	31.00	165.00	430.00
1-SD-10	Feb-94	5.00	165.00	165.00	165.00	165.00	61.00	52.00	84.00
1-SD-11	Feb-94	5.00	165.00	165.00	165.00	44.00	160.00	140.00	190.00
1-SD-12	Feb-94	5.00	165.00	31.00	165.00	43.00	170.00	140.00	240.00
1-SD-13	Feb-94	5.00	110.00	180.00	165.00	290.00	560.00	420.00	550.00
1-SD-14	Feb-94	5.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00
1-SD-15	Feb-94	5.00	165.00	165.00	165.00	165.00	165.00	165.00	50.00
1-SD-16	Feb-94	5.00	165.00	11.00	165.00	220.00	750.00	620.00	880.00
1-SD-17	Feb-94	5.00	165.00	165.00	165.00	97.00	400.00	290.00	410.00
1-SD-18	Feb-94	5.00	165.00	39.00	165.00	59.00	240.00	180.00	230.00
Freq		2/28	3/28	6/28	3/28	13/28	22/28	21/28	26/28
Min		5.00	63.00	11.00	165.00	43.00	31.00	52.00	50.00
Max		100.00	500.00	180.00	15000.00	27000.00	47000.00	54000.00	74000.00
Mean		11.54	171.36	144.54	713.75	1140.00	1976.64	2213.93	3013.79
StDev		24.02	67.91	48.39	2801.34	5070.50	8831.59	10155.94	13919.73
Note: Organics	in ug/kg; inorganics								

Table 1. Chemistry data for the Old Landfill: (a) Sediments.

Duplicates	Sample Date	benzo(ghi)perylene	benzo(k)fluoranthene	bis(2-ethylhexyl)phthalate	butylbenzylphthalate	carbazole	chrysene	dibenz(ah)anthracene
P1-SD-9	Aug-91	ND	ND	ND	ND	NA	ND	ND
P1-SD-9D	Aug-91	ND	ND	ND	ND	NA	83.00	ND
P1-SD-11	Feb-91	ND	ND	ND	ND	NA	ND	ND
P1-SD-11D	Feb-91	ND	ND	ND	ND	NA	ND	ND
1-SD-7	Feb-94	ND	49.00	82.00	ND	ND	130.00	ND
1-SD-7D	Feb-94	ND	ND	75.00	ND	ND	56.00	ND
Samples								
P1-SD-3	Feb-91	70.00	70.00	165.00	165.00	NA	85.00	165.00
P1-SD-3	Aug-91	165.00	165.00	165.00	165.00	NA	165.00	165.00
P1-SD-4	Feb-91	250.00	280.00	165.00	165.00	NA	460.00	58.00
P1-SD-4	Aug-91	130.00	150.00	165.00	165.00	NA	210.00	165.00
P1-SD-5	Feb-91	890	1500	165.00	165.00	NA	1800.00	270.00
P1-SD-5	Aug-91	110.00	140.00	165.00	165.00	NA	170.00	165.00
P1-SD-6	Feb-91	47.00	46.00	165.00	165.00	NA	70.00	165.00
P1-SD-6	Aug-91	93.00	130.00	165.00	165.00	NA	210.00	165.00
P1-SD-7	Feb-91	700.00	690.00	165.00	165.00	NA	1100.00	180.00
P1-SD-7	Aug-91	61.00	60.00	165.00	165.00	NA	140.00	165.00
P1-SD-8	Feb-91	150.00	150.00	165.00	165.00	NA	260.00	165.00
P1-SD-8	Aug-91	165.00	165.00	165.00	165.00	NA	165.00	165.00
P1-SD-9	Feb-91	36000	35000	165.00	165.00	NA	55000.00	9100.00
P1-SD-9	Aug-91	165.00	165.00	165.00	165.00	NA	83.00	165.00
P1-SD-11	Feb-91	165.00	165.00	165.00	165.00	NA	165.00	165.00
P1-SD-11	Aug-91	165.00	165.00	1100.00	165.00	NA	165.00	165.00
1-SD-7	Feb-94	165.00	49.00	82.00	165.00	ND	130.00	165.00
1-SD-8	Feb-94	180.00	160.00	86.00	165.00	91.00	430.00	66.00
1-SD-9	Feb-94	165.00	165.00	41.00	165.00	ND	36.00	165.00
1-SD-10	Feb-94	32.00	25.00	59.00	165.00	ND	73.00	165.00
1-SD-11	Feb-94	165.00	64.00	165.00	165.00	ND	140.00	165.00
1-SD-12	Feb-94	80.00	67.00	62.00	165.00	ND	190.00	35.00
1-SD-13	Feb-94	160.00	180.00	47.00	165.00	110.00	500.00	60.00
1-SD-14	Feb-94	165.00	165.00	165.00	165.00	ND	165.00	165.00
1-SD-15	Feb-94	165.00	165.00	53.00	165.00	ND	48.00	165.00
1-SD-16	Feb-94	230.00	290.00	73.00	165.00	97.00	790.00	110.00
1-SD-17	Feb-94	140.00	160.00	180.00	165.00	ND	430.00	55.00
1-SD-18	Feb-94	69.00	98.00	310.00	165.00	ND	260.00	165.00
Freq		18/28	20/28	11/28	0/28	3/12	23/28	9/28
Min		32.00	25.00	41.00		91.00	36.00	35.00
Max		36000.00	35000.00	1100.00		110.00	55000.00	9100.00
Mean		1465.79	1451.04	174.93		99.33	2265.71	466.75
StDev		6770.50	6580.97	190.32		9.71	10341.71	1692.69
Note: Organics	in ug/kg; inorganics							

Table 1. Chemistry data for the Old Landfill: (a) Sediments.

Duplicates	Sample Date	di-n-butylphthalate	di-n-octylphthalate	dibenzofuran	diethylphthalate	fluoranthene	fluorene	indeno(1,2,3-cd)pyrene	naphthalene	phenanthrene
P1-SD-9	Aug-91	ND	ND	ND	ND	ND	ND	ND	ND	ND
P1-SD-9D	Aug-91	ND	ND	ND	ND	130.00	ND	ND	ND	76.00
P1-SD-11	Feb-91	ND	ND	ND	ND	84.00	ND	ND	ND	ND
P1-SD-11D	Feb-91	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-SD-7	Feb-94	ND	ND	ND	ND	330.00	ND	77.00	ND	170.00
1-SD-7D	Feb-94	ND	ND	ND	ND	140.00	ND	ND	ND	68.00
Samples										
P1-SD-3	Feb-91	165.00	165.00	165.00	165.00	150.00	165.00	69.00	165.00	82.00
P1-SD-3	Aug-91	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00	165.00
P1-SD-4	Feb-91	165.00	165.00	165.00	165.00	590.00	165.00	290.00	165.00	340.00
P1-SD-4	Aug-91	165.00	165.00	165.00	165.00	290.00	165.00	130.00	165.00	220.00
P1-SD-5	Feb-91	165.00	165.00	270.00	165.00	3700.00	530.00	1100.00	140.00	3700.00
P1-SD-5	Aug-91	165.00	165.00	165.00	165.00	200.00	165.00	110.00	165.00	100.00
P1-SD-6	Feb-91	165.00	165.00	165.00	165.00	130.00	165.00	55.00	165.00	110.00
P1-SD-6	Aug-91	165.00	165.00	165.00	165.00	430.00	62.00	100.00	165.00	360.00
P1-SD-7	Feb-91	165.00	165.00	61.00	165.00	1700.00	150.00	810.00	165.00	1500.00
P1-SD-7	Aug-91	165.00	165.00	165.00	165.00	270.00	165.00	59.00	165.00	160.00
P1-SD-8	Feb-91	165.00	165.00	165.00	165.00	410.00	165.00	170.00	165.00	290.00
P1-SD-8	Aug-91	165.00	165.00	165.00	165.00	50.00	165.00	165.00	165.00	165.00
P1-SD-9	Feb-91	165.00	165.00	6600.00	165.00	120000.00	13000	38000.00	1700.00	120000.00
P1-SD-9	Aug-91	165.00	165.00	165.00	165.00	130.00	165.00	165.00	165.00	76.00
P1-SD-11	Feb-91	165.00	165.00	165.00	165.00	84.00	165.00	165.00	165.00	165.00
P1-SD-11	Aug-91	320.00	165.00	165.00	165.00	600.00	165.00	165.00	165.00	430.00
1-SD-7	Feb-94	165.00	165.00	165.00	165.00	330.00	165.00	77.00	165.00	170.00
1-SD-8	Feb-94	165.00	165.00	55.00	43.00	1100.00	110.00	260.00	73.00	720.00
1-SD-9	Feb-94	165.00	165.00	165.00	25.00	90.00	165.00	26.00	165.00	50.00
1-SD-10	Feb-94	165.00	165.00	165.00	1300.00	180.00	165.00	48.00	165.00	94.00
1-SD-11	Feb-94	165.00	165.00	165.00	165.00	360.00	165.00	86.00	165.00	230.00
1-SD-12	Feb-94	39.00	165.00	165.00	250.00	440.00	165.00	120.00	165.00	250.00
1-SD-13	Feb-94	165.00	165.00	88.00	165.00	1400.00	230.00	280.00	170.00	1300.00
1-SD-14	Feb-94	165.00	165.00	165.00	165.00	120.00	165.00	165.00	165.00	165.00
1-SD-15	Feb-94	165.00	165.00	165.00	165.00	83.00	165.00	165.00	165.00	53.00
1-SD-16	Feb-94	165.00	165.00	165.00	165.00	1600.00	120.00	440.00	165.00	990.00
1-SD-17	Feb-94	165.00	165.00	165.00	165.00	770.00	55.00	220.00	165.00	580.00
1-SD-18	Feb-94	165.00	165.00	165.00	165.00	450.00	165.00	120.00	165.00	320.00
Freq		2/28	0/28	3/28	4/28	27/28	8/28	21/28	4/28	24/28
Min		39.00		55.00	25.00	50.00	55.00	26.00	73.00	50.00
Max		320.00		6600.00	1300.00	120000.00	13000.00	38000.00	1700.00	120000.00
Mean		166.04		388.18	199.21	4850.79	627.04	1561.61	215.82	4742.32
StDev		38.43		1217.99	219.19	22579.99	2426.13	7144.98	291.42	22600.19
Note: Organics	in ug/kg; inorganics									

Table 1. Chemistry data for the Old Landfill: (a) Sediments.

Duplicates	Sample Date	pyrene	4,4'-DDD	4,4'-DDE	4,4'-DDT	aldrin	alpha-chlordane	gamma-chlordane	heptachlor	heptachlor epoxide	TPHC (mg/kg)	Total PAH	Total DDT
P1-SD-9	Aug-91	ND	6.90	5.70	38.00	ND	ND	ND	ND	ND	NA	0.00	0.00
P1-SD-9D	Aug-91	150.00	15.00	13.00	46.00	ND	ND	ND	ND	ND	NA	0.00	0.00
P1-SD-11	Feb-91	57.00	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND
P1-SD-11D	Feb-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	ND	ND
1-SD-7	Feb-94	190.00	110.00	29.00	39.00	ND	ND	ND	ND	ND	160.00	77.00	ND
1-SD-7D	Feb-94	80.00	68.00	19.00	16.00	ND	ND	ND	ND	ND	170.00	ND	ND
Samples													
P1-SD-3	Feb-91	130.00	5.30	11.00	27.00	0.85	0.85	0.85	0.85	0.85	NA	804.00	43.30
P1-SD-3	Aug-91	165.00	1.65	4.00	17.00	0.85	0.85	0.85	0.85	0.85	NA	0.00	21.00
P1-SD-4	Feb-91	650.00	24.00	23.00	100.00	0.85	0.85	0.85	0.85	0.85	NA	3919.00	147.00
P1-SD-4	Aug-91	400.00	24.00	19.00	97.00	0.85	0.85	0.85	0.85	0.85	NA	2030.00	140.00
P1-SD-5	Feb-91	3200.00	20.00	15.00	1.65	0.85	0.85	0.85	0.85	0.85	NA	22453.00	35.00
P1-SD-5	Aug-91	270.00	88.00	34.00	140.00	0.85	0.85	0.85	0.85	0.85	NA	1550.00	262.00
P1-SD-6	Feb-91	100.00	11.00	11.00	48.00	0.85	0.85	0.85	0.85	0.85	NA	725.00	70.00
P1-SD-6	Aug-91	400.00	11.00	8.90	43.00	0.85	2.00	2.00	0.85	0.85	NA	2254.00	62.90
P1-SD-7	Feb-91	1600.00	220.00	200.00	440.00	0.85	280.00	410.00	29.00	0.85	NA	11690.00	860.00
P1-SD-7	Aug-91	260.00	27.00	36.00	110.00	0.85	33.00	53.00	8.80	0.85	NA	1340.00	173.00
P1-SD-8	Feb-91	460.00	24.00	27.00	85.00	0.85	19.00	24.00	0.85	0.85	NA	2498.00	136.00
P1-SD-8	Aug-91	57.00	30.00	26.00	60.00	0.85	8.90	13.00	0.85	0.85	NA	169.00	116.00
P1-SD-9	Feb-91	89000.00	1.65	1.65	1.65	0.85	0.85	0.85	0.85	0.85	NA	679300.00	ND
P1-SD-9	Aug-91	150.00	15.00	13.00	46.00	0.85	0.85	0.85	0.85	0.85	ND	ND	ND
P1-SD-11	Feb-91	57.00	1.65	1.65	1.65	0.85	0.85	0.85	0.85	0.85	NA	ND	ND
P1-SD-11	Aug-91	660.00	1.65	1.65	1.65	0.85	0.85	0.85	0.85	0.85	NA	2030.00	ND
1-SD-7	Feb-94	190.00	110.00	29.00	39.00	0.85	0.85	0.85	0.85	0.85	170.00	77.00	ND
1-SD-8	Feb-94	560.00	16.00	11.00	8.90	0.85	0.85	0.85	0.85	0.85	90.00	4789.00	35.90
1-SD-9	Feb-94	45.00	5.10	4.50	20.00	0.85	0.85	0.85	0.85	0.85	110.00	672.00	29.60
1-SD-10	Feb-94	90.00	10.00	7.20	26.00	0.85	0.85	0.85	0.85	0.85	95.00	666.00	43.20
1-SD-11	Feb-94	270.00	5.70	6.90	32.00	2.50	0.85	0.85	0.85	0.85	130.00	1544.00	44.60
1-SD-12	Feb-94	240.00	11.00	12.00	57.00	0.85	2.60	2.00	0.85	0.85	140.00	1856.00	80.00
1-SD-13	Feb-94	1200.00	7.80	9.60	31.00	0.85	4.30	5.10	0.85	0.85	41.00	7090.00	48.40
1-SD-14	Feb-94	100.00	1.65	1.65	1.65	0.85	0.85	0.85	0.85	0.85	130.00	220.00	ND
1-SD-15	Feb-94	86.00	23.00	28.00	68.00	0.85	11.00	13.00	0.85	0.85	95.00	272.00	119.00
1-SD-16	Feb-94	1200.00	10.00	78.00	100.00	0.85	0.85	0.85	0.85	0.85	85.00	7461.00	188.00
1-SD-17	Feb-94	750.00	43.00	37.00	86.00	0.85	19.00	0.85	0.85	0.85	43.00	3927.00	166.00
1-SD-18	Feb-94	450.00	75.00	130.00	300.00	0.85	90.00	110.00	0.85	0.85	130.00	2255.00	505.00
Freq		27/28	23/28	24/28	23/28	1/28	9/28	7/28	2/28	0/28	12/13		
Min		45.00	1.65	1.65	1.65	0.85	0.85	0.85	0.85		41.00	ND	ND
Max		89000.00	220.00	200.00	440.00	2.50	280.00	410.00	29.00		170.00	679300.00	860
Mean		3669.29	29.43	28.13	71.04	0.91	17.33	23.15	2.14		104.92	25433.70	110.86
StDev		16736.06	45.93	42.94	94.57		54.48	79.11	5.47		38.28	123579.05	176.35
Note: Organics	in ug/kg; inorganics												

Table 1. Chemistry data for the Old Landfill: (a) Sediments.

Duplicates	Sample Date	Total Chlordane	aluminum	antimony	arsenic	barium	beryllium	cadmium	calcium	chromium	cobalt	copper	iron	lead	magnesium
P1-SD-9	Aug-91	0.00	2690.00	ND	0.62	23.30	0.50	ND	423.00	7.30	8.70	4.70	7940.00	7.70	1450.00
P1-SD-9D	Aug-91	0.00	4400.00	ND	0.82	35.70	0.72	ND	646.00	11.30	11.80	7.20	10800.00	8.60	4150.00
P1-SD-11	Feb-91	ND	8880.00	ND	ND	55.60	ND	2.20	1260.00	45.90	6.90	19.00	16600.00	52.20	6650.00
P1-SD-11D	Feb-91	ND	9410.00	ND	0.91	66.90	ND	2.10	1560.00	36.90	9.90	23.20	18000.00	8.10	6420.00
1-SD-7	Feb-94	ND	1770.00	ND	1.50	136.00	0.60	ND	5440.00	12.90	40.40	52.30	208000.00	23.10	660.00
1-SD-7D	Feb-94	ND	1140.00	ND	2.10	112.00	0.46	ND	4460.00	11.20	33.60	42.90	176000.00	17.10	397.00
Samples															
P1-SD-3	Feb-91	ND	3190.00	6.00	1.00	34.50	0.50	0.50	811.00	6.80	3.80	5.20	8490.00	14.30	2360.00
P1-SD-3	Aug-91	ND	2090.00	17.90	0.66	25.20	0.50	0.50	837.00	8.50	6.90	3.90	5940.00	4.70	2290.00
P1-SD-4	Feb-91	ND	4570.00	6.00	2.00	27.50	0.50	2.10	1030.00	18.10	3.80	12.70	18200.00	30.90	1770.00
P1-SD-4	Aug-91	ND	5320.00	6.00	1.40	55.20	0.78	0.50	1240.00	12.50	17.30	13.10	22100.00	88.70	2150.00
P1-SD-5	Feb-91	ND	3070.00	6.00	1.50	46.30	0.50	1.50	1110.00	6.60	5.10	6.00	11400.00	24.40	1410.00
P1-SD-5	Aug-91	ND	3680.00	6.00	0.81	40.60	0.64	0.50	1220.00	37.00	11.90	8.10	15200.00	102.00	1480.00
P1-SD-6	Feb-91	ND	3830.00	6.00	0.94	30.40	0.50	3.10	1010.00	9.00	3.70	16.00	20900.00	15.50	3230.00
P1-SD-6	Aug-91	2.00	2890.00	6.00	0.88	53.50	0.45	0.50	770.00	5.50	9.40	7.70	8680.00	24.40	1990.00
P1-SD-7	Feb-91	690.00	5450.00	6.00	1.70	39.90	0.50	0.50	1150.00	11.70	5.30	9.40	12400.00	23.30	2170.00
P1-SD-7	Aug-91	86.00	5390.00	6.00	0.78	42.00	0.99	0.50	996.00	14.40	14.80	25.00	18400.00	9.90	2820.00
P1-SD-8	Feb-91	43.00	4080.00	6.00	1.40	26.20	0.50	1.40	769.00	8.20	ND	8.20	11900.00	11.10	1760.00
P1-SD-8	Aug-91	21.90	2590.00	6.00	1.00	25.10	0.49	0.50	357.00	7.20	7.90	5.70	6280.00	7.80	1410.00
P1-SD-9	Feb-91	ND	3210.00	6.00	1.40	25.00	0.50	0.50	515.00	7.90	2.80	8.70	9500.00	12.50	1530.00
P1-SD-9	Aug-91	ND	4400.00	6.00	0.82	35.70	0.72	0.50	646.00	11.30	11.80	7.20	10800.00	8.60	4150.00
P1-SD-11	Feb-91	ND	9410.00	6.00	0.91	66.90	0.50	2.20	1560.00	45.90	9.90	23.20	18000.00	52.20	6650.00
P1-SD-11	Aug-91	ND	9680.00	6.00	0.20	515.00	3.30	0.50	30000.00	49.40	89.60	25.00	115000.00	387.00	6380.00
1-SD-7	Feb-94	ND	1770.00	6.00	2.10	136.00	0.60	0.50	5440.00	12.90	40.40	52.30	208000.00	23.10	660.00
1-SD-8	Feb-94	ND	3000.00	6.00	0.88	55.10	0.47	0.50	2020.00	6.30	13.40	15.40	35600.00	16.30	853.00
1-SD-9	Feb-94	ND	1170.00	6.00	0.20	37.70	0.25	0.50	660.00	4.80	5.20	8.30	7520.00	24.00	1060.00
1-SD-10	Feb-94	ND	2210.00	6.00	0.62	36.90	0.27	0.50	829.00	4.10	5.30	7.40	9380.00	7.50	1070.00
1-SD-11	Feb-94	ND	2730.00	6.00	0.20	36.00	0.27	0.50	884.00	8.10	9.00	26.60	11600.00	16.60	2730.00
1-SD-12	Feb-94	4.60	3290.00	6.00	0.75	60.10	0.37	0.50	1380.00	7.20	13.20	14.50	12600.00	25.70	1970.00
1-SD-13	Feb-94	9.40	2460.00	6.00	0.20	27.80	0.27	0.50	481.00	7.80	4.80	11.50	7830.00	12.50	1680.00
1-SD-14	Feb-94	ND	2610.00	6.00	0.20	62.30	0.39	0.50	6510.00	8.60	8.60	19.60	11600.00	47.90	2080.00
1-SD-15	Feb-94	24.00	3210.00	6.00	0.62	30.80	0.33	0.50	1180.00	7.90	5.70	8.50	7320.00	11.50	2510.00
1-SD-16	Feb-94	ND	4540.00	6.00	1.60	49.40	0.47	0.50	1050.00	7.80	5.90	13.30	8120.00	22.10	1850.00
1-SD-17	Feb-94	19.00	3070.00	6.00	0.90	33.30	0.37	0.50	594.00	7.50	5.10	7.60	7310.00	14.70	1450.00
1-SD-18	Feb-94	200.00	5650.00	6.00	1.40	56.50	0.75	0.50	1340.00	17.40	11.10	18.10	14100.00	95.20	2880.00
Freq			28/28	1/28	23/28	28/28	19/28	5/28	28/28	28/28	27/28	28/28	28/28	28/28	28/28
Min		0.00	1170.00	6.00	0.20	25.00	0.25	0.50	357.00	4.10	2.80	3.90	5940.00	4.70	660.00
Max		690.00	9680.00	17.90	2.10	515.00	3.30	3.10	30000.00	49.40	89.60	52.30	208000.00	387.00	6650.00
Mean		36.66	3877.14	6.43	0.97	61.10	0.60	0.78	2371.04	12.87	12.29	13.86	23363.21	40.51	2297.96
StDev		129.53	1968.55	2.25	0.54	91.59	0.56	0.66	5583.60	11.66	17.08	9.96	41491.97	72.82	1408.36
Note: Organics	in ug/kg; inorganics														

Table 1. Chemistry data for the Old Landfill: (a) Sediments.

Duplicates	Sample Date	manganese	mercury	nickel	potassium	selenium	sodium	vanadium	zinc	cyanide
P1-SD-9	Aug-91	295.00	0.11	10.50	433.00	ND	ND	14.50	20.50	4.10
P1-SD-9D	Aug-91	425.00	ND	32.50	749.00	ND	ND	22.60	30.80	ND
P1-SD-11	Feb-91	143.00	ND	17.00	1950.00	ND	79.20	27.60	52.70	ND
P1-SD-11D	Feb-91	156.00	ND	14.30	2570.00	ND	155.00	31.00	55.50	ND
1-SD-7	Feb-94	3210.00	ND	41.50	ND	ND	ND	28.10	11.40	ND
1-SD-7D	Feb-94	2240.00	ND	35.70	ND	ND	2820.00	20.30	8.10	ND
Samples										
P1-SD-3	Feb-91	264.00	0.02	12.20	1000.00	ND	ND	12.60	24.80	ND
P1-SD-3	Aug-91	258.00	0.02	14.50	692.00	ND	50.70	10.30	22.90	ND
P1-SD-4	Feb-91	380.00	0.02	8.10	555.00	ND	76.50	21.80	65.60	ND
P1-SD-4	Aug-91	1320.00	0.02	18.60	939.00	ND	ND	25.90	69.50	ND
P1-SD-5	Feb-91	1630.00	0.02	10.60	457.00	ND	ND	23.70	38.00	ND
P1-SD-5	Aug-91	1720.00	0.02	16.30	334.00	ND	ND	22.00	29.00	ND
P1-SD-6	Feb-91	882.00	0.02	28.80	499.00	ND	ND	25.50	34.70	ND
P1-SD-6	Aug-91	1191.00	0.12	13.30	427.00	ND	ND	13.30	51.40	ND
P1-SD-7	Feb-91	252.00	0.19	9.40	796.00	ND	91.00	22.70	38.40	ND
P1-SD-7	Aug-91	182.00	0.02	13.30	992.00	ND	ND	37.60	24.90	ND
P1-SD-8	Feb-91	229.00	0.02	8.70	549.00	ND	ND	20.40	38.00	ND
P1-SD-8	Aug-91	174.00	0.11	10.30	432.00	ND	ND	16.00	18.40	ND
P1-SD-9	Feb-91	284.00	0.02	6.90	641.00	ND	ND	15.00	23.30	ND
P1-SD-9	Aug-91	425.00	0.11	32.50	749.00	ND	ND	22.60	30.80	4.10
P1-SD-11	Feb-91	156.00	0.02	17.00	2570.00	ND	155.00	31.00	55.50	ND
P1-SD-11	Aug-91	5600.00	0.02	57.10	1930.00	ND	473.00	68.00	186.00	ND
1-SD-7	Feb-94	3210.00	0.02	41.50	ND	ND	2820.00	28.10	11.40	ND
1-SD-8	Feb-94	1510.00	0.02	11.10	ND	ND	ND	16.70	22.40	ND
1-SD-9	Feb-94	1170.00	0.02	16.90	ND	ND	926.00	12.60	32.20	ND
1-SD-10	Feb-94	892.00	0.02	8.30	644.00	ND	ND	12.10	35.10	ND
1-SD-11	Feb-94	597.00	0.02	33.10	ND	ND	ND	14.10	42.60	ND
1-SD-12	Feb-94	903.00	0.02	13.40	ND	ND	470.00	18.50	41.30	ND
1-SD-13	Feb-94	255.00	0.02	10.90	ND	ND	ND	12.70	28.90	ND
1-SD-14	Feb-94	555.00	0.02	11.00	ND	ND	1650.00	13.00	87.50	ND
1-SD-15	Feb-94	208.00	0.02	17.00	919.00	ND	ND	14.90	39.10	ND
1-SD-16	Feb-94	193.00	0.02	7.10	1940.00	ND	ND	19.50	43.00	ND
1-SD-17	Feb-94	184.00	0.02	10.70	ND	ND	502.00	14.80	33.80	ND
1-SD-18	Feb-94	357.00	0.02	16.10	ND	ND	ND	33.70	50.80	ND
Freq		28/28	4/28	28/28	19/28	0/28	10/28	28/28	28/28	1/28
Min		156.00	0.02	6.90	334.00		50.70	10.30	11.40	4.10
Max		5600.00	0.19	57.10	2570.00		2820.00	68.00	186.00	4.10
Mean		892.18	0.04	16.95	898.16		721.42	21.40	43.55	4.10
StDev		1153.22	0.04	11.60	602.01		886.02	11.53	32.41	
Note: Organics	in ug/kg; inorganics									

Table 1. Chemistry data for the Old Landfill: (b) Surface Water.

Duplicates	Sample Date	1,2-dichloroethene (total)	acetone	bromodichloromethane	carbon disulfide	chlorobenzene	chloroform	ethylbenzene	methylene chloride
P1-SW-9	Aug-91	ND	ND	1.00	ND	ND	1.00	ND	ND
P1-SW-9D	Aug-91	ND	ND	ND	ND	ND	1.00	ND	ND
P1-SW-11	Feb-91	10.00	ND	ND	7.00	ND	ND	ND	ND
P1-SW-11D	Feb-91	15.00	ND	ND	ND	ND	ND	ND	ND
1-SW-7	Feb-94	ND	16.00	ND	ND	11.00	ND	ND	ND
1-SW-7D	Feb-94	ND	17.00	ND	ND	ND	ND	ND	ND
1-SW-13	Aug-94	ND	ND	2.00	ND	ND	9.00	ND	ND
1-SW-13D	Aug-94	ND	ND	2.00	ND	ND	8.00	ND	ND
Samples									
P1-SW-3	Feb-91	ND	5.00	ND	5.00	ND	ND	5.00	ND
P1-SW-3	Aug-91	ND	5.00	ND	**5.00**	ND	ND	5.00	ND
P1-SW-4	Feb-91	ND	5.00	ND	5.00	**2.00**	ND	5.00	ND
P1-SW-4	Aug-91	ND	5.00	ND	5.00	ND	ND	**1.00**	ND
P1-SW-5	Feb-91	ND	5.00	ND	5.00	ND	ND	5.00	ND
P1-SW-5	Aug-91	ND	5.00	ND	5.00	ND	ND	5.00	ND
P1-SW-6	Feb-91	ND	5.00	ND	5.00	ND	ND	5.00	ND
P1-SW-6	Aug-91	ND	5.00	ND	5.00	ND	ND	5.00	ND
P1-SW-7	Feb-91	ND	5.00	ND	5.00	ND	ND	5.00	ND
P1-SW-7	Aug-91	ND	5.00	ND	5.00	ND	ND	5.00	ND
P1-SW-8	Feb-91	ND	5.00	ND	5.00	ND	ND	5.00	ND
P1-SW-8	Aug-91	ND	5.00	ND	5.00	ND	ND	5.00	ND
P1-SW-9	Feb-91	ND	5.00	ND	**7.00**	ND	ND	5.00	ND
P1-SW-9	Aug-91	ND	5.00	**1.00**	5.00	ND	**1.00**	5.00	ND
P1-SW-11	Feb-91	**15.00**	5.00	ND	**7.00**	ND	ND	5.00	ND
P1-SW-11	Aug-91	**8.00**	5.00	ND	**290.00**	ND	ND	5.00	ND
1-SW-7	Feb-94	ND	**17.00**	ND	5.00	**11.00**	ND	5.00	ND
1-SW-7	Aug-94	ND	5.00	ND	5.00	**10.00**	ND	5.00	ND
1-SW-8	Feb-94	ND	5.00	ND	5.00	ND	ND	5.00	ND
1-SW-8	Aug-94	ND	5.00	ND	5.00	**15.00**	ND	5.00	ND
1-SW-10	Feb-94	ND	**27.00**	ND	5.00	ND	ND	5.00	ND
1-SW-10	Aug-94	ND	5.00	ND	5.00	ND	**1.00**	5.00	ND
1-SW-11	Aug-94	ND	5.00	ND	5.00	ND	ND	5.00	ND
1-SW-13	Feb-94	ND	5.00	ND	5.00	ND	ND	5.00	ND
1-SW-13	Aug-94	ND	5.00	**2.00**	5.00	ND	**9.00**	5.00	ND
1-SW-14	Aug-94	**7.00**	5.00	ND	**2.00**	ND	ND	5.00	ND
1-SW-16	Feb-94	ND	**6.00**	ND	5.00	ND	ND	5.00	ND
1-SW-16	Aug-94	**2.00**	**14.00**	ND	5.00	ND	ND	5.00	ND
1-SW-19	Aug-94	ND	5.00	ND	5.00	ND	**1.00**	5.00	ND
Freq		4/29	4/29	2/29	5/29	4/29	4/29	1/29	0/29
Min		2.00	5.00	1.00	2.00	2.00	1.00	1.00	
Max		15.00	27.00	2.00	290.00	15.00	9.00	5.00	
Mean		8.00	6.52	1.50	14.86	9.50	3.00	4.86	
StDev		5.35	4.79	0.71	52.92	5.45	4.00	0.74	
Data in ug/L	except TPHC	in mg/L							

Table 1. Chemistry data for the Old Landfill: (b) Surface Water.

Duplicates	Sample Date	tetrachloroethene	toluene	trichlororethene	vinyl chloride	xylenes (total)	1,4-dichlorobenzene	2-chlorophenol	2-methylnaphthalene	2-methylphenol
P1-SW-9	Aug-91	ND	ND	ND	ND	ND	ND	ND	ND	ND
P1-SW-9D	Aug-91	ND	ND	ND	ND	ND	ND	ND	ND	ND
P1-SW-11	Feb-91	ND	ND	ND	ND	ND	ND	ND	ND	ND
P1-SW-11D	Feb-91	ND	ND	2.00	ND	ND	ND	ND	ND	ND
1-SW-7	Feb-94	ND	ND	ND	ND	ND	2.00	ND	ND	ND
1-SW-7D	Feb-94	ND	ND	ND	ND	ND	2.00	ND	ND	ND
1-SW-13	Aug-94	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-SW-13D	Aug-94	ND	ND	ND	ND	ND	ND	ND	ND	ND
Samples										
P1-SW-3	Feb-91	ND	ND	ND	ND	5.00	ND	ND	5.00	5.00
P1-SW-3	Aug-91	ND	ND	ND	ND	5.00	ND	ND	5.00	5.00
P1-SW-4	Feb-91	ND	ND	ND	ND	5.00	ND	ND	5.00	5.00
P1-SW-4	Aug-91	**1.00**	**1.00**	**1.00**	ND	**2.00**	ND	ND	5.00	5.00
P1-SW-5	Feb-91	ND	ND	ND	ND	5.00	ND	ND	5.00	5.00
P1-SW-5	Aug-91	ND	ND	ND	ND	**2.00**	ND	ND	5.00	5.00
P1-SW-6	Feb-91	ND	ND	ND	ND	5.00	ND	ND	5.00	5.00
P1-SW-6	Aug-91	ND	ND	ND	ND	**2.00**	ND	ND	5.00	5.00
P1-SW-7	Feb-91	ND	ND	ND	ND	5.00	ND	ND	5.00	5.00
P1-SW-7	Aug-91	ND	ND	ND	ND	**1.00**	ND	ND	5.00	5.00
P1-SW-8	Feb-91	ND	ND	ND	ND	5.00	ND	ND	5.00	5.00
P1-SW-8	Aug-91	ND	ND	ND	ND	5.00	ND	ND	5.00	5.00
P1-SW-9	Feb-91	ND	ND	ND	ND	5.00	ND	ND	5.00	5.00
P1-SW-9	Aug-91	ND	ND	ND	ND	5.00	ND	ND	5.00	5.00
P1-SW-11	Feb-91	ND	ND	**2.00**	ND	5.00	ND	ND	5.00	5.00
P1-SW-11	Aug-91	ND	ND	**1.00**	ND	5.00	ND	ND	5.00	5.00
1-SW-7	Feb-94	ND	ND	ND	ND	5.00	**2.00**	ND	5.00	5.00
1-SW-7	Aug-94	ND	ND	ND	ND	5.00	**2.00**	ND	5.00	5.00
1-SW-8	Feb-94	ND	ND	ND	ND	5.00	**2.00**	ND	5.00	5.00
1-SW-8	Aug-94	ND	ND	ND	ND	5.00	**9.00**	ND	5.00	5.00
1-SW-10	Feb-94	ND	ND	ND	ND	5.00	ND	ND	5.00	5.00
1-SW-10	Aug-94	ND	ND	ND	ND	5.00	ND	ND	5.00	5.00
1-SW-11	Aug-94	ND	ND	ND	ND	5.00	ND	ND	5.00	5.00
1-SW-13	Feb-94	ND	ND	ND	ND	5.00	ND	ND	5.00	5.00
1-SW-13	Aug-94	ND	ND	ND	ND	5.00	ND	ND	5.00	5.00
1-SW-14	Aug-94	ND	ND	**2.00**	ND	5.00	ND	ND	5.00	5.00
1-SW-16	Feb-94	ND	ND	**7.00**	ND	5.00	ND	ND	5.00	5.00
1-SW-16	Aug-94	ND	ND	**8.00**	ND	5.00	ND	ND	5.00	5.00
1-SW-19	Aug-94	ND	ND	ND	ND	5.00	ND	ND	5.00	5.00
Freq		1/29	1/29	6/29	0/29	4/29	4/29	0/29	0/29	0/29
Min		1.00	1.00	1.00		1.00	2.00			
Max		1.00	1.00	8.00		5.00	9.00			
Mean		1.00	1.00	3.50		4.55	3.75			
StDev				3.15		1.15	3.50			
Data in ug/L	except TPHC									

Table 1. Chemistry data for the Old Landfill: (b) Surface Water.

Duplicates	Sample Date	acenaphthene	acenaphthylene	anthracene	bis(2-ethylhexyl)phthalate	chrysene	dibenzofuran	diethylphthalate	fluoranthene	fluorene	naphthalene
P1-SW-9	Aug-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
P1-SW-9D	Aug-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
P1-SW-11	Feb-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
P1-SW-11D	Feb-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-SW-7	Feb-94	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-SW-7D	Feb-94	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-SW-13	Aug-94	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1-SW-13D	Aug-94	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Samples											
P1-SW-3	Feb-91	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
P1-SW-3	Aug-91	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
P1-SW-4	Feb-91	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
P1-SW-4	Aug-91	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
P1-SW-5	Feb-91	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
P1-SW-5	Aug-91	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
P1-SW-6	Feb-91	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
P1-SW-6	Aug-91	5.00	5.00	5.00	5.00	5.00	5.00	**430.00**	5.00	5.00	5.00
P1-SW-7	Feb-91	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
P1-SW-7	Aug-91	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
P1-SW-8	Feb-91	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
P1-SW-8	Aug-91	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
P1-SW-9	Feb-91	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
P1-SW-9	Aug-91	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
P1-SW-11	Feb-91	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
P1-SW-11	Aug-91	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
1-SW-7	Feb-94	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
1-SW-7	Aug-94	5.00	5.00	5.00	**22.00**	5.00	5.00	5.00	5.00	5.00	5.00
1-SW-8	Feb-94	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
1-SW-8	Aug-94	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
1-SW-10	Feb-94	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
1-SW-10	Aug-94	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
1-SW-11	Aug-94	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
1-SW-13	Feb-94	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
1-SW-13	Aug-94	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
1-SW-14	Aug-94	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
1-SW-16	Feb-94	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
1-SW-16	Aug-94	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
1-SW-19	Aug-94	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Freq		0/29	0/29	0/29	1/29	0/29	0/29	1/29	0/29	0/29	0/29
Min					5.00			5.00			
Max					22.00			430.00			
Mean					5.59			19.66			
StDev											
Data in ug/L	except TPHC										

Table 1. Chemistry data for the Old Landfill: (b) Surface Water.

Duplicates	Sample Date	phenanthrene	phenol	pyrene	4,4'-DDD	4,4'-DDE	4,4'-DDT	endosulfan sulfate	endrin	methoxychlor	TPHC (mg/L)	aluminum	antimony	arsenic	barium
P1-SW-9	Aug-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	492.00	ND	ND	50.10
P1-SW-9D	Aug-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	3620.00	ND	ND	80.50
P1-SW-11	Feb-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	5040.00	ND	4.50	120.00
P1-SW-11D	Feb-91	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	22700.00	ND	8.60	502.00
1-SW-7	Feb-94	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	60.30	ND	ND	39.30
1-SW-7D	Feb-94	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	53.70	ND	ND	38.10
1-SW-13	Aug-94	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	95.40	ND	ND	31.50
1-SW-13D	Aug-94	ND	ND	ND	ND	ND	ND	ND	ND	0.31	ND	212.00	ND	ND	36.30
Samples															
P1-SW-3	Feb-91	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	NA	100.00	ND	ND	**37.90**
P1-SW-3	Aug-91	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	NA	**213.00**	ND	ND	**41.90**
P1-SW-4	Feb-91	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	NA	**208.00**	ND	ND	**31.30**
P1-SW-4	Aug-91	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	NA	**5610.00**	ND	ND	**108.00**
P1-SW-5	Feb-91	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	NA	100.00	ND	ND	**27.40**
P1-SW-5	Aug-91	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	NA	**278.00**	ND	ND	**24.20**
P1-SW-6	Feb-91	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	NA	**95.70**	ND	**2.10**	**26.20**
P1-SW-6	Aug-91	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	NA	**540.00**	ND	ND	**30.40**
P1-SW-7	Feb-91	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	NA	**1100.00**	ND	ND	**53.20**
P1-SW-7	Aug-91	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	NA	**144.00**	ND	ND	**51.20**
P1-SW-8	Feb-91	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	NA	**418.00**	ND	ND	**36.80**
P1-SW-8	Aug-91	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	NA	**1066.00**	**58.70**	ND	**43.20**
P1-SW-9	Feb-91	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	NA	**93.80**	ND	ND	**36.70**
P1-SW-9	Aug-91	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	NA	**3620.00**	ND	ND	**80.50**
P1-SW-11	Feb-91	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	NA	**22700.00**	ND	**8.60**	**502.00**
P1-SW-11	Aug-91	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	NA	**65300.00**	ND	**22.40**	**1080.00**
1-SW-7	Feb-94	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	ND	**60.30**	ND	ND	**39.30**
1-SW-7	Aug-94	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	ND	**2310.00**	ND	ND	**433.00**
1-SW-8	Feb-94	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	ND	**15100.00**	ND	**7.50**	**250.00**
1-SW-8	Aug-94	5.00	5.00	5.00	**0.81**	**0.18**	**0.11**	ND	ND	0.25	ND	**399000.00**	ND	**44.70**	**2540.00**
1-SW-10	Feb-94	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	ND	**111.00**	ND	ND	**31.50**
1-SW-10	Aug-94	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	ND	**2110.00**	ND	**2.20**	**41.80**
1-SW-11	Aug-94	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	ND	**94.90**	ND	ND	**30.70**
1-SW-13	Feb-94	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	ND	**85.10**	ND	ND	**29.80**
1-SW-13	Aug-94	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	**0.31**	ND	**212.00**	ND	ND	**36.30**
1-SW-14	Aug-94	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	ND	**4140.00**	ND	2.60	**251.00**
1-SW-16	Feb-94	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	ND	**3340.00**	ND	ND	**107.00**
1-SW-16	Aug-94	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	ND	**11800.00**	ND	ND	**187.00**
1-SW-19	Aug-94	5.00	5.00	5.00	0.05	0.05	0.05	ND	ND	0.25	ND	**879.00**	ND	ND	**30.00**
Freq		0/29	0/29	0/29	1/29	1/29	1/29	0/29	0/29	1/29	0/13	27/29	1/29	7/29	29/29
Min					0.05	0.05	0.05			0.25		60.30	58.70	2.10	24.20
Max					0.81	0.18	0.11			0.31		399000.00	58.70	44.70	2540.00
Mean					0.08	0.05	0.05			0.25		18649.27	58.70	12.87	2'4.42
StDev					0.14	0.02	0.01			0.01		74245.76		15.74	497.84
Data in ug/L except TPHC															

Table 1. Chemistry data for the Old Landfill: (b) Surface Water.

Duplicates	Sample Date	beryllium	cadmium	calcium	chromium	cobalt	copper	iron	lead	magnesium	manganese	mercury	nickel	potassium	selenium	silver
P1-SW-9	Aug-91	ND	ND	34900.00	ND	15.20	ND	609.00	1.10	13800.00	71.30	ND	ND	3300.00	ND	ND
P1-SW-9D	Aug-91	ND	ND	34800.00	ND	9.30	11.00	5730.00	14.50	14400.00	368.00	0.24	22.20	2700.00	ND	ND
P1-SW-11	Feb-91	ND	7.70	56100.00	17.00	61.20	25.10	58500.00	33.80	23400.00	719.00	ND	19.70	3740.00	ND	ND
P1-SW-11D	Feb-91	ND	25.40	10100.00	62.20	169.00	115.00	168000.00	111.00	34500.00	2960.00	ND	78.10	8580.00	ND	ND
1-SW-7	Feb-94	ND	ND	67500.00	ND	3.10	2.70	21900.00	ND	16800.00	2880.00	ND	ND	2770.00	ND	ND
1-SW-7D	Feb-94	0.16	ND	71700.00	ND	3.10	3.80	19400.00	ND	17900.00	2950.00	ND	ND	ND	ND	ND
1-SW-13	Aug-94	ND	ND	33200.00	ND	ND	ND	127.00	3.80	11700.00	8.60	ND	ND	2300.00	ND	ND
1-SW-13D	Aug-94	ND	ND	27500.00	ND	ND	ND	394.00	2.40	10300.00	23.60	ND	ND	2220.00	ND	ND
Samples																
P1-SW-3	Feb-91	2.50	2.50	16200.00	5.00	ND	12.50	37.70	0.50	5830.00	6.00	0.10	20.00	1230.00	5.00	5.00
P1-SW-3	Aug-91	2.50	2.50	22300.00	5.00	ND	12.50	315.00	3.60	7880.00	39.70	0.10	20.00	1740.00	5.00	5.00
P1-SW-4	Feb-91	2.50	2.50	57000.00	5.00	ND	12.50	3060.00	2.90	11800.00	784.00	0.10	20.00	2450.00	5.00	5.00
P1-SW-4	Aug-91	2.50	2.50	63600.00	5.00	31.40	5.10	48400.00	28.10	14400.00	2690.00	0.10	20.00	4570.00	5.00	5.00
P1-SW-5	Feb-91	2.50	2.50	57100.00	5.00	ND	12.50	361.00	0.50	12400.00	308.00	0.10	20.00	2430.00	5.00	5.00
P1-SW-5	Aug-91	2.50	2.50	59000.00	5.00	11.50	12.50	652.00	4.30	1270.00	96.20	0.10	20.00	3100.00	5.00	5.00
P1-SW-6	Feb-91	2.50	2.50	35200.00	5.00	ND	12.50	269.00	1.10	11500.00	56.40	0.10	20.00	1610.00	5.00	5.00
P1-SW-6	Aug-91	2.50	2.50	38300.00	5.00	13.70	12.50	877.00	1.80	12600.00	56.10	0.10	20.00	2700.00	5.00	5.00
P1-SW-7	Feb-91	2.50	2.50	25600.00	10.30	ND	12.50	3650.00	9.80	10700.00	86.90	0.10	20.00	1730.00	5.00	5.00
P1-SW-7	Aug-91	2.50	2.50	28900.00	5.00	9.10	12.50	1300.00	1.60	12100.00	173.00	0.10	20.00	1970.00	5.00	5.00
P1-SW-8	Feb-91	2.50	2.50	27300.00	5.00	ND	12.50	69.80	0.50	11100.00	36.40	0.10	20.00	1420.00	5.00	5.00
P1-SW-8	Aug-91	2.50	2.50	30000.00	5.00	13.20	12.50	1270.00	8.00	12900.00	60.10	0.20	20.00	2170.00	5.00	5.00
P1-SW-9	Feb-91	2.50	2.50	26700.00	5.00	ND	12.50	169.00	1.10	10700.00	23.80	0.10	20.00	1490.00	5.00	5.00
P1-SW-9	Aug-91	2.50	2.50	34900.00	5.00	15.20	11.00	5730.00	14.50	14400.00	368.00	0.24	22.20	3300.00	5.00	5.00
P1-SW-11	Feb-91	2.50	25.40	56100.00	62.20	169.00	115.00	168000.00	111.00	34500.00	2960.00	0.10	78.10	8580.00	5.00	5.00
P1-SW-11	Aug-91	7.60	2.50	15600.00	201.00	363.00	216.00	449000.00	656.00	52900.00	5800.00	0.81	277.00	14100.00	5.00	5.00
1-SW-7	Feb-94	0.16	2.50	71700.00	5.00	3.10	3.80	21900.00	0.50	17900.00	2950.00	0.10	20.00	2770.00	5.00	5.00
1-SW-7	Aug-94	1.60	2.50	83500.00	39.10	120.00	118.00	709000.00	4.90	16400.00	4930.00	0.10	119.00	2500.00	5.00	5.00
1-SW-8	Feb-94	2.00	2.50	46300.00	25.00	71.20	82.50	239000.00	66.40	15800.00	5260.00	0.28	66.80	4870.00	5.00	5.00
1-SW-8	Aug-94	40.50	21.10	13300.00	532.00	749.00	950.00	833000.00	1360.00	121000.00	15600.00	0.10	614.00	60300.00	22.40	5.00
1-SW-10	Feb-94	2.50	2.50	26000.00	5.00	ND	12.50	94.60	0.50	9740.00	35.70	0.10	20.00	ND	5.00	5.00
1-SW-10	Aug-94	0.20	2.50	28700.00	3.00	ND	4.90	3490.00	8.50	9180.00	183.00	0.10	5.50	3410.00	5.00	5.00
1-SW-11	Aug-94	2.50	2.50	33000.00	5.00	ND	12.50	127.00	1.20	11700.00	8.50	0.10	20.00	2510.00	5.00	5.00
1-SW-13	Feb-94	2.50	2.50	24400.00	5.00	ND	12.50	67.10	0.50	9240.00	32.30	0.10	20.00	ND	5.00	5.00
1-SW-13	Aug-94	2.50	2.50	33200.00	5.00	ND	12.50	394.00	3.80	11700.00	23.60	0.10	20.00	2300.00	5.00	5.00
1-SW-14	Aug-94	0.57	2.50	66500.00	19.30	27.60	29.60	53600.00	42.40	26200.00	2840.00	0.10	28.60	3170.00	5.00	5.00
1-SW-16	Feb-94	0.49	2.50	41900.00	3.30	ND	26.80	4880.00	16.00	15900.00	88.00	0.28	13.60	2590.00	5.00	5.00
1-SW-16	Aug-94	1.30	2.50	52600.00	17.70	7.40	114.00	14300.00	32.20	21000.00	1010.00	0.10	26.10	4490.00	2.00	3.40
1-SW-19	Aug-94	2.50	2.50	26800.00	5.00	ND	12.50	1340.00	3.60	7960.00	66.60	0.10	20.00	2730.00	5.00	5.00
Freq		9/29	2/29	29/29	10/29	14/29	12/29	29/29	24/29	29/29	29/29	5/29	10/29	27/29	2/29	1/29
Min		0.16	2.50	13300.00	3.00	3.10	3.80	37.70	0.50	1270.00	6.00	0.10	5.50	1230.00	2.00	3.40
Max		40.50	25.40	83500.00	532.00	749.00	950.00	833000.00	1360.00	121000.00	15600.00	0.81	614.00	60300.00	22.40	3.40
Mean		3.60	3.93	39368.97	34.76	114.60	65.14	88425.97	82.27	18300.00	1605.94	0.15	56.24	5415.93	5.50	4.94
StDev		7.21	5.38	18316.35	102.77	207.47	177.03	212364.12	274.17	21957.92	3212.25	0.14	119.00	11275.07	3.30	
Data in ug/L	except TPHC															

Table 1. Chemistry data for the Old Landfill: (b) Surface Water.

Duplicates	Sample Date	sodium	vanadiu	zinc
P1-SW-9	Aug-91	21500.00	12.90	10.00
P1-SW-9D	Aug-91	21100.00	14.10	46.50
P1-SW-11	Feb-91	20300.00	20.80	107.00
P1-SW-11D	Feb-91	21200.00	87.50	477.00
1-SW-7	Feb-94	18000.00	ND	ND
1-SW-7D	Feb-94	19300.00	ND	ND
1-SW-13	Aug-94	15300.00	ND	24.90
1-SW-13D	Aug-94	14900.00	ND	30.40
Samples				
P1-SW-3	Feb-91	9910.00	ND	4.10
P1-SW-3	Aug-91	11200.00	ND	5.80
P1-SW-4	Feb-91	17500.00	ND	10.00
P1-SW-4	Aug-91	18500.00	28.90	60.40
P1-SW-5	Feb-91	21600.00	ND	9.00
P1-SW-5	Aug-91	22100.00	13.00	7.50
P1-SW-6	Feb-91	20800.00	ND	15.70
P1-SW-6	Aug-91	22500.00	11.00	7.60
P1-SW-7	Feb-91	16000.00	ND	10.00
P1-SW-7	Aug-91	15400.00	9.60	20.00
P1-SW-8	Feb-91	15800.00	ND	13.80
P1-SW-8	Aug-91	15500.00	12.80	11.50
P1-SW-9	Feb-91	15600.00	ND	11.50
P1-SW-9	Aug-91	21500.00	14.10	46.50
P1-SW-11	Feb-91	21200.00	87.50	477.00
P1-SW-11	Aug-91	23400.00	322.00	1570.00
1-SW-7	Feb-94	19300.00	ND	10.00
1-SW-7	Aug-94	19100.00	41.70	10.00
1-SW-8	Feb-94	12200.00	71.80	98.70
1-SW-8	Aug-94	25000.00	1130.00	2980.00
1-SW-10	Feb-94	14000.00	ND	3.90
1-SW-10	Aug-94	18700.00	9.00	158.00
1-SW-11	Aug-94	20200.00	ND	24.90
1-SW-13	Feb-94	13300.00	ND	4.10
1-SW-13	Aug-94	15300.00	ND	30.40
1-SW-14	Aug-94	24500.00	26.70	140.00
1-SW-16	Feb-94	23400.00	13.70	26.50
1-SW-16	Aug-94	28100.00	25.50	97.10
1-SW-19	Aug-94	15500.00	ND	85.50
Freq		29/29	15/29	25/29
Min		9910.00	9.00	3.90
Max		28100.00	1130.00	2980.00
Mean		18521.03	121.15	205.16
StDev		4461.56	290.10	610.42
Data in ug/L	except TPHC			

Table 2. Chemistry data for the Fire Training Area: (a) Sediments.

Sample	Sample Date	toluene	2-methylnaphthalene	acenaphthene	anthracene	benzo(a)anthracene	benzo(a)pyrene	benzo(b)fluoranthene	benzo(ghi)perylene
Duplicates									
P2-SD-8	Feb-91	ND	ND	ND	ND	ND	ND	ND	ND
P2-SD-8D	Feb-91	0.50	ND	ND	ND	ND	ND	ND	ND
P2-SD-5	Feb-91	ND	165.00	165.00	165.00	165.00	165.00	165.00	165.00
P2-SD-5	Aug-91	ND	165.00	165.00	165.00	165.00	165.00	165.00	165.00
P2-SD-8	Feb-91	0.50	165.00	165.00	165.00	165.00	165.00	165.00	165.00
P2-SD-8	Aug-91	ND	165.00	165.00	165.00	165.00	165.00	165.00	165.00
2-SD-1	Feb-94	ND	165.00	165.00	165.00	165.00	165.00	165.00	165.00
2-SD-2	Feb-94	ND	165.00	165.00	56.00	150.00	70.00	140.00	37.00
2-SD-3	Feb-94	ND	165.00	165.00	165.00	165.00	165.00	165.00	165.00
2-SD-5	Feb-94	NA	165.00	165.00	165.00	165.00	165.00	165.00	165.00
2-SD-9	Feb-94	NA	165.00	165.00	165.00	165.00	165.00	165.00	165.00
2-SD-10	Feb-94	NA	165.00	165.00	165.00	165.00	32.00	40.00	165.00
Freq		1/10	0/10	0/10	1/10	1/10	2/10	2/10	1/10
Min		0.50			56.00	150.00	32.00	40.00	37.00
Max		0.50			165.00	165.00	165.00	165.00	165.00
Mean		0.50			154.10	163.50	142.20	150.00	152.20
StDev							48.89	39.44	
Note: Organics	in ug/kg; inorganics	in mg/kg							

Table 2. Chemistry data for the Fire Training Area: (a) Sediments.

Sample	Sample Date	benzo(k)fluoranthene	bis(2-ehtylhexyl)phthalate	butylbenzylphthalate	chrysene	di-n-butylphthalate	dibenz(ah)anthracene	diethylphthalate
Duplicates								
P2-SD-8	Feb-91	ND	ND	ND	ND	ND	ND	ND
P2-SD-8D	Feb-91	ND	ND	ND	ND	ND	ND	ND
P2-SD-5	Feb-91	165.00	165.00	165.00	165.00	165.00	165.00	165.00
P2-SD-5	Aug-91	165.00	165.00	165.00	165.00	165.00	165.00	165.00
P2-SD-8	Feb-91	165.00	165.00	165.00	165.00	165.00	165.00	165.00
P2-SD-8	Aug-91	165.00	165.00	165.00	165.00	165.00	165.00	165.00
2-SD-1	Feb-94	165.00	51.00	165.00	165.00	37.00	165.00	165.00
2-SD-2	Feb-94	40.00	50.00	165.00	130.00	165.00	165.00	165.00
2-SD-3	Feb-94	165.00	40.00	165.00	165.00	40.00	165.00	22.00
2-SD-5	Feb-94	165.00	165.00	165.00	165.00	165.00	165.00	165.00
2-SD-9	Feb-94	165.00	165.00	165.00	165.00	165.00	165.00	165.00
2-SD-10	Feb-94	165.00	110.00	110.00	42.00	165.00	165.00	165.00
Freq		1/10	4/10	1/10	2/10	2/10	0/10	1/10
Min		40.00	40.00	110.00	42.00	37.00		22.00
Max		165.00	165.00	165.00	165.00	165.00		165.00
Mean		152.50	124.10	159.50	149.20	139.70		150.70
StDev			55.92		39.24	53.34		
Note: Organics	in ug/kg; inorganics							

Table 2. Chemistry data for the Fire Training Area: (a) Sediments.

Sample	Sample Date	fluoranthene	indeno(1,2,3-cd)pyrene	naphthalene	phenanthrene	pyrene	4,4'-DDD	4,4-DDE	4,4'-DDT	alpha-chlordane	endosulfan sulfate
Duplicates											
P2-SD-8	Feb-91	ND	ND	ND	ND	ND	8.80	10.00	17.00	ND	ND
P2-SD-8D	Feb-91	ND	ND	ND	ND	ND	7.10	6.80	13.00	ND	ND
P2-SD-5	Feb-91	165.00	165.00	165.00	165.00	165.00	2.00	2.40	9.80	0.85	ND
P2-SD-5	Aug-91	165.00	165.00	165.00	165.00	165.00	5.40	6.10	1.65	0.85	ND
P2-SD-8	Feb-91	165.00	165.00	165.00	165.00	165.00	8.80	10.00	17.00	0.85	ND
P2-SD-8	Aug-91	165.00	165.00	165.00	165.00	165.00	2.40	1.65	6.90	0.85	ND
2-SD-1	Feb-94	28.00	165.00	165.00	165.00	29.00	6.00	4.50	14.00	0.85	ND
2-SD-2	Feb-94	340.00	72.00	165.00	260.00	240.00	1.65	1.65	8.50	0.85	ND
2-SD-3	Feb-94	165.00	165.00	165.00	165.00	165.00	1.65	1.65	11.00	0.85	ND
2-SD-5	Feb-94	165.00	165.00	165.00	165.00	165.00	1.65	1.65	9.00	0.85	ND
2-SD-9	Feb-94	165.00	165.00	165.00	165.00	165.00	1.65	6.90	22.00	0.85	ND
2-SD-10	Feb-94	84.00	165.00	165.00	64.00	56.00	9.70	13.00	49.00	0.85	ND
Freq		3/10	1/10	0/10	2/10	3/10	6/10	6/10	9/10	0/10	0/10
Min		28.00	72.00		64.00	29.00	1.65	1.65	1.65		
Max		340.00	165.00		260.00	240.00	9.70	13.00	49.00		
Mean		160.70	155.70		164.40	148.00	4.09	4.95	14.89		
StDev		78.72			46.21	60.66	3.16	4.02	13.23		
Note: Organics	in ug/kg; inorganics										

Table 2. Chemistry data for the Fire Training Area: (a) Sediments.

Sample	Sample Date	endrin aldehyde	endrin	heptachlor epoxide	TFHC (mg/kg)	Total PAH	Total DDT	*Inorganics (mg/kg)* aluminum	arsenic	barium	beryllium	cadmium
Duplicates												
P2-SD-8	Feb-91	ND	ND	ND	ND	0.00	0.00	2900.00	0.65	23.80	ND	1.30
P2-SD-8D	Feb-91	ND	ND	ND	ND	0.00	0.00	2890.00	1.00	50.20	ND	ND
P2-SD-5	Feb-91	ND	ND	ND	ND	0.00	14.20	1380.00	0.62	10.70	0.50	0.50
P2-SD-5	Aug-91	ND	ND	ND	11.00	0.00	11.50	1470.00	0.67	16.00	0.50	0.50
P2-SD-8	Feb-91	ND	ND	ND	ND	0.00	35.80	2900.00	1.00	50.20	0.50	1.30
P2-SD-8	Aug-91	ND	ND	ND	29.00	0.00	9.30	1050.00	0.62	12.60	0.50	0.50
2-SD-1	Feb-94	ND	ND	ND	70.00	57.00	24.50	2170.00	0.62	15.30	0.22	0.50
2-SD-2	Feb-94	ND	ND	ND	88.00	1535.00	8.50	3710.00	0.82	30.30	0.38	0.50
2-SD-3	Feb-94	ND	ND	ND	43.00	0.00	11.00	1740.00	0.83	27.20	0.24	0.50
2-SD-5	Feb-94	ND	ND	ND	NA	0.00	9.00	NA	NA	NA	NA	NA
2-SD-9	Feb-94	ND	ND	ND	NA	0.00	28.90	NA	NA	NA	NA	NA
2-SD-10	Feb-94	ND	ND	ND	NA	318.00	71.70	NA	NA	NA	NA	NA
Freq		0/10	0/10	0/10	5/7			7/7	7/7	7/7	3/7	1/7
Min					11.00	0.00	8.50	1050.00	0.62	10.70	0.22	0.50
Max					88.00	1535.00	840.00	3710.00	1.00	50.20	0.50	1.30
Mean					48.20	173.64	96.76	2060.00	0.74	23.19	0.41	0.61
StDev					30.98	461.41	247.22	946.33	0.15	14.01	0.13	
Note: Organics	in ug/kg; inorganics											

Table 2. Chemistry data for the Fire Training Area: (a) Sediments.

Sample	Sample Date	calcium	chromium	cobalt	copper	iron	lead	magnesium	manganese	mercury	nickel	potassium	selenium	silver	sodium	vanadium	zinc
Duplicates																	
P2-SD-8	Feb-91	843.00	5.30	2.00	3.70	6920.00	6.30	927.00	235.00	ND	7.30	226.00	ND	ND	ND	7.40	32.00
P2-SD-8D	Feb-91	863.00	9.10	4.10	5.70	9220.00	35.50	778.00	719.00	ND	2.80	290.00	ND	ND	ND	9.80	27.90
P2-SD-5	Feb-91	346.00	6.00	ND	2.40	4470	3.60	1320.00	170.00	0.02	14.80	173.00	ND	1.00	ND	5.50	20.50
P2-SD-5	Aug-91	522.00	7.10	10.50	1.50	27800	14.10	789.00	402.00	0.02	18.80	318.00	ND	1.00	40.80	8.70	27.50
P2-SD-8	Feb-91	863.00	9.10	4.10	5.70	9220	35.50	927.00	719.00	0.02	7.30	290.00	ND	1.00	ND	9.80	32.00
P2-SD-8	Aug-91	211.00	5.30	2.00	0.77	3320	7.10	305.00	189.00	0.02	4.80	254.00	ND	0.86	ND	4.40	14.80
2-SD-1	Feb-94	458.00	4.30	4.80	4.80	5450	20.80	1000.00	223.00	0.02	8.00	ND	ND	1.00	700.00	9.00	38.40
2-SD-2	Feb-94	813.00	6.30	5.80	8.80	6980	12.50	1110.00	286.00	0.02	9.70	1380.00	ND	1.00	ND	13.20	42.20
2-SD-3	Feb-94	370.00	4.20	11.00	5.30	5890	8.50	893.00	386.00	0.02	8.40	1210.00	ND	1.00	ND	9.10	33.90
2-SD-5	Feb-94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-SD-9	Feb-94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-SD-10	Feb-94	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Freq		7/7	7/7	6/7	7/7	7/7	7/7	7/7	7/7	0/7	7/7	6/7	0/7	1/7	2/7	7/7	7/7
Min		211.00	4.20	2.00	0.77	3320.00	3.60	305.00	170.00		4.80	173.00		0.86	40.80	4.40	14.80
Max		863.00	9.10	11.00	8.80	27800.00	35.50	1320.00	719.00		18.80	1380.00		1.00	700.00	13.20	42.20
Mean		511.86	6.04	6.37	4.18	9018.57	14.59	906.29	339.29		10.26	604.17		0.98	370.40	8.53	29.91
StDev		243.29	1.71	3.62	2.81	8491.41	10.76	315.53	190.57		4.85	540.01			466.12	2.89	9.70
Note: Organics	in ug/kg; inorganics																

Table 2. Chemistry data for the Fire Training Area: (a) Sediments.

Sample	Sample Date	cyanide
Duplicates		
P2-SD-8	Feb-91	ND
P2-SD-8D	Feb-91	ND
P2-SD-5	Feb-91	ND
P2-SD-5	Aug-91	ND
P2-SD-8	Feb-91	ND
P2-SD-8	Aug-91	ND
2-SD-1	Feb-94	ND
2-SD-2	Feb-94	ND
2-SD-3	Feb-94	ND
2-SD-5	Feb-94	NA
2-SD-9	Feb-94	NA
2-SD-10	Feb-94	NA
Freq		0/7
Min		
Max		
Mean		
StDev		
Note: Organics	in ug/kg; inorganics	

Table 2. Chemistry data for the Fire Training Area: (b) Surface Water.

Sample	Sample Date	acetone	carbon disulfide	bis(2-ethylhexyl)phthalate	4,4'-DDD	4,4'-DDE	4,4'-DDT	BTEX	TPHC	aluminum	arsenic	barium	beryllium	cadmium	calcium
P2-SW-8	Feb-91	ND	ND	5.00	ND	ND	ND	ND	NA	335.00	ND	28.90	ND	ND	11900.00
P2-SW-8D	Feb-91	ND	ND	6.00	ND	ND	ND	ND	NA	112.00	ND	25.50	ND	ND	11900.00
P2-SW-5	Feb-91	5.00	5.00	2.00	0.05	0.05	0.05	ND	NA	105.00	ND	20.60	2.50	2.50	10900
P2-SW-5	Aug-91	5.00	5.00	5.00	0.05	0.05	0.05	NA	1.30	107.00	ND	31.00	2.50	2.50	21600
P2-SW-6	Feb-91	5.00	5.00	7.00	14.00	4.00	16.00	ND	NA	33200.00	58.30	867.00	1.60	234.00	38700
P2-SW-6	Aug-91	5.00	5.00	5.00	2.10	0.05	0.05	NA	1.20	7720.00	6.40	216.00	1.10	2.50	190000
P2-SW-7	Feb-91	5.00	5.00	4.00	0.15	0.05	0.05	ND	NA	157.00	ND	17.60	2.50	2.50	17600
P2-SW-7	Aug-91	5.00	5.00	5.00	0.81	0.05	0.05	NA	3.60	4420.00	4.70	109.00	2.50	8.20	29900
P2-SW-8	Feb-91	5.00	5.00	6.00	0.05	0.05	0.05	ND	NA	335.00	ND	28.90	2.50	2.50	11900
P2-SW-8	Aug-91	5.00	2.00	5.00	0.05	0.05	0.05	NA	ND	98.70	ND	30.50	2.50	2.50	19600
2-SW-1	Feb-94	5.00	5.00	1.00	0.05	0.05	0.05	NA	ND	47.20	ND	25.40	2.50	2.50	13500
2-SW-1	Aug-94	5.00	5.00	1.00	0.05	0.05	0.05	NA	ND	122.00	ND	28.00	2.50	2.50	14500
2-SW-4	Feb-94	5.00	5.00	12.00	0.05	0.05	0.05	NA	ND	50.40	ND	15.10	2.50	2.50	17300
2-SW-4	Aug-94	6.00	5.00	5.00	1.80	0.05	0.05	NA	1.48	3540.00	2.80	90.60	0.41	2.50	28500
Freq		1/12	1/12	7/12	4/12	1/12	1/12	0/12	4/12	12/12	4/12	12/12	3/12	2/12	12/12
Min		5.00	2.00	1.00	0.05	0.05	0.05		1.20	47.20	2.80	15.10	0.41	2.50	10900
Max		6.00	5.00	12.00	14.00	4.00	16.00		3.60	33200.00	58.30	867.00	2.50	234.00	190000
Mean		5.08	4.75	4.83	11.00	0.38	1.38		1.90	4158.53	18.05	123.31	2.13	22.27	34500
StDev		0.29	0.87	2.95	3.97	1.14	4.60		1.14	9470.41	26.87	241.41	0.71	66.70	49666
												max det	1.60		
Note: All data in	ug/L except TPHC	in mg/L													

Table 2. Chemistry data for the Fire Training Area: (b) Surface Water.

Sample	Sample Date	chromium	cobalt	copper	iron	lead	magnesium	manganese	mercury	nickel	potassium	sodium	vanadi	zinc
P2-SW-6	Feb-91	ND	ND	ND	667.00	3.40	5190.00	57.80	ND	ND	924.00	8590.00	ND	14.20
P2-SW-6D	Feb-91	ND	ND	ND	247.00	2.10	5120.00	26.40	ND	ND	1090.00	8650.00	ND	14.40
P2-SW-5	Feb-91	5.00	ND	12.50	227	1.40	4280	21.40	0.10	20.00	979	7620	ND	20.70
P2-SW-5	Aug-91	5.00	ND	12.50	148	1.50	6410	9.00	0.10	20.00	1700	9430	ND	7.60
P2-SW-6	Feb-91	80.90	48.50	435.00	1460000	498.00	15200	3350	0.52	23.50	4830	5670	533.00	379.00
P2-SW-6	Aug-91	5.00	127.00	4.40	18500	40.20	67000	7080	0.10	39.40	6190	14800	26.90	370.00
P2-SW-7	Feb-91	5.00	ND	12.50	1210	3.90	4560	151	0.10	20.00	1330	7200	ND	8.90
P2-SW-7	Aug-91	14.60	20.00	15.80	42100	81.90	5800	1630	0.10	19.40	1160	7330	29.80	128.00
P2-SW-8	Feb-91	5.00	ND	12.50	667	3.40	5190	57.80	0.10	20.00	1090	8650	ND	14.40
P2-SW-8	Aug-91	5.00	ND	12.50	170	4.70	7660	28.00	0.10	20.00	1200	10200	ND	8.10
2-SW-1	Feb-94	3.50	ND	12.50	87	0.50	5100	13.80	0.10	6.40	ND	8150	ND	5.70
2-SW-1	Aug-94	5.00	ND	12.50	207	2.90	6320	30.00	0.10	20.00	1420	9200	ND	144.00
2-SW-4	Feb-94	5.00	ND	12.50	467	0.50	4250	122.00	0.10	20.00	ND	5440	ND	3.60
2-SW-4	Aug-94	8.00	4.80	20.00	10600	58.00	4850	679.00	0.55	7.10	4210	4510	15.10	108.00
Freq		4/12	4/12	4/12	12/12	10/12	12/12	12/12	2/12	5/12	10/12	12/12	4/12	12/12
Min		3.50	4.80	4.40	87	0.50	4250	9.00	0.10	6.40	979	4510	15.10	3.60
Max		80.90	127.00	435.00	1460000	498.00	67000	7080.00	0.55	39.40	6190	14800	533.00	379.00
Mean		12.25	50.08	47.93	127865	58.08	11385	1097.67	0.17	19.65	2411	8183	151.20	99.83
StDev		21.81	54.39	121.94	419701	141.19	17765	2133.11	0.17	8.20	1911	2697	254.61	138.37
Note: All data in	ug/L except TPHC													

Table 2. Chemistry data for the Fire Training Area: (c) Soil.

Sample	Sample Date	4,4' - DDD	4,4' - DDE	4,4' - DDT
2-SS-1	Mar-94	3.9	26	42
2-SS-13	Mar-94	ND	ND	ND
2-SS-14	Mar-94	ND	6.1	4.7
2-SS-16 (Surface Soil Location)	Mar-94	ND	38	22
Freq		1/4	3/4	3/4
Min		3.9	6.1	4.7
Max		3.9	38	42
Mean		3.9	23.37	22.9
StDev			16.11	18.67

Table 3. Comparison of maximum concentrations with EPA Region III BTAG screening levels : Old Landfill.

Contaminant	Sediment (ug/kg organics; mg/kg metals)						Water (ug/L)					
	Maximum Sediment Concentration	Number of Detections	Total Number of Samples	Benchmark	Reference Source	Hazard Quotient	Maximum Water Concentration	Number of Detections	Total Number of Samples	Benchmark	Reference Source	Hazard Quotient
Low Molecular Weight PAHs												
2-methylnapthalene	500	3	28	70	x - fauna	7.1	ND		29	NB	NB	
Acenaphthene	180	6	28	16	x - fauna	11	ND		29	520	x - fauna	
Acenaphthylene	15000	3	28	44	x - fauna	341	ND		29	NB	NB	
Anthracene	27000	13	28	85.3	x - fauna	317	ND		29	0.1	x - fauna	
Fluorene	13000	8	28	19	x - fauna	684	ND		29	430	x - fauna	
Naphthalene	1700	4	28	160	x - fauna	11	ND		29	100	x - fauna	
Phenanthrene	120000	24	28	240	x - fauna	500	ND		29	6.3	x - fauna	
Total Low Molecular Weight PAHs	NA			552	a		NA			NB	NB	
High Molecular Weight PAHs												
Benzo(a)anthracene	47000	22	23	261	x - fauna	180	NA			6.3	x - fauna	
Benzo(a)pyrene	54000	22	23	430	x - fauna	126	NA			0.014	e	
Benzo(b)fluoranthene	74000	26	23	3200	x - fauna	23	NA			NB	NB	
Benzo(g,h,i)perylene	36000	18	23	670	x - fauna	54	NA			NB	NB	
Benzo(k)fluoranthene	35000	20	23	NB			NA			NB	NB	
Chrysene	55000	23	23	384	x - fauna	143	ND		29	NB	NB	
Dibenz(a,h)anthracene	9100	9	23	63.4	x - fauna	144	NA			NB	NB	
Fluoranthene	120000	27	23	600	x - fauna	200	ND		29	3980	x - fauna	
Indeno(1,2,3-c,d)pyrene	38000	21	23	600	x - fauna	63	NA			NB	NB	
Pyrene	89000	27	28	665	x - fauna	134	ND		29	NB	NB	
Total High Molecular Weight PAHs				1700	a		NA			NB	NB	
Total PAHs				4022	a		NA			NB	NB	
Other Semi-Volatile Compounds												
1,4-Dichlorobenzene	100	2	28	110	x - fauna	0.9	9	4	29	763	d	0.01
bis(2-ethylhexyl)phthalate	NA			1300	x - fauna		22	1	29	30	x - fauna	0.7
Butylbenzylphthalate	NA			63	x - fauna		NA			3.0	x - fauna	
Carbozole	110	3	12	NB	NB		NA			NB	NB	
Dibenzofuran	6600	3	28	540	x - fauna	12	ND			20.4	e	
Diethylphthalate	1300	4	28	200	x - fauna	6.5	430	1	29	3	e	143
Di-n-butylphthalate	320	2	28	1400	x - fauna	0.2	NA			0.3	x - fauna	
Volatile Organic Compounds												
Acetone	ND		28	NB	NB		27	4	29	11200	e	0.002
Carbon Disulfide	4	1	28	NB	NB		290	5	29	2.0	x - fauna	145
Chlorobenzene	NA			NB	NB		15	4	29	50	x - fauna	0.3
Chloroform	5	1	28	NB	NB		9	4	29	1240	x - fauna	0.01
Ethylbenzene	ND		28	10	x - fauna		1	1	29	32000	x - fauna	0.000
Tetrachloroethene	3	1	28	NB	NB		ND		29	125	e	
Toluene	ND	2	28	NB	NB		1	1	29	17000	x - fauna	0.0001
Trichloroethene	9	2	28	NB	NB		8	6	29	NB	NB	
Xylenes (Total)	ND	2	28	40	x - fauna		2	4	29	6000	x - fauna	0.0003
Pesticides/PCB												
4,4'-DDD	220	22	28	16	x - fauna	14	0.81	1	29	0.5	x - fauna	1.4
4,4'-DDE	200	24	28	2.2	x - fauna	91	0.18	1	29	1050	x - fauna	0.0002
4,4'-DDT	440	23	28	1.58	x - fauna	278	0.11	1	29	0.001	x - fauna	110
Aldrin	25	1	28	2	a	1.3	NA			3.0	x - fauna	
alpha-Chlordane	280	9	28	0.5	b	560	NA			0.0043	x - fauna	
gamma-Chlordane	410	7	28	0.5	b	820	NA			0.0043	x - fauna	
Heptachlor	29	2	28	NB	NB		NA			0.0038	x - fauna	
Methoxychlor	NA			NB	NB		0.31	1	29	0.03	x - fauna	10.3
Metals												

Table 3. Comparison of maximum concentrations with EPA Region III BTAG screening levels : Old Landfill.

	Sediment (ug/kg organics; mg/kg metals)						Water (ug/L)					
Contaminant	Maximum Sediment Concentration	Number of Detections	Total Number of Samples	Benchmark	Reference Source	Hazard Quotient	Maximum Water Concentration	Number of Detections	Total Number of Samples	Benchmark	Reference Source	Hazard Quotient
Aluminum	9680	28	28	NB	NB		399000	27	29	25	x - fauna	15960
Antimony	17.9	1	28	150	x - fauna	0.1	58.7	1	29	30	x - fauna	2.0
Arsenic (total)	2.1	23	28	8.2	x - fauna	0.3	44.7	7	29	874	x - fauna	0.1
Barium	515	28	28	NB	NB		2540	29	29	10000	x - fauna	0.3
Beryllium	3.3	19	28	NB	NB		40.5	9	29	5.3	x - fauna	7.6
Cadmium	3.1	5	28	1.2	x - fauna	2.6	25.4	2	29	0.53	x - fauna	48
Calcium	30000	28	28	NB	NB		83500	29	29	116000	e*	0.7
Chromium (total)	49.4	28	28	5.0	x - flora	9.9	532	10	29	120	x - fauna	4.4
Cobalt	89.6	27	28	NB	NB		749	14	29	35000	x - fauna	0.02
Copper	52.3	28	28	34	x - fauna	1.5	950	12	29	6.5	x - fauna	146
Cyanide	4.1	1	28	NB	NB		NA			5.2	x - fauna	
Iron	208000	28	28	NB	NB		833000	29	29	320	x - fauna	2603
Lead	387	28	28	46.7	x - fauna	8.3	1360	23	29	3.2	x - fauna	425
Magnesium	6650	28	28	NB	NB		121000	29	29	82000	e*	1.5
Manganese	5600	28	28	460	c	12	15600	29	29	14500	x - fauna	1.1
Mercury	0.19	4	28	0.15	x - fauna	1.3	0.81	5	29	0.012	x - fauna	68
Nickel	57.1	28	28	20.9	x - fauna	2.7	614	10	29	160	x - fauna	3.8
Potassium	2570	19	28	NB	NB		60300	27	29	53000	e*	1.1
Selenium	ND		28	NB	NB		22.4	2	29	5.0	x - fauna	4.5
Silver	NA			1.0	x - fauna		3.4	1	29	0.0001	x - fauna	34000
Sodium	2820	10	28	NB	NB		28100	29	29	680000	e*	0.04
Vanadium	68	28	28	NB	NB		1130	15	29	10000	x - fauna	0.1
Zinc	186	28	28	150	x - fauna	2.0	2980	25	29	110	x- fauna	27

NB = No benchmark
NA = Not analyzed
ND = Not detected
a = Long et al. 1995 (ER-L)
b = Long and Morgan 1990 (ER-L)
c = Persuad et al. 1992 (LEL)
d = USEPA AWQC 1992 (Chronic Criteria)
e = Suter and Mabrey 1994 (SCV)
e* = Suter and Mabrey 1994 (LCV)

x - fauna = Region III BTAG Screening Level for fauna (lowest of flora and fauna chosen)
x - flora = Region III BTAG Screening Level for flora (lowest of flora and fauna chosen)
ug/L = micrograms per liter (ppb)
ug/kg=micrograms per kilogram (ppb)
mg/L = milligrams per liter (ppm)
HQ = Hazard Quotient = maximum concentration divided by benchmark

Table 4. Comparison of maximum concentrations with EPA Region III BTAG screening levels: Fire Training Area.

	Sediment (ug/kg organics, mg/kg metals)						Water (ug/L)						
Contaminant	Maximum Sediment Concentration	Number of Detections	Total Number of Samples	Benchmark	Reference Source	Hazard Quotient	Maximum Water Concentration	Number of Detections	Total Number of Samples	Benchmark	Reference Source	Hazard Quotient	Soil Maximum Concentration
Low Molecular Weight PAHs													
Anthracene	56	1	10	85.3	x - fauna	0.7	NA			0.1	x - fauna		NA
Phenanthrene	260	2	10	240	x - fauna	1.1	NA			6.3	x - fauna		NA
Total Low Molecular Weight PAHs				552	a		NA			NB	NB		NA
High Molecular Weight PAHs													
Benzo(a)anthracene	150	1	10	261	x - fauna	0.6	NA			6.3	x - fauna		NA
Benzo(a)pyrene	70	2	10	430	x - fauna	0.2	NA			0.014	e		NA
Benzo(b)fluoranthene	140	2	10	3200	x - fauna	0.04	NA			NB	NB		NA
Benzo(g,h,i)perylene	37	1	10	670	x - fauna	0.1	NA			NB	NB		NA
Benzo(k)fluoranthene	40	1	10	NB			NA			NB	NB		NA
Chrysene	130	2	10	384	x - fauna	0.3	NA			NB	NB		NA
Fluoranthene	340	3	10	600	x - fauna	0.6	NA			3980	x - fauna		NA
Indeno(1,2,3-c,d)pyrene	72	1	10	600	x - fauna	0.1	NA			NB	NB		NA
Pyrene	240	3	10	665	x - fauna	0.4	NA			NB	NB		NA
Total High Molecular Weight PAHs				1700	a		NA			NB	NB		NA
Total PAHs				4022	a		NA			NB	NB		NA
Other Semi-Volatile Compounds													
bis(2-ethylhexyl)phthalate	110	4	10	1300	x - fauna	0.1	12	7	12	30	x - fauna	0.4	NA
Butylbenzylphthalate	110	1	10	63	x - fauna	1.7	NA			3.0	x - fauna		NA
Diethylphthalate	22	1	10	200	x - fauna	0.1	NA			3	e		NA
Di-n-butylphthalate	40	2	10	1400	x - fauna	0.03	NA			0.3	x - fauna		NA
Volatile Organic Compounds													
Acetone	NA			NB	NB		6	1	12	11200	e	0.001	NA
Carbon Disulfide	NA			NB	NB		2	1	12	2.0	x - fauna	1.0	NA
Toluene	0.5	1	10	NB	NB		NA			17000	x - fauna		NA
Pesticides/PCB													
4,4'-DDD	9.7	7	10	16	x - fauna	0.6	14	4	12	0.6	x - fauna	23	3.9
4,4'-DDE	13	7	10	2.2	x - fauna	5.9	4	1	12	1050	x - fauna	0.004	38
4,4'-DDT	49	10	10	1.58	x - fauna	31	16	1	12	0.001	x - fauna	16000	42
Metals													
Aluminum	3710	7	7	NB	NB		33200	12	12	25	x - fauna	1328	NA
Antimony	NA			150	x - fauna		NA			30	x - fauna		NA
Arsenic (total)	1	7	7	8.2	x - fauna	0.1	58.3	4	12	874	x - fauna	0.1	NA
Barium	50.2	7	7	NB	NB		867	12	12	10000	x - fauna	0.1	NA
Beryllium	0.38	3	7	NB	NB		1.6	3	12	5.3	x - fauna	0.3	NA
Cadmium	1.3	1	7	1.2	x - fauna	1.1	234	2	12	0.53	x - fauna	442	NA
Calcium	863	7	7	NB	NB		190000	12	12	116000	e*	1.6	NA
Chromium (total)	9.1	7	7	5.0	x - flora	1.8	80.9	4	12	120	x - fauna	0.7	NA
Cobalt	11	6	7	NB	NB		127	4	12	35000	x - fauna	0.004	NA
Copper	8.8	7	7	34	x - fauna	0.3	435	4	12	6.5	x - fauna	67	NA
Cyanide	ND		7	NB	NB		NA			5.2	x - fauna		NA
Iron	27800	7	7	NB	NB		1460000	12	12	320	x - fauna	4563	NA
Lead	35.5	7	7	46.7	x - fauna	0.8	498	10	12	3.2	x - fauna	156	NA
Magnesium	1320	7	7	NB	NB		67000	12	12	82000	e*	0.8	NA
Manganese	719	7	7	460	c	1.6	7080	12	12	14500	x - fauna	0.5	NA
Mercury	ND		7	0.15	x - fauna		0.55	2	12	0.012	x - fauna	46	NA
Nickel	18.8	7	7	20.9	x - fauna	0.9	39.4	5	12	160	x - fauna	0.2	NA
Potassium	1380	6	7	NB	NB		6190	10	12	53000	e*	0.1	NA
Selenium	ND		7	NB	NB		NA			5.0	x - fauna		NA
Silver	0.86	1	7	1.0	x - fauna	0.9	NA			0.0001	x - fauna		NA

Table 4. Comparison of maximum concentrations with EPA Region III BTAG screening levels: Fire Training Area.

	Sediment (ug/kg organics, mg/kg metals)						Water (ug/L)						
Contaminant	Maximum Sediment Concentration	Number of Detections	Total Number of Samples	Benchmark	Reference Source	Hazard Quotient	Maximum Water Concentration	Number of Detections	Total Number of Samples	Benchmark	Reference Source	Hazard Quotient	Soil Maximum Concentration
Sodium	700	2	7	NB	NB		14800	12	12	680000	e*	0.02	NA
Vanadium	13.2	7	7	NB	NB		533	4	12	10000	x - fauna	0.1	NA
Zinc	42.2	7	7	150	x - fauna	2.0	379	12	12	110	x- fauna	3.4	NA

NB = No benchmark
NA=Not analyzed
ND=Not detected
a = Long et al. 1995 (ER-L)
b = Long and Morgan 1990 (ER-L)
c = Persuad et al. 1992 (LEL)
d = USEPA AWQC 1992 (Chronic Criteria)
e = Suter and Mabrey 1994 (SCV)
e* = Suter and Mabrey 1994 (LCV)
x - fauna = Region III BTAG Screening Level for fauna (lowest of flora and fauna chosen)
x - flora = Region III BTAG Screening Level for flora (lowest of flora and fauna chosen)
ug/kg=micrograms per kilogram (ppb)
ug/L = micrograms per liter (ppb)
mg/L = milligrams per liter (ppm)
HQ = Hazard Quotient (=maximum concentration divided by benchmark)

Table 4. Comparison of maximum concentrations with EPA Region III BTAG screening levels: Fire Training Area.

	Soil (ug/kg)				
Contaminant	Number of Detections	Total Number of Samples	Benchmark	Reference Source	Hazard Quotient
Low Molecular Weight PAHs					
Anthracene			100	x - fauna	
Phenanthrene			100	x - fauna	
Total Low Molecular Weight PAHs			NB	NB	
High Molecular Weight PAHs					
Benzo(a)anthracene			100	x - fauna	
Benzo(a)pyrene			100	x - fauna	
Benzo(b)fluoranthene			100	x - fauna	
Benzo(g,h,i)perylene			100	x - fauna	
Benzo(k)fluoranthene			100	x - fauna	
Chrysene			100	x - fauna	
Fluoranthene			100	x - fauna	
Indeno(1,2,3-c,d)pyrene			100	x - fauna	
Pyrene			100	x - fauna	
Total High Molecular Weight PAHs			NB	NB	
Total PAHs			NB	NB	
Other Semi-Volatile Compounds					
bis(2-ethylhexyl)phthalate			NB	NB	
Butylbenzylphthalate			NB	NB	
Diethylphthalate			NB	NB	
Di-n-butylphthalate			NB	NB	
Volatile Organic Compounds					
Acetone			NB	NB	
Carbon Disulfide			NB	NB	
Toluene			100	x - fauna	
Pesticides/PCB					
4,4'-DDD	1	4	100	x - fauna	0.04
4,4'-DDE	3	4	100	x - fauna	0.4
4,4'-DDT	3	4	100	x - fauna	0.4
Metals					
Aluminum			1	x - flora	
Antimony			0.48	x - flora	
Arsenic (total)			328	x - flora	
Barium			440	x - fauna	
Beryllium			0.02	x - flora	
Cadmium			2.5	x - flora	
Calcium			NB	NB	
Chromium (total)			0.0075	x - fauna	
Cobalt			100	x - flora	
Copper			15	x - flora	
Cyanide			0.005	x - fauna	
Iron			12	x - fauna	
Lead			0.01	x - fauna	
Magnesium			4400	x - fauna	
Manganese			330	x - fauna	
Mercury			0.058	x - fauna	
Nickel			2	x - fora	
Potassium			NB	NB	
Selenium			1.8	x - fauna	
Silver			0.0000098	x - fora	

Table 4. Comparison of maximum concentrations with EPA Region III BTAG screening levels: Fire Training Area.

	Soil (ug/kg)				
Contaminant	Number of Detections	Total Number of Samples	Benchmark	Reference Source	Hazard Quotient
Sodium			NB	NB	
Vanadium			0.5	x - flora	
Zinc			10	x - flora	
NB = No benchmark					
NA=Not analyzed					
ND=Not detected					
a = Long et al. 1995 (ER-L)					
b = Long and Morgan 1990 (ER-L)					
c = Persuad et al. 1992 (LEL)					
d = USEPA AWQC 1992 (Chronic Criteria)					
e = Suter and Mabrey 1994 (SCV)					
e* = Suter and Mabrey 1994 (LCV)					
x - fauna = Region III BTAG Screening Level for fauna (lowest of flora and fauna chosen)					
x - flora = Region III BTAG Screening Level for flora (lowest of flora and fauna chosen)					
ug/kg=micrograms per kilogram (ppb)					
ug/L = micrograms per liter (ppb)					
mg/L = milligrams per liter (ppm)					
HQ = Hazard Quotient (=maximum concentration divided by benchmark)					

Table 5. Conservative food chain screening analysis for the Old Landfill: Kingfisher.

Chemical	Maximum Conc. (mg/kg)	BAF	Conc. in Fish (mg/kg)	Conc. from Sediment (mg/kg)	Ingestion Rate (kg/day)	Water Conc. (mg/kg)	Water Ingestion (kg/day)	AUF	Body Weight (1/kg)	Dose (mg/kg/day)	LOAEL (mg/kg/day)	HQ based on LOAEL	NOAEL (mg/kg/day)	HQ based on NOAEL
PAHs														
2-methylnaphthalene	0.25	1	0.2	0.0004	0.06	0.000	0.012	1	8.85	0.1	100	0.001	10	0.01
Acenaphthene	0.090	1	0.1	0.0002	0.06	0.001	0.012	1	8.85	0.05	100	0.0005	10	0.005
Acenaphthylene	7.5	1	7.5	0.01	0.06	0.000	0.012	1	8.85	4.0	100	0.04	10	0.4
Anthracene	13.5	1	13.5	0.02	0.06	0.000	0.012	1	8.85	7.2	100	0.1	10	0.7
Fluorene	6.5	1	6.5	0.01	0.06	0.003	0.012	1	8.85	3.5	100	0.03	10	0.3
Naphthalene	0.85	1	0.8	0.001	0.06	0.000	0.012	1	8.85	0.5	100	0.005	10	0.05
Phenanthrene	60	1	59.9	0.1	0.06	0.010	0.012	1	8.85	31.9	100	0.3	10	3.2
Benzo(a)anthracene	24	1	23.5	0.04	0.06	0.000	0.012	1	8.85	12.5	100	0.1	10	1.2
Benzo(a)pyrene	27	1	27.0	0.05	0.06	0.000	0.012	1	8.85	14.3	100	0.1	10	1.4
Benzo(b)fluoranthene	37	1	36.9	0.1	0.06	0.000	0.012	1	8.85	19.6	100	0.2	10	2.0
Benzo(g,h,i)perylene	18	1	18.0	0.03	0.06	0.000	0.012	1	8.85	9.6	100	0.1	10	1.0
Benzo(k)fluoranthene	17.5	1	17.5	0.03	0.06	0.000	0.012	1	8.85	9.3	100	0.1	10	0.9
Chrysene	27.5	1	27.5	0.05	0.06	0.003	0.012	1	8.85	14.6	100	0.1	10	1.5
Dibenz(a,h)anthracene	4.6	1	4.5	0.01	0.06	0.000	0.012	1	8.85	2.4	100	0.02	10	0.2
Fluoranthene	60	1	59.9	0.1	0.06	0.008	0.012	1	8.85	31.9	100	0.3	10	3.2
Indeno(1,2,3-c,d)pyrene	19	1	19.0	0.03	0.06	0.000	0.012	1	8.85	10.1	100	0.1	10	1.0
Pyrene	44.5	1	44.4	0.1	0.06	0.005	0.012	1	8.85	23.6	100	0.2	10	2.4
Other Semivolatiles														
Carbon disulfide	0.005	1	0.0	0.00001	0.06	0.290	0.012	1	8.85	0.03	NA		NA	
Carbazole	0.055	1	0.1	0.00009	0.06	0.000	0.012	1	8.85	0.03	NA		NA	
Dibenzofuran	3.3	1	3.3	0.01	0.06	0.000	0.012	1	8.85	1.8	NA		NA	
Diethylphthalate	0.65	1	0.6	0.001	0.06	0.430	0.012	1	8.85	0.39	NA		NA	
Volatiles														
Acetone	0.000	1	0.0	0.0000	0.06	0.027	0.012	1	8.85	0.003	NA		NA	
Ethylbenzene	0.09	1	0.1	0.0002	0.06	0.026	0.012	1	8.85	0.1	NA		NA	
Xylenes	0.000	1	0.0	0.0000	0.06	0.124	0.012	1	8.85	0.0	NA		NA	
Organochlorines														
4,4'-DDD	0.11	1	0.1	0.0002	0.06	0.001	0.012	1	8.85	0.1	4	0.01	1.25	0.05
4,4'-DDE	0.1	1	0.1	0.0002	0.06	0.0003	0.012	1	8.85	0.1	4	0.01	1.25	0.04
4,4'-DDT	0.22	1	0.2	0.0004	0.06	0.0008	0.012	1	8.85	0.1	4	0.03	1.25	0.1
Aldrin	0.00125	1	0.0	0.000002	0.06	0.000	0.012	1	8.85	0.001	NA		NA	
alpha-chlordane	0.14	1	0.1	0.0002	0.06	0.000	0.012	1	8.85	0.1	0.19	0.4	0.019	3.9
gamma-chlordane	0.205	1	0.2	0.0003	0.06	0.000	0.025	1	8.85	0.1	0.19	0.6	0.019	5.7
Methoxychlor	NA	1			0.06	0.0003	0.025	1	8.85	0.0001	NA		NA	
Metals														
Aluminum	4840	1	4831.8	8.2	0.06	399	0.012	1	8.85	2612	165	16	84	31
Antimony	9.0	1	8.9	0.02	0.06	0.059	0.012	1	8.85	4.8	NA		NA	
Beryllium	1.7	1	1.6	0.003	0.06	0.041	0.012	1	8.85	0.9	NA		NA	
Cadmium	1.6	1	1.5	0.003	0.06	0.025	0.012	1	8.85	0.8	3.31	0.2	0.30	2.5
Chromium (total)	24.7	1	24.7	0.04	0.06	0.532	0.012	1	8.85	13.2	277.8	0.05	27.8	0.5
Copper	26.2	1	26.1	0.04	0.06	0.749	0.012	1	8.85	14.0	2.35	5.9	0.235	59
Cyanide	2.1	1	2.0	0.003	0.06	0.00	0.012	1	8.85	1.1	NA		NA	
Iron	104000	1	103823	177	0.06	833	0.012	1	8.85	55312	NA		NA	
Lead	193.5	1	193	0.3	0.06	1.8	0.012	1	8.85	103	3.0	34	0.3	343
Magnesium	3325	1	3319	5.7	0.06	121	0.012	1	8.85	1778	NA		NA	
Manganese	2800	1	2795	4.8	0.06	15.6	0.012	1	8.85	1488	NA		NA	
Mercury	0.095	1	0.1	0.0002	0.06	0.0008	0.012	1	8.85	0.05	0.12	0.42	0.012	4.2
Nickel	28.6	1	28.5	0.05	0.06	0.614	0.012	1	8.85	15.2	NA		NA	
Potassium	1285	1	1282.8	2.2	0.06	60.3	0.012	1	8.85	689	NA		NA	
Selenium	0	1	0.0	0.000	0.06	0.022	0.012	1	8.85	0.0	NA		NA	
Silver	NA	1	0.0	0.0	0.06	0.003	0.012	1	8.85	0.0004	NA		NA	
Sodium	1410	1	1407.6	2.4	0.06	28.1	0.012	1	8.85	752	NA		NA	
Zinc	93	1	92.8	0.2	0.06	2.98	0.012	1	8.85	50	139	0.4	13.9	3.6

% moisture not available, used 50% moisture as an estimate

Table 6. Conservative food chain screening analysis for the Old Landfill. Raccoon.

Chemical	Maximum Conc. (mg/kg)	BAF	Conc. in Fish (mg/kg)	Conc. from Sediment (mg/kg)	Ingestion Rate (kg/day)	Water Conc. (mg/kg)	Water Ingestion (kg/day)	AUF	Body Weight (1/kg)	Dose (mg/kg/day)	LOAEL (mg/kg/day)	HQ based on LOAEL	NOAEL (mg/kg/day)	HQ based on NOAEL
PAHs														
2-methylnaphthalene	0.25	1	0.2	0.02	0.5	0.000	0.025	1	0.5	0.1	2.6	0.02	1.3	0.05
Acenaphthene	0.090	1	0.1	0.01	0.5	0.001	0.025	1	0.5	0.02	2.6	0.01	1.3	0.02
Acenaphthylene	7.5	1	7	0.7	0.5	0.000	0.025	1	0.5	1.9	2.6	0.7	1.3	1.4
Anthracene	13.5	1	12	1.3	0.5	0.000	0.025	1	0.5	3.4	2.6	1.3	1.3	2.6
Fluorene	6.5	1	6	0.6	0.5	0.003	0.025	1	0.5	1.6	2.6	0.6	1.3	1.3
Naphthalene	0.85	1	1	0.1	0.5	0.000	0.025	1	0.5	0.2	2.6	0.1	1.3	0.2
Phenanthrene	60	1	54	5.6	0.5	0.010	0.025	1	0.5	15.0	2.6	5.8	1.3	12
Benzo(a)anthracene	23.5	1	21	2.2	0.5	0.000	0.025	1	0.5	5.9	2.6	2.3	1.3	4.5
Benzo(a)pyrene	27	1	24	2.5	0.5	0.000	0.025	1	0.5	6.8	2.6	2.6	1.3	5.2
Benzo(b)fluoranthene	37	1	34	3.5	0.5	0.000	0.025	1	0.5	9.3	2.6	3.6	1.3	7.1
Benzo(g,h,i)perylene	18	1	16	1.7	0.5	0.000	0.025	1	0.5	4.5	2.6	1.7	1.3	3.5
Benzo(k)fluoranthene	17.5	1	16	1.6	0.5	0.000	0.025	1	0.5	4.4	2.6	1.7	1.3	3.4
Chrysene	27.5	1	25	2.6	0.5	0.003	0.025	1	0.5	6.9	2.6	2.6	1.3	5.3
Dibenz(a,h)anthracene	4.55	1	4.1	0.4	0.5	0.000	0.025	1	0.5	1.1	2.6	0.4	1.3	0.9
Fluoranthene	60	1	54	5.6	0.5	0.008	0.025	1	0.5	15.0	2.6	5.8	1.3	12
Indeno(1,2,3-c,d)pyrene	19	1	17	1.8	0.5	0.000	0.025	1	0.5	4.8	2.6	1.8	1.3	3.7
Pyrene	44.5	1	40	4.2	0.5	0.005	0.025	1	0.5	11.1	2.6	4.3	1.3	8.6
Other Semivolatiles														
Carbon disulfide	0.005	1	0.005	0.0005	0.5	0.290	0.025	1	0.5	0.0	NA		NA	
Carbazole	0.055	1	0.05	0.005	0.5	0.000	0.025							
Dibenzofuran	3.3	1	3.0	0.31	0.5	0.000	0.025	1	0.5	0.8	NA		NA	
Diethylphthalate	0.65	1	0.6	0.06	0.5	0.430	0.025	1	0.5	0.2	NA		NA	
Volatiles														
Acetone	0.185	1	0.17	0.017	0.5	0.027	0.025	1	0.5	0.05	NA		NA	
Ethylbenzene	0.09	1	0.082	0.008	0.5	0.026	0.025	1	0.5	0.02	NA		NA	
Xylenes	0	1	0.00	0.00	0.5	0.124	0.025	1	0.5	0.0	NA		NA	
Organochlorines														
4,4'-DDD	0.11	1	0.10	0.01	0.5	0.001	0.025	1	0.5	0.03	1.25	0.02	0.125	0.2
4,4'-DDE	0.1	1	0.09	0.01	0.5	0.0003	0.025	1	0.5	0.03	1.25	0.02	0.125	0.2
4,4'-DDT	0.22	1	0.20	0.02	0.5	0.0008	0.025	1	0.5	0.06	1.25	0.04	0.125	0.4
Aldrin	0.00125	1	0.001	0.0001	0.5	0.000	0.025	1	0.5	0.000	NA		NA	
alpha-chlordane	0.14	1	0.13	0.01	0.5	0.000	0.025	1	0.5	0.04	1.88	0.02	0.188	0.2
gamma-chlordane	0.21	1	0.19	0.02	0.5	0.000	0.025	1	0.5	0.05	1.88	0.03	0.188	0.3
Methoxychlor	NA	1	0	0	0.5	0.0003	0.025	1	0.5	0.000004	NA		NA	
Metals														
Aluminum	4840	1	4385	455	0.5	399	0.025	1	0.5	1215.0	55	22	5.5	221
Antimony	9.0	1	8	0.8	0.5	0.059	0.025	1	8.85	39.6	NA		NA	
Beryllium	1.7	1	1.5	0.16	0.5	0.041	0.025	1	0.5	0.4	NA		NA	
Cadmium	1.6	1	1.4	0.15	0.5	0.025	0.025	1	0.5	0.4	7.5	0.1	0.75	0.5
Chromium (total)	24.7	1	22	2.3	0.5	0.532	0.025	1	0.5	6.2	1.7	3.6	0.17	36
Copper	26.2	1	24	2.5	0.5	0.749	0.025	1	0.5	6.5	10	0.7	1	6.5
Cyanide	2.1	1	2	0.19	0.5	0.00	0.012	1	8.85	9.1	NA		NA	
Iron	104000	1	94224	9776	0.5	833	0.025	1	0.5	26010	NA		NA	
Lead	193.5	1	175	18	0.5	1.8	0.025	1	0.5	48	1.5	32	0.15	323
Magnesium	3325	1	3012	313	0.5	121	0.025	1	0.5	833	NA		NA	
Manganese	2800	1	2537	263	0.5	15.6	0.025	1	0.5	700	13	54	1.3	539
Mercury	0.095	1	0.09	0.009	0.5	0.0008	0.025	1	0.5	0.02	0.1	0.2	0.01	2.4
Nickel	28.6	1	26	2.7	0.5	0.614	0.025	1	0.5	7.1	625	0.01	62.5	0.1
Potassium	1285	1	1164	120.8	0.5	60.3	0.025	1	0.5	322.0	NA		NA	
Selenium	0	1	0	0.00	0.5	0.022	0.025	1	0.5	0.0	NA		NA	
Silver	NA	1	0	0	0.5	0.003	0.025	1	0.5	0.00004	NA		NA	
Sodium	1410	1	1277	133	0.5	28.1	0.025	1	0.5	352.85	NA		NA	
Zinc	93	1	84	8.7	0.5	2.98	0.025	1	0.5	23.3	250	0.1	25	0.9

% moisture not available, used 50% moisture as an estimate

Table 7. Conservative food chain screening analysis for the Fire Training Area: Kingfisher.

Chemical	Maximum Conc. (mg/kg)	BAF	Conc. in Fish (mg/kg)	Conc. from Sediment (mg/kg)	Ingestion Rate (kg/day)	Water Conc. (mg/kg)	Water Ingestion (kg/day)	AUF	Body Weight (1/kg)	Dose (mg/kg/day)	LOAEL (mg/kg/day)	HQ based on LOAEL	NOAEL (mg/kg/day)	HQ
PAHs														
Phenanthrene	0.13	1	0.1	0.0002	0.06	0.000	0.012	1	8.85	0.1	100	0.001	10	0.01
Benzo(k)fluoranthene	0.020	1	0.02	0.00003	0.06	0.000	0.012	1	8.85	0.0	100	0.0001	10	0.001
Other Semivolatiles														
Butylbenzylphthalate	0.065	1	0.1	0.0001	0.06	0.000	0.012	1	8.85	0.03	NA		NA	
Volatiles														
Carbon disulfide	NA	1	0.0	0.00	0.06	0.002	0.012	1	8.85	0.0002	NA		NA	
Organochlorines														
4,4'-DDD	0.065	1	0.1	0.0001	0.06	0.014	0.012	1	8.85	0.03	1.25	0.02	0.125	0.2
4,4'-DDE	0.24	1	0.2	0.0004	0.06	0.004	0.012	1	8.85	0.1	1.25	0.1	0.125	1.0
4,4'-DDT	0.13	1	0.1	0.0002	0.06	0.016	0.012	1	8.85	0.1	1.25	0.1	0.125	0.5
Metals														
Aluminum	1855	1	1851.8	315	0.06	33.2	0.012	1	8.85	989	165	6.0	84	12
Cadmium	0.65	1	0.6	0.001	0.06	0.234	0.012	1	8.85	0.4	3.31	0.1	0.33	1.1
Calcium	432	1	430.8	0.73	0.06	190	0.012	1	8.85	249	NA		NA	
Chromium (total)	4.55	1	4.5	0.01	0.06	0.081	0.012	1	8.85	2.4	277.8	0.01	27.8	0.1
Copper	4.4	1	4.4	0.01	0.06	0.435	0.012	1	8.85	2.4	2.35	1.0	0.235	10
Iron	13900	1	13876	23.6	0.06	1460	0.012	1	8.85	7536	NA		NA	
Lead	17.8	1	17.7	0.03	0.06	0.498	0.012	1	8.85	9.5	3	3.2	0.3	32
Manganese	360	1	358.9	0.61	0.06	7.080	0.012	1	8.85	191.6	NA		NA	
Mercury	ND	1	0.0	0.00	0.06	0.001	0.012	1	8.85	0.0001	0.12	0.0005	0.012	0.005
Zinc	21.1	1	21.1	0.04	0.06	0.379	0.012	1	8.85	11.2	139	0.1	139	0.8

% moisture not available, used 50% moisture as an estimate

Table 8. Conservative food chain analysis for the Fire Training Area: Raccoon.

Chemical	Maximum Conc. (mg/kg)	BAF	Conc. in Fish (mg/kg)	Conc. from Sediment (mg/kg)	Ingestion Rate (kg/day)	Water Conc. (mg/kg)	Water Ingestion (kg/day)	AUF	Body Weight (1/kg)	Dose (mg/kg/day)	LOAEL (mg/kg/day)	HQ based on LOAEL	NOAEL (mg/kg/day)	HQ based on NOAEL
PAHs														
Phenanthrene	0.13	1	0.1	0.01	0.5	0.000	0.025	1	0.5	0.03	2.6	0.01	1.3	0.02
Benzo(k)fluoranthene	0.02	1	0.0	0.00	0.5	0.000	0.025	1	0.5	0.004	2.6	0.002	1.3	0.003
Other Semivolatiles														
Butylbenzylphthalate	0.055	1	0.04	0.01	0.5	0.000	0.025	1	0.5	0.01	NA		NA	
Volatiles														
Carbon disulfide	NA	1	0.00	0.00	0.5	0.002	0.025	1	0.5	0.00002	70	0.0000004	11	0.000002
Organochlorines														
4,4'-DDD	0.055	1	0.05	0.01	0.5	0.014	0.025	1	0.5	0.01	4.0	0.003	1.0	0.01
4,4'-DDE	0.24	1	0.22	0.02	0.5	0.004	0.025	1	0.5	0.06	4.0	0.02	1.0	0.06
4,4'-DDT	0.13	1	0.11	0.01	0.5	0.016	0.025	1	0.5	0.03	4.0	0.008	1.0	0.03
Metals														
Aluminum	1855	1	1680.63	174.4	0.5	33.2	0.025	1	0.5	464	55	8.4	5.5	84
Cadmium	0.65	1	0.59	0.1	0.5	0.234	0.025	1	0.5	0.2	7.5	0.02	0.75	0.2
Calcium	431.5	1	390.94	40.6	0.5	190	0.025	1	0.5	110	NA		NA	
Chromium (total)	4.55	1	4.12	0.4	0.5	0.081	0.025	1	0.5	1.1	1.7	0.7	0.17	6.7
Copper	4.4	1	3.99	0.4	0.5	0.435	0.025	1	0.5	1.1	10	0.1	1	1.1
Iron	13900	1	12593.40	1307	0.5	1460	0.025	1	0.5	3493	NA		NA	
Lead	17.8	1	16.13	1.7	0.5	0.498	0.025	1	0.5	4.5	1.5	3.0	0.15	30
Manganese	359.5	1	325.71	33.8	0.5	7.080	0.025	1	0.5	90	13	6.9	1.3	69
Mercury	ND	1	0.00	0.00	0.5	0.001	0.025	1	0.5	0.000007	0.1	0.00007	0.01	0.0007
Zinc	21.1	1	19.12	2.0	0.5	0.379	0.025	1	0.5	5.3	250	0.02	25	0.2

% moisture not available, used 50% moisture as an estimate

Table 9. Comparison of sediment contaminant concentrations with guidance values.

Contaminant	>ER-L[a]	>TEL[b]	>ER-M[c]	>PEL[d]
Old Landfill				
Total chlordane	10/28	9/28	8/28	8/28
Total DDT	22/28	22/28	2/28	0/28
Total PAHs	6/28	Not avail.	1/28	Not avail.
Arsenic	0/28	0/28	0/28	0/28
Cadmium	0/28	0/28	0/28	0/28
Chromium	0/28	2/28	0/28	0/28
Copper	0/28	0/28	0/28	0/28
Lead	6/28	6/28	1/28	3/28
Mercury	1/28	1/28	0/28	0/28
Nickel	3/28	6/28	1/28	2/28
Zinc	1/28	1/28	0/28	0/28
Fire Training Area				
Total chlordane	0/10	0/10	0/10	0/10
Total DDT	10/10	10/10	0/10	0/10
Total PAHs	0/10	Not avail.	0/10	Not avail.
Arsenic	0/7	0/7	0/7	0/7
Cadmium	0/7	0/7	0/7	0/7
Chromium	0/7	0/7	0/7	0/7
Copper	0/7	0/7	0/7	0/7
Lead	1/7	1/7	0/7	0/7
Mercury	0/7	0/7	0/7	0/7
Nickel	0/7	1/7	0/7	0/7
Zinc	0/7	0/7	0/7	0/7

[a] ER-L values (ppm dry weight): Total chlordane: 0.0005; Total DDT--0.003; Total PAH--4.00, As--33; Cd--5; Cr--80; Cu--70; Pb--35; Hg--0.15;; Ni--30; Zn--120 (Long and Morgan 1990).

[b] TEL values (ppm dry weight):Total chlordane: 0.0045; Total DDT--0.007; Total PAH--Not available; As--5.9; Cd--0.596; Cr--37.3; Cu--35.7; Pb--35; Hg--0.174; Ni--18; Zn--123 (Smith et al. 1996).

[c] ER-M values (ppm dry weight): Total chlordane: 0.006; Total DDT--0.350; Total PAH--35.00, As--85; Cd--9; Cr--145; Cu--390; Pb--110; Hg--1.3;; Ni--50; Zn--270 (Long and Morgan 1990).

[d] PEL values (ppm dry weight):Total chlordane: 0.0089; Total DDT--4.45; Total PAH--Not available; As--517; Cd--3.53; Cr--90; Cu--197; Pb--91.3; Hg--0.486; Ni--36; Zn--315 (Smith et al. 1996).

Table 10. Chemicals detected in exceedance of water quality criteria.

Chemical	Freq. Of Det.	Concentration exceeding criteria (µg/L)	Acute (µg/L) (a)-Maryland (b)-EPA	Chronic (µg/L) (a)-Maryland (b)-EPA
Old Landfill				
4,4'DDD	2/29	1/29: 0.81	0.6 (b)	None listed
4,4'-DDT	1/29	1/29: 0.11	1.1 (a)	0.001 (a)
methoxychlor	1/29	1/29: 0.31	None listed	0.03 (b)
aluminum	27/29	25/29: 399000, 65300, 22700, 15100, 11800, 5610, 4140, 3620, 3340, 2310, 2110, 1100, 1066, 879, 540, 418, 278, 213, 212, 208, 144, 111, 95.7, 94.9, 93.8	750 (b)	87 (b)
antimony	1/29	1/29: 58.7	88.0 (b)	30.0 (b)
beryllium	9/29	2/29: 40.5, 7.6	130 (b)	5.3 (b)
cadmium	2/29	2/29: 25.4, 21.1	3.9 (a)	1.1 (a)
chromium (VI)	10/29	7/29: 532, 201, 62.2, 39.1, 25.0, 19.3, 17.7	16.0 (a)	11.0 (a)
copper	12/29	8/12: 950, 216, 118, 115, 114, 82.5, 29.6, 26.8	18 (a)	12 (a)
iron	29/29	17/29: 833, 709, 449, 239, 168, 53.6, 48.4, 21.9, 14.3, 5.73, 4.88, 3.65, 3.49, 3.06, 1.34, 1.30, 1.27 (all mg/L)	None listed	1.0 mg/L (b)
lead	24/29	16/29: 1360, 656, 111, 66.4, 42.4, 32.2, 28.1, 16.0, 14.5, 9.8, 8.5, 8.0, 4.9, 4.3, 3.8, 3.6	82 (a)	3.2 (a)
manganese	29/29	21/29: 15,600, 5800, 5260, 4930, 2960, 2950, 2840, 2690, 1010, 784, 368, 308, 183, 173, 96.2, 88.0, 86.9, 66.6, 60.1, 56.4, 56.1	None listed	50.0 (b)

Table 10. Continued.

mercury	5/29	5/29: 0.81, 0.28, 0.28, 0.24, 0.20	2.4 (a)	0.012 (a)
nickel	10/29	2/29: 614, 277	1400 (a)	160 (a)
selenium	2/29	1/29: 22.4	20.0 (a)	5.0 (a)
zinc	25/29	5/29: 2980, 1570, 477, 158, 140	120 (a)	110 (a)
Fire Training Area				
4,4'DDD	4/12	3/12: 14.0, 2.1, 0.81	0.6 (b)	None listed
4,4'-DDT	1/12	1/12: 16.0	1.1 (a)	0.001 (a)
aluminum	12/12	10/12: 33200, 7720, 4420, 3540, 335, 157, 122, 107, 105, 98.7	750 (b)	87 (b)
cadmium	2/12	2/12: 234, 8.2	3.9 (a)	1.1 (a)
chromium	4/12	2/12: 80.9, 14.6	16.0 (a)	11.0 (a)
copper	4/12	3/12: 435, 15.8, 20.0	18.0 (a)	12.0 (a)
iron	12/12	5/12:146, 42.1, 18.5, 10.6, 1.21 (all in mg/L)	None listed	mg/L: 1.0 (b)
lead	10/12	7/12: 498, 81.9, 58.0, 40.2, 4.7, 3.9, 3.4	82.0 (a)	3.2 (a)
mercury	2/12	2/12: 0.55, 0.52	2.4 (a)	0.012 (a)
zinc	12/12	4/12: 379, 370, 144, 128	120 (a)	110 (a)

EPA criteria used if Maryland criteria have not been established; average water hardness was 166 mg/L $CaCO_3$ at Old Landfill and 130.9 $CaCO_3$ at Fire Training Area; criteria based on a hardness of 100 mg/L $CaCO_3$ were used in this assessment.

APPENDIX A

TOXICOLOGICAL PROFILES

Aluminum

Data concerning the ingestion of aluminum are not currently available for fish, and NOAEL and LOAEL values could not be developed; therefore, the risk posed by dietary exposure to aluminum by smallmouth bass was not determined in this risk assessment.

Dixon et al. (1979) conducted a study that evaluated the reproductive success of rats exposed to aluminum in drinking water for 90 days prior to breeding. The highest dose administered was 77.5 milligrams per kilogram body weight per day (mg/kg BW/day) and did not result in reproductive abnormalities. Lal et al. (1993) conducted a 180-day drinking water study in which rats were exposed to 55 mg/kg BW/day of aluminum. At this dose, behavioral effects were observed, including a significant reduction in spontaneous locomotor activity and significant deficits in acquisition and retention of learned responses. Based on these results, a LOAEL of 55 mg/kg BW/day and an estimated NOAEL of 5.5 mg/kg BW/day were used to evaluate the risk posed by aluminum to the raccoon.

No effects were observed when Japanese quail were fed a diet containing 0.05 percent (84 mg/kg BW/day) aluminum for four weeks (Hussein et al. 1988). When quail were fed a diet containing 0.1 percent (165 mg/kg BW/day) aluminum, a decrease in egg shell breaking strength was observed. Finally, when quail were fed a diet containing 0.15 percent (257 mg/kg BW/day) aluminum, a decrease in body weight, egg shell strength, and egg shell production was observed. A 48-day feeding study using chickens concluded that dietary levels of 28.4 mg/kg BW/day aluminum resulted in a decrease in weight gain, feed intake, and plasma inorganic phosphorus, as well as an increase in plasma calcium (Hussein 1990). However, only the altered metabolism of calcium and phosphorus could be attributed to the direct effects of aluminum. The associated NOAEL for this effect is 22.8 mg/kg BW/day. Because a range of concentrations were used and the endpoints were ecologically significant and related to the dose, the study by Hussein et al. (1988) was used to the develop the NOAEL and LOAEL values. A NOAEL of 84 mg/kg BW/day and a LOAEL of 165 mg/kg BW/day were used to evaluate the risk posed by aluminum to the green heron.

Arsenic

Cockell and Hilton (1985) found growth depression, food avoidance, and impaired feeding efficiency in adult rainbow trout (*Oncorhynchus mykiss*) fed diets ranging from 7.1 to 9.5 mg/kg BW/day for a period of eight weeks. No effects were noted in fish fed 0.59 mg/kg BW/day. Based on the results of this study, a NOAEL of 0.59 mg/kg BW/day and a LOAEL of 7.1 mg/kg BW/day were used to evaluate the risk posed by arsenic to the smallmouth bass

Several studies were located which determined the effects of As to mammals. A study conducted on cats indicated that a chronic oral toxicity dose was 1.5 mg/kg BW/day (Pershagen and Vahter 1979). The National Resources Council of Canada (1978) states that mammals in general have oral LD_{50}s that range from 10 to 50 mg/kg of lead arsenate. A study conducted on mice indicated an oral dose LD_{50} of 39.4 mg/kg BW/day and an oral dose LD_0 of 10.4 mg/kg BW/day after 96 hours (NAS 1977). For the purposes of this risk assessment, the chronic value for the cat was used to calculate HQs for mammals (1.5 mg/kg BW/day). This value was converted to a NOAEL of 0.15 mg/kg BW/day by dividing by a factor of 10. These values were used in the food chain exposure model for the raccoon.

Eisler (1988a) reviewed several studies in which the toxicity of inorganic arsenicals to birds were measured. These studies indicate that sensitive species include the California quail (single oral dose LD_{50} of 47.6 mg/kg BW/day) (Hudson et al. 1984) and chicken (single oral dose LD_{50} of 33

mg/kg BW/day) (NAS 1977). For the purposes of this risk assessment, a LOAEL was calculated by dividing an acute dose of 33 mg/kg BW/day by 10 to achieve a value of 3.3 mg/kg BW/day. This LOAEL was then converted to a NOAEL of 0.33 mg/kg BW/day by dividing by a factor of 10. These values were used in the food chain exposure model for the green heron.

Cadmium

Although several studies were found that determined the effects of Cd exposure to fish, none of these studies were based on an ingested value. Therefore, a hazard quotient based on a food chain accumulation model for smallmouth bass was not calculated.

One study was located which determined the effects of cadmium to mammals. This study indicated a NOAEL of 0.75 mg/kg/day (Loser and Lorke 1977). This value was converted to a LOAEL of 7.5 mg/kg BW/day by multiplying by a factor of 10. These values were used in the food chain exposure model for the raccoon.

Several studies were located which described the toxicity of cadmium to avian receptors. A study conducted on mallard ducks indicated a decrease in packed cell volume and hemoglobin, and mild to severe kidney lesions based on 20 mg/kg Cd. This converts to a daily dose of 3.31 mg/kg/day (Cain et al. 1983). White et al. (1978) found that a dose of 4 mg/kg/day causes testicular damage in mallards and Leach et al. (1979) found that 8.4 mg/kg/day caused a significant decrease in egg production in chickens. For the purposes of this risk assessment, a LOAEL of 3.31 mg/kg/day was used to evaluate risk to avian species. This value was converted to a NOAEL of 0.33 mg/kg BW/day by dividing by a factor of 10. These values were used in the food chain exposure model for the green heron.

Chromium

Only one study measuring the toxicological effects of dietary Cr to a piscivorous fish was found. The test species used in this study, *Oncorhynchus mykiss* (rainbow trout) was be used as a surrogate for piscivorous fish in the evaluation of dietary Cr exposure in this risk assessment.

Juvenile rainbow trout (mean weight = 5.5 g) were fed to satiation five times daily with a diet containing Cr^{+3} as $CrCl_3 \cdot 6H_2O$ at concentrations of 1, 3, or 6 mg/kg for a period of eight weeks in a flow-through system (Tacon and Beveridge 1982). Background Cr concentration in the flow-through aerated water was 1.87 µg/L. Fish fed the diet containing 6 mg/kg of Cr^{+3} (0.12 mg/kg BW/day) exhibited a significant ($p<0.05$) 27% reduction in body weight gain from the 1 mg Cr/kg treatment. The reduced growth rate resulting from a dietary Cr level of 0.12 mg/kg/day was considered an adverse effect in this risk assessment due to the lack of additional literature. A dietary level of 6 mg/kg (0.12 mg/kg BW/day) of Cr in prey items was used as a LOAEL for the smallmouth bass. This value was converted to a NOAEL of 0.012 mg/kg BW/day by dividing by a factor of 10.

Several studies measuring the toxicological effects of dietary chromium to mammals were found. Steven et al (1976) found the LD_{50} for mice of 260 mg/kg BW for trivalent chromium and 5 mg/kgBW for hexavalent chromium. Rabbits fed both tri- and hexavalent chromium at a rate of 1.7 mg/kg BW/day had altered blood chemistry and severe morphological changes in the liver (Tandon et al. 1978). A dietary level of 1.7 mg/kg BW/day chromium will be used as a LOAEL and a dietary level of 0.17 mg/kg BW/day will be used as a NOAEL for the raccoon.

Heinz and Haseltine (1981) exposed 2- to 3-year old breeding pairs of black ducks (*Anas rubripes*) to a diet containing 0, 20, or 200 mg/kg, wet weight, (0, 2.77, or 27.77 mg/kg BW/day) of Cr^{+3} as

chromium potassium sulfate [$CrK(SO_4)_2 \cdot 12H_2O$] for a period of approximately five months, until the onset of egg-laying by the females. Hatched ducklings were then fed a mash diet containing the same Cr concentrations that the parents were fed. Seven-day old chicks were tested for avoidance behavior in response to a fright stimulus. None of the Cr concentrations resulted in alteration of avoidance behavior. A dietary level of 200 mg/kg (27.8 mg/kg BW/day) of Cr in prey was used as a NOAEL for the avian species. This value was converted to a LOAEL of 277.8 mg/kg BW/day by multiplying by a factor of 10. These values were used in the food chain exposure models for the green heron.

Copper

Although several studies were available which determined the effects of Cu exposure in the water, none were available which determined the effects due to the ingestion of Cu. Therefore, a hazard quotient based on a food chain accumulation model for smallmouth bass was not calculated.

One study was located which determined the effects of ingestion of Cu to mammals. An oral dose of 100 mg/kg/day to a dog caused death (OHMTD 1987). For the purposes of this risk assessment, this concentration was converted to a LOAEL of 10 mg/kg/day by dividing by a factor of 10. This value was converted to a NOAEL of 1 mg/kg/day by dividing by a factor of 10. These values were used in the food chain exposure models for the raccoon.

Several studies were located which determined the effects of Cu on chickens. A dose of 350 mg/kg (61.3 mg/kg/day) caused a significant decrease in growth and food consumption (Smith 1969). Another study found that a dose of 325 mg/kg (23.5 mg/kg/day) caused respiratory problems (Hatch 1978). Assuming that respiratory problems are an acute effect, a concentration of 23. 5 mg/kg BW/day was converted to a LOAEL of 2.35 mg/kg/day by dividing by a factor of 10. This value was further converted to a NOAEL of 0.235 mg/kg/day by dividing by a factor of 10. These values were used in the food chain exposure model for the green heron.

Lead

The literature was reviewed to locate a NOAEL based on the dietary ingestion of Pb to a fish species. A NOAEL based on the dietary ingestion of Pb was not located. Therefore, a hazard quotient based on a food chain accumulation model for smallmouth bass was not calculated.

Several studies were located which determined the effects of Pb ingestion to mammals. A study conducted on mice indicated that 1.5 mg/kg/day of Pb caused a reduction in success of implanted ova (Clark 1979). Another study found that 2.2 mg/kg/day caused a reduction in the frequency of pregnancy when the dose was administered 3 to 5 days following mating (Clark 1979). A dietary dose of 1.5 mg/kg BW/day was used as a LOAEL. This value was converted to a NOAEL of 0.15 mg/kg BW/day by dividing by a factor of 10. These values were used in the food chain exposure model for the raccoon.

The gastric motility of adult male and female red-tailed hawks fed 0.82 and 1.64 mg Pb/kg BW/day in a single oral dose was evaluated through the use of surgically implanted transducers for a period of three weeks following the dose. Neither concentration had any effect on gastric contractions or egestion of undigested material pellets (Lawler et al. 1991). Another study conducted on red-tailed hawk found that 3 mg/kg/day of Pb caused the clinical symptoms of Pb poisoning (Reiser and Temple 1981). A similar study found that 3 mg/kg/day fed to starlings caused a reduction in muscle condition and altered their feeding activity (Osborne et al. 1983). A dietary dose of 3 mg/kg/day was used as a LOAEL. This value was converted to a NOAEL of 0.3 mg/kg BW/day by dividing by a factor of 10. These values were used in the food chain exposure

model for the green heron.

Manganese

The effects levels for manganese toxicity vary widely, most likely attributable to the form of manganese tested. Rats exposed to 13 mg/kg BW/day of manganese as Mn_3O_4 in their diet for 224 days exhibited reduced testosterone levels (Laskey et al. 1982). In mice, a dietary level of 140 mg/kg BW/day, also of Mn_3O_4 for 90 days resulted in decreased activity (Gray and Laskey 1980). A much higher exposure concentration of 2,300 mg/kg BW/day of manganese as $MnCl_2$ resulted in reduced dopamine levels (Gianutsos and Murray 1982).

In contrast, levels as high as 930 mg/kg BW/day of manganese as $MnSO_4$ for 103 weeks had no effect on the respiratory, cardiovascular, gastrointestingal, hematological, musculoskeletal, hepatic, renal, dermal, and ocular systems of mice (Hejtmancik et al. 1987).

For this risk asssessment, a dietary exposure level of 13 mg/kg BW/day will be used as a LOAEL to estimate risk of manganese to the selected mammalian receptor. A NOAEL of 1.3 mg/kg BW/day was derived from this LOAEL using an accepted conversion factor of 10.

No studies pertaining to the dietary toxicity of manganese to an avian receptor were found in the literature.

Mercury

No studies measuring the effects of dietary Hg to the smallmouth bass were found; therefore, studies utilizing the rainbow trout were reviewed. The rainbow trout was used as a surrogate for piscivorous fish in this risk assessment.

Fingerling rainbow trout (1.7 g) fed 1.60 mg Hg/33.3 g food (0.94 mg Hg/kg BW/day) as methyl mercuric chloride (CH_3HgCl) for approximately 40 weeks exhibited a 40 percent reduction in growth, loss of appetite, inability to locate food, darkened color, and an increase in the frequency of swimming collision with the wall of the test vessel (Matida et al. 1988). A dietary level of 0.94 mg/kg BW/day was used as LOAEL. This value was converted to a NOAEL of 0.094 mg/kg BW/day by dividing by a factor of 10. These values were used in food chain exposure models for smallmouth bass.

Several studies were found that evaluated the effects of Hg on mammals. A study conducted on rats indicated that 0.5 mg/kg/day caused reduced fertility (Khera 1973). A study conducted on dogs indicated that 0.1 mg/kg/day caused a high incidence of still births (Khera 1973). A dietary level of 0.1 mg/kg BW/day was used as a LOAEL. This value was converted to a NOAEL of 0.01 mg/kg BW/day by dividing by a factor of 10. These values were used in food chain exposure models for the raccoon.

Kidney lesions were found in juvenile starlings (*Sturnus vulgaris*; omnivores) that consumed a commercial diet contaminated with 1.1 mg/kg Hg (0.12 mg/kg BW/day) (Nicholson and Osborn 1984). A dietary dose of 0.12 mg/kg BW/day was used as a LOAEL. This value was converted to a NOAEL of 0.012 mg/kg BW/day by dividing by a factor of 10. These values were used in food chain exposure models for the green heron.

Nickel

The literature was reviewed to locate a NOAEL based on the dietary ingestion of Ni to a fish

species. A NOAEL based on the dietary ingestion of Ni was not located. Therefore, a hazard quotient based on a food chain accumulation model for smallmouth bass was not calculated.

Several studies were available which determined the effects of Ni ingestion to mammals. Wistar rats fed Ni sulfate indicated a NOAEL of 187.5 mg/kg/day to most systems except for body weight. This level of Ni sulfate caused a 27 to 29 percent decreased body weight (Ambrose et al. 1976). In a similar study with a beagle, a NOAEL of 62.5 mg/kg/day was noted (Ambrose et al. 1976). A dietary dose of 62.5 mg/kg BW/day was used as a NOAEL. This value was converted to a LOAEL of 625.0 mg/kg BW/day by multiplying by a factor of 10. These values were used in the food chain exposure model for the raccoon.

Hill and Camardese (1986) reported that no overt signs of toxicity were observed in Japanese quail fed 5000 ppm nickel sulfate (1896.5 mg Ni/kg BW/day) in their diet for five days. Weber and Reid (1968) conducted a study in which Hubbard broiler chicks were exposed to nickel in their diet for four weeks. Feeding levels at or greater than 500 ppm (31 mg/kg BW/day) of Ni, as nickel sulfate, resulted in significantly depressed weight gains. The NOAEL for this effect was 17 mg/kg BW/day.

For this risk assessment, a LOAEL of 31 mg/kg BW/day and a NOAEL of 17 mg/kg BW/day were used to estimate the risk of nickel to the green heron.

Zinc

The literature was reviewed to locate a NOAEL based on the dietary ingestion of Zn to a fish species. A NOAEL based on the dietary ingestion of Zn was not located. Therefore, a hazard quotient based on a food chain accumulation model for smallmouth bass was not calculated.

A study conducted on dogs, indicated that 1,000 mg/kg (25 mg/kg BW/day) caused no effects after one year (NAS 1979b). A dietary dose of 25 mg/kg BW/day was used as a NOAEL. This value was converted to a LOAEL of 250 mg/kg BW/day by multiplying by a factor of 10. These values were used in the food chain exposure model for the raccoon.

Several studies were available which determined the effects of ingested Zn to birds. A concentration of 144.5 mg/kg/day caused a decrease in growth and anemia in chickens (Stahl et al. 1989). In a similar study conducted on chickens, a concentration of 361 mg/kg/day caused a reduction in body weight (Dean et al. 1991). In a study conducted on Japanese quail, a concentration of 139 mg/kg/day caused 7 percent mortality in chicks and reduced food intake (Hill and Camardese 1986). A dietary dose of 139 mg/kg BW/day was used as a LOAEL. This value was converted to a NOAEL of 13.9 mg/kg BW/day by dividing by a factor of 10. These values were used in the food chain exposure model for the green heron.

Polychlorinated Biphenyls

Monosson et al. (1994) tested the reproductive effects of a single PCB (3,3',4,4'-tetrachlorobiphenyl) on the white perch (*Morone americana*). The doses were administered as three intraperitoneal injections with three weeks between injections (6 weeks total). Low (0.2 mg/kg BW), medium (1.0 mg/kg BW), and high (5.0 mg/kg BW) dosages were evaluated. To express these dosages in units of mg/kg BW/day, the individual dosages were added and then divided by the total dosage period (42 days). Using this approach, the test specimens were exposed to 0.014, 0.071, and 0.355 mg/kg BW/day. Blood and oocyte samples were collected six weeks following the final injection and endpoints measured included percent mature females as indicated by oocyte diameter; gonad weight; blood plasma levels of steroid hormones (estradiol-

17β and testosterone) and vitellogenin; and hatching success, larval survival, and growth of embryos and larvae. The high dose (0.071 mg/kg BW/day) reduced the proportion of mature females. The control, low, and medium dosages exhibited similar results (66 to 69 percent mature). The high dose had only 25 percent mature females which was significantly less than the control ($p<0.01$). Gonad weight was significantly reduced in both males and females in the high dose group. Significant differences were not noted at the low and medium doses for gonad weight. Blood plasma levels of steroid hormones or vitellogenin, hatching rate, viability of embryos, initial larval length, and five day larval length were not statistically different between treatment groups. However, larval survival was significantly lower after seven days in the medium and high treatments. Survival was 54, 20, zero, 1 percent in the control, low, medium, and high treatments, respectively. Based on the ecological significance of the endpoints, a LOAEL of 0.071 mg/kg/day and a NOAEL of 0.014 mg/kg/day were used to evaluate the risk posed by PCBs to smallmouth bass.

Several studies were found pertaining to the dietary toxicity of PCBs to mink, most of which examined its effects on reproduction, growth and survival. Mink are one of the most sensitive organisms to the effects of PCBs (Giesy et al. 1994). Studies were not available for the raccoon, therefore, the values selected for use in the food chain exposure model for raccoon were derived using mink data. Reproductive effects are seen at parent dietary levels as low as 0.13 mg/kg BW/day (Heaton et al. 1995) and embryotoxicity at parent dietary levels of 0.66 mg/kg BW/day (Aulerich and Ringer 1977). Some adult mortality and behavioral effects are seen at dietary levels starting at 0.148 mg/kg BW/day (Platanow and Karstad 1973), reduced adult weight at dietary levels starting at 1.31 mg/kg BW/day (Aulerich and Ringer 1977), and complete adult mortality at dietary levels starting at 3.3 mg/kg BW/day (Aulerich and Ringer 1977).

Male and female ranch-bred mink were acclimated to a diet consisting of ocean fish scraps, commercial mink cereal, and meat by-products. Ocean fish scraps made up 40 percent of this diet. Dietary treatment levels were prepared by substituting 10, 20, and 40 percent of the ocean fish scraps with PCB-contaminated carp. The mean dietary PCB concentrations were 0.015 mg/kg (control), 0.72 mg/kg (10 percent carp), 1.53 mg/kg (20 percent carp), and 2.56 mg/kg (40 percent carp). Groups of 15 mink (3 males, 12 females) were assigned to one of the four treatment groups for a period of 12 weeks. Mink receiving the highest PCB-containing diet (40 percent carp or 0.32 mg/kg BW/day, as reported by the investigators) exhibited a 42 percent reduction in mean litter size, 86 percent fewer live kits at birth, and no kits surviving beyond 24-hours post-partum. Even mink receiving the 10 percent carp diet (or 0.13 mg/kg BW/day, as reported by the investigators) exhibited a 67 percent reduction in kits surviving three to six weeks relative to the control (Heaton et al. 1995).

One-year-old mink were fed a diet of beef and cereal prepared from cows which had been given 10 consecutive daily oral doses of 1 and 10 mg/kg of Aroclor 1254 dissolved in an olive oil and dairy concentrate (Platanow and Karstad 1973). The cows did not exhibit any clinical, gross, or histopathological signs of PCB toxicity. The cows were killed 24 hours following the last dose, and the musculature, liver, and kidneys ground and mixed with commercial mink food cereal at a level of 24 percent cereal. The resulting rations containing 0.64 and 3.57 mg/kg of total PCB were fed to mink for a period of 160 days. The mink were fed this diet *ad libitum* 2 months prior to the breeding season and continued for 160 days. All 16 mink that were fed 3.57 mg/kg of PCBs died by day 105. Two of the 16 mink that were fed 0.64 mg/kg died by days 122 and 129. The mink exhibited poor appetites, lethargy, and weakness before dying. Some passed tarry feces, indicating gastrointestinal hemorrhaging. At both treatment levels, males survived longer than females. These doses were converted to a daily exposure concentration by multiplying them with the inverse of the lowest reported body weight of the mink (0.52 kg) and the food ingestion rate of the mink (0.121 kg/day). This yielded exposure concentrations of 0.148 and 0.785 mg/kg BW/day for the

0.64 and 3.57 mg/kg dose, respectively.

Eight month old mink fed a basal diet containing 1.0 mg/kg of Aroclor 1254 for a period of approximately six months exhibited no mortality or any significant changes in the thyroid, pituitary, adrenal glands, or serum T3 and T4 levels (Wren et al 1987a). Reproduction and kit development was evaluated under the same test conditions in a separate study (Wren et al. 1987b) by the same investigators. Male fertility and female offspring production were not affected by the 1.0 mg/kg Aroclor 1254 diet. However, growth rate of kits nursed by exposed mothers was significantly reduced. The investigators estimated the daily exposure concentrations to be 0.10 mg/kg BW/day for males and 0.18 mg/kg BW/day for females.

In a preliminary study to determine the cause of reproductive complications in mink fed Great Lakes fish, adult breeder mink were fed a basal diet supplemented with 30 mg/kg of PCBs for six months (181 days). However, all of the mink died emaciated by the end of the experimental period (Aulerich and Ringer 1977). For this risk assessment, the 30 mg/kg dose was converted to a daily exposure concentration by multiplying it with the inverse of the lowest reported body weight for the mink (0.52 kg) and the food ingestion rate (0.121 kg/day) to yield an exposure concentration of 6.6 mg/kg BW/day.

As a result of this preliminary study, a long-term study was conducted to ascertain the effects of long-term, low-level consumption of PCBs on growth. Mink were fed a basal diet supplemented with 5 and 10 mg/kg of PCBs for a period of approximately 8.5 months. The basal diet plus 10 mg/kg of PCBs resulted in a significant 56 percent decrease in body weight gain after a period of 4 months. Body weight gain was reduced by 39 percent in the 5 mg/kg treatment group, but this reduction was not significant. Both the 5 and 10 mg/kg treatment groups failed to produce offspring; the control group produced 17 live and 8 dead kits. Various degrees of embryotoxicity were observed during necropsy of the treated animals (Aulerich and Ringer 1977). The 5 and 10 mg/kg doses were converted to a daily exposure concentration by multiplying it with the inverse of the lowest body weight reported by the investigators for this treatment group (0.923 kg) and the food ingestion rate (0.121 kg/day) of the mink. This yielded exposure concentrations of 0.66 and 1.31 mg/kg BW/day for the 5 and 10 mg/kg treatment group, respectively.

Based on the results of this experiment, another experiment was conducted to determine the effects of long-term consumption of low-level PCBs on reproduction. Fifteen mg/kg of PCB as Aroclor 1254 in the diet resulted in a complete inhibition of reproduction and 31 percent adult mortality, compared to 6 percent mortality in the controls. Five mg/kg of Aroclor 1254 resulted in a 95 percent reduction in the number of kits born live; the ratio of live kits to female adults was reduced by 87 percent. However, in an effort to determine the persistency of the impaired reproductive condition, 11 adult females that received 5 mg/kg of Aroclor 1254 for a period of six months were placed on a control diet for one year. The results indicate that the impaired reproductive performance of these females was not a permanent condition (Aulerich and Ringer 1977). The 5 and 15 mg/kg dose was converted to a daily exposure concentration by multiplying it with the inverse of the lowest reported body weight for the mink [and the food ingestion rate (0.121 kg/day)] to yield exposure concentrations of 1.1 and 3.3 mg/kg BW/day, respectively.

A dietary dose of 0.13 mg/kg BW/day of PCBs (Heaton et al. 1995) was used as a LOAEL. A NOAEL of 0.10 mg/kg BW/day (Wren et al. 1987b) was used. These values were used in the food chain exposure model for the raccoon.

American kestrels fed a diet of 9-10 mg/kg BW/day of Arochlor 1254 for a period of 62-69 days, showed a marked decrease in sperm concentration (Bird et al. 1983). American kestrel and red-tailed hawk are both predatory species. Predatory birds might consume enough PCBs to alter

semen quality, which in conjunction with courtship behavioral disorders, might be disastrous in some breeding areas. Therefore, a dietary dose of 9 mg/kg BW/day was used as a LOAEL. This value was converted to a NOAEL of 0.9 mg/kg BW/day by dividing by a factor of 10. These values were used in the food chain exposure model for the green heron.

Chlordane

Data concerning the ingestion of chlordane are not currently available for fish, and NOAEL and LOAEL values could not be developed; therefore, the risk posed by dietary exposure to chlordane by smallmouth bass was not determined in this risk assessment.

Talamantes and Jang (1977) gave newborn mice (ages 2, 3 and 4 days old), 3 mg/kg BW/day of chlordane and observed depressed growth and delayed development in eye and vaginal opening during the first 12 weeks. Additional studies of mice receiving an oral dose of 100 mg/kg BW/day had significant dose-related reduction in the size of seminiferous tubules and in the percentage of damaged tubules, and also a 11 - 21% reduction in spermatogenesis (Balash et al. 1987). A NOAEL of 1.175 mg/kg BW/day was found for rats for 130 weeks (2.5 years) with no significant effects on body weight or survival rate observed (EPA 1988). Finally, rats fed 1.88 mg/kg BW/day of technical chlordane showed severe toxic signs at this level (WHO 1984). For this risk assessment, a dietary exposure level of 1.88 mg/kg BW/day was used as a LOAEL and a dietary exposure level of 0.188 mg/kg BW/day was used as a NOAEL to estimate risk of chlordane to the raccoon.

Common barn owl (*Tyto alba*) were fed diets containing 75 mg/kg until 50 percent died and the survivors were sacrificed and measured for residues. Mortality was reached on day 40 (Eisler 1990). Hudson et al. (1984) in an LD50 study administered a single oral dose of 1200 mg/kg BW to mallards, ages 4-5 months, while a similar 5 day LD50 study was performed by Hill et al. (1975) where mallards were fed 93.3 mg/kg BW/day. In a longer term study, European starlings (*Sturnus vulgaris*) were fed a diet of various chlordane concentrations of which the lowest concentration (0.19 mg/kg BW/day) caused 50% mortality in 57 days. For this risk assessment, a dietary exposure level of 0.19 mg/kg BW/day was used as a LOAEL and a dietary exposure level of 0.019 mg/kg BW/day was used as a NOAEL to estimate the risk of chlordane to the green heron.

DDT

Data concerning the ingestion of DDT are not currently available for fish, and NOAEL and LOAEL values could not be developed; therefore, the risk posed by dietary exposure to DDT by smallmouth bass was not determined in this risk assessment.

Cats were fed a single dose of DDT incorporated into the diet at levels of 300 to 500 mg/kg Within 24 hours, generalized tremors and marked ataxia were noted in most animals (Pollock and Wang 1953). Electroencephalograph readings showed a markedly increased amplitude of cerebellar activity over that seen in normal control animals.

Deichmann et al., (1971) reported subnormal reproduction in Beagles fed 12 mg/kg BW/day *p,p'*-DDT five days a week for 14 months. Effects noted were delayed estrous, reduction in libido, stillbirths, lack of mammary development, reduced milk production, and high mortality in offspring. The experimental design makes the reported results difficult to interpret. Only four

females were tested in this experiment. Two of the females did not become pregnant after copulation, and one never went into heat. In addition, females fed only DDT were mated with a male that had been fed a mixture of DDT and aldrin.

In another study, dogs were fed gelatin capsules containing 4 mg/kg BW/day of pure *p,p'*-DDD or technical DDD for four days (Cueto et al., 1958). The number of dogs which received a particular dosage level of a compound ranged from one to three. No effects were noted in the dogs fed pure *p,p'*-DDD. Symptoms noted in dogs which received the technical DDD included anorexia, apathy, weakness, and inability to stand. At autopsy, atrophy of the adrenal cortex was noted. Pure *p,p'*-DDD was prepared from the technical material. This isomer produced massive necrosis and atrophy of the adrenal glands at a dose of 4 mg/kg BW/day.

Nelson and Woodard (1949) also reported severe adrenal cortical atrophy in dogs fed DDD. Eleven adult dogs were fed DDD dissolved in corn oil at levels of 50 to 200 mg/kg BW/day for periods of one to three months. Seven of the dogs died by the end of the experiment, including two of the four that received the lowest dosage. The only symptoms noted prior to death were weakness and anorexia. Copeland and Cranmer (1974) reported histological changes in the adrenal glands of dogs fed 50 mg of *o,p'*-DDT/kg BW/day for 32 days.

Effects of oral exposure to 1, 5 and 10 mg of technical DDT/kg BW/day were studied through three generations of beagle dogs (Ottoboni *et al.* 1977). There were a total of 135 adult female and 63 adult male dogs in the experiment, and 650 pups were produced. DDT-treated females had their first estrous cycles two to three months earlier than control females. There were no statistically significant differences among control and DDT dogs in any other reproductive parameter measured. The liver/body weight ratio was also higher in some DDT-treated animals. No histological changes were noted in the adrenal glands of DDT-treated dogs. Previous studies have reported histologic changes in the adrenal glands at dietary levels of 4 mg/kg BW/day *o,p'*-DDD (Cueto et al. 1958) or 50 mg/kg BW/day *o,p'*-DDT (Copeland and Cranmer 1974). The technical DDT used in this study contained 17 percent *o,p'*-DDT; therefore dogs receiving the highest dose received 1.7 mg of *o,p'*-DDT/kg BW/day.

These results were used to identify a LOAEL of 4 mg/kg BW/day and a NOAEL of 1 mg/kg BW/day for the raccoon in this risk assessment.

Henny et al. (1990) determined that western grebes accumulated significant tissue levels of DDT while nesting at Puget Sound. Other authors (McEwan 1984, Dilworth et al. 1972) have also indicated that residues of DDX detected in eggs and young hatchlings generally reflect the contaminant levels existing in breeding areas.

Robins were fed earthworms injected with a DDT peanut oil solution (Bernard 1963). Dietary exposure of robins to DDT was 110 mg/kgBW/day. One hundred percent mortality (n = 8) was noted within 14 days.

Three groups of 15 house sparrows were fed diets containing DDT added to chick starter mash at levels of 100, 200 and 300 mg/kg (23.8, 47.6 and 71.4 mg/kg BW/day, respectively (Bernard 1963). All of the birds fed the highest dose (except three which were sacrificed) were dead within 29 days. Forty-nine days of exposure to 200 mg/kg DDT resulted in 100 percent mortality. After 90 days of exposure, all but two of the birds receiving the lowest dose were dead. Levels of DDT measured in brain tissue from dead birds were similar, regardless of the dietary exposure level.

Ingestion of diets containing 8 mg/kg DDT (22 pairs) or 4 mg/kg DDE (15 pairs) resulted in reduced fertility, hatchability, and fledging success in Bengalese Finches (*Lonchura striata*) 2.49

and 1.25 mg/kg BW/day, respectively (Jefferies 1971). Birds were fed the contaminated diet from six weeks prior to pairing until fledging of the young had occurred.

One hundred percent mortality was noted in cowbirds (*Molothrus ater*) fed diets containing 500 mg/kg *p,p'*-DDT (55.3 mg/kg BW/day) dissolved in cottonseed oil mixed with turkey starter crumbles (Stickel and Stickel 1969). All birds were dead within 11 days. Time to mortality for individual birds was correlated with weight at the beginning of the experiment, with heaviest birds surviving longest.

Brown (1978) reported that high residues of DDT in fat may be metabolized and result in adverse effects if birds are starved or activity increases. Cowbirds which had survived a diet containing 40 mg/kg DDT (4.4 mg/kg BW/day) for two months suffered tremors if they were unusually disturbed by workers handling their cages.

For this risk assessment, a LOAEL of 1.25 mg/kg BW/day, and a NOAEL of 0.125 mg/kg BW/day were used for the green heron.

Dieldrin

Data concerning the ingestion of dieldrin are not currently available for fish, and NOAEL and LOAEL values could not be developed; therefore, the risk posed by dietary exposure to dieldrin by smallmouth bass was not determined in this risk assessment.

In a 128-week study, no adverse effects were noted in mice exposed to 0.1 and 1 mg/kg dieldrin (0.013 and 0.13 mg/kg BW/day) in their diet (Walker et al. 1972). In a similar study, no effect on mortality or longevity was observed in three generations of rats exposed to 2.5, 12.5, or 25.0 mg/kg dieldrin in the diet (0.15, 0.75, and 1.5 mg/kg BW/day); however, an increase in the liver/body weight ratio was observed at all concentrations (Treon and Cleveland 1955). Another chronic study resulted in no significant pup mortality when mice were fed a dose of 0.33 mg/kg BW/day of dieldrin (Virgo and Bellward 1975). In another study, rats of varying ages (28 to 750 days old) were exposed to dietary concentrations of dieldrin ranging from 0.08 to 40 mg/kg (Harr et al. 1970). The exposure resulted in nonspecific neural and vascular lesions, cranial edema, and convulsions at dietary concentrations of 2.5 mg/kg (0.11 mg/kg BW/day) and greater; no effects were noted at dietary concentrations of 1.25 mg/kg (0.058 mg/kg BW/day) or less.

For the purposes of this risk assessment, a LOAEL of 0.11 mg/kg BW/day and a NOAEL of 0.058 mg/kg BW/day were used to evaluate the dietary toxicity of dieldrin to the raccoon.

Three studies were found in which the toxic effects of dieldrin to mallard ducks was evaluated. In one study, exposure of mallard ducks (*Anas platyrhynchos*) to dietary concentrations of dieldrin ranging from 4 to 30 mg/kg dieldrin (0.36 to 2.7 mg/kg BW/day) for 75 days resulted in a decrease in the biogenic amines serotonin, norepinephrine, and dopamine (Sharma et al. 1976). However, due to the nature of the endpoints evaluated in this study, toxicity studies evaluating endpoints with more ecological significance using other bird species were used in this risk assessment to evaluate the dietary toxicity of dieldrin to the American robin.

Adverse reproductive effects were observed in pheasants exposed to a concentration of 25 and 50 mg/kg dieldrin (4.3 and 8.75 mg/kg BW/day) in their diet (Genelly and Rudd 1956). Hungarian partridges exposed to 3 mg/kg dieldrin (0.5 mg/kg BW/day) in their diet for 90 days during the breeding season resulted in decreased egg production and hatchability (Neill et al. 1969). Heath et al. (1972) reported an acute LD50 of 6 mg/kg BW/day for the bobwhite quail. Chickens exposed to 5 mg/kg dieldrin (0.9 mg/kg BW/day) in their diet showed no effects on egg production or

hatchability (Graves et al. 1969). It was estimated that the lowest observed adverse effect level of dieldrin in brown pelican (*Pelecanus occidentalis*) eggs is approximately 1 mg/kg (0.3 mg/kg BW/day) in their diet (Blus 1982). Eggshells of normal thickness were laid by pheasants fed a diet containing approximately 0.1 mg/kg BW/day dieldrin (Dahlgren and Linder 1974).

A LOAEL 0.3 mg/kg BW/day and a NOAEL of 0.1 mg/kg BW/day were used in this risk assessment to evaluate the dietary toxicity of dieldrin to the green heron.

Polynuclear Aromatic Hydrocarbons

In a study to establish safe levels of PAH compounds for fish, levels as low as 1.0 mg/kg total sediment PAHs increased mixed-function oxygenase levels and fat content of the liver (Payne et al. 1988). Varanasi et al. (1989) found that fish collected from locations with total sediment PAHs as high as 8.7 mg/kg, had significantly greater incidence of DNA adducts than fish collected from relatively uncontaminated environments. The formation of such adducts is a precursor to the formation of tumors. Martin (1980) found that ingestion of PAH-contaminated food at a rate of 30 mg/kg BW/day of benzo(a)pyrene for nine days caused 100 percent mortality to channel catfish fingerlings (*Ictalurus punctatus*). Lower doses (3 mg/kg BW/day) were observed to cause to cause 88 percent mortality in 14 days. Most fish exhibited "spiraling" behavior before death. Based on the results of this study, a LOAEL of 3 mg/kg BW/day and a NOAEL of 0.3 mg/kg BW/day will be used to evaluate risk posed by PAHs to smallmouth bass.

Neff (1982) reported forestomach tumors in 100 percent of female mice fed 1,000 mg/kg BW/day for 29 weeks. Neal and Rigdon (1967) performed a feeding test on mice with forestomach tumor formation as the endpoint. Mice were placed in nine treatment groups and fed between 0.13 mg/kg BW/day and 32.5 mg/kg BW/day for 110 days. The highest dose produced tumors in 90 percent of the mice and, based on the results of this study, a NOAEL of 1.3 mg/kg BW/day and LOAEL of 2.6 mg/kg BW/day (4 percent occurrence of tumors) were identified. These values will be used to evaluate risk posed by PAHs to the raccoon.

Trust et al. (1993) performed tests on adult and nestling European starlings (*Sturnus vulgaris*). Nestling birds (nine days old) were gavaged with corn oil containing 7,12-dimethylbenz(a)anthracene at total doses of 0, 10, and 100 mg/kg BW/day (5 equal doses of 0, 2, and 20 mg/kg BW/day over five days). Nestling birds showed no adverse effects at 0 and 10 mg/kg BW/day. However, 100 mg/kg BW/day resulted in an 11 percent reduction in mean body weight, a 16 percent reduction in mean hemoglobin concentrations, and a 90 percent reduction in lymphocyte proliferation (as measured via stimulation index). Adult starlings dosed as high as 300 mg/kg BW/day showed no adverse effects. Based on the results of this study, a LOAEL of 100 mg/kg BW/day and a NOAEL of 10 mg/kg BW/day were used to evaluate risk posed by PAHs to the green heron.

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Summary of NOAELs and LOAELs			
		Raccoon	Kingfisher
PAHs	LOAEL	2.6	100
	NOAEL	1.3	10
PCBs	LOAEL	0.13	9
	NOAEL	0.1	0.9
DDT	LOAEL	4	1.25
	NOAEL	1	0.125
Chlordane	LOAEL	1.88	0.19
	NOAEL	0.188	0.019
Dieldrin	LOAEL	0.11	0.3
	NOAEL	0.058	0.1
Aluminum	LOAEL	55	165
	NOAEL	5.5	84
Arsenic	LOAEL	1.5	3.3
	NOAEL	0.15	0.33
Cadmium	LOAEL	7.5	3.31
	NOAEL	0.75	0.33
Chromium	LOAEL	1.7	277.8
	NOAEL	0.17	27.8
Copper	LOAEL	10	2.35
	NOAEL	1	0.235
Lead	LOAEL	1.5	3.0
	NOAEL	0.15	0.3
Manganese	LOAEL	13	NA
	NOAEL	1.3	NA
Mercury	LOAEL	0.1	0.12
	NOAEL	0.01	0.012
Nickel	LOAEL	625	31
	NOAEL	62.5	17
Zinc	LOAEL	250	139
	NOAEL	25	13.9
Note: This summary of NOAELs and LOAELs and the toxicological profiles			
were provided by the EPA Environmental Response Team, Edison, NJ.			
The profiles include all chemicals of potential concern at BNTC and several			
additional contaminants.			

APPENDIX B

LIFE HISTORY AND EXPOSURE PROFILES

4LIFE HISTORY OF THE BELTED KINGFISHER (*Megaceryle alcyon*)

The belted kingfishers is a pigeon-sized, territorial bird that is the only kingfisher present throughout most of North America (Bull and Farrand 1977; NGS 1987). They inhabit rivers, lakes, and estuaries and are often seen patrolling a favorite sheltered section of a waterway for prey (NGS 1987). Food items include primarily shallow water fish, although crayfish, frogs, small snakes, salamanders, insects, crabs, and even mice may be consumed (Bull and Farrand 1977; Landrum et al. 1993). It is estimated that a pair of kingfishers with nearly fledged young requires approximately 90 fish per day to feed their offspring and themselves (Landrum et al. 1993).

This species is solitary with the exception of the nesting season. Breeding times for this species vary with locale. Unseasonably mild weather may initiate early nesting in the lower United States. The presence of herbaceous cover and good fishing habitat are the basis for the selection of breeding areas and nest sites. Nests consists of streambank or shoreline burrows and vary in length depending upon the soil texture. Although usually near water, nests have been found up to 1.6 km away from water. A clutch of six to seven eggs are usually laid between early April and mid-June. Incubation lasts for 25 days with nest occupation for an additional 23 days. The fledglings remain near the nest and juveniles disperse by mid-summer (Landrum et al. 1993).

Males generally do not readily leave their territories and will remain there throughout the winter as long as ice does not impede fishing. Females typically migrate southward and return to the same mate and nesting site every year. The likelihood of migration for both males and females appears to depend on the severity of the winter (Landrum et al. 1993).

EXPOSURE PROFILE OF THE BELTED KINGFISHER (*Megaceryle alcyon*)

Adult belted kingfishers (*Megaceryle alcyon*) weigh from 113 to 215 g (Fry and Fry 1992). The lowest reported body weight of 113 g was assumed for this risk assessment. Although the home range of this species varies seasonally and is usually reported as kilometers of shoreline (Landrum *et al.* 1993), the home range was assumed to be approximately 160 acres (DeGraaf and Rudis 1993).

Food ingestion rates for adult kingfishers vary from 50 percent BW/day, and 60 g/day, to 0.5 g/g body weight/day (Newell 1987, U.S. EPA 1988; U.S. EPA 1993). The highest food ingestion rate of 60 g/day was assumed for this risk assessment.

A water ingestion rate of 0.11 g/g BW/day is estimated for this species (U.S. EPA 1993). To express this value in units of g/day, the water ingestion rate was multiplied by the lowest reported body weight, 113 g, to yield a water ingestion rate of 12.43 g/day (12.43 ml/day).

Belted kingfishers are reported to consume fish ranging in size from 25 to 178 mm in length (Sayler and Langler 1946). In keeping with the conservative approach of this risk assessment, the amount of sediment entrained in fish 178 mm long was predicted. The standard weight of a 178 mm bluegill was calculated to be 122.6 g based on the following algorithm relating length to weight (Hillman 1982):

$$\log \text{Weight (g)} = -5.374 + 3.316 \log \text{Length (mm)}$$

An incidental sediment ingestion rate could not be identified for the belted kingfisher. To evaluate this exposure pathway, a model was developed that predicted the amount of sediment which may be entrained in the digestive system of a fish, the bluegill (*Lepomis machrochirus*). This was assumed to be the primary mechanism by which a piscivorous bird such as the belted kingfisher may incidentally ingest sediment.

A study evaluating the stomach contents of 153 bluegills reported an average content of detritus and sediment to be 9.6 percent of the total diet (Kolehmainen 1974). A daily food ingestion rate of 1.75 percent of the body weight per

day has been reported for the bluegill (Kolehmainen 1974). This provides a predicted intake rate of 2.15 g of food per day for a 122.6 g fish. If a conservative assumption is made that 9.6 percent of the food ingested is entirely sediment, it can be predicted that a fish of this size may contain 0.206 g of sediment in its digestive system.

For the purpose of this model, it was assumed that the level of sediment contained in the digestive system of a fish remains constant over time. This value (0.206 g) was divided by the predicted fish body weight (122.6 g) to express sediment entrained in fish digestive systems in units of grams of sediment per gram of fish body weight. This provided a value of 0.0017 g sediment/g body weight. When this value is multiplied by the food ingestion rate of the belted kingfisher (60 g/day), the predicted sediment ingestion rate for the kingfisher is 0.1 g/day.

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LIFE HISTORY OF THE RACCOON (*Procyon lotor*)

Raccoons are common and mostly nocturnal mammals inhabiting wooded areas near water, marshes, suburban areas, or virtually any area that can provide food, a den, and permanent water (Hoffmeister 1989; Jones and Birney 1988). Their dens are usually within 1,200 feet from a water supply but are situated in an area where the den can remain dry (Hoffmeister 1989). These dens may be in hollow trees, burrows, caves, crevices in rock, haystacks, chimneys, or under logs (Hoffmeister 1989; Schwartz and Schwartz 1981). During periods of heavy snow or ice, raccoons will den together for several days (Schwartz and Schwartz 1981), otherwise, they are normally solitary and remain active throughout the year (Jones and Birney 1988).

Raccoons are opportunistic omnivores consuming various food items such as berries, fruit, nuts, corn, seeds, aquatic and terrestrial invertebrates, eggs, frogs, snakes, fish, muskrats, and young waterfowl (Jones and Birney 1988; Schwartz and Schwartz 1981). Seasonal and local food availability appears to dictate dietary composition, although as a general rule, plant matter comprises a greater portion of the diet than does animal matter (Barbour and Davis 1974).

Breeding may occur from December through July, although most breeding occurs from January to March (Schwartz and Schwartz 1981; Jones and Birney 1988). Gestation lasts for approximately 63 days with litter sizes ranging from two to seven young (Barbour and Davis 1974). The young are weaned at 10 to 12 weeks, forage with the female parent well into the autumn, and are ready to breed their first winter (Barbour and Davis 1974). Natural predators of the raccoon include owls, hawks, bobcats, coyotes (Merritt 1987; Schwartz and Schwartz 1981). Most raccoons live less than 5 years in the wild (Schwartz and Schwartz 1981).

EXPOSURE PROFILE OF THE RACCOON (*Procyon lotor*)

Adult raccoons weigh from 3 to 15 kg (Merritt 1987; U.S. EPA 1993). The home range of this species varies from 12 to 12,350 acres (Merritt 1987).

The food ingestion rate for a raccoon is reported to be approximately 500 g/day (Newell 1987); the water ingestion rate is estimated to be approximately 0.083 g/g BW/day. To express the water ingestion rate in units of g/day, the water ingestion rate of 0.083 g/g BW/day was multiplied by the lowest reported body weight of 3 kg to yield a water ingestion rate of 24.9 g/day (24.9 ml/day).

A soil ingestion rate of 9.4 percent of the total diet has been reported for the raccoon (Beyer *et al.* 1994). To express this value in units of g/day, the soil ingestion rate of 9.4 percent was multiplied by the food ingestion rate of 500 g/day to yield a soil ingestion rate of 47 g/day.

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