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End Date: FY 01

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4. Phase:

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6. Survey Type: GROUND-WATER CONSULTATION

7. INSTALLATION OR SOURCE OF INFORMATION (CITY & STATE OR COUNTY ARE ESSENTIAL)
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8. Authors:

9. ARLOC/Activity: 11933 WRAMC
Location: WALTER REED AMC
State: DC

10. Project Control Number: 38-EH-2190-00

11. Title: GROUND-WATER CONSULTATION, WRAMC, 18 SEPTEMBER – 3 OCTOBER 2000

12. DSA:

Install

DEPARTMENT OF THE ARMY
U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MARYLAND 21010-5403

REPLY TO
ATTENTION OF

MCHB-TS-EGW (40)

26 JAN 2001

MEMORANDUM FOR Commander, Walter Reed Army Medical Center, Environmental Office, ATTN: MCWR-GEO (Mr. C. Flippo), 6900 Georgia Avenue, NW, Washington, DC 20307-5001

SUBJECT: Ground-Water Consultation No. 38-EH-2190-00, Walter Reed Army Medical Center, Washington, DC, 18 September - 3 October 2000

Two copies of subject report with Executive Summary are enclosed. One copy of the enclosure, laboratory data packages, is also included.

FOR THE COMMANDER:

John W. Bauer

Encl

JOHN W. BAUER, P.G.
Program Manager
Ground Water and Solid Waste

CF(w/o encl):
HQDA(DAIM-ED)
CDR, MEDCOM, ATTN: MCHO
POPM, ATTN: MCPO-SA(EXSUM ONLY)
CDR, MEDDAC, FT MEADE, ATTN: PVNTMED SVC
CDR, USAEC, ATTN: SFIM-AEC-EQ
CDR, USAEC, ATTN: TECH INFO CTR
CDR, USACHPPM-N

U.S. Army Center for Health Promotion and Preventive Medicine

USCHPPM

GROUND-WATER CONSULTATION NO. 38-EH-2190-00
WALTER REED ARMY MEDICAL CENTER
WASHINGTON, D.C.
18 SEPTEMBER - 3 OCTOBER 2000

Readiness Thru Health

DEPARTMENT OF THE ARMY
U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
6158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MARYLAND 21010-5403

REPLY TO
ATTENTION OF

26 JAN 2001

MCHB-TS-EGW

EXECUTIVE SUMMARY
GROUND-WATER CONSULTATION NO. 38-EH-2190-00
WALTER REED ARMY MEDICAL CENTER
WASHINGTON D.C.
18 SEPTEMBER - 3 OCTOBER 2000

1. PURPOSE. To collect and chemically analyze ground-water samples from all the monitoring wells at the Forest Glen Annex, Glen Haven Annex, and Main Post of the Walter Reed Army Medical Center (WRAMC); to interpret the analytical results; and to provide a consolidated report of ground-water monitoring at all WRAMC properties.

2. CONCLUSIONS.

2.1 Forest Glen Annex.

2.1.1 Bldg. 500. Fuel contamination is being actively remediated using a ground-water pump-and-treat system operated by a contractor. The contractor prepares quarterly reports that indicate the continuing presence of small quantities of free product in two monitoring wells (that have been incorporated into the pump-and-treat system). This study clearly demonstrates that the observed free product has not migrated to surrounding wells (i.e., it has been contained by the remediation efforts).

2.1.2 Bldg. 602 (fuel point). Petroleum contamination is evident in two of the three monitoring wells at the site. The methyl-t-butyl-ether (MTBE) concentration is substantially greater than the U.S. Environmental Protection Agency (EPA) advisory limit for drinking water in MW-11, and benzene concentrations exceed EPA maximum contaminant levels (MCLs) in MW-11 and MW-12. The detected concentrations of all other petroleum compounds are less than EPA thresholds; however, the presence of so many petroleum compounds may indicate subsurface leakage from the petroleum underground storage tanks and/or associated piping at this facility; or they may indicate surface spillage of petroleum products, or a combination of both leakage and spillage.

2.1.3 Bldg. 164 (AAFES fuel station). MTBE contamination was evident in all three monitoring wells at concentrations greater than EPA advisory limits for drinking water. No other petroleum compounds were present. This contamination pattern may indicate surface petroleum spillage from handling of gasoline because all the wells are located in an area where

gasoline is handled (fueling island), and MTBE disperses faster than other petroleum compounds in ground water. If a sustained gasoline leak were causing this contamination, it is likely that other gasoline hydrocarbons would be detected.

2.2 Glen Haven Annex. No significant contamination was observed in any of the three monitoring wells.

2.3 Main Post. Aroclor-1260 [a polychlorinated biphenyl (PCB)] was detected in two monitoring wells located hydraulically down gradient from a former transformer vault, located near the Rumbaugh Parking Garage. These low PCB concentrations may indicate that PCB contamination remains at the former transformer vault location and that small quantities of this material are dispersing into the ground water.

3. RECOMMENDATIONS.

3.1 Bldg. 500. Continue free product remediation efforts using the ground-water pump-and-treat system currently in place, as long as it produces effective results (i.e., it actually removes quantities of free product). When this system no longer removes free product, consider an alternate remedial action that is compatible with the limited amounts of petroleum products remaining at the site. Monitored natural attenuation may be an acceptable course of action at that time.

3.2 Bldg. 602 (fuel point). Conduct a follow-on investigation to determine the source of MTBE and other fuel-related hydrocarbons in the ground water near this facility.

3.3 Bldg. 164 (AAFES fuel station). Conduct a follow-on investigation to determine the source of MTBE in the ground water near this facility.

3.4 Glen Haven Annex. Conduct a follow-up round of ground-water sampling. If this round of sampling also comes up negative for contaminants, consider properly closing the monitoring wells.

3.5 Main Post. Conduct a follow-up round of ground-water sampling to confirm the presence of Aroclor-1260 in the monitoring wells located near the Rumbaugh Parking Garage.

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APPENDICES

FIGURES

DEPARTMENT OF THE ARMY
U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MARYLAND 21010-5403

REPLY TO
ATTENTION OF

MCHB-TS-EGW

GROUND-WATER CONSULTATION NO. 38-EH-2190-00
WALTER REED ARMY MEDICAL CENTER
WASHINGTON D.C.
18 SEPTEMBER - 3 OCTOBER 2000

1. REFERENCES. See Appendix A for a list of references.

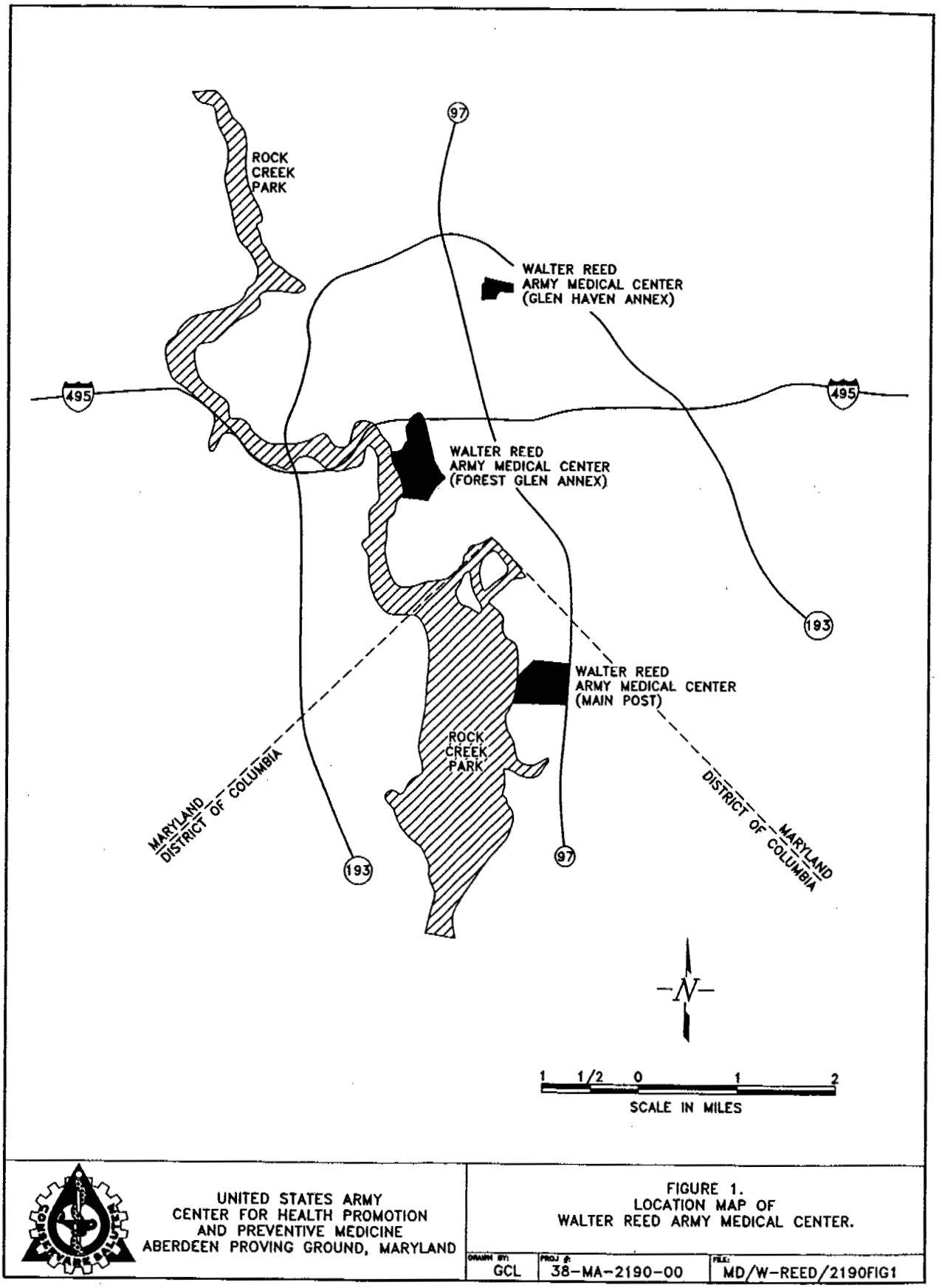
2. AUTHORITY. USAEHA Form 250, Request for USAEHA Field Service, Dr. Winston Williams, WRAMC Environmental Office, 25 July 2000, subject: perform groundwater monitoring at all the monitoring wells at WRAMC-Main Post, Forest Glen Annex and Glen Haven Annex.

3. PURPOSE. To collect and chemically analyze ground-water samples from all the monitoring wells at the Forest Glen Annex, Glen Haven Annex, and Main Post of the Walter Reed Army Medical Center (WRAMC); to interpret the analytical results; and to provide a consolidated report of ground-water monitoring at all WRAMC properties.

4. GENERAL.

4.1 Locations. The WRAMC comprises three geographically separate areas: the Forest Glen Annex, Glen Haven Annex, and the Main Post (Figure 1). Forest Glen Annex had the largest number of monitoring wells sampled during this study and will be discussed in greatest detail. Forest Glen Annex is located in Montgomery County, approximately 1/2 mile north of Washington, D.C., near the town of Silver Spring, Maryland. Glen Haven Annex is located approximately 1.5 miles northeast of Forest Glen Annex, also in Montgomery County. The Main Post is located approximately 2 miles to the southeast of Forest Glen Annex in the District of Columbia (reference 1).

4.2 Mission. The WRAMC is a world-renown medical center with over 50 different speciality and subspeciality clinics, top-ranked academic professionals, cardiovascular care, neurosurgery, and organ transplantation capability. The WRAMC is under the North Atlantic Regional Medical Command, a major subordinate command of the U.S. Army Medical Command (MEDCOM). The Main Post contains the hospital and the major research and teaching facilities; Forest Glen Annex is an auxiliary service, support and research area; and Glen Haven Annex contains family housing for enlisted military personnel assigned to the WRAMC (reference 2).



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ABERDEEN PROVING GROUND, MARYLAND

FIGURE 1.
LOCATION MAP OF
WALTER REED ARMY MEDICAL CENTER.

DRAWN BY:	PROJ #:	FILE:
GCL	38-MA-2190-00	MD/W-REED/2190FIG1

4.3 Project Personnel. This investigation was conducted by the following personnel from the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM): Mr. William Smithson, Section Chief, Engineering Services; Mr. Richard Kestner, Senior Engineering Technician; Mr. Robert Desocio, Engineering Technician; Mr. Rocky Hoover, Engineering Technician; and Mr. Brian Hammond, Geologist. Mr. Smithson and Mr. DeSocio conducted a physical inspection of each well that included a down-hole video survey. A discussion of this physical inspection is included in a separate report.

5. ENVIRONMENTAL SETTING. The following information briefly describes the physical and environmental setting of the area of investigation.

5.1 Physiography. Montgomery County is located on the eastern edge of the Piedmont physiographic province, which is characterized by varied topography that ranges from lowlands to peaks and ridges of moderate elevation and relief (reference 3). Rolling hills are predominant in the three study areas; these landforms slope in a westerly direction, towards the Rock Creek drainage system.

5.2 Geology. The lithology of the region consists of a thin mantle of soils overlying a layer of saprolite, which overlies a metamorphic rock unit. Saprolite is a general geologic term for a soft, earthy, clay-rich thoroughly decomposed rock, formed in place by chemical weathering of igneous, sedimentary, or metamorphic rocks. Saprolite is characterized by preservation of structures that were present in the unweathered rock. In the areas of investigation, saprolite exhibits foliation characteristic of the metamorphic gneiss and schist that underlie this layer. Gneiss is a rock in which bands of granular minerals alternate with bands of micaceous minerals having a subparallel to parallel orientation. Schist is a strongly foliated metamorphic rock with well-developed parallelism of more than 50 percent of the minerals present.

5.3 Hydrogeology. Although metamorphic bedrock in the areas of investigation does not serve as an aquifer, a thick wedge of coastal sediments lies approximately 10 to 20 miles to the south and east, forming the Potomac Aquifer. This aquifer underlies the North Atlantic Coastal Plain and consists of the Patuxent, Patapsco, and Magothy Aquifers in the Delaware and Maryland vicinity. A confining unit of clay and sandy clay overlies the aquifer in most of this region. The areas of investigation are located within the recharge area of the Patuxent Aquifer (Figure 2; references 1, 2, and 3).

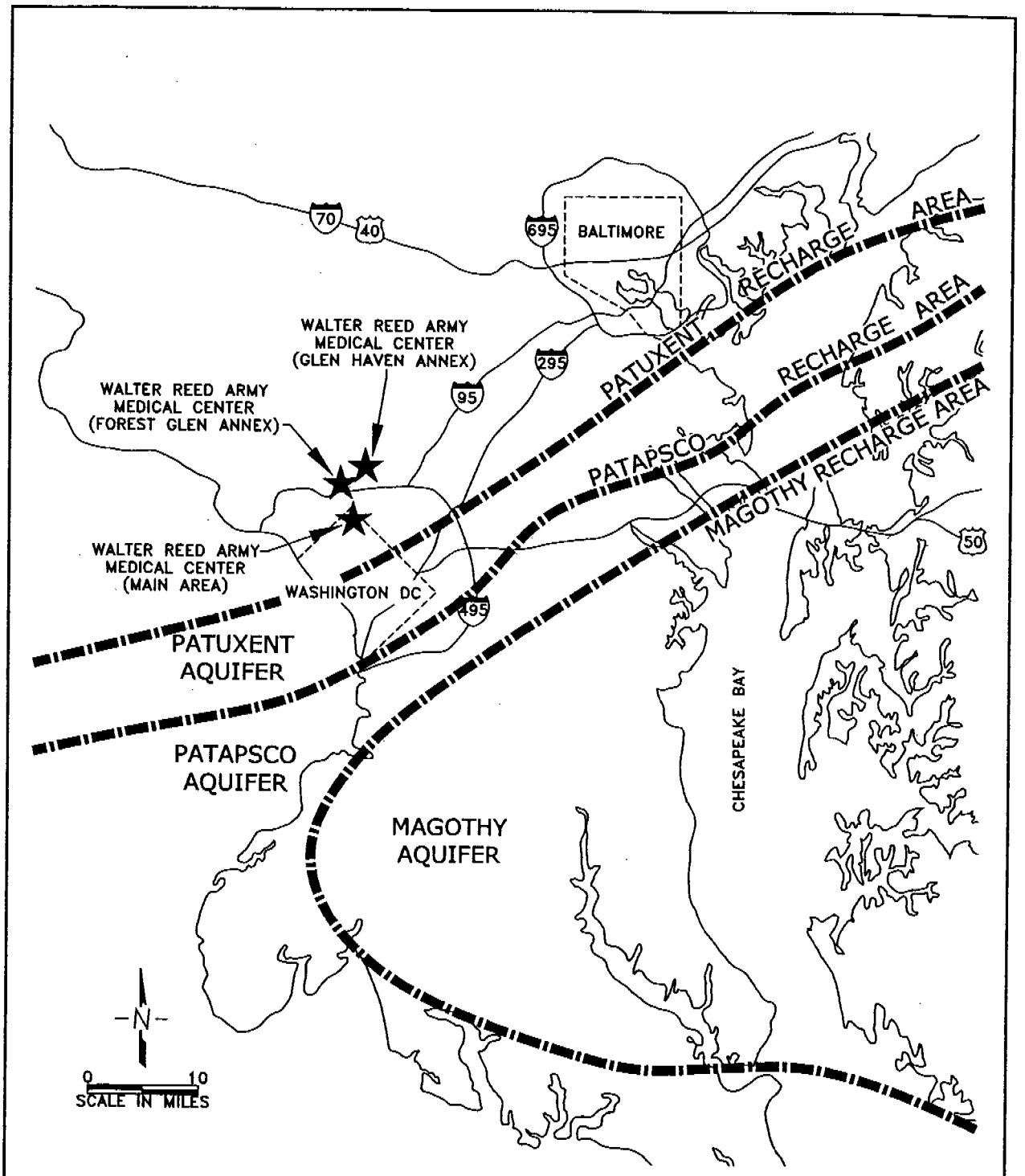

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FIGURE 2.
MAP SHOWING LOCATIONS OF AQUIFER RECHARGE AREAS NEAR WALTER REED ARMY MEDICAL CENTER.

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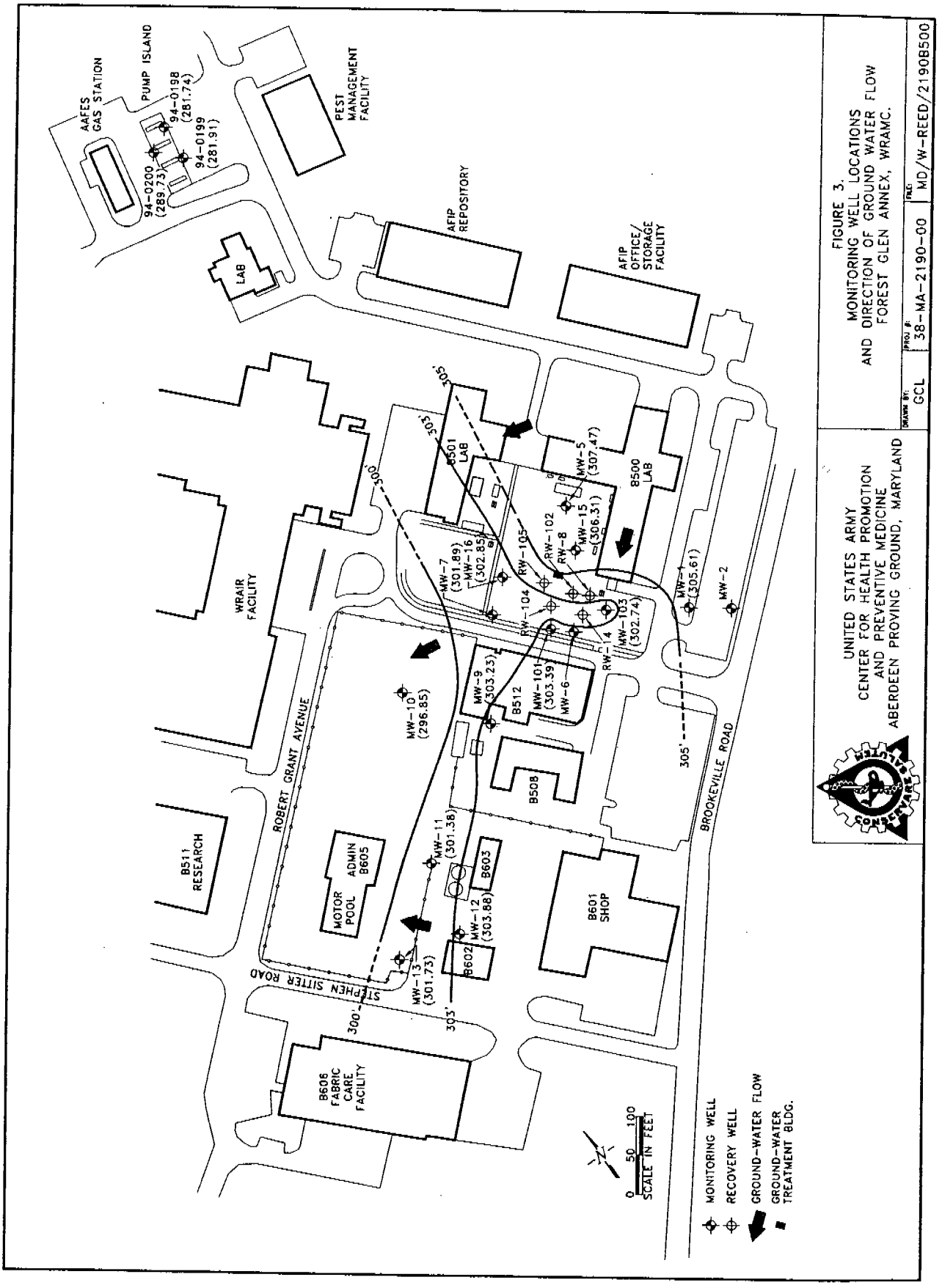
6. BACKGROUND AND PREVIOUS INVESTIGATIONS.

6.1 Forest Glen Annex. Background information was provided by WRAMC personnel (and additional information was available in USACHPPM archives) for the area near Bldg. 500 (historic fuel spill), but not for the two fuel points at the Forest Glen Annex (Bldgs. 602 and 164).

6.1.1 In May 1988, a thin film of oil was observed floating on ground water in an excavation located approximately 25 feet west of the north corner of Bldg. 512 (the Post Motor Pool). At this time, there were 14 underground storage tanks (USTs) containing fuel oil in the immediate vicinity of Bldgs. 500 and 512 (reference 4). WRAMC environmental staff notes dated September 1988 (author unknown) indicate tightness testing was conducted in June 1988 and that a 50,000-gallon UST located near Bldg. 500 and containing No. 2 fuel oil failed the tightness test. In June 1989, 10 ground-water monitoring wells were installed by this Center [formerly the U.S. Army Environmental Health Agency (USAEHA)] in the area surrounding Bldgs. 500 and 512. A sheen of oil was noted on the water surface in monitoring wells MW-1, MW-5, MW-6, MW-7, and MW-8. Ground-water contamination was determined to be minimal at the time, and tightness testing of all USTs in the area was recommended (reference 1).

6.1.2 In December 1992, a 12,000-gallon UST located near Bldg. 500 and containing No. 2 fuel oil was removed. Free-phase petroleum product (hereinafter referred to as "free product") was observed in the excavation and 4 feet of free-product was measured in MW-6 and MW-8. A total of 5,000 gallons of free-product were pumped from the excavation on 3 and 4 December 1992 (reference 5). Ten additional ground-water monitoring wells were installed in December 1992 and February 1993. Locations of remaining monitoring wells are illustrated in Figure 3. Two 50,000-gallon USTs located near Bldg. 500 were removed in January 1993 (reference 2). Mr. Robert Day, regional inspector for the State of Maryland Department of the Environment also reported during this time period that a UST in the Bldg. 500 area had been improperly abandoned (reference 6). In May 1993, an extensive search was conducted for this UST. An area near the southwest corner of Bldg. 500 was excavated and a metal detector was used to search another area west of the building. Neither effort produced evidence of a UST. Blueprints were located that indicate that the UST was removed under a contract dated July 1977 (reference 7).

6.1.3 A daily free-product bailing program was initiated in November 1993. A total of 5.69 gallons of free-product were removed in November, 1.38 gallons were removed in December, and 1.14 gallons were removed in January 1994 from MW-6, MW-8, MW-15, MW-102, and MW-104 (reference 8). A ground-water pump-and-treat system was installed in March 1994, incorporating MW-102, MW-104 (renamed RW-102 and RW-104) and a new well (RW-105) serving as recovery wells. A total of 26 gallons of free-product was removed


AAFES GAS STATION
PUMP ISLAND
94-0198 (281.74)
94-0199 (281.91)
94-0200 (289.73)
PEST MANAGEMENT FACILITY
AFIP REPOSITORY
AFIP OFFICE/ STORAGE FACILITY
LAB
B501 LAB
B500 LAB
WRAIR FACILITY
MW-7 (301.89)
MW-16 (302.85)
MW-5 (307.47)
MW-15 (306.31)
RW-102
RW-8
RW-105
RW-104
RW-103
RW-14
MW-103 (302.74)
MW-1 (305.61)
MW-2
MW-9 (303.23)
B512
MW-101 (303.39)
MW-6
MW-10 (296.85)
B508
ROBERT GRANT AVENUE
BROOKEVILLE ROAD
B511 RESEARCH
ADMIN B605
MOTOR POOL
MW-11 (301.38)
B603
MW-12 (303.88)
B602
MW-13 (301.73)
STEPHEN SITTER ROAD
B601 SHOP
B606 FABRIC CARE FACILITY
300'
303'
305'
0 50 100
SCALE IN FEET
MONITORING WELL
RECOVERY WELL
GROUND-WATER FLOW
GROUND-WATER TREATMENT BLDG.
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ABERDEEN PROVING GROUND, MARYLAND
FIGURE 3.
MONITORING WELL LOCATIONS
AND DIRECTION OF GROUND WATER FLOW
FOREST GLEN ANNEX, WRAMC.
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PROJ #: 38-MA-2190-00
FILE: MD/W-REED/2190B500

during March through September 1994, and 20 gallons were removed in March through June 1995 (references 9 and 10). Although free-product recovery information could not be obtained for the period July 1995 through 1999, WRAMC environmental staff reported that free-product recovery had decreased to less than a gallon per month (reference 11).

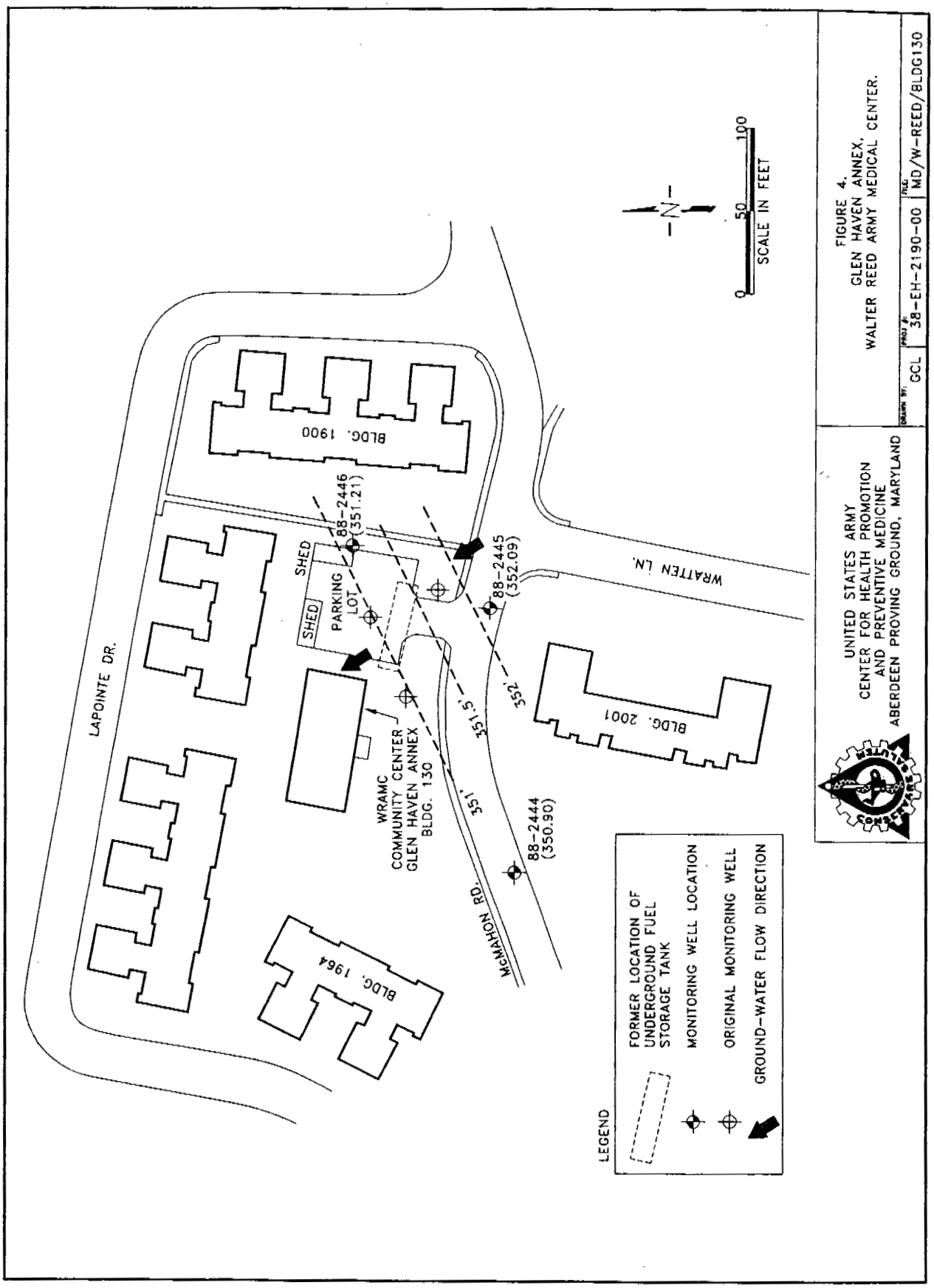
6.1.4 From 1989 to 1998, MW-8 contained substantial quantities of free-product. The maximum quantities of free-product recorded in 1994, 1995, and 1996 were 0.92 feet, 2.04 feet, and 0.76 feet, respectively (references 12 and 13). Although a system operations report indicated that no free-product recovery was achieved during the month of February 1998, 1.19 feet of free-product was measured in MW-8 on 24 February 1998 (reference 14). MW-8 and MW-14 were converted into recovery wells in 1998 and renamed RW-8 and RW-14, respectively. Quarterly monitoring conducted in July 2000 indicated that the ground-water pump-and-treat system near Bldg 500 treated 39,270 gallons of water, but recovered no free-product (reference 15). However, 0.10 foot of free-product was measured in RW-8 and 0.01 foot in RW-14. A sheen of free-product was also present in MW-15, MW-101 and MW-103 (reference 15).

6.2 Glen Haven Annex.

6.2.1 The present housing units at Glen Haven Annex were built in the mid-1970s. A 30,000-gallon UST with associated pump house and underground fuel distribution system provided fuel to the apartment furnaces. By 1979-80, the underground piping had corroded and began leaking No. 2 heating oil. Attempts to repair the system failed. The system was abandoned and a natural gas system installed (reference 16).

6.2.2 In August 1989, No. 2 fuel and water were observed flowing from a manhole located 360 feet to the west of the UST. The UST was thought to be the source of this fuel. In January 1990, three monitoring wells were installed around the UST. Soil samples were collected during the installation of the monitoring wells and analyzed for total petroleum hydrocarbons (TPH) and naphthalene. Ground-water samples were collected after monitoring well construction and analyzed for the same constituents. The approximate location of this UST and original monitoring wells are shown on Figure 4. Analytical results for both soil and ground water were below method detection limits (reference 16).

6.2.3 In 1994, the UST and adjacent monitoring wells were removed by a contractor and three new monitoring wells installed. This was apparently due to the construction of a new parking lot and community center at that location. A report documenting this activity could not be located. Figure 4 also shows the locations of these new monitoring wells.


LAPOINTE DR.
BLDG. 1900
BLDG. 1964
BLDG. 2001
SHED
SHED
PARKING LOT
WRATTEN LN.
McMAHON RD.
WRAMC COMMUNITY CENTER GLEN HAVEN ANNEX BLDG. 130
88-2446 (351.21)
88-2445 (352.09)
88-2444 (350.90)
351'
351.5'
352'
-N-
0
50
100
SCALE IN FEET
LEGEND
FORMER LOCATION OF UNDERGROUND FUEL STORAGE TANK
MONITORING WELL LOCATION
ORIGINAL MONITORING WELL
GROUND-WATER FLOW DIRECTION
UNITED STATES ARMY
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AND PREVENTIVE MEDICINE
ABERDEEN PROVING GROUND, MARYLAND
FIGURE 4.
GLEN HAVEN ANNEX,
WALTER REED ARMY MEDICAL CENTER.
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PROJ #: 38-EH-2190-00
FILE: MD/W-REED/BLDG130

6.3 Main Post.

6.3.1 The WRAMC Main Post is located in Washington, D.C, between 16th Street, Georgia Avenue NW, Aspen Street, Fern Street, and Alaska Avenue NW. The New Garage Polychlorinated Biphenyl (PCB) Site is located along the northern WRAMC boundary, near the intersection of Fern Street and 13th Place (Figure 5). The site is located approximately 70 feet north of the Rumbaugh Parking Garage, a four-level concrete structure known informally as the "New Garage" (reference 17).

6.3.2 In 1961, a subsurface transformer vault, measuring 6.25 feet x 19.25 feet x 11.5 feet deep was installed at the site. The transformer and vault were removed in 1992 during the construction of the Rumbaugh Parking Garage. At that time, the vault material (concrete) was sampled and determined to contain levels of PCBs that required disposal as a regulated PCB waste. Soil contamination was identified and subsequently excavated, resulting in an excavation 23 feet deep. Although PCBs were again identified at the bottom of the excavation, the WRAMC petitioned the U.S. Environmental Protection Agency (EPA) to allow backfilling of the excavation. This request was granted by the EPA (reference 17).

6.3.3 Four monitoring wells were installed in 1996. Split-spoon, composite soil and drill cuttings samples were collected for TPH and PCB analyses to determine if there had been any detectable contaminant migration away from the former vault area. One soil sample had a detectable concentration of PCBs (1.18 ug/g of Aroclor-1260®). All other soil samples had PCB concentrations less than 0.10 ug/g. Concentrations of TPH were found in six of eight soil samples at concentrations ranging from 11 to 32 mg/kg. Ground-water samples from the four monitoring wells were also analyzed for TPHs and PCBs. All ground-water analyses for PCBs were below the method detection limit of 0.50 ug/L. TPH were detected in two down gradient monitoring wells, RUM-2 and RUM-3, at concentrations of 0.35 and 0.26 mg/L, respectively. A complete discussion of the results is included in reference 17.

7. PROCEDURES.

7.1 Ground-Water Sample Collection Procedures.

7.1.1 Water levels were measured in each monitoring well at the site with a battery-operated water level indicator. The water level indicator probe was lowered into the well and used to measure the depth to water from the top of the well casing and the total depth

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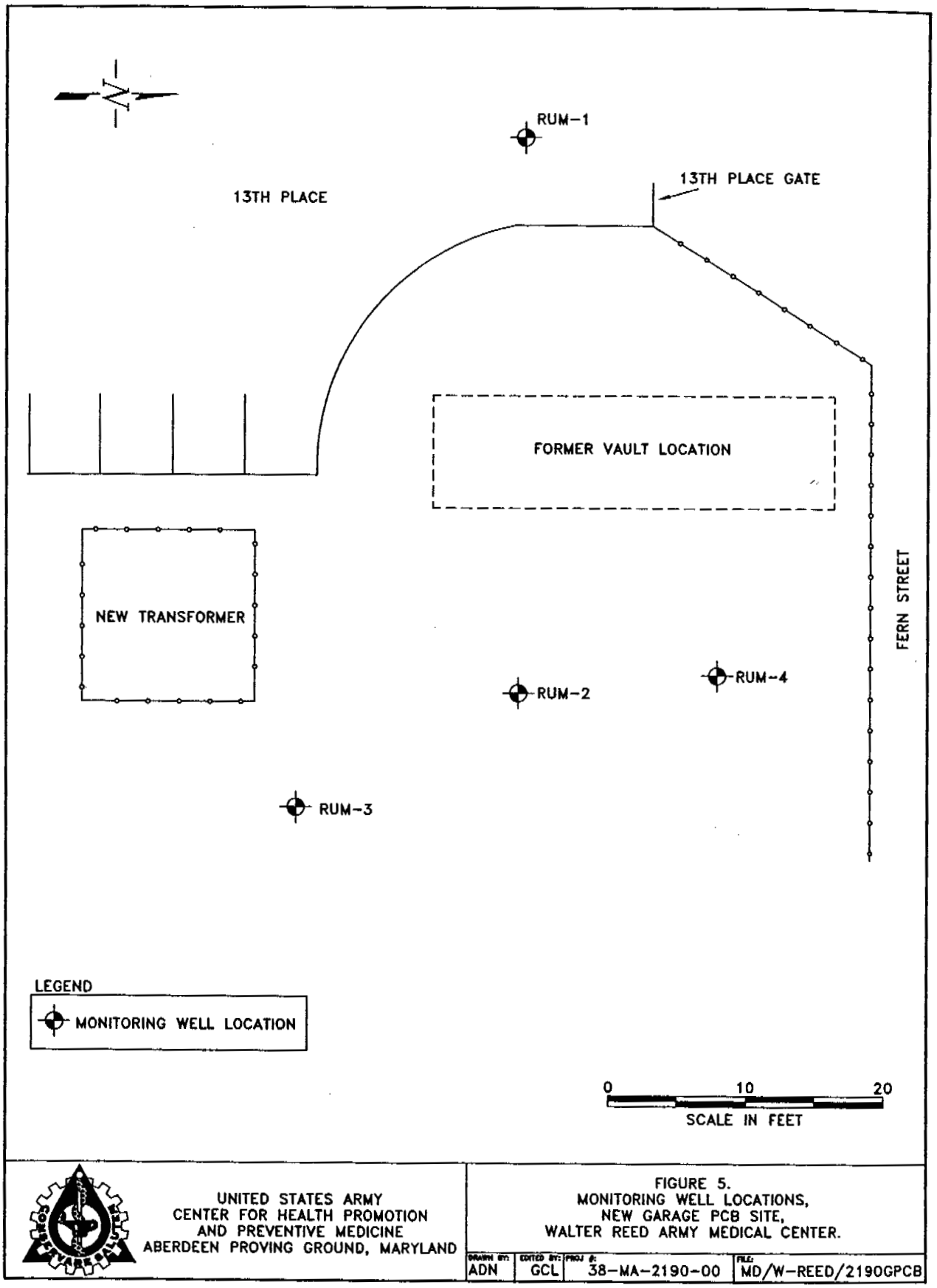

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FIGURE 5.
MONITORING WELL LOCATIONS,
NEW GARAGE PCB SITE,
WALTER REED ARMY MEDICAL CENTER.

DRAWN BY:	EDITED BY:	PROJ #:	FILE:
ADN	GCL	38-MA-2190-00	MD/W-REED/2190GPCB

of water in the well. Samples were collected following "low flow" purging of the wells. This technique has become widely accepted because it reduces the turbidity of ground-water samples and collects samples that are representative of conditions in the surrounding aquifer.

7.1.2 Low flow sampling and purging was conducted with a small, disposable, electric impeller pump and tubing. At each monitoring well, the pump and tubing were lowered to the approximate midpoint in the screened interval of the well. Water was pumped out at approximately 0.5 liters per minute into a container where temperature, conductivity, and pH were measured at 2-minute intervals. When the readings had stabilized (defined as three successive readings that were within 10 percent), water samples were collected. Ground-water samples were placed in sample containers and preserved in accordance with respective EPA methods. The samples were stored at 4 degrees Celsius and transported to the USACHPPM laboratory for chemical analysis.

7.2 Analytical Parameters.

7.2.1 Laboratory Analyses. Ground water from each well was analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, PCBs, and metals. A complete list of the individual analytes, analytical methods, and method detection limits are shown in Table B-1, Appendix B. As noted in the data tables contained in Appendix B and in the paragraphs below (FINDINGS AND DISCUSSION section), the laboratory reported estimated concentrations of VOCs and SVOCs that were below method reporting limits. These instances are noted on the data tables and in the laboratory reports with "J" qualifiers. The compounds were analyzed for and positively identified, but the associated numerical values are estimated quantities. The laboratory is able to positively identify the compounds by matching their mass spectra with the known signature spectra of compounds. The quantities are estimates because the concentrations of the compounds detected were below the calibration standards used in analyzing samples according to EPA methods 8260 (VOCs) and 8270 (SVOCs). Enclosure 1 contains individual laboratory analysis data sheets for all analytical work.

7.2.2 Field Measurements. Conductivity, temperature, pH, and depth to water (from top of casing) were measured on site at each monitoring well and are shown in Table B-2, Appendix B. Additionally, the elevation was resurveyed for the top of casing at each well on Forest Glen Annex and Glen Haven Annex. This information is also shown on Table B-2, Appendix B.

7.3 Regulatory Guidance. The State of Maryland and the District of Columbia have not promulgated cleanup standards for contaminated ground water (reference 18). All decisions on "how to clean" are made via site-specific risk characterization if concentrations of a contaminant are greater than "background." Analytical results are compared to the National

Primary Drinking Water Regulations maximum contaminant levels (MCLs; reference 19) and to the National Secondary Drinking Water Regulations MCLs, hereinafter referred to as SMCLs (reference 19). MCLs and SMCLs are defined as the maximum permissible level of a contaminant in water delivered to users of a public water system. If a contaminant concentration is greater than background, but less than the respective MCL or SMCL, it is not likely to pose a human health threat through consumption of ground water. However, consultation with local regulatory authorities may be necessary to determine if follow-on actions are required.

8. FINDINGS AND DISCUSSION.

8.1 Forest Glen Annex.

8.1.1 Bldg. 500. Sixteen wells have been installed near Bldg. 500. Five wells have been incorporated into a "free-product" recovery system (RW-8, RW-14, RW-102, RW-104, and RW-105). These wells have historically contained free-product and are monitored quarterly by ENSAT Corp. (reference 14), who maintains the system. This system was not dismantled and the individual recovery wells were not sampled during this monitoring event. Collecting samples from wells with free-product contaminates equipment, damages sensitive laboratory instruments, and produces difficult to interpret data (because oil-water emulsions can be formed during disturbance of the water in the well). MW-6 could not be located. It may have been damaged/destroyed by construction activities in the area. The 10 wells that were sampled near Bldg. 500 are as follows: MW-1, MW-2, MW-5, MW-7, MW-9, MW-10, MW-15, MW-16, MW-101 and MW-103. The results from these 10 wells are discussed below.

8.1.1.1 Water Quality Paramenters and Field Observations.

8.1.1.1.1 Ground-Water Flow. A ground-water potentiometric map was produced from the field data and is shown on Figure 3. This map indicates that ground-water flow is generally west across the site, with the exception of the area near the free-product recovery system. The ground water in that area appears to flow toward the recovery wells-indicating that removal of ground water has successfully reduced ground-water flow to the west (away from the site).

8.1.1.1.2 Electrical Conductivity. The electrical conductivity ranged from 178 uS/cm in monitoring well MW-9 to 1,898 uS/cm in MW-2. Empirical data has shown that there is a strong correlation between electrical conductivity and the amount of total dissolved solids (TDS) in water (reference 20). For most ground waters, the electrical conductivity multiplied by a factor of 0.55 to 0.75 gives a reasonable estimate of the dissolved solids

(reference 20). Using the more conservative factor (0.75) the estimated TDS ranged from 133 to 1424 mg/L, with eight wells having calculated TDS concentrations greater than the EPA SMCL of 500 mg/L (Table B-2, Appendix B).

8.1.1.1.3 pH. The pH ranged from a low of 5.5 to a high of 7.0. Seven wells had a pH that was less than the EPA SMCL of 6.5 (Table B-2, Appendix B). Most ground waters have pH values that range from 6.0 to 8.5 (reference 20). Therefore, the pH in ground water at Bldg. 500 should not be considered unusual.

8.1.1.2 VOCs. Low concentrations of VOCs were observed in several wells. These results are shown in Table B-3, Appendix B. All VOC concentrations were substantially less than EPA MCLs. Five individual VOCs were detected in MW-15, three in MW-101, and a maximum of two compounds in the rest of the wells.

8.1.1.3 SVOCs. Low concentrations of SVOCs were observed in several wells. These results are shown in Table B-4, Appendix B. All SVOC concentrations were substantially less than EPA MCLs. Again, MW-15 had the most number of individual compounds (five), followed by MW-103 (three). None of the remaining wells had more than one SVOC detected.

8.1.1.4 Metals. Several metals were detected at concentrations greater than their respective method detection limits (MDLs). The results are shown in Table B-5, Appendix B. All metal concentrations were less than EPA MCLs.

8.1.1.5 Pesticides and PCBs. Alpha-chlordane was detected in MW-9 at a concentration of 0.0600 ug/L, which is less than the 2 ug/L EPA MCL for "technical Chlordane." Although this MCL is not directly applicable because technical Chlordane is a mixture of many individual Chlordanes (alpha, gamma, etc.), it is useful for evaluating the data. No other pesticides or PCBs were detected at concentrations greater than the MDLs shown in Table B-1, Appendix B.

8.1.2 Bldg. 602 (Fuel Point; MW-11, MW-12, MW-13).

8.1.2.1 Water Quality Paramenters and Field Observations.

8.1.2.1.1 Ground-Water Flow. A ground-water potentiometric map was produced from the field data and is shown on Figure 3. This map indicates that ground-water flow is generally northwest across the site.

8.1.2.1.2 Electrical Conductivity. The electrical conductivity ranged from 340 uS/cm in MW-13 to 702 uS/cm in MW-11. The calculated TDS concentrations ranged from 255 mg/L in MW-13 to 527 mg/L in MW-11. Only MW-11 had a calculated TDS concentration greater than the EPA SMCL of 500 mg/L (Table B-2, Appendix B).

8.1.2.1.3 pH. The pH ranged from a low of 5.8 to a high of 6.7. Two wells had a pH that is less than the EPA SMCL of 6.5 (Table B-2, Appendix B). Most ground waters have pH values that range from 6.0 to 8.5 (reference 20). Therefore, the pH in ground water at Bldg. 602 should not be considered unusual.

8.1.2.2 VOCs. Methyl-t-butyl-ether (MTBE) was detected at a concentration of 27,000 ug/L in MW-11. This exceeds the EPA calculated Margin of Exposure (MoE) and odor threshold for drinking water of 20 ug/L (reference 19). MTBE was not detected in MW-12 or MW-13. Benzene was detected in MW-11 and MW-12 at 6.5 ug/L and 140 ug/L, respectively. These concentrations exceed the EPA MCL of 0.2 ug/L. Numerous other fuel-related compounds were detected in MW-11 and MW-12 at concentrations less than EPA MCLs. MW-13 contained no detectible VOCs. All the detected VOCs are shown on Table B-3, Appendix B.

8.1.2.3 SVOCs. 2-Methylnaphthalene was detected at a concentration of 11 ug/L in MW-12 and 6.2 ug/L in MW-11. Naphthalene was detected at a concentration of 96 ug/L in MW-12. No EPA MCLs have been developed for these chemicals. However, naphthalene has a published health advisory relating to drinking water consumption for a 10-kg child. That advisory is at a concentration of 500 ug/L-substantially greater than the concentration detected in MW-12 (reference 20). No other SVOCs were detected. All the detected SVOCs are shown in Table B-4, Appendix B.

8.1.2.4 Metals. Several metals were detected at concentrations greater than their respective MDLs. The results are shown in Table B-5, Appendix B. Lead was detected at a concentration of 18.7 ug/L in MW-12. This exceeds the EPA drinking water limit of 15 ug/L, however, this limit applies to drinking water at the tap-not the source water (ground water). All other detected concentrations were less than published EPA MCLs and SMCLs.

8.1.2.5 Pesticides and PCBs. Aroclor-1260 was detected at a concentration of 2.73 ug/L in MW-13. This concentration is greater than the EPA MCL of 0.5 ug/L. The concentration in the duplicate sample for MW-13 was less than the detection limit of 0.5 ug/L of Aroclor-1260. Both MW-13 and MW-13-duplicate were reanalyzed using Solid Phase Microextraction (SPME) to confirm the presence of Aroclor-1260. The results were less than 0.3 ug/L for both samples. No sample analytical results were available for MW-11 because

the sample was lost during extraction. No other PCBs or pesticides were detected at concentrations greater than the MDLs shown in Table B-1, Appendix B. All detected concentrations are shown on Table B-6, Appendix B.

8.1.3 Bldg. 164 [Army and Air Force Exchange Services (AAFES) Fuel Station; 94-198, 94-199, 92-200].

8.1.3.1 Water Quality Paramenters and Field Observations.

8.1.3.1.1 Ground-Water Flow. Ground-water elevations are shown on Figure 3. Because the wells were not all installed at the same depth, an accurate potentiometric map could not be drawn to show the two-dimensional (horizontal) flow direction of the ground water. The depths of the wells are as follows: 94-198, 38.90 feet; 94-199, 34.85 feet; 94-200, 24.73 feet. The ground surface is essentially level across the fueling station (no significant elevation difference). The data displayed on Figure 3 shows that the water in well 94-200 is at an elevation of 289.73 feet and in wells 94-199 and 94-198 at 281.91 feet and 281.74 feet, respectively. It is likely that this hydraulic gradient is the "vertical" component of three-dimensional ground-water flow and not reflective of the horizontal ground-water flow direction. Because the shallow well has ground water at a higher elevation than the deeper wells the vertical gradient at the site is downward.

8.1.3.1.2 Electrical Conductivity. The electrical conductivity ranged from 519 uS/cm in monitoring well 94-198 to 1,862 uS/cm in well 94-200. The calculated TDS concentrations ranged from 389 mg/L in well 94-198 to 1,397 mg/L in well 94-200. Only well 94-200 had a calculated TDS concentration greater than the EPA SMCL of 500 mg/L (Table B-2, Appendix B).

8.1.3.1.3 pH. The pH ranged from a low of 4.9 to a high of 6.7. Two wells had a pH that is less than the EPA SMCL of 6.5 (Table B-2, Appendix B). Because the pH in the two wells was less than 5.5, this may indicate the presence of mineral acids from the underlying bedrock or the lowering of the natural pH because of the presence of contaminants (reference 20).

8.1.3.2 VOCs. MTBE was detected in all three monitoring wells at the following concentrations: 52 ug/L, 94-198; 2,600 ug/L, 94-199; 50 ug/L, 94-200. All of these concentrations exceed the EPA calculated MoE and odor threshold for drinking water of 20 ug/L. No other VOCs were detected above the MDLs shown on Table B-1, Appendix B. All detected concentrations are shown on Table B-3, Appendix B.

8.1.3.3 SVOCs. No SVOCs were detected. All MDLs were the same as shown on Table B-1, Appendix B.

8.1.3.4 Metals. Several metals were detected at concentrations greater than their respective MDLs. The results are shown in Table B-5, Appendix B. Silver was detected at a concentration of 153 ug/L in 94-200. This exceeds the EPA SDWR of 100 ug/L. All other detected concentrations were less than published EPA MCLs and SMCLs.

8.1.3.5 Pesticides and PCBs. No pesticides or PCBs were detected. All MDLs were the same as shown on Table B-1, Appendix B.

8.2 Glen Haven Annex.

8.2.1 Water Quality Paramenters and Field Observations.

8.2.1.1 Ground-Water Flow. The ground-water flow was determined to be in a northwest direction based on the elevations of water in the three monitoring wells measured during this monitoring episode. This flow direction is shown on Figure 4. The positions of the monitoring wells are not reliable for determining if contamination is emanating from the former UST location because none are hydraulically down gradient from the site. However, analytical results of samples previously collected from the original wells, which were located much closer to the former UST (and two were down gradient), were all less than the MDLs for TPH and naphthalene (reference 17). Therefore, there is no reason to suspect that the former UST location is a source of contamination.

8.2.1.2 Electrical Conductivity. The electrical conductivity ranged from 170 uS/cm in monitoring well 88-2444 to 751 uS/cm in well 88-2445. The calculated TDS concentrations ranged from 128 mg/L in well 88-2444 to 563 mg/L in well 88-2445. Only well 88-2445 had a calculated TDS concentration greater than the EPA SMCL of 500 mg/L (Table B-2, Appendix B).

8.2.1.3 pH. The pH ranged from a low of 5.0 to a high of 5.1. All three wells had a pH that is less than the EPA SMCL of 6.5 (Table B-2, Appendix B). Because the pH in the three wells was less than 5.5, this may indicate the presence of mineral acids from the underlying bedrock or the lowering of the natural pH because of the presence of contaminants (reference 20).

8.2.2 VOCs. No VOCs were detected at concentrations greater than the MDLs shown on Table B-1, Appendix B. Three VOCs were detected at concentrations less than the MDLs: 1,2,4-trimethylbenzene (1.3 ug/L) and naphthalene (1.2 ug/L) in well 88-2446, and trichlorofluoromethane (1.2 ug/L) in well 88-2445. No EPA MCLs have been developed for these chemicals. However, naphthalene has a published health advisory relating to drinking

water consumption for a 10-kg child. That advisory is at a concentration of 500 ug/L- substantially greater than the concentration detected in well 88-2446 (reference 19). No other VOCs were detected. All detected concentrations are shown on Table B-3, Appendix B.

8.2.3 SVOCs. No SVOCs were detected. All MDLs were the same as shown on Table B-1, Appendix B.

8.2.4 Metals. Several metals were detected at concentrations greater than their respective MDLs. The results are shown in Table B-5, Appendix B. All detected concentrations were less than published EPA MCLs and SMCLs.

8.2.5 Pesticides and PCBs. Aroclor-1260 was detected at a concentration of 1.10 ug/L in well 88-2444. This concentration is greater than the EPA MCL of 0.5 ug/L. The sample was re-analyzed using SPME to confirm the presence of Aroclor-1260. The results were less than 0.3 ug/L. No other PCBs or pesticides were detected at concentrations greater than the MDLs shown in Table B-1, Appendix B. All detected concentrations are shown on Table B-6, Appendix B.

8.3 Main Post.

8.3.1 Water Quality Paramenters and Field Observations.

8.3.1.1 Ground-Water Flow. The elevations of the monitoring well casings were not surveyed during this field event because a reliable benchmark could not be located. The water levels were measured and ground-water elevations determined in 1996 (reference 17). Based on these observations, the ground-water flow direction is to the southeast (i.e., from the former transformer vault toward wells RUM-2 and RUM-3).

8.3.1.2 Electrical Conductivity. The electrical conductivity ranged from 923 uS/cm in monitoring well RUM-4 to 2005 uS/cm in well RUM-1. The calculated TDS concentrations ranged from 692 mg/L in well RUM-4 to 1,504 mg/L in well RUM-1. All four wells had calculated TDS concentrations greater than the EPA SMCL of 500 mg/L (Table B-2, Appendix B).

8.3.1.3 pH. The pH ranged from a low of 4.0 to a high of 5.0. All four wells had a pH that is less than the EPA SMCL of 6.5 (Table B-2, Appendix B). Because the pH in the four wells was substantially less than 5.5, this may indicate the presence of mineral acids from the underlying bedrock or the lowering of the natural pH because of the presence of contaminants (reference 20).

8.3.2 VOCs. No VOCs were detected. All MDLs were the same as shown on Table B-1, Appendix B.

8.3.3 SVOCs. No SVOCs were detected at concentrations greater than the MDLs shown on Table B-1, Appendix B. One SVOC [bis(2-Ethylhexyl)phthalate] was detected at a concentration of 7.2 ug/L in monitoring well RUM-2. This concentration is less than the MDL of 10 ug/L. No EPA drinking water standards or health advisories are available for this chemical (reference 19).

8.3.4 Metals. Several metals were detected at concentrations greater than their respective MDLs. The results are shown in Table B-5, Appendix B. All detected concentrations were less than published EPA MCLs and SMCLs.

8.3.5 Pesticides and PCBs. Aroclor-1260 was detected at a concentration of 0.880 ug/L in monitoring well RUM-2 and at 1.10 ug/L in RUM-3. The duplicate for RUM-3 contained Aroclor-1260 at a concentration of 0.920 ug/L. These concentrations are greater than the EPA MCL of 0.5 ug/L. These samples were re-analyzed using SPME to confirm the presence of Aroclor-1260. The presence of Aroclor-1260 was confirmed in samples from both wells. Analytical data is shown on Table B-6, Appendix B. These results represent an increase in the PCB concentration from the monitoring event conducted in 1996, when PCBs were not detected at concentrations greater than 0.50 ug/L. No other PCBs or pesticides were detected at concentrations greater than the MDLs shown in Table B-1, Appendix B.

9. CONCLUSIONS.

9.1 Forest Glen Annex.

9.1.1 Bldg. 500. Fuel contamination is being actively remediated using a ground-water pump-and-treat system operated by a contractor. The contractor prepares quarterly reports that indicate the continuing presence of small quantities of free-product in two monitoring wells (that have been incorporated into the pump-and-treat system). This study clearly demonstrates that the observed free-product has not migrated to surrounding wells (i.e., it has been contained by the remediation efforts).

9.1.2 Bldg. 602 (fuel point). Petroleum contamination is evident in two of the three monitoring wells at the site. The MTBE concentration is substantially greater than the EPA advisory limit for drinking water in MW-11, and benzene concentrations exceed EPA MCLs in MW-11 and MW-12. The detected concentrations of all other petroleum compounds are less than EPA thresholds; however, the presence of so many petroleum compounds may

indicate subsurface leakage from the petroleum USTs and/or associated piping at this facility, or they may indicate surface spillage of petroleum products, or a combination of both leakage and spillage.

9.1.3 Bldg. 164 (AAFES fuel station). MTBE contamination was evident in all three monitoring wells at concentrations greater than EPA advisory limits for drinking water. No other petroleum compounds were present. This contamination pattern may indicate surface petroleum spillage from handling of gasoline because all the wells are located in an area where gasoline is handled (fueling island) and MTBE disperses faster than other petroleum compounds in ground water. If a sustained gasoline leak were causing this contamination, it is likely that other gasoline hydrocarbons would be detected.

9.2 Glen Haven Annex. No significant contamination was observed in any of the three monitoring wells.

9.3 Main Post. Aroclor-1260 was detected in two monitoring wells located hydraulically down gradient from a former transformer vault, located near the Rumbaugh Parking Garage. These low PCB concentrations may indicate that PCB contamination remains at the former transformer location and that small quantities of this material are dispersing into the ground water.

10. RECOMMENDATIONS.

10.1 Bldg. 500. Continue free-product remediation efforts using the ground-water pump-and-treat system currently in place, as long as it produces effective results (i.e., it actually removes quantities of free-product). When this system no longer removes free-product, consider an alternate remedial action that is compatible with the limited amounts of petroleum products remaining at the site. Monitored natural attenuation may be an acceptable course of action at that time.

10.2 Bldg. 602 (fuel point). Conduct a follow-on investigation to determine the source of MTBE and other fuel-related hydrocarbons in the ground water near this facility.

10.3 Bldg. 164 (AAFES fuel station). Conduct a follow-on investigation to determine the source of MTBE in the ground water near this facility.

10.4 Glen Haven Annex. Conduct a follow-up round of ground-water sampling. If this round of sampling also comes up negative for contaminants, consider properly closing the monitoring wells.

10.5 Main Post. Conduct a follow-up round of ground-water sampling to confirm the presence of Aroclor-1260 in the monitoring wells located near the Rumbaugh Parking Garage.

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APPENDIX A

REFERENCES

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APPENDIX B

TABLES

Table B-1: List of VOCs Analyzed in Ground-Water Samples.

PARAMETERS	UNITS	MDL	METHOD	PARAMETERS	UNITS	MDL	METHOD
Volatile Organic Compounds				**Volatile Organic Compounds**			
dichlorodifluormethane	ug/L	2.0	8260	4-methyl-2-pentanone	ug/L	20	8260
chloromethane	ug/L	2.0	8260	toluene	ug/L	2.0	8260
vinyl chloride	ug/L	2.0	8260	trans-1,3-dichloropropene	ug/L	2.0	8260
bromomethane	ug/L	2.0	8260	1,1,2-trichloroethane	ug/L	2.0	8260
chloroethane	ug/L	2.0	8260	ethyl methacrylate	ug/L	20	8260
trichlorofluoromethane	ug/L	2.0	8260	tetrachloroethene	ug/L	2.0	8260
ethyl ether	ug/L	20	8260	1,3-dichloropropane	ug/L	2.0	8260
iodomethane	ug/L	20	8260	2-hexanone	ug/L	20	8260
carbon disulfide	ug/L	20	8260	dibromochloromethane	ug/L	2.0	8260
acetone	ug/L	20	8260	1,2-dibromoethane	ug/L	2.0	8260
1,1-dichloroethene	ug/L	2.0	8260	chlorobenzene	ug/L	2.0	8260
allyl chloride	ug/L	20	8260	1,1,1,2-tetrachloroethane	ug/L	2.0	8260
methylene chloride	ug/L	2.0	8260	ethylbenzene	ug/L	2.0	8260
acrylonitrile	ug/L	20	8260	m/p-xylene	ug/L	2.0	8260
methyl-t-butyl ether	ug/L	20	8260	o-xylene	ug/L	2.0	8260
trans-1,2-dichloroethene	ug/L	2.0	8260	styrene	ug/L	2.0	8260
1,1-dichloroethane	ug/L	2.0	8260	bromoform	ug/L	2.0	8260
2,2-dichloropropane	ug/L	2.0	8260	isopropylbenzene	ug/L	2.0	8260
cis-1,2-dichloroethene	ug/L	2.0	8260	bromobenzene	ug/L	2.0	8260
2-butanone	ug/L	20	8260	1,1,2,2-tetrachloroethane	ug/L	2.0	8260
propionitrile	ug/L	20	8260	1,2,3-trichloropropane	ug/L	2.0	8260
methyl acrylate	ug/L	20	8260	trans-1,4-dichloro-2-butene	ug/L	20	8260
methacrylonitrile	ug/L	20	8260	n-propylbenzene	ug/L	2.0	8260
tetrahydrofuran	ug/L	20	8260	2-chlorotoluene	ug/L	2.0	8260
bromochloromethane	ug/L	2.0	8260	4-chlorotoluene	ug/L	2.0	8260
chloroform	ug/L	2.0	8260	1,3,5-trimethylbenzene	ug/L	2.0	8260
1,1,1-trichloroethane	ug/L	2.0	8260	tert-butylbenzene	ug/L	2.0	8260
carbon tetrachloride	ug/L	2.0	8260	pentachloroethane	ug/L	20	8260
1,1-dichloropropene	ug/L	2.0	8260	1,2,4-trimethylbenzene	ug/L	2.0	8260
1-chlorobutane	ug/L	20	8260	sec-butylbenzene	ug/L	2.0	8260
benzene	ug/L	2.0	8260	1,3-dichlorobenzene	ug/L	2.0	8260
1,2-dichloroethane	ug/L	2.0	8260	4-isopropyltoluene	ug/L	2.0	8260
trichloroethene	ug/L	2.0	8260	1,4-dichlorobenzene	ug/L	2.0	8260
1,2-dichloropropane	ug/L	2.0	8260	1,2-dichlorobenzene	ug/L	2.0	8260
dibromomethane	ug/L	2.0	8260	n-butylbenzene	ug/L	2.0	8260
methyl methacrylate	ug/L	20	8260	hexachloroethane	ug/L	20	8260
bromodichloromethane	ug/L	2.0	8260	1,2-dibromo-3-chloropropane	ug/L	2.0	8260
2-nitropropane	ug/L	20	8260	1,2,4-trichlorobenzene	ug/L	2.0	8260
chloroacetonitrile	ug/L	20	8260	hexachlorobutadiene	ug/L	2.0	8260
cis-1,3-dichloropropene	ug/L	2.0	8260	naphthalene	ug/L	2.0	8260
				1,2,3-trichlorobenzene	ug/L	2.0	8260

Table B-1 Cont.: List of SVOCs Analyzed in Ground-Water Samples.

PARAMETERS	UNITS	MDL	METHOD	PARAMETERS	UNITS	MDL	METHOD
Semivolatile Organic Compounds				**Semivolatile Organic Compounds**			
N-Nitrosodimethylamine	ug/L	10	8270	2,6-Dinitrotoluene	ug/L	10	8270
bis(2-Chloroethyl)ether	ug/L	10	8270	Acenaphthene	ug/L	10	8270
Phenol	ug/L	100	8270	3-Nitroaniline	ug/L	10	8270
2-Chlorobenzene	ug/L	100	8270	2,4-Dinitrophenol	ug/L	50	8270
1,3-Dichlorobenzene	ug/L	10	8270	Dibenzofuran	ug/L	10	8270
1,4-Dichlorobenzene	ug/L	10	8270	2,4-Dinitrotoluene	ug/L	10	8270
1,2-Dichlorobenzene	ug/L	10	8270	4-Nitrophenol	ug/L	50	8270
Benzyl alcohol	ug/L	10	8270	Fluorene	ug/L	10	8270
bis(2-chloroisopropyl)ether	ug/L	10	8270	4-Chlorophenyl-phenylether	ug/L	10	8270
2-Methylphenol	ug/L	100	8270	Diethylphthalate	ug/L	10	8270
Hexachloroethane	ug/L	10	8270	4-Nitroaniline	ug/L	10	8270
N-Nitroso-di-n-propylamine	ug/L	10	8270	4,6-Dinitro-2-methylphenol	ug/L	50	8270
4-Methylphenol	ug/L	100	8270	n-Nitrosodiphenylamine	ug/L	10	8270
Nitrobenzene	ug/L	10	8270	4-Bromophenyl-phenylether	ug/L	10	8270
Isophorone	ug/L	10	8270	Hexachlorobenzene	ug/L	10	8270
2-Nitrophenol	ug/L	50	8270	Pentachlorophenol	ug/L	100	8270
2,4-Dimethylphenol	ug/L	50	8270	Phenanthrene	ug/L	10	8270
bis(2-Chloroethoxy)methane	ug/L	10	8270	Anthracene	ug/L	10	8270
2,4-Dichlorophenol	ug/L	100	8270	Di-n-butylphthalate	ug/L	10	8270
1,2,4-Trichlorobenzene	ug/L	10	8270	Fluoranthene	ug/L	10	8270
Naphthalene	ug/L	10	8270	Pyrene	ug/L	10	8270
4-Chloroaniline	ug/L	10	8270	Butylbenzylphthalate	ug/L	10	8270
Hexachlorobutadiene	ug/L	10	8270	Benzo[a]anthracene	ug/L	10	8270
4-Chloro-3-methylphenol	ug/L	50	8270	Chrysene	ug/L	10	8270
2-Methylnaphthalene	ug/L	10	8270	bis(2-Ethylhexyl)phthalate	ug/L	10	8270
Hexachlorocyclopentadiene	ug/L	10	8270	Di-n-octylphthalate	ug/L	10	8270
2,4,6-Trichlorophenol	ug/L	100	8270	Benzo[b]fluoranthene	ug/L	10	8270
2,4,5-Trichlorophenol	ug/L	100	8270	Benzo[k]fluoranthene	ug/L	10	8270
2-Chloronaphthalene	ug/L	10	8270	Benzo[a]pyrene	ug/L	10	8270
2-Nitroaniline	ug/L	10	8270	Indeno[1,2,3,-cd]pyrene	ug/L	10	8270
Acenaphthylene	ug/L	10	8270	Dibenz[a,h]anthracene	ug/L	10	8270
Dimethylphthalate	ug/L	10	8270	Benzo[g,h,I]perylene	ug/L	10	8270

Table B-1 Cont.: List of Pesticides, PCBs and Metals Analyzed in Ground-Water Samples.

PARAMETERS	UNITS	MDL	METHOD	PARAMETERS	UNITS	MDL	METHOD
Pesticides				**Polychlorinated Biphenyls**			
Aldrin	ug/L	0.0500	8081A	Aroclor-1016	ug/L	0.500	8081A
alpha-BHC	ug/L	0.0500	8081A	Aroclor-1221	ug/L	0.500	8081A
alpha-Chlordane	ug/L	0.0500	8081A	Aroclor-1232	ug/L	0.500	8081A
beta-BHC	ug/L	0.0500	8081A	Aroclor-1242	ug/L	0.500	8081A
Chlordane, Technical	ug/L	0.250	8081A	Aroclor-1248	ug/L	0.500	8081A
Chlorobenzilate	ug/L	0.20	8081A	Aroclor-1254	ug/L	0.500	8081A
delta-BHC	ug/L	0.0500	8081A	Aroclor-1260	ug/L	0.500	8081A
Diallate	ug/L	0.10	8081A				
Dieldrin	ug/L	0.0500	8081A	**Metals**			
Endosulfan I	ug/L	0.050	8081A	Antimony	ug/L	5.00	6020
Endosulfan II	ug/L	0.10	8081A	Arsenic	ug/L	4.00	6020
Endosulfan sulfate	ug/L	0.050	8081A	Barium	ug/L	5.00	6020
Endrin	ug/L	0.0500	8081A	Beryllium	ug/L	2.00	6020
Endrin aldehyde	ug/L	0.20	8081A	Cadmium	ug/L	2.00	6020
Endrin ketone	ug/L	0.050	8081A	Chromium	ug/L	4.00	6020
gamma-BHC (Lindane)	ug/L	0.0500	8081A	Cobalt	ug/L	4.00	6020
gamma-Chlordane	ug/L	0.0500	8081A	Copper	ug/L	5.00	6020
Heptachlor	ug/L	0.0500	8081A	Lead	ug/L	4.00	6020
Heptachlor epoxide	ug/L	0.0500	8081A	Mercury	ug/L	0.200	7470A
Hexachlorobenzene	ug/L	0.10	8081A	Nickel	ug/L	10.0	6020
Hexachlorocyclopentadiene	ug/L	0.20	8081A	Selenium	ug/L	4.00	6020
Isodrin	ug/L	0.10	8081A	Silver	ug/L	2.00	6020
Methoxychlor	ug/L	0.500	8081A	Thallium	ug/L	4.00	6020
p,p'-DDD	ug/L	0.0500	8081A	Vanadium	ug/L	5.00	6020
p,p'-DDE	ug/L	0.0500	8081A	Zinc	ug/L	0.0500	6010B
p,p'-DDT	ug/L	0.100	8081A				
Toxaphene	ug/L	1.0	8081A				

Table B-2: Water Quality Parameters and Field Observations.

				Monitoring Wells Sampled Near Building 500, Forest Glen Annex, WRAMC									
PARAMETERS	UNITS	EPA MCL	MDL	MW-1	MW-2	MW-5	MW-7	MW-9	MW-10	MW-15	MW-16	MW-101	MW-103
Electrical Conductivity (EC)*	uS/cm			1273	1898	591	876	178	689	679	829	1101	1290
Total Dissolved Solids (TDS)***	mg/L	500**		**955**	**1424**	443	**657**	134	**517**	**509**	**622**	**826**	**968**
Temperature	Centigrade			19.4	19.5	20.2	22.5	20.8	21.3	29.0	25.2	21.4	19.7
pH	su	6.5-8.5**		7.0	**5.7**	6.7	**6.3**	**6.2**	**5.5**	**6.4**	7.0	**6.3**	**5.9**
FIELD OBSERVATIONS													
Depth to Ground Water*	feet			20.14	19.77	19.39	11.99	13.45	15.59	18.88	16.39	13.34	22.40
Total Measured Depth*	feet			20.95	27.80	26.30	18.90	21.19	20.26	48.73	21.00	21.25	35.50
Top of Casing Elevation	feet			325.75	NA	326.86	313.88	316.68	312.44	325.19	319.24	316.73	325.14

Table B-2 Cont: Water Quality Parameters and Field Observations.

				Bldg. 602 (fuel point)			Bldg. 164 (AAFES fuel station)			Glen Haven Annex			Main Post, New Garage Site			
PARAMETERS	UNITS	EPA MCL	MDL	MW-11	MW-12	MW-13	94-198	94-199	94-200	88-2444	88-2445	88-2446	RUM-1	RUM-2	RUM-3	RUM-4
Electrical Conductivity	uS/cm			702	632	340	519	575	1862	170	751	310	2005	1250	1098	923
Total Dissolved Solids***	mg/L	500**		**527**	474	255	389	431	**1397**	128	**563**	233	**1504**	**938**	**824**	**692**
Temperature	Centigrade			20.0	18.8	21.0	19.3	18.4	20.6	10.0	18.8	17.8	16.8	16.7	16.0	16.1
pH	su	6.5-8.5**		**5.8**	**6.1**	6.7	**4.9**	**5.3**	6.7	**5.0**	**5.0**	**5.1**	**5.0**	**4.4**	**4.4**	**4.0**
FIELD OBSERVATIONS																
Depth to Ground Water*	feet			14.96	11.25	12.21	27.22	26.88	19.90	11.59	12.59	15.11	25.39	24.78	23.92	24.11
Total Measured Depth*	feet			29.42	29.75	30.30	38.90	34.85	24.73	22.95	25.13	27.00	50.40	37.71	41.17	32.52
Top of Casing Elevation	feet			316.34	315.23	313.94	308.96	308.79	309.63	362.49	364.68	366.32	326.21^	325.28^	324.38^	324.55^

*as measured from top of casing.

**Secondary drinking water regulation (EPA).

***Calculated by multiplying EC by 0.75 (reference 20). Estimated concentration only.

NA=Not available because automobiles were repeatedly parked at this location when the wells were surveyed.

^Top of casing elevations measured in 1996

Table B-3: Concentrations of Detected VOCs in Ground-Water at the Forest Glen Annex, WRAMC.

				Monitoring Wells Sampled Near Building 500, Forest Glen Annex, WRAMC										
PARAMETERS	UNITS	EPA MCL	MDL	MW-1	MW-2	MW-2D	MW-5	MW-7	MW-9	MW-10	MW-15	MW-16	MW-101	MW-103
ethylbenzene	ug/L	700	2.0	nd	nd	nd	nd	nd	nd	nd	2.4	nd	nd	nd
isopropylbenzene	ug/L	11,000*	2.0	nd	nd	nd	nd	nd	nd	nd	6.2	nd	1.6 J	nd
n-propylbenzene	ug/L	NA	2.0	nd	nd	nd	nd	nd	nd	nd	8.6	nd	2.1	nd
sec-butylbenzene	ug/L	NA	2.0	2.4	nd	nd	nd	2.6	nd	nd	3.3	nd	2.3	2.0
naphthalene	ug/L	500*	2.0	nd	nd	nd	1.2	nd	nd	nd	14	nd	nd	nd
hexachlorobutadiene	ug/L	300*	2.0	1.0 J	1.4 J	1.1 J	nd	nd	nd	1.1 J	nd	nd	nd	nd

Table B-3 Cont.: Concentrations of Detected VOCs in Ground-Water at the Forest Glen Annex, Glen Haven Annex and Main Post, WRAMC.

				Bldg. 602 (fuel point)					Bldg. 164 (AAFES fuel station)			Glen Haven Annex			Main Post, New Garage Site				
PARAMETERS	UNITS	EPA MCL	MDL	MW-11	MW-12	MW-13	MW-13D	Blank	94-198	94-199	94-200	88-2444	88-2445	88-2446	RUM-1	RUM-2	RUM-3	RUM-3D	RUM-4
trichlorofloromethane	ug/L	NA	2	nd	nd	nd	nd	nd	nd	nd	nd	nd	1.2 J	nd	nd	nd	nd	nd	nd
acetone	ug/L	NA	20	210	nd	nd	nd	72	nd	14	12	nd	nd	nd	nd	nd	nd	nd	nd
methyl-t-butyl ether	ug/L	20**	20	**27,000**	nd	nd	nd	nd	**52**	**2600**	**50**	nd	nd	nd	nd	nd	nd	nd	nd
2-butanone	ug/L	NA	20	20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
benzene	ug/L	0.2	2	**6.5**	**140**	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
toluene	ug/L	1000	2	nd	190	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
ethylbenzene	ug/L	700	2.0	2.6	120	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
m/p xylene	ug/L	10000	2.0	nd	140	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
o-xylene	ug/L	10000	2.0	nd	49	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
isopropylbenzene	ug/L	11,000*	2.0	4.1	17	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
n-propylbenzene	ug/L	NA	2.0	12	21	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,3,5-trimethylbenzene	ug/L	10000*	2.0	20	11	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,2,4-trimethylbenzene	ug/L	NA	2.0	6.5	110	nd	nd	nd	nd	nd	nd	nd	nd	1.3	nd	nd	nd	nd	nd
sec-butylbenzene	ug/L	NA	2.0	3.9	2.3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4-isopropyltoluene	ug/L	NA	2.0	1.6 J	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
naphthalene	ug/L	500*	2.0	2.2	36	nd	nd	nd	nd	nd	nd	nd	nd	1.2	nd	nd	nd	nd	nd
hexachlorobutadiene	ug/L	300*	2.0	nd	nd	nd	nd	nd	nd	1.3	1.9	nd	nd	nd	nd	nd	nd	nd	nd

*Maximum allowed for 10-kg child (one day).

**Calculated Margin of Exposure (MoE) and odor threshold (reference 19).

NA=no standard available.

nd=not detected.

"J" indicates estimated concentration.

Bold indicates concentration greater than EPA MCL or other drinking water regulation.

Table B-4: Concentrations of Detected SVOCs in Ground-Water at the Forest Glen Annex, WRAMC.

				Monitoring Wells Sampled Near Building 500, Forest Glen Annex, WRAMC										
PARAMETERS	UNITS	EPA MCL	MDL	MW-1	MW-2	MW-2D	MW-5	MW-7	MW-9	MW-10	MW-15	MW-16	MW-101	MW-103
naphthalene	ug/L	500*	10	nd	nd	nd	nd	nd	nd	nd	15	nd	nd	nd
2-methylnaphthalene	ug/L	NA	10	nd	nd	nd	nd	nd	nd	nd	82	nd	nd	17
acenaphthene	ug/L	NA	10	nd	nd	nd	nd	nd	nd	nd	5.1 J	nd	nd	nd
fluorene	ug/L	NA	10	nd	nd	nd	nd	nd	nd	nd	5.1 J	nd	6.2 J	nd
phenanthrene	ug/L	NA	10	nd	nd	nd	nd	nd	nd	nd	5.8 J	nd	nd	5.3 J
bis(2-ethylhexyl)phthalate	ug/L	NA	10	6.1 J	nd	nd	nd	7.4	nd	nd	nd	nd	nd	8.6 J

Table B-4 Cont.: Concentrations of Detected SVOCs in Ground-Water at the Forest Glen Annex, Glen Haven Annex and Main Post, WRAMC.

				Bldg. 602 (fuel point)					Bldg. 164 (AAFES fuel station)			Glen Haven Annex			Main Post, New Garage Site				
PARAMETERS	UNITS	EPA MCL	MDL	MW-11	MW-12	MW-13	MW-13D	Blank	94-198	94-199	94-200	88-2444	88-2445	88-2446	RUM-1	RUM-2	RUM-3	RUM-3D	RUM-4
naphthalene	ug/L	500*	10	nd	96	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
2-methylnaphthalene	ug/L	NA	10	6.2 J	11	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
bis(2-ethylhexyl)phthalate	ug/L	NA	10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	7.2	nd	nd	nd

*Maximum allowed for 10-kg child (one day).

**Calculated Margin of Exposure (MoE) and odor threshold (reference 19).

NA=no standard available.

nd=not detected

"J" indicates estimated concentration.

Table B-5: Concentrations of Detected Metals in Ground-Water at the Forest Glen Annex, WRAMC.

				Monitoring Wells Sampled Near Building 500, Forest Glen Annex, WRAMC										
PARAMETERS	UNITS	EPA MCL	MDL	MW-1	MW-2	MW-2-D	MW-5	MW-7	MW-9	MW-10	MW-15	MW-16	MW-101	MW-103
Antimony	ug/L	6	5.00	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Arsenic	ug/L	5	4.00	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Barium	ug/L	2000	5.00	605	650	691	216	230	74.4	126	228	218	363	501
Beryllium	ug/L	4	2.00	nd	2.25	2.00	2.95	nd	nd	nd	nd	nd	nd	nd
Cadmium	ug/L	5	2.00	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chromium^	ug/L	100	4.00	nd	nd	nd	35.8	nd	9.82	5.91	6.70	nd	nd	nd
Cobalt	ug/L	NA	4.00	9.97	nd	nd	13.4	nd	nd	nd	nd	nd	4.12	15.3
Copper	ug/L	1000**	5.00	6.70	9.91	9.37	27.50	nd	11.8	nd	6.12	nd	nd	6.74
Lead	ug/L	15*	4.00	nd	nd	nd	9.39	nd	nd	15.5	nd	nd	nd	nd
Mercury	ug/L	2	0.20	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Nickel^	ug/L	NA	10.0	27.2	24.1	26.3	46.6	19.0	11.9	80.8	nd	11.9	nd	35.8
Selenium	ug/L	50	4.00	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Silver	ug/L	100**	2.00	nd	2.16	2.55	nd	2.07	nd	nd	nd	nd	nd	2.04
Thallium	ug/L	2	4.00	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Vanadium	ug/L	NA	5.00	nd	nd	nd	36.2	nd	8.40	nd	nd	nd	nd	nd
Zinc	ug/L	5000**	0.0500	nd	nd	nd	0.1200	nd	nd	nd	nd	nd	nd	nd

Table B-5 Cont.: Concentrations of Detected Metals in Ground-Water at the Forest Glen Annex, Glen Haven Annex and Main Post, WRAMC.

				Forest Glen Annex, WRAMC													
				Bldg. 602 (fuel point)				Bldg. 164 (AAFES fuel station)			Glen Haven Annex			Main Post, New Garage Site			
PARAMETERS	UNITS	EPA MCL	MDL	MW-11	MW-12	MW-13	MW-13-D	94-198	94-199	94-200	88-2444	88-2445	88-2446	RUM-1	RUM-2	RUM-3	RUM-3D	RUM-4
Antimony	ug/L	6	5.00	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Arsenic	ug/L	5	4.00	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Barium	ug/L	2000	5.00	227	1480	9.90	10.6	102	144	361	136	195	154	407	288	278	274	367
Beryllium	ug/L	4	2.00	nd	nd	nd	nd	2.57	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Cadmium	ug/L	5	2.00	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chromium^	ug/L	100	4.00	4.18	81.7	nd	nd	5.16	5.64	nd	9.84	7.15	28.3	nd	nd	nd	nd	4.34
Cobalt	ug/L	NA	4.00	29.0	5.86	nd	nd	4.33	6.98	nd	nd	nd	nd	8.59	nd	nd	nd	5.14
Copper	ug/L	1000**	5.00	nd	42.4	18.9	13.9	nd	nd	nd	nd	nd	nd	16.1	74.8	58.0	100	nd
Lead	ug/L	15*	4.00	4.07	18.7	4.62	5.15	14.7	nd	12.8	31.3	nd	nd	nd	nd	nd	nd	nd
Mercury	ug/L	2	0.20	nd	nd	nd	nd	nd	nd	nd	nd	0.208	nd	nd	nd	nd	nd	nd
Nickel^	ug/L	NA	10.0	40.4	159	46.3	46.2	14.6	22.2	nd	26.4	41.7	50.0	22.2	17	16.3	17.8	17.5
Selenium	ug/L	50	4.00	nd	7.74	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Silver	ug/L	100**	2.00	nd	nd	nd	nd	nd	nd	153	nd	nd	nd	nd	nd	nd	nd	nd
Thallium	ug/L	2	4.00	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Vanadium	ug/L	NA	5.00	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Zinc	ug/L	5000**	0.0500	nd	nd	nd	nd	nd	nd	nd	nd	0.0860	0.0570	0.1000	0.0560	0.0790	0.0840	nd

*Copper and lead concentrations at tap (NA for source water).

**Secondary drinking water regulation (EPA)

NA=Not Available.

nd=not detected

Bold indicates concentration greater than EPA MCL or other drinking water regulation.

^Cr and Ni in the reagent blank were above the MDLs at 33 and 31 ug/L, respectively. Therefore, Cr and Ni results should be considered "estimated concentrations".

Table B-6: Concentrations of Detected Pesticides and PCBs in Ground-Water at the Forest Glen Annex, WRAMC.

				Monitoring Wells Sampled Near Building 500, Forest Glen Annex, WRAMC										
PARAMETERS	UNITS	EPA MCL	MDL	MW-1	MW-2	MW-2D	MW-5	MW-7	MW-9	MW-10	MW-15	MW-16	MW-101	MW-103
alpha-Chlordane	ug/L	2*	0.0500	nd	nd	nd	nd	nd	0.0600	nd	nd	nd	nd	nd

Table B-6 Cont.: Concentrations of Detected Pesticides and PCBs in Ground-Water at the Forest Glen Annex, Glen Haven Annex and Main Post, WRAMC.

				Bldg. 602 (fuel point)					Bldg. 164 (AAFES fuel station)			Glen Haven Annex			Main Post, New Garage Site				
PARAMETERS	UNITS	EPA MCL	MDL	MW-11	MW-12	MW-13	MW-13D	Blank	94-198	94-199	94-200	88-2444	88-2445	88-2446	RUM-1	RUM-2	RUM-3	RUM-3D	RUM-4
Aroclor-1260 (PCB)	ug/L	0.5	0.500	NoA	nd	**2.73**	nd	nd	nd	nd	nd	**1.10**	nd	nd	nd	**0.880**	**1.10**	**0.920**	nd
Aroclor-1260 (PCB) 6 Nov	ug/L		0.3			<0.3**	<0.3**												
Aroclor-1260 (PCB) 7 Nov	ug/L		0.3									<0.3**							
Aroclor-1260 (PCB) 8 Nov	ug/L		0.3													1.7**	<0.3**	0.5**	
Aroclor-1260 (PCB) 9 Nov	ug/L		0.3													0.9**		0.3**	

*EPA MCL for "technical Chlordane"--a mixture of many individual chlordanes (alpha, gamma, etc.)

**Samples re-analyzed by Solid Phase Microextraction

NoA = Sample lost during extraction.

nd = not detected.

Bold indicates concentration greater than EPA MCL or other drinking water regulation.