ALTERNATE SOURCE DEMONSTRATION
FOR
TRICHLOROETHENE

HAZARDOUS WASTE MANAGEMENT UNIT 5
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

Submitted to:

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1.0 EXECUTIVE SUMMARY

This report presents the results of the Alternate Source Demonstration (ASD) for trichloroethene (TCE) conducted for Hazardous Waste Management Unit 5 (HWMU-5) at the Radford Army Ammunition Plant (Radford AAP) in Radford, Virginia. TCE has been detected at concentrations exceeding the U.S. Environmental Protection Agency (USEPA) Maximum Contaminant Level (MCL) of 5 µg/l in four groundwater monitoring wells within the monitoring network for HWMU-5. Radford AAP is submitting this ASD in support of clean closure of HWMU-5.

Historical information regarding operations at HWMU-5 prior to closure indicates that the wastes processed through the Unit did not contain TCE. The results of field investigations conducted in 2002 and 2004 indicate that TCE is not present in the residual material contained in the Unit. A review of Radford AAP cleaning and maintenance practices in the vicinity of HWMU-5 identified buildings and areas where chlorinated solvents were routinely used. An evaluation of historic waste disposal practices in these buildings and areas indicates the potential for groundwater impact from these operations. Sewer lines, floor drains, and equipment cleaning operations that occurred on the ground surface are potential sources or conduits for groundwater impact. Hydrogeologic features, such as fractures and sinkholes in this area, control the transport of impacted groundwater from these source areas to monitoring wells 5W5B, 5WC21, 5WC22, and 5WC23, which exhibit or have exhibited TCE concentrations in exceedance of the USEPA MCL of 5 µg/l. In addition, a surface drainage feature (drainage pipe and channel) in the vicinity of one of the identified buildings would transport any liquids released onto the ground surface directly toward the impacted monitoring wells. TCE has also been detected in upgradient groundwater monitoring well 5W8B.

Based on these factors, HWMU-5 is not the source of the TCE detected in the groundwater as TCE was not handled in the Unit and has been detected in the upgradient groundwater monitoring well. In accordance with Virginia Department of Environmental Quality (VDEQ) guidance and pursuant to 40 CFR 264.99(i), Radford AAP demonstrates that TCE is derived from a source other than HWMU-5. Accordingly, as TCE is derived from an alternate source, Radford AAP respectfully requests that TCE be removed from the list of constituents of concern in the Post-Closure Permit for HWMU-5. Evaluation of TCE in groundwater in this area will fall under the jurisdiction of Radford AAP's USEPA Region III Corrective Action Program. As a result, Radford AAP has begun the process to classify the suspected TCE source areas as a new Area of Concern within the facility's Installation Restoration Program (IRP).

2.0 SITE DESCRIPTION

2.1 FACILITY DESCRIPTION

Radford AAP is located in the mountains of southwestern Virginia within Pulaski and Montgomery Counties. A Site Location Map is presented as **Figure 1**. The facility is situated in one of a series of narrow valleys typical of the Valley and Ridge physiographic province of the Appalachian Highland Region of North America. The valley is approximately 25 miles long and is oriented in a northeast-southwest direction. The valley has a width of approximately eight miles at the southwest end and narrows to approximately two miles at the northeast end. Radford AAP lies along the New River in the relatively narrow northeast corner of the valley. The maximum elevation at Radford AAP is 2,225 feet above mean sea level (amsl) in the southeast corner, and the minimum elevation is approximately 1,675 feet amsl along the New River at the northern property boundary.

Radford AAP is divided by the New River into two sections. The southern section, which comprises approximately two-thirds of Radford AAP, is called the "Main Plant." The remaining northern one-third section is called the "Horseshoe Area." HWMU-5 is located in the Main Plant area.

2.2 HAZARDOUS WASTE MANAGEMENT UNIT 5

2.2.1 Operational History

HWMU-5 is a former lined surface impoundment. As shown on the Site Location Map (**Figure 1**), HWMU-5 is located approximately 3,000 feet southwest of the New River. The Unit is located on a river terrace which slopes gently downward to the north toward the New River. The Unit was put into operation as an unlined surface impoundment in 1970 and was retrofitted with a liner in 1981. The dimensions of the Unit measured approximately 150 feet by 100 feet along the top of the berm, with a total embankment height of 10 feet above the base of the impoundment. Quarterly groundwater maps from 2006 are included as **Figures 2** through **5**. A cross-section passing through wells located east of the Unit is included as **Figure 6**, and a cross-section passing through wells located northwest, north, and northeast of the Unit is included as **Figure 7**. (The cross-section locations are shown on **Figure 8**.) Monitoring well boring logs and construction diagrams are included in **Appendix A**. A historical summary of TCE concentrations in groundwater is included as **Table 1**.

During operation, the Unit received stormwater runoff, spill, and washdown waters for neutralization from the acid tank farm (nitric and sulfuric acids), which is located approximately 1,000 feet south of HWMU-5 as shown on **Figure 1**. Prior to 1983, the Unit also received process wastewater containing low concentrations of nitrocellulose.

The wastes received at HWMU-5 were characteristically hazardous due to corrosivity. The acidic wastewater was both nitric (HNO_3) and sulfuric (H_2SO_4) in origin with a pH of 1.5 and a dominant constituent of mixed acids. Based on verbal descriptions of the operational

processes for HWMU-5 from Radford AAP personnel as well as written documentation contained in the 1988 Closure Plan for the Unit, the wastes handled at HWMU-5 did not contain TCE, perchloroethylene (PCE), or other organic compounds. Also, the Unit did not receive acidic waste containing chloride or chlorate.

The Unit was taken out of operation in 1986 and was closed in 1989 in accordance with the VDEQ-approved Closure Plan dated May 1988. At the time of closure, HWMU-5 was drained of all waters, the residual material was treated in place with flyash and cement kiln dust to achieve a target pH range of 6.3 to 10.5, and the basin was filled with residual material and stone and was capped. (The residual materials were not analyzed prior to placement. The flyash and cement dust were not analyzed for chlorinated compounds as the compounds are not constituents of concern for these substances.) The liner was removed as part of closure activities. No waste has been processed through HWMU-5 since it was closed.

2.2.2 Subsurface Investigations

In October 2002 and February 2004, Radford AAP conducted a subsurface evaluation to determine the nature and extent of waste contained in closed HWMU-5. (Complete details regarding the October 2002 subsurface evaluation were submitted to the VDEQ in the March 2003 Field Investigation Report, and complete details regarding the February 2004 subsurface evaluation will be presented in the forthcoming Clean Closure Report for the Unit.) During both investigations, soil and residual material samples were analyzed for USEPA Target Analyte List (TAL) inorganic constituents and for Target Compound List (TCL) organic constituents. A summary of the TAL inorganic constituents and the TCL organic constituents detected in the soil and residual material samples at concentrations exceeding their respective quantitation limits is presented in **Table 2**.

As shown in **Table 2**, TCE and PCE were not detected in the residual material samples collected within the Unit or in any of the soil samples collected around the Unit. TCE was detected in one soil sample collected from boring 5GP-21 at a depth of 14 feet below the Unit (**Figure 9**). However, this sample was collected across the water table (including the overlying capillary fringe) from the boring closest to groundwater monitoring well 5W5B. Therefore, the TCE originated from TCE dissolved in the groundwater rather than the waste processed through the Unit. TCE and PCE were not detected in any of the other borings collected beneath the Unit.

4,4-DDD, a chlorinated pesticide, was detected at low levels in native soil underlying the Unit, in three residual material samples, and in one sample from the bottom clay liner. Chlordane was detected at low levels in one sample from the bottom clay liner. 4,4'-DDD and chlordane are both listed in 40 CFR 264 Appendix IX; however, neither constituent has ever been detected in the groundwater at HWMU-5. The VDEQ Voluntary Remediation Program (VRP) Tier II Soil Screening Levels for residential soil for chlordane and 4,4'-DDD are 1.8 mg/kg and 2.7 mg/kg, respectively. The only chlordane concentration detected in the soil samples at HWMU-5 was 0.0015 mg/kg, which is three orders of magnitude lower than the VRP Tier II Soil Screening Level. The highest 4,4'-DDD concentration detected in the soil samples at

HWMU-5 was 0.051 mg/kg, which is almost two orders of magnitude lower than the VRP Tier II Soil Screening Level.

2.3 CLEANING SOLVENTS USED IN RADFORD AAP FACILITY OPERATIONS

Several solvents are used for equipment cleaning purposes in certain areas of the Radford AAP facility. According to Alliant Procedure No. 4-27-078, Revision No. 5 (dated January 13, 1999), the following cleaning solvents are approved for use at the facility. A copy of this procedure is included in **Appendix B**.

- Stoddard-type solvents (clear, colorless liquids of the kerosene naphtha class; used as an oil and grease remover).
- 1,1,1-Trichloroethane (inhibited).
- DuPont Cleaning Solvent #49 (70% Stoddard Solvent, 25% methylene chloride, 5% PCE; used in electric motor cleaning).
- Acetone.
- Ethyl alcohol.
- Inhibisol (colorless liquid of chlorinated solvents; chemical formula CCl_4).
- Nitroglycerin remover (mixture of sodium sulfide, alcohol, acetone, and water).
- "Gunk" (degreasing-cleaning solvent; approximately 16% cresole; used in a vat or tank in the Degreasing Shop to clean and paint strip scales for overhaul).
- Butyl alcohol (used by the Electric Shop for strain gauge maintenance).
- Intex #8793 - Paint Stripper (used in Degreasing Shop for paint removal).
- Intex #827 - Safety Solvent (used in Degreasing Shop for paint removal and cleaning purposes).
- Lectra Clean (used in Electric Shop for cleaning and degreasing electrical equipment).
- Voltz (used in Electric Shop motor cleaning vat).

These solvents are/were used primarily for tasks involving operations and maintenance of motors, valves, and gauges. There are no records or operational indications that any of these solvents could have come into contact with wastewater influent to HWMU-5. Wastewater discharged to HWMU-5 originated at the Acid Tank Farm, which is shown in **Figure 1**.

2.4 SOURCE AREAS FOR TRICHLOROETHENE

As part of the TCE Alternate Source Demonstration, Radford AAP identified facility buildings and underground lines in the vicinity of HWMU-5 that have contributed to TCE impact on the site. Chlorinated solvents have historically been used at these buildings. The buildings, sewer lines, and their spatial relationships to HWMU-5 are illustrated in **Figure 10**. Historical building use information is included in **Appendix B**.

Building 1549 is an Area Maintenance Shop located approximately 300 feet southeast of HWMU-5. According to Area Mechanics who worked in facility B-Line Maintenance, the cleaning of equipment at Building 1549 in the 1960s and 1970s involved the use of Varsol and

WD-40. Disposal of the used solvents consisted of pouring the solvents down the nearest floor drain. This disposal practice was later discontinued; after that time, the spent solvents were collected in a barrel to be transported by the Roads and Grounds Department to a collection area for disposal. As shown in **Figures 9** and **10**, Building 1549 was constructed on a filled sinkhole.

Building 1041 was formerly used as the Degreasing Shop and is currently being used as the Scale Maintenance and Cleaning Shop. The building is located approximately 980 feet southeast of HWMU-5. The building formerly contained a dip tank. The dip tank has been removed, and the containment area is filled with concrete. An interview with Walter Carpenter of ATK indicated that the dip tank was not in service when he started in the scale maintenance shop in 1980. Currently, a grate-covered pit in the floor drains to an outside underground storage tank. According to a Senior Instrument Mechanic, the Scale Shop used this building in the past for the cleaning of scales. At times, the scales would be taken outside of the building to be washed off, and the wash liquids would be allowed to drain onto the ground surface. According to the Radford AAP Sewers and Drains Atlas, a four-inch terracotta pipe runs westward from the western end of Building 1041 to a former underground storage tank (UST).

Building 1034 formerly housed a facility nitrocellulose laboratory and currently houses the Electric and Refrigeration Shop. Building 1034 is located approximately 950 feet southeast of HWMU-5. DuPont Cleaning Solvent #49, one of the solvents commonly used in electric motor cleaning, contains PCE and was used at Building 1034. TCE is a daughter product of the degradation of PCE. No documentation of laboratory waste disposal practices is available.

As shown on **Figure 10**, several sewer lines are located in the vicinity of HWMU-5 including two general purpose sewer lines that pass underneath HWMU-5. These lines were installed prior to the 1960s and predate the Unit. Specific contents of the general purpose lines are unknown, although these lines are not expected to contain sanitary, storm, or acid waters. However, acid lines appear to join the general purpose lines in several areas of the facility (as shown in **Figure 10**). Due to age of the lines, leakage of the sewer lines is expected. Their location throughout the facility in filled sinkholes and fracture traces provides preferential pathways for migration. The gravel-filled sewer line backfill also serves as a conduit for flow.

3.0 HYDROGEOLOGIC FRAMEWORK

3.1 TOPOGRAPHY

The TCE Area of Concern is located approximately 3,000 feet southwest of the New River. The Area is located on a river terrace which slopes gently downward to the north toward the New River. Surface drainage area boundaries are illustrated in **Figures 9** and **10**.

Surface drainage in the vicinity of Building 1549 flows through a drainage grate in the parking area for the building and through a pipe underneath the road and discharges to a drainage channel. As shown on **Figures 9** and **10**, the drainage channel ends in the vicinity of a filled sinkhole and the monitoring wells that have shown TCE impact.

As shown on **Figures 9** and **10**, a surface drainage divide separates Buildings 1034 and 1041 from the other potential source buildings in the TCE Area of Concern and HWMU-5. Surface drainage in the vicinity of Buildings 1034 and 1041 flows to the northeast, while the surface drainage in the vicinity of the other potential source buildings in the TCE Area of Concern and HWMU-5 flows to the north-northwest.

3.2 GEOLOGIC SETTING

The Valley and Ridge physiographic province consists of folded and thrust-faulted Paleozoic sedimentary rocks ranging from Cambrian to Mississippian in age. Post-deformation weathering of these thrust-faulted and overturned Paleozoic rocks has resulted in the formation of resistant sandstone and dolomite ridges separated by valleys underlain by more easily eroded shale and limestone. Well-developed karst features such as sinkholes and caves are common in the Valley and Ridge.

The general geology at Radford AAP consists of limestone/dolomite bedrock covered by weathered residual deposits and/or alluvial deposits. The alluvial deposits consist of typical fluvial deposits of interbedded clay, silt, and sand/gravel deposits with cobble lenses. The thickness of the alluvial deposits ranges from a few feet to approximately 50 feet with an average thickness of 20 feet. The residual deposits consist of clay, silt, and clasts resulting from the physical and chemical weathering of the parent bedrock. The residual deposits typically underlie the alluvium, except in locations where the residuum has been eroded to bedrock and replaced by alluvium. The thickness of the residual deposits ranges from a few feet to approximately 40 feet. Underlying the alluvium and residuum throughout most of Radford AAP is a series of dolomite, limestone, and shale strata known as the Cambrian-aged Elbrook Formation. The Elbrook Formation is the major outcropping formation as well as the predominant karstic formation below the facility. Sinkholes, solution channels, pinnacled surfaces, and springs are common to the Elbrook Formation.

Boring logs and well construction diagrams for the monitoring network at HWMU-5 are included in **Appendix A**. Geologic cross-sections derived from the boring logs for the Unit's monitoring wells are presented as **Figure 6** and **Figure 7**. The cross-section location is shown on

Figure 8. (The cross-sections are drawn through the impacted wells on the site.) The area surrounding HWMU-5 is underlain by unconsolidated alluvial sediments and weathered bedrock residuum, which are in turn underlain by carbonate bedrock of the Elbrook Formation. The bedrock beneath this area is generally encountered at depths ranging from approximately 28 feet to over 56 feet below ground level, although the residuum/bedrock interface is gradational. In general, the bedrock in the vicinity of monitoring wells 5W8B, 5WC11, 5WC12, and S5W8 slopes downward to the north-northeast, while the bedrock in the vicinity of monitoring wells S5W6 and 5W9A slopes downward to the southwest (**Figure 6**). This appears to indicate the development of a karst solutional feature in the bedrock in the vicinity of monitoring wells 5W5B, 5WCA, and well cluster 5WC21, 5WC22 and 5WC23.

Wells 5W8B, 5W5B, and 5W7B were installed in August 1983. Wells 5WC21, 5WC22, and 5WC23 were installed in May 1987. No soil samples were analyzed during monitoring well installation. Well boring logs are included in **Appendix A**.

3.3 KARST HYDROLOGY

3.3.1 Fracture Trace Analysis

A total of 66 fracture traces were identified within and around Radford AAP in a photogeologic study conducted by the USEPA's Environmental Photographic Interpretation Center (EPIC) in 1992. Fracture traces are linear features identified in aerial photographs that represent the surface expression of primary joint sets, major fractures, and/or zones of fracturing in the subsurface. These features may be expressed as soil-tonal variations and vegetational and topographical alignments and are significant features controlling groundwater flow at Radford AAP. The fractures and joint sets can act as discrete conduits for groundwater flow, increasing flow rates, and, in some cases, redirecting flow away from the expected flow direction. In karst terranes, such features are environmentally significant because solutionization and resulting conduits develop along bedding planes as well as fractures and joints (USEPA, 1992).

The primary fracture traces identified by the 1992 USEPA EPIC study in the vicinity of the TCE Area of Concern are illustrated in **Figures 9** and **10**. The fracture lineations appear to be oriented radially, with trends ranging from northeast-southwest to northwest-southeast in the TCE Area of Concern. Additional fracture traces are illustrated on the maps based on the linear occurrence of sinkholes as noted in Section 3.3.2.

3.3.2 Sinkhole Delineation

The locations of sinkholes at Radford AAP were also mapped during the 1992 USEPA EPIC study. In the vicinity of Radford AAP, the strike of bedding in the Elbrook Formation is roughly west-southwest to east-northeast with dips to the south-southeast. Most of the sinkholes in the vicinity of Radford AAP are oval-shaped and elongated with respect to the strike of bedding planes. In some instances, the sinkholes align with the fracture traces. The sinkholes represent bedrock units with a greater carbonate content and lower shale content within the underlying Elbrook Formation (USEPA, 1992).

As mapped by the 1992 USEPA EPIC study, the area surrounding the TCE Area of Concern is characterized by the development of sinkholes with an apparent northwest-southeast trend (**Figures 9** and **10**). Many of these sinkholes were filled during historic site development in the 1940s; therefore, there is no analytical information regarding the nature of the fill materials. At present, several facility structures are now located on these historic sinkholes. In a typical karst setting, well-developed karst conduits connect sinkholes and convey groundwater as well as aerated surface water during precipitation events at relatively rapid velocities through solution-enhanced fractures and joints.

3.4 OCCURRENCE OF GROUNDWATER

The general hydrogeologic setting for Radford AAP is characterized by porous alluvial sediments overlying weathered and unweathered dolomite and limestone. In areas where the porous alluvial sediments are the uppermost water-bearing zone, groundwater flow is generally from topographically high areas to topographically low areas. In some areas of Radford AAP, the uppermost water-bearing zone is within the limestone and dolomite bedrock. The karst features within the bedrock aquifer can provide conduits for rapid transport of groundwater to the New River, which is the discharge area for regional groundwater flow.

The monitoring wells at HWMU-5 are screened entirely within either alluvium or weathered carbonate bedrock residuum or across the residuum/carbonate bedrock interface. Static water levels measured during the Fourth Quarter 2006 monitoring event ranged from 1754.96 feet to 1775.03 feet above mean sea level. As shown on the Potentiometric Surface Maps (**Figures 2** through **5**), groundwater movement beneath the site is generally to the northeast. The groundwater contours and the topography in this area suggest that the TCE Area of Concern is located on a river terrace that contains several karst features and that drains north toward the New River.

3.5 RELATION OF HYDROGEOLOGIC FEATURES TO POTENTIAL SOURCES OF TCE

Area Maintenance Shop Building 1549 is located on a large historic sinkhole measuring approximately 430 feet by 200 feet (**Figure 9**). A smaller historic sinkhole (approximately 150 feet by 130 feet) is located approximately 80 feet north of the large sinkhole. Monitoring wells 5WCA, 5W5B, and nested wells 5WC21, 5WC22, and 5WC23 are located within this smaller sinkhole. Both sinkholes were filled during site development and are expected to be connected by well-developed karst conduits. These sinkholes are part of the linear feature of sinkhole development shown on **Figures 9** and **10**. According to facility personnel, past disposal practices at Building 1549 involved pouring used solvents into floor drains. Liquids released to the subsurface through floor drains or spilled on the ground surface in the vicinity of Building 1549 would percolate to the groundwater through the soil filling the large sinkhole. Karst conduits would convey groundwater from the larger sinkhole to the smaller sinkhole containing monitoring wells 5WCA, 5W5B, and nested wells 5WC21, 5WC22, and 5WC23. As discussed in Section 4.0, these wells consistently exhibit TCE concentrations in exceedance of the USEPA MCL of 5 µg/l. Also, any material poured onto the ground outside of Building 1549 would travel

via surface drainage toward the impacted monitoring wells via a drainage pipe and channel as shown in **Figures 9** and **10**.

Electric and Refrigeration Shop Building 1034 and Degreasing Shop Building 1041 are separated from the TCE Area of Concern by a surface drainage divide. However, as shown on **Figures 9** and **10**, Buildings 1034 and 1041 are located near two fracture traces which trend through the large sinkhole upon which Building 1549 is located. As indicated by facility personnel, past practices at Building 1041 included cleaning scales by washing them outside of the building with the wash liquids allowed to drain to the ground surface. Liquids released to the subsurface through floor drains, the UST system, and/or the former dip tank associated with Building 1041, or spilled on the ground surface in the vicinity of Buildings 1034 and 1041 would flow to the northeast and percolate through the soil to the groundwater. Any subsurface flow from the vicinity of these buildings is expected to be intercepted by the fracture located to the northeast and conveyed to the sinkhole underlying Building 1549, and then be conveyed to the sinkhole containing monitoring wells 5WCA, 5W5B, and nested wells 5WC21, 5WC22, and 5WC23. Furthermore, waste solvents could be conveyed by the four-inch terracotta pipe running westward from the western end of Building 1041, released to the subsurface, and intercepted by the fracture located to the west of the buildings. This fracture also would convey any liquids to the large sinkhole underlying Building 1549.

As shown on **Figure 10**, sewer lines in the vicinity of HWMU-5 include two general purpose sewer lines that pass underneath HWMU-5. One of the lines passes underneath the Unit, through the fracture trace and filled sinkhole, and in the direct vicinity of monitoring wells 5WCA, 5W5B, and nested wells 5WC21, 5WC22, and 5WC23. These lines were installed prior to the 1960s and predate the Unit. Impact to the wells could result from historical sewer line leakage or from materials that have traveled along the gravel backfill surrounding the piping.

4.0 HISTORICAL GROUNDWATER ANALYTICAL RESULTS

Graphs of historical TCE concentrations detected in the monitoring network for HWMU-5 are presented in **Appendix C**. The graphs were compiled using quarterly groundwater monitoring data from First Quarter 1996 through Fourth Quarter 2006. Historical groundwater data are summarized in **Table 1**.

As shown on the graphs, TCE has been detected at concentrations exceeding the USEPA MCL of 5 µg/l in downgradient monitoring wells 5W5B, 5WC21, 5WC22, and 5WC23. TCE concentrations in well 5W5B have consistently exceeded the USEPA MCL of 5 µg/l since 1997. Concentrations have fluctuated between 5 µg/l and 20 µg/l for most of the 10-year timeframe from 1996-2006 without any apparent trend due to seasonal factors. The TCE concentrations in nested wells 5WC21, 5WC22, and 5WC23 have been declining since the beginning of 2005 and were consistently below the USEPA MCL for most of 2005 and/or all of 2006.

During First Quarter 1999, TCE was detected at a concentration of 7.4 µg/l in downgradient well 5W10A; however, this detection is considered to be an anomaly as TCE has only been detected in well 5W10A one other time at a concentration below the quantitation limit of 1 µg/l. During First Quarter 2002, TCE was detected at a concentration of 9.13 µg/l in upgradient well 5W8B. TCE was also detected in 5W8B during two other events at concentrations less than 1 µg/l. (Please note that data prior to Second Quarter 2003 are only available on Excel data sheets from REIC Laboratories. Laboratory analytical reports are not available. These samples were collected before Draper Aden Associates (DAA) began handling sampling, laboratory coordination, and data validation. REIC did not provide data validation information regarding these data.)

Minor detections of TCE at concentrations less than 1 µg/l have been observed occasionally in downgradient wells 5W7B, S5W5, S5W7, and 5W9A. TCE has never been detected in 5W11A. It should be noted that these wells are located on the opposite sides of fracture traces from the remaining wells in the monitoring network (**Figures 9** and **10**).

The observation wells 5WC11, 5WC22, and S5W8 and sidegradient well 5WCA are not part of the permitted groundwater monitoring well network; therefore, no additional data from these wells are available.

Monitoring wells at HWMU-5 have been historically monitored for TCE daughter products as well as for tetrachloroethene (PCE), a possible parent product for TCE. No PCE or TCE daughter products have been detected in any of the wells at the Unit. Summary tables for PCE and TCE daughter products are included in **Appendix D**.

5.0 CONCLUSIONS

Historical information regarding operations at HWMU-5 prior to closure indicates that the wastes processed through the Unit did not contain TCE. The results of field investigations conducted in 2002 and 2004 indicate that TCE is not present in the residual material contained in the Unit. A review of Radford AAP cleaning and maintenance practices in the vicinity of HWMU-5 identified buildings and areas where chlorinated solvents were routinely used. An evaluation of historic waste disposal practices in these buildings and areas indicates the potential for groundwater impact from these operations. Sewer lines, floor drains, and equipment cleaning operations that occurred on the ground surface are potential sources or conduits for groundwater impact. Hydrogeologic features such as fractures and sinkholes in this area control the transport of impacted groundwater from these source areas to certain monitoring wells within the groundwater monitoring network for HWMU-5. In addition, a surface drainage feature (drainage pipe and channel) in the vicinity of one of the identified buildings would transport any liquids released onto the ground surface directly toward the impacted monitoring wells. Monitoring wells 5W5B, 5WC21, 5WC22, and 5WC23 consistently exhibit TCE concentrations in exceedance of the USEPA MCL of 5 µg/l. TCE has also been detected in upgradient groundwater monitoring well 5W8B.

Based on these factors, HWMU-5 is not the source of the TCE detected in the groundwater as TCE was not handled in the Unit and has been detected in the upgradient groundwater monitoring well. In accordance with Virginia Department of Environmental Quality (VDEQ) guidance and pursuant to 40 CFR 264.99(i), Radford AAP demonstrates that TCE is derived from a source other than HWMU-5. Accordingly, as TCE is derived from an alternate source, Radford AAP respectfully requests that TCE be removed from the list of constituents of concern in the Post-Closure Permit for HWMU-5. Evaluation of TCE in groundwater in this area will fall under the jurisdiction of Radford AAP's USEPA Region III Corrective Action Program. As a result, Radford AAP has begun the process to classify the suspected TCE source areas as a new Area of Concern within the facility's Installation Restoration Program (IRP).

6.0 REFERENCES

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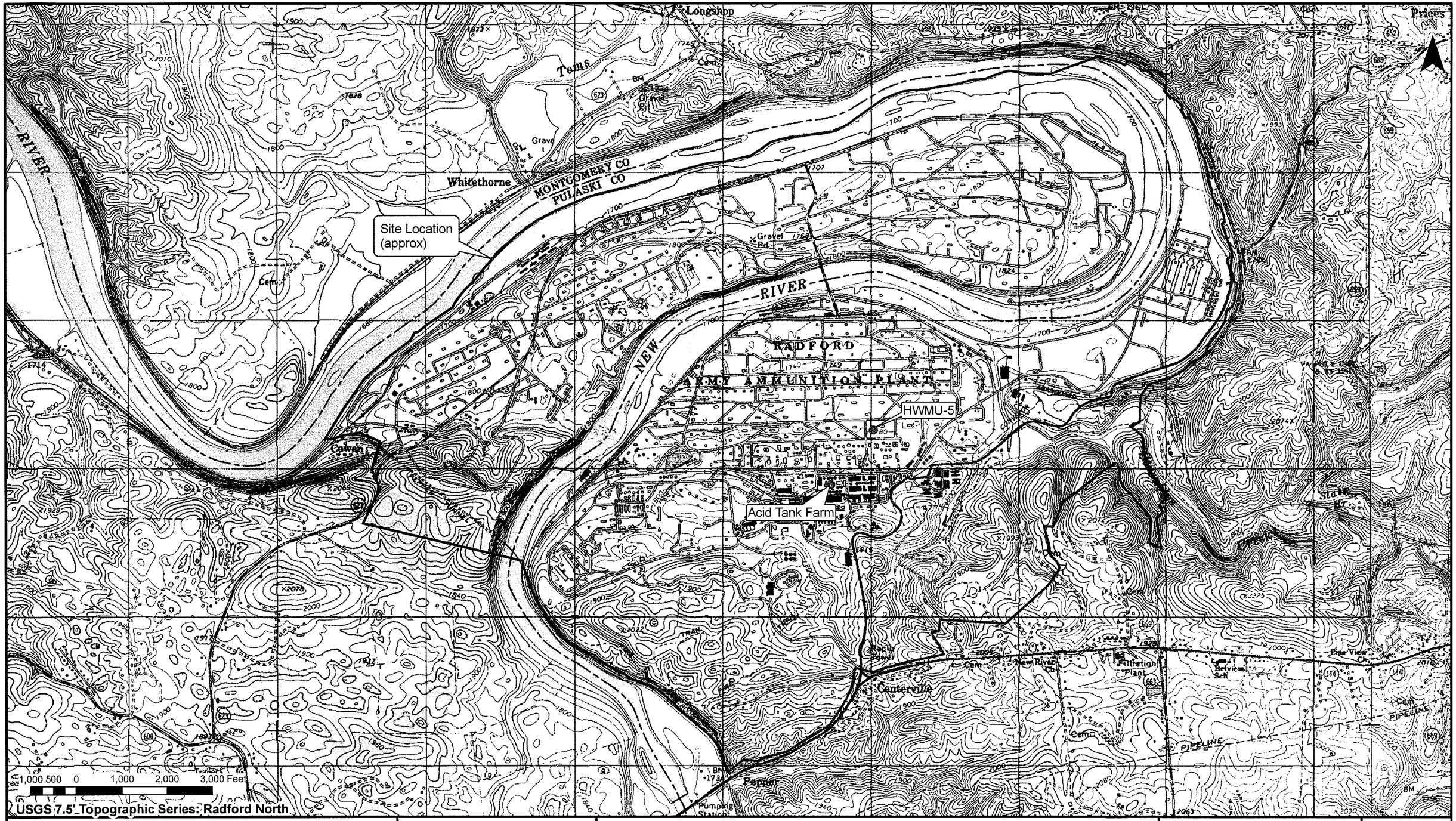
U.S. Environmental Protection Agency (USEPA). 1992. Installation Assessment, Radford Army Ammunition Plant, Radford, Virginia. Environmental Photographic Interpretation Center.

FIGURES



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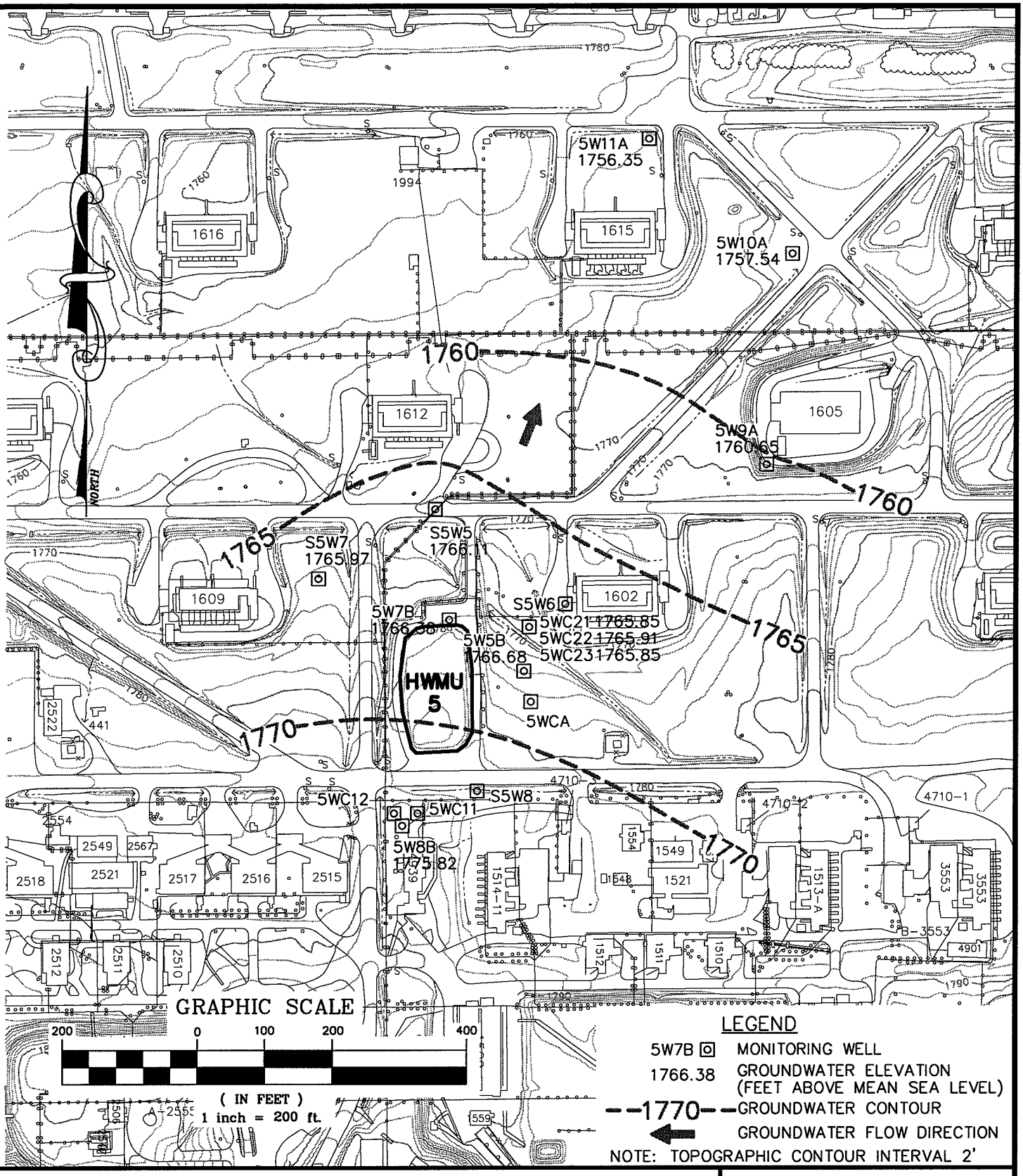
DRAWN	KKD
CHECKED	MDL
DATE	03-16-07

Site Location Map
Radford Army Ammunition Plant
Montgomery County, Virginia

SCALE 1" = 2000'

PLAN NO. B03204-102

FIGURE
1



HWMU-5 POTENTIOMETRIC SURFACE MAP (1ST QUARTER 2006)

RADFORD ARMY AMMUNITION PLANT

RADFORD, VIRGINIA

SCALE: 1"=200'

PLAN NO. B03204-102

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DESIGNED	MDL
DRAWN	AVW
CHECKED	MDL
DATE	03/20/2007

FIGURE 2

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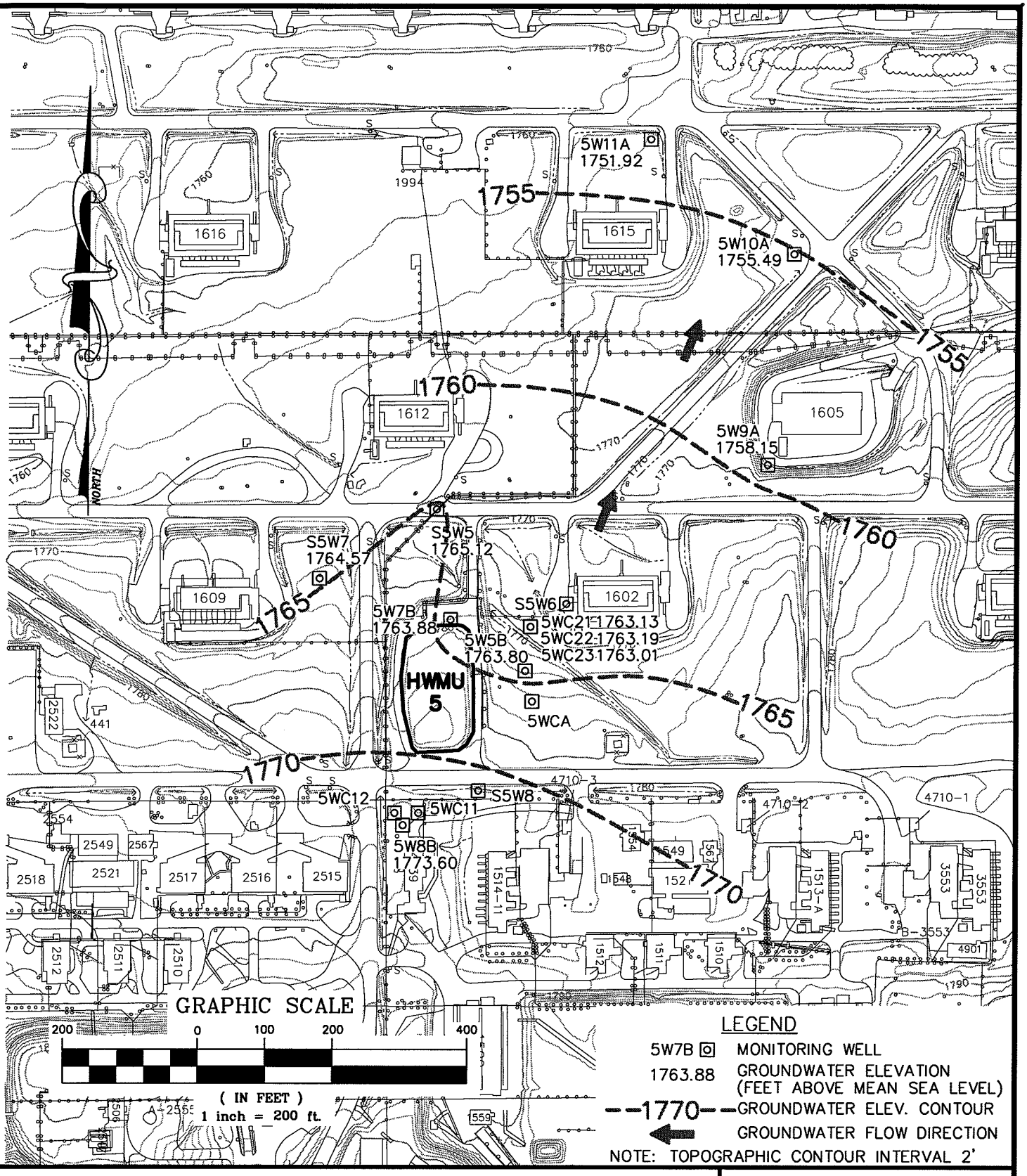

HWMU-5 POTENTIOMETRIC SURFACE MAP (2ND QUARTER 2006)

RADFORD ARMY AMMUNITION PLANT

RADFORD, VIRGINIA

SCALE: 1"=200'

PLAN NO. B03204-102

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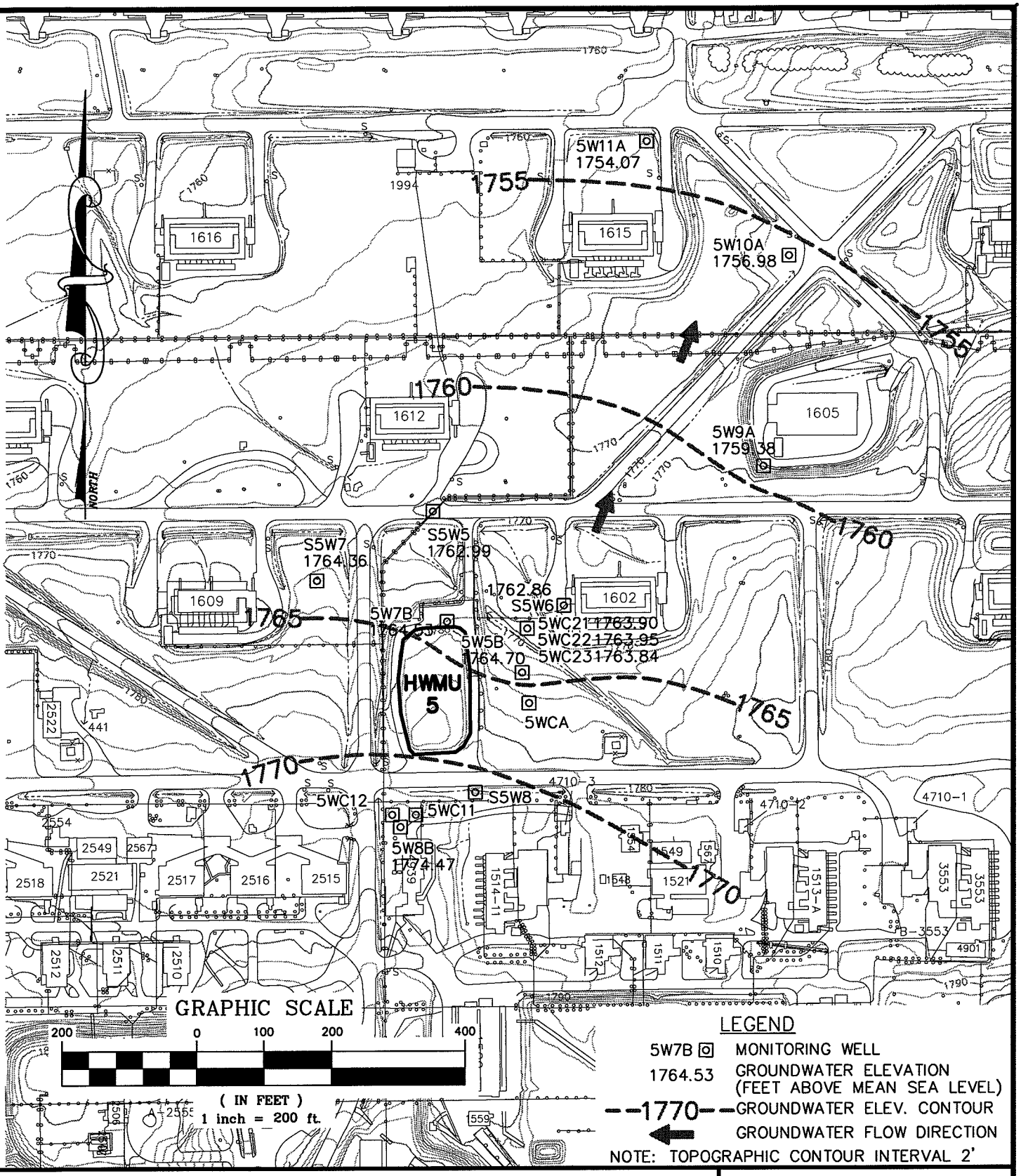
Richmond, VA
Charlottesville, VA
Hampton Roads, VA

DESIGNED	LCL
DRAWN	AVW
CHECKED	MDL
DATE	03/20/2007

FIGURE 3

P:\B03\200\B03204\B03204-102\CAD\B03204-102_ENV\dwg\B03204-102_HWMU-5.dwg Mar 23, 2007 1:55pm



HWMU-5 POTENTIOMETRIC SURFACE MAP (3RD QUARTER 2006)

RADFORD ARMY AMMUNITION PLANT

RADFORD, VIRGINIA

SCALE: 1"=200'

PLAN NO. B03204-102

Draper Aden Associates

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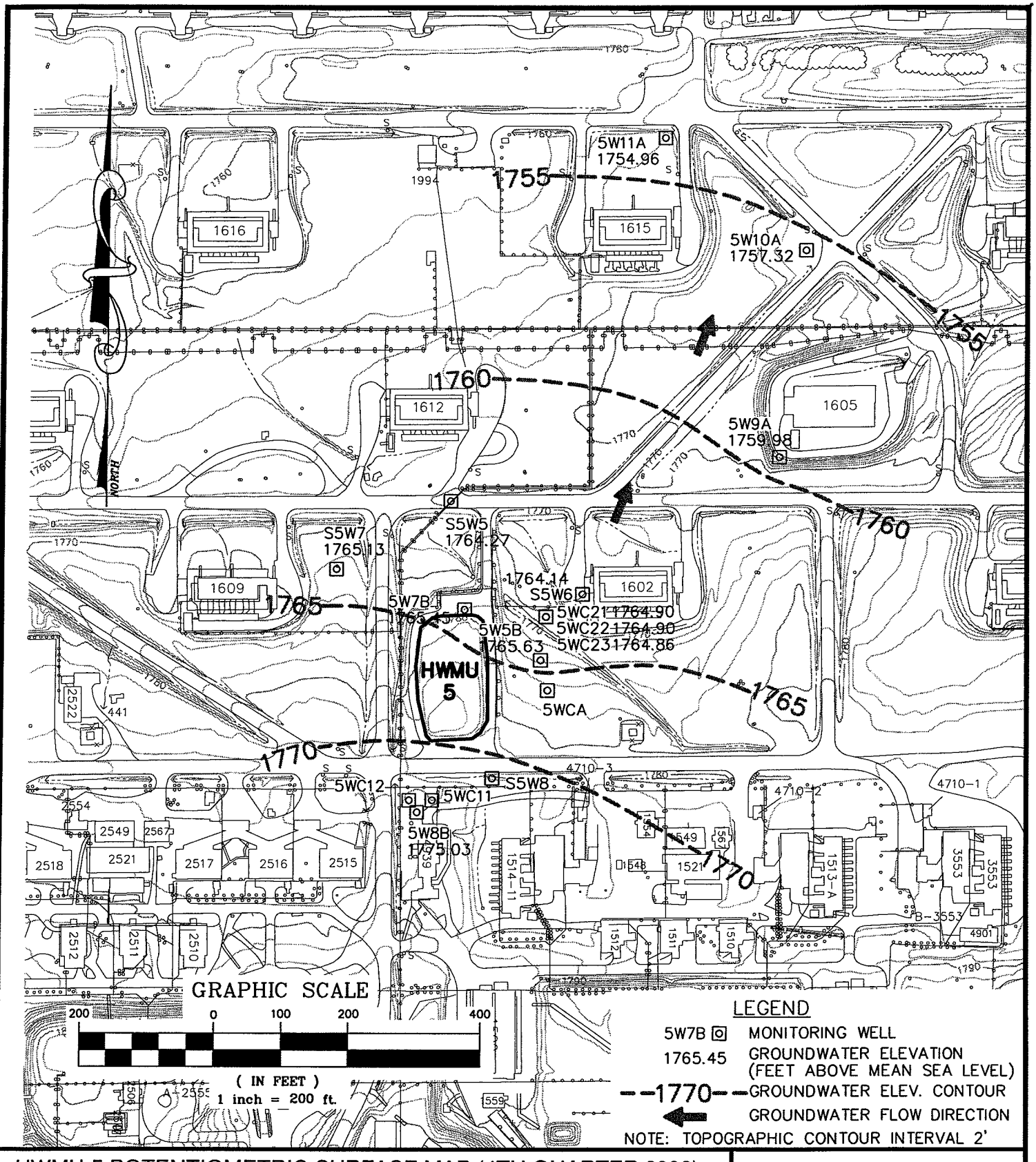
DESIGNED	LCL
DRAWN	AVW
CHECKED	MDL
DATE	03/20/2007

FIGURE 4

P:\B03200\B03204\B03204-102\CAD\B03204-102_ENVdwg\B03204-102_HWMU-5.dwg Mar 23, 2007 1:55pm



HWMU-5 POTENTIOMETRIC SURFACE MAP (4TH QUARTER 2006)

RADFORD ARMY AMMUNITION PLANT

RADFORD, VIRGINIA

SCALE: 1"=200'

PLAN NO. B03204-102

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Hampton Roads, VA

DESIGNED	LCL
DRAWN	AVW
CHECKED	MDL
DATE	03/20/2007

FIGURE 5

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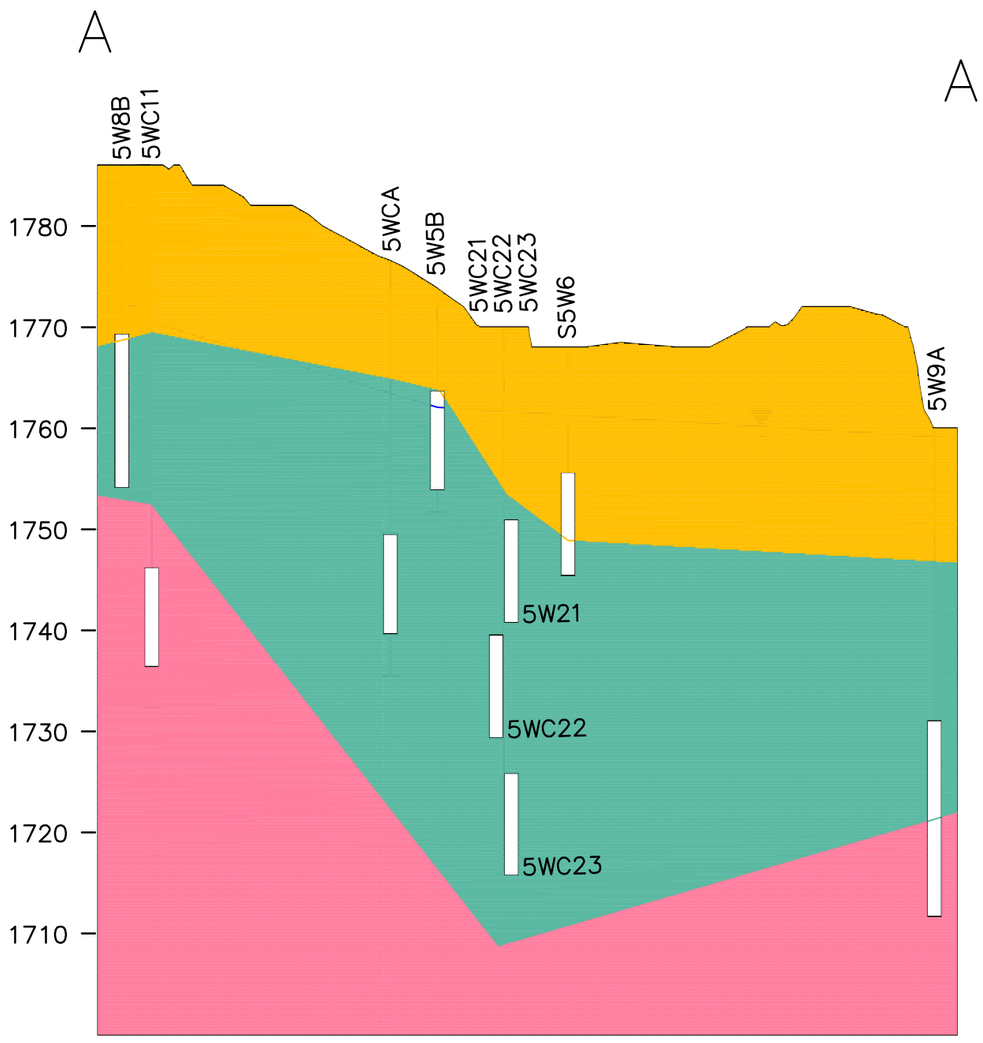

LEGEND

- ALLUVIUM (SILT, SAND, AND GRAVEL)
- WEATHERED BEDROCK (SANDY SILT AND CLAY, RELICT ROCK TEXTURE)
- ELBROOK FORMATION (LIMESTONE AND SHALE, BRECCIATED)
- GROUNDWATER MONITORING WELL
  - SCREENED INTERVAL
  - BOTTOM OF WELL
  - BORING TERMINATION
- POTENTIOMETRIC SURFACE (MEASURED FIRST QUARTER 2001)

VERTICAL EXAGGERATION = 10X

NOTE: 5WC21, 5WC22, AND 5WC23 ARE THREE NESTED WELLS

GRAPHIC SCALE

150 0 75 150 300 600

(IN FEET)
1 inch = 150 ft.

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Hampton Roads, VA

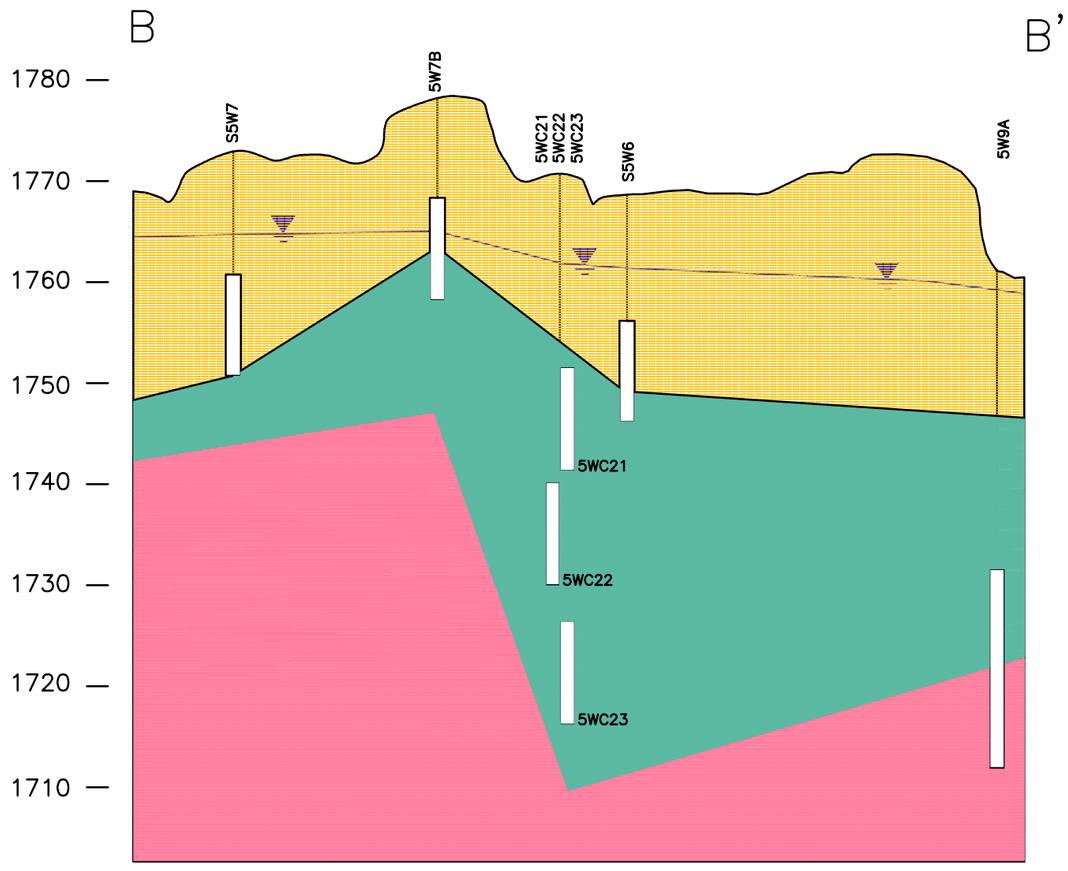
DESIGNED	RGM
DRAWN	KKD
CHECKED	MDL
DATE	04/17/07

GEOLOGIC CROSS-SECTION A-A' - HWMU 5 TCE ALTERNATE SOURCE DEMONSTRATION
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

SCALE: H: 1"=150' V:1"=15'

PLAN NO. B03204-102

FIGURE 6



LEGEND

- ALLUVIUM (SILT, SAND, AND GRAVEL)
- WEATHERED BEDROCK (SANDY SILT AND CLAY, RELICT ROCK TEXTURE)
- ELBROOK FORMATION (LIMESTONE AND SHALE, BRECCIATED)
- GROUNDWATER MONITORING WELL
  - SCREENED INTERVAL
  - BOTTOM OF WELL
  - BORING TERMINATION
- POTENTIOMETRIC SURFACE (MEASURED FIRST QUARTER 2001)

VERTICAL EXAGGERATION = 10X

NOTE: 5WC21, 5WC22, AND 5WC23 ARE THREE NESTED WELLS

GRAPHIC SCALE

150 0 75 150 300 600

(IN FEET)
1 inch = 150 ft.

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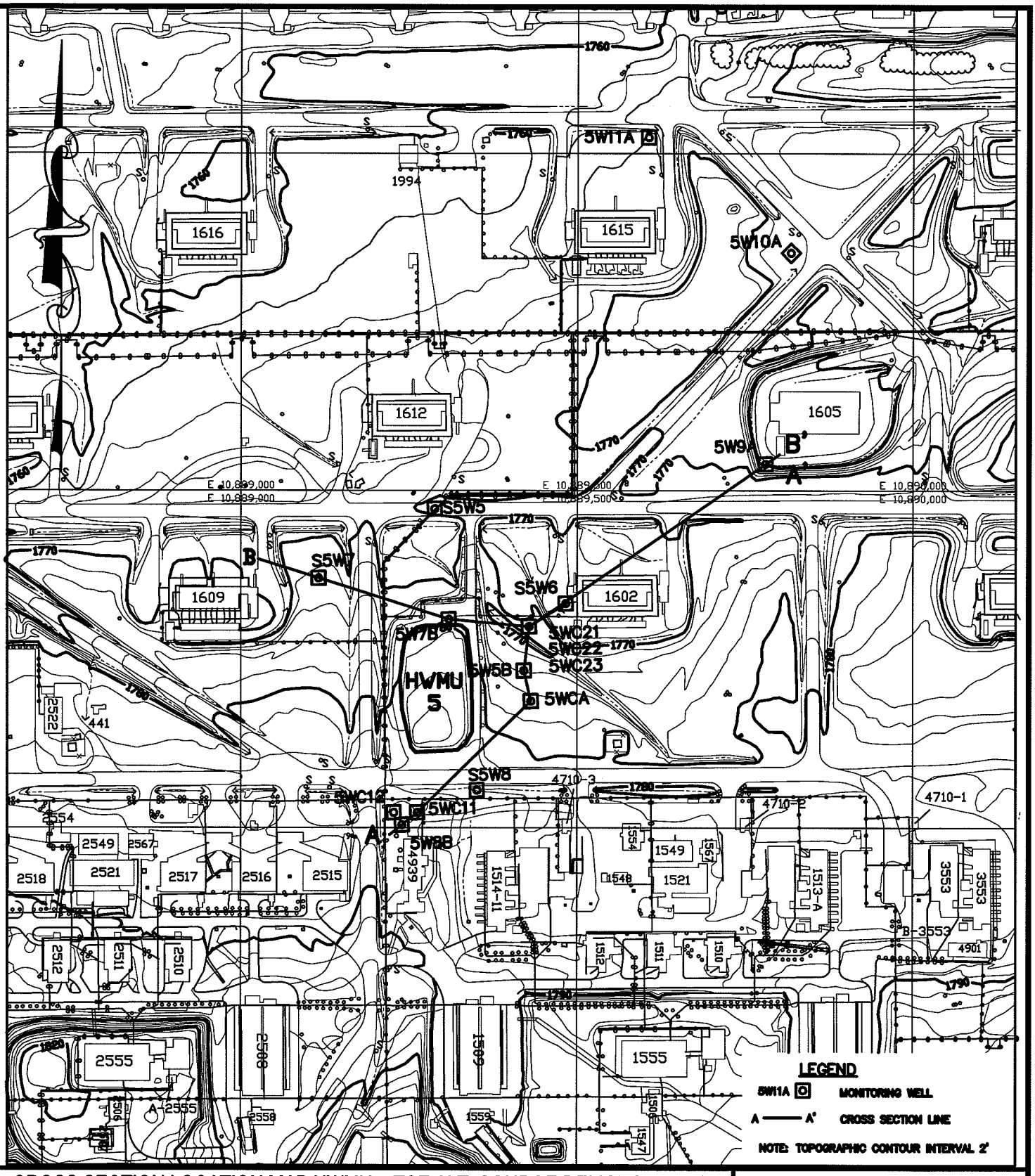
DESIGNED	RGM
DRAWN	KKD
CHECKED	MDL
DATE	04/17/07

GEOLOGIC CROSS-SECTION B-B' - HWMU 5 TCE ALTERNATE SOURCE DEMONSTRATION
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

SCALE: H: 1"=150' V:1"=15'

PLAN NO. B03204-102

FIGURE 7



CROSS SECTION LOCATION MAP HWMU-5 TCE ALT. SOURCE DEMONSTRATION

RADFORD ARMY AMMUNITION PLANT

RADFORD, VIRGINIA

SCALE: 1"=200'

PLAN NO. B03204-102

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DESIGNED	LCL
DRAWN	KKD
CHECKED	MDL
DATE	04/17/07

FIGURE 8

P:\B03\200\B03204\B03204-102\CAD\B03204-102_ENVdwg\B03204-102 - CROSS SECTION LOCATION MAP.dwg April 17, 2007 9:43:11 AM

LEGEND

- HWMU 5 — HAZARDOUS WASTE MANAGEMENT UNIT 5
- HISTORIC SINKHOLE LOCATIONS MAPPED BY THE USEPA ENVIRONMENTAL PHOTOGRAPHIC INTERPRETATION CENTER (1992)
- FRACTURE TRACES MAPPED BY THE USEPA ENVIRONMENTAL PHOTOGRAPHIC INTERPRETATION CENTER (1992)
- FRACTURE TRACES MAPPED BY DAA (2007)
- 5W10A — MONITORING WELL
- 5GP–1 — OCT. 2002 GEOPROBE BORING LOCATION
- 5GP–17 — FEB. 2004 CLOSURE SOIL SAMPLE LOCATION
- SURFACE DRAINAGE BOUNDARIES

POTENTIAL TCE SOURCES (TCE USED IN THESE AREAS)

- 1041–DEGREASING BUILDING
- 1034–FORMER LABORATORY BUILDING EXISTING ELECTRICAL MAINTENANCE SHOP
- 1549 MAINTENANCE RELATED BUILDING

NOTE: MAP AREA IS UNDERLAIN BY THE CAMBRIAN AGED ELBROOK FORMATION (LIMESTONE/DOLOMITE)

GROUNDWATER FLOW DIRECTION

GRAPHIC SCALE

60 0 30 60 120 240

(IN FEET)
1 inch = 60 ft.

5W11A 5W10A 5W9A S5W6 S5W5 5WC2 5WC22 5WC23 5W5B 5WCA STA. 5 S5W7 S5W8 5WC11 5WC1 5W8B

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SITE MAP / GEOLOGICAL FEATURES MAP W/ SOIL SAMPLING LOCATIONS
HWMU-5 TCE ALTERNATE SOURCE DEMONSTRATION
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

REVISIONS

DESIGNED BY:	RGM
DRAWN BY:	AVW
CHECKED BY:	MDL
SCALE:	1" = 60'
DATE:	MARCH 20, 2007
PROJECT NUMBER:	B03204-102

FIGURE 9

LEGEND

- HWMU 5 — HAZARDOUS WASTE MANAGEMENT UNIT 5
- HISTORIC SINKHOLE LOCATIONS MAPPED BY THE USEPA ENVIRONMENTAL PHOTOGRAPHIC INTERPRETATION CENTER (1992)
- FRACTURE TRACES MAPPED BY THE USEPA ENVIRONMENTAL PHOTOGRAPHIC INTERPRETATION CENTER (1992)
- FRACTURE TRACES MAPPED BY DAA (2007)
- 5W10A ⊡ — MONITORING WELL
- SURFACE DRAINAGE BOUNDARIES

POTENTIAL TCE SOURCES (TCE USED IN THESE AREAS)

- 1041—DEGREASING BUILDING
- 1034—FORMER LABORATORY BUILDING EXISTING ELECTRICAL MAINTENANCE SHOP
- 1549 MAINTENANCE RELATED BUILDING

NOTE: MAP AREA IS UNDERLAIN BY THE CAMBRIAN AGED ELBROOK FORMATION (LIMESTONE/DOLOMITE)

GROUNDWATER FLOW DIRECTION

SEWER LEGEND

- NEW LINE
- GENERAL PURPOSE
- STORM DRAIN
- SANITARY SEWER
- ACID
- MAN HOLE
- SEPTIC TANK
- CATCH TANK

GRAPHIC SCALE

60 0 30 60 120 240

(IN FEET)
1 inch = 60 ft.

5W11A 5W10A 5W9A 5W5B 5WCA S5W6 S5W5 S5W7 S5W8 5W8B 5WC11 5WC2 5WC22 5WC23 1615 1605 1601 1602 1612 1613 1546 1549 1561 1553 1541 1517 1521 1522 1780 1770 1760 1790 1800 1785

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SITE MAP / GEOLOGICAL FEATURES MAP W/ SEWER LINES & DRAINS
HWMU-5 TCE ALTERNATE SOURCE DEMONSTRATION
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

REVISIONS

DESIGNED BY:	RGM
DRAWN BY:	AVW
CHECKED BY:	MDL
SCALE:	1" = 60'
DATE:	MARCH 20, 2007
PROJECT NUMBER:	B03204-102

FIGURE 10

TABLES

TABLE 1

HAZARDOUS WASTE MANAGEMENT UNIT 5
SUMMARY OF TRICHLOROETHENE CONCENTRATIONS IN GROUNDWATER 1996-2006
RADFORD ARMY AMMUNITION PLANT, RADFORD, VIRGINIA

Monitoring Event	Trichloroethene Concentrations in ug/l										
	5W8B	5W5B	5WC21	5WC22	5WC23	5W7B	S5W5	S5W7	5W9A	5W10A	5W11A
1st Qtr 1996	~	2.3	~	2.2	2.9	~	~	~	0.6 J	~	~
2nd Qtr 1996	~	5.7	~	3.8	4.5	~	~	~	0.7 J	~	~
3rd Qtr 1996	~	4.3	0.4 J	5	5.8	~	~	~	0.8 J	~	~
4th Qtr 1996	~	2.4	0.9 J	6.2	5.3	~	~	~	0.6 J	~	~
1st Qtr 1997	~	2.5	1.8	7.4	6.6	0.2 J	~	0.1 J	0.3 J	~	~
2nd Qtr 1997	0.3 J	7.8	2.7	7.4	6.8	0.1 J	0.4 J	~	0.8 J	0.1 J	~
3rd Qtr 1997	~	6	2.4	8.4	8.7	~	0.2 J	~	0.5 J	~	~
4th Qtr 1997	0.8 J	9.4	1.2	8.9	2.8	0.3 J	0.3 J	~	0.3 J	~	~
1st Qtr 1998	~	3.2	0.5	4.5	5.6	~	~	~	0.2 J	~	~
2nd Qtr 1998	~	~	1.3	4.7	4.7	~	0.2 J	~	0.2 J	~	~
3rd Qtr 1998	~	12.8	2	4.7	5.1	~	~	~	0.5 J	~	~
4th Qtr 1998	~	7.5	4.6	5.4	5.6	~	~	~	~	~	~
1st Qtr 1999	~	9.5	6.7	7.5	7.5	~	~	~	~	7.4	~
2nd Qtr 1999	~	15.9	5.6	6.7	6	~	~	~	0.2 J	~	~
3rd Qtr 1999	~	20.5	7.8	9.9	7.8	~	~	~	0.5 J	~	~
4th Qtr 1999	~	19.5	4.06	6.68	6.98	~	~	~	~	~	~
1st Qtr 2000	~	15.8	3.1	6.3	6.3	~	~	~	~	~	~
2nd Qtr 2000	~	13.2	3.9	5.7	5.5	~	~	~	~	~	~
3rd Qtr 2000	~	16.3	5.42	DRY	DRY	~	~	~	~	~	~
4th Qtr 2000	~	14.9	6.55	5.33	5.41	~	~	~	~	~	~
1st Qtr 2001	~	18.8	7.32	5.81	4.98	~	~	~	~	~	~
2nd Qtr 2001	~	1.67	12.1	9.33	9.11	~	~	~	~	~	~
3rd Qtr 2001	~	6.06	20.4	13.2	11.8	~	~	~	~	~	~
4th Qtr 2001	~	9.91	19.2	7.78	7.83	~	~	~	~	~	~
1st Qtr 2002	9.13	~	19.1	6.63	6.33	~	~	~	~	~	~
2nd Qtr 2002	~	9.84	16.6	7.03	6.25	~	~	~	~	~	~
3rd Qtr 2002	~	6.36	8.46	1.94	2.13	~	~	~	~	~	~
4th Qtr 2002	~	5.84	11.3	2.54	2.69	~	~	~	~	~	~
1st Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2003	~	4.2	26	7.4	7.6	~	~	~	~	~	~
3rd Qtr 2003	~	1.9	22	8	7.9	~	~	~	~	~	~
4th Qtr 2003	~	6	23	7.1	7.1	~	~	~	~	~	~
1st Qtr 2004	~	7.4	23	7.4	6.8	~	~	~	~	~	~
2nd Qtr 2004	~	8	22	6.2	6.8	~	~	~	~	~	~
3rd Qtr 2004	~	7	17	4.8	4.9	~	~	~	~	~	~
4th Qtr 2004	~	9.4	20	6.2	6.6	~	~	~	~	~	~
1st Qtr 2005	~	7.9	24	5.9	5.9	~	~	~	~	~	~
2nd Qtr 2005	~	13	16	5.5	5.8	~	~	~	~	~	~
3rd Qtr 2005	~	12	10	4.2	5.1	~	~	~	~	~	~
4th Qtr 2005	~	12	6.8	4.4	4.3	~	~	~	~	~	~
1st Qtr 2006	~	8.5	3.9	3.7	4.5	~	~	~	~	~	~
2nd Qtr 2006	~	17	4	4	4	~	~	~	~	~	~
3rd Qtr 2006	~	11	3.7	3.3	3.7	~	~	~	~	~	~
4th Qtr 2006	~	9.4	3.5	4.7	3.5	~	~	~	~	~	~

NOTES:

Well 5W8B is the upgradient monitoring well for HWMU-5.

~: Not detected.

J: Trichloroethene was detected at a concentration greater than the detection limit but less than the quantitation limit. These results are estimates only.

DRY: Monitoring wells 5WC22 and 5WC23 were dry during 3rd Quarter 2000. No samples were collected.

NA: Not analyzed. The monitoring wells at HWMU-5 were not analyzed for trichloroethene during 1st Quarter 2003.

TABLE 2

HAZARDOUS WASTE MANAGEMENT UNIT 5
SUMMARY OF TAL INORGANIC CONSTITUENTS AND TCL ORGANIC CONSTITUENTS DETECTED IN RESIDUAL MATERIAL AND SOILS
RADFORD ARMY AMMUNITION PLANT, RADFORD, VIRGINIA

Concentrations in mg/kg and based on dry weight

Analyte / Sample Location	Date	Aluminum	Arsenic*	Barium*	Beryllium*	Calcium	Chromium*	Cobalt	Copper	Iron	Lead*	Magnesium	Manganese	Mercury*	Nickel*	Potassium	Sodium	Thallium	Vanadium	Zinc	Cyanide*	Aroclor-1254*	Chlordane*	4,4-DDD*	Trichloroethene*
CAP MATERIAL SAMPLE																									
5GP-1 (1-2')	10/31/02	19200	2.2	85.1	~	1060	22.4	9	13.9	30700	12.9	1530	337	~	9.4	1580	~	~	64.9	35.3	~	~	~	~	~
RESIDUAL MATERIAL SAMPLES																									
5GP-1 (9-10')	10/31/02	12100	3.9	47.3	1.1	~	31.7	17.6	19.8	26700	9.8	1730	360	~	19	851	~	~	32	20.7	~	~	~	0.019	~
5GP-3 (9-10')	10/31/02	14800	2.6	37.2	~	866	22.8	~	9.5	24400	9.7	~	90.8	~	5.3	~	~	~	54.3	18.6	~	~	~	~	~
5GP-6 (10-11')	10/31/02	19400	1.6	56.9	~	9930	17.9	~	11.6	22400	11.3	1220	154	~	7.9	1120	~	~	57.5	26.4	~	~	~	0.0067	~
5GP-8 (7-8')	10/31/02	14200	4.1	46.1	1.3	~	21.6	11.6	16.8	28400	9.6	1410	242	~	10.7	1090	~	~	26.7	23.9	~	~	~	0.051	~
5GP-8 (11-12')	10/31/02	19600	3.4	61.4	0.81	~	26.9	10	14.8	29000	9.6	1560	372	~	11	1420	~	~	55.2	33.8	~	~	~	~	~
BOTTOM CLAY LINER/NATIVE SOIL UNDERLYING UNIT																									
5GP-18 (13')	02/17/04	15000	3.8	~	~	639	23.5	~	7.5	23500	10.6	~	225	~	~	~	~	~	45.5	18.5	~	~	~	~	~
5GP-20 (14')	02/17/04	18900	2.7	59.8	~	1000	19.8	~	8.8	14700	8.4	~	207	0.12	7	781	~	~	42.2	21.5	~	~	~	~	~
5GP-22 (14')	02/17/04	12700	2.8	78.8	~	~	15.6	~	6.5	12900	9.9	~	331	~	5.3	~	~	~	36.1	17.5	~	~	0.0015	~	~
5GP-22-22 (14') (Field Duplicate)	02/17/04	13900	3.7	91.2	~	~	18.7	~	6.6	14800	10.2	~	372	~	6.1	~	~	~	38.8	19.9	~	~	~	~	~
5GP-23 (14')	02/17/04	16600	3.7	57.6	~	12000	22.2	~	9.2	18100	21.9	906	268	~	7	833	~	~	45	20.6	~	~	~	~	~
5GP-24 (14')	02/17/04	13000	3.6	49.5	~	18700	25.7	~	7.5	17100	24	864	245	~	5.3	856	~	~	36.6	18.7	~	0.052	~	0.0044	~
NATIVE SOIL UNDERLYING UNIT																									
5GP-17 (15')	02/17/04	18300	3.2	53.3	~	~	20.8	~	9.7	21400	10.1	698	380	~	7	826	~	~	54.1	22.4	~	0.039	~	0.0074	~
5GP-19 (15')	02/17/04	17400	3.4	62.1	~	1970	18.8	~	8.8	15300	9.9	~	247	0.13	6.7	719	~	~	44.7	20.6	~	~	~	0.0045	~
5GP-21 (14')	02/17/04	12800	3.1	44	~	12000	17.9	9.5	8.5	16500	27.4	1330	520	~	9.3	1180	1190	1.2	32.6	21.6	0.62	0.039	~	0.01	0.011
5GP-21-21 (14') (Confirmation Sample)	03/24/04	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	0.12
SOIL ADJACENT TO UNIT																									
5GP-12 (3-4')	10/31/02	19600	2.7	56.2	~	3200	27	9.1	13.6	33400	12.6	2200	457	~	8.2	915	~	~	61.8	32.1	~	~	~	~	~

TABLE 2

HAZARDOUS WASTE MANAGEMENT UNIT 5
SUMMARY OF TAL INORGANIC CONSTITUENTS AND TCL ORGANIC CONSTITUENTS DETECTED IN RESIDUAL MATERIAL AND SOILS
RADFORD ARMY AMMUNITION PLANT, RADFORD, VIRGINIA

Analyte / Sample Location	Date	Concentrations in mg/kg and based on dry weight																								
		Aluminum	Arsenic*	Barium*	Beryllium*	Calcium	Chromium*	Cobalt	Copper	Iron	Lead*	Magnesium	Manganese	Mercury*	Nickel*	Potassium	Sodium	Thallium	Vanadium	Zinc	Cyanide*	Aroclor-1254*	Chlordane*	4,4-DDD*	Trichloroethene*
UNIT BACKGROUND SAMPLE LOCATION																										
5GP-16 (3-4')	10/31/02	17000	4	51.2	~	1020	24.4	8.2	10.6	28200	11.4	812	393	~	6.3	~	~	~	55.4	20.2	~	~	~	~	~

NOTES:
*: Hazardous Constituent (listed in Appendix VIII to 40 CFR Part 261).
~: Not detected above the Limit of Quantitation (LOQ).
na: Sample was not analyzed for that constituent.
Any TAL inorganic constituents and TCL organic constituents that are not listed were not detected in any of the samples.

APPENDIX A

MONITORING WELL BORING LOGS/CONSTRUCTION DIAGRAMS

HWMU 5

RAAP

UNIT 5

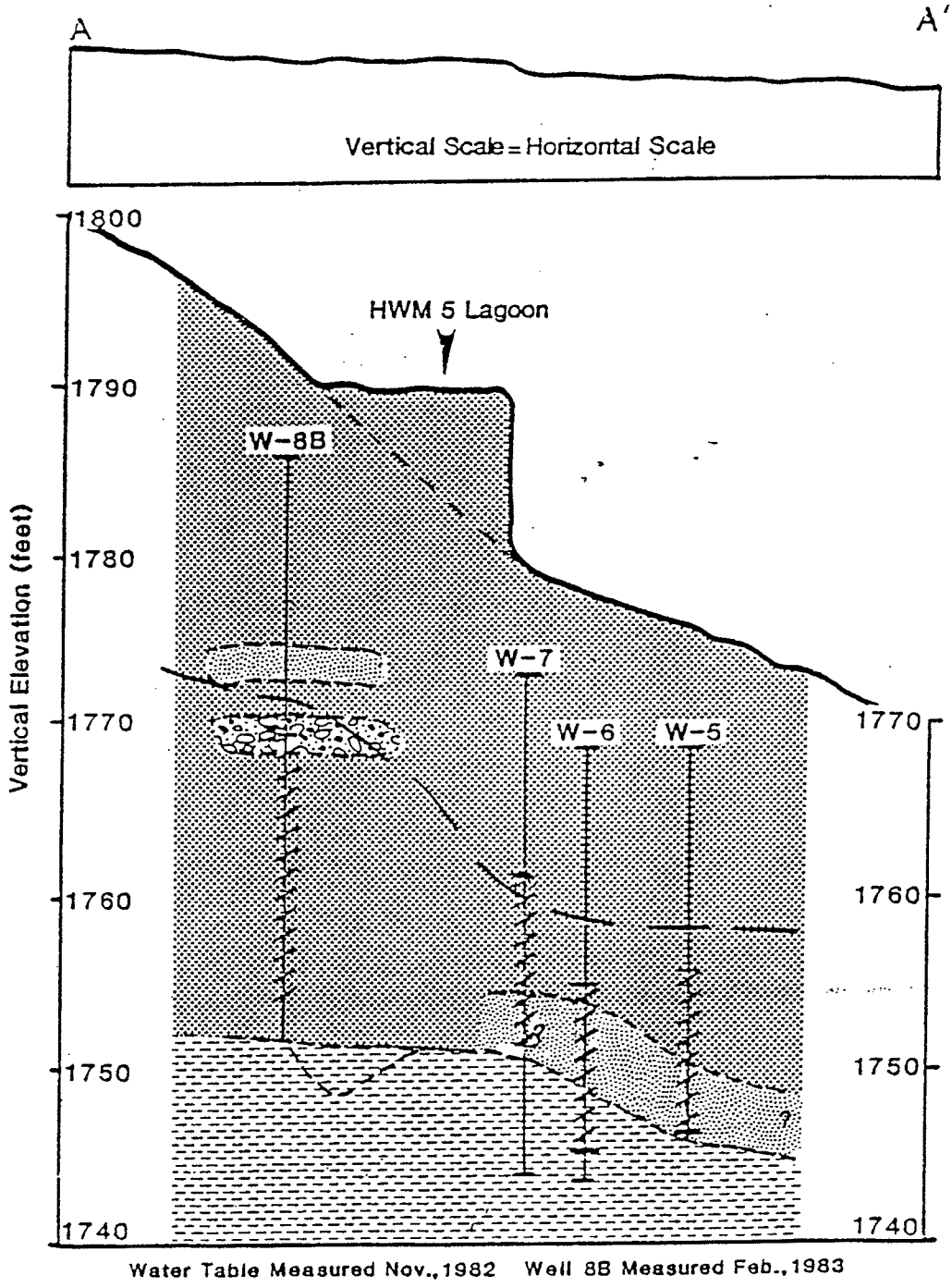
02/07/95

WELLS	TYPE	STATUS	TD	DATE DRILLED	BORING LOG	COMPLETIO DIAGRAM	DATUM G.L.	DATUM T.O.C.	SCREEN LENGTH	SCREEN SIZE	SCREEN SLOT	SCREEN TYPE
W8-B	UP/BG	ACTIVE	31.50	02/16/83	YES	YES	1787.58	1789.55	15.00	2.00	0.01	PVC
5WC2-1	POC	ACTIVE					1772.10	1774.43				
W5-B	POC	ACTIVE			YES	YES	1773.13	1775.08	10.00	2.00	0.01	PVC
W7-B	POC	ACTIVE	20.00		YES	YES	1772.78	1774.90	10.00	2.00	0.01	PVC
5WC2-2	ASMT	ACTIVE					1771.99	1774.45				
5WC2-3	ASMT	ACTIVE					1771.28	1773.84				
S5W-5	ASMT	ACTIVE	25.00	04/05/81	YES	YES	1769.81	1771.74	10.00	2.00	PVC40	
S5W-6	ASMT	ACTIVE					1769.42	1771.43				
S5W-7	ASMT	ACTIVE	26.00	04/05/81	YES	YES	1773.08	1775.06	10.00	2.00	PVC40	
W10-A	ASMT	ACTIVE			YES		1768.42	1770.79	20.00			TEFLON
W11-A	ASMT	ACTIVE			YES		1764.70	1765.90				
W9-A	ASMT	ACTIVE			YES		1761.07	1761.82				
5WC1-2		SWL					1787.43	1789.89				
5WCA	POC	SWL					1777.37	1779.96				
5WC1-1	UP	SWL					1787.55	1789.99				
S5W-8	UP	SWL	34.00	04/05/81	YES		1783.51	1784.77	5.00	2.00	PVC40	
S5W-8	UP	SWL					1787.02	1785.28				

RAAP

UNIT 5

WELLS			GROUT		ANNULAR SEALANT		FILTER PACK		hydraulic conductivity	
	TOP	BASE	TOP	BASE	TOP	BASE	TOP	BASE	K (ft/sec)	K (cm/sec)
W8-B	16.50	31.50							3.84E-04	1.17E-02
5WC2-1	(1749.80)								3.14E-06	9.58E-05
W5-B	10.00	20.00	0.00	6.00	8.00	10.00	8.00	20.00		
W7-B	10.00	20.00								
5WC2-2	(1749.80)								2.52E-05	7.69E-04
5WC2-3	(1725.39)								2.76E-05	8.42E-04
S5W-5	13.00	23.00								
S5W-6	(1755.42)									
S5W-7	12.00	22.00								
W10-A	(1745.77)									
W11-A	(1735.90)									
W9-A	(1729.85)									
5WC1-2	(1721.63)								1.10E-06	3.36E-05
5WCA	(1747.27)								2.37E-07	7.23E-06
5WC1-1	(1745.25)								9.60E-06	2.93E-04
S5W-8	29.00	34.00								
S5W-8	(1757.52)									



HORIZONTAL SCALE

0 200'

LEGEND

- Sandy Silt
- Sand with Silt and Gravel
- Sand, Gravel and Cobbles
- Bedrock
- Water Table

Monitoring Well Profile

Screened Interval

BCM Betz-Converse-Murdoch-Inc.
Engineers, Planners and Scientists

RAAP HWM 5

Geology and Groundwater Profile

FIGURE 2

Betz·Converse·Murdoch·Inc. BCM

UNITS
W-8B

Drilling Log

Well Number W-8-B

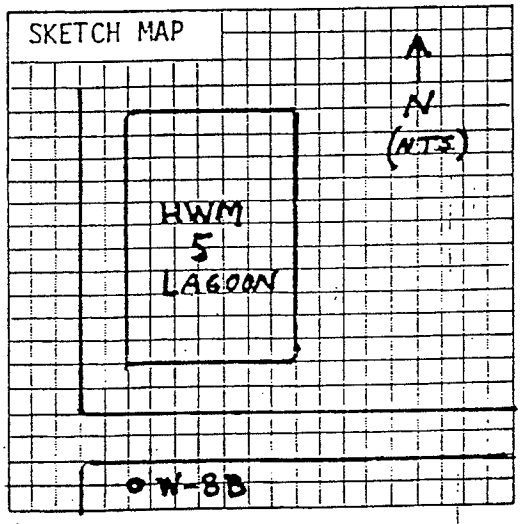
Client Corps of Engineers/Radford AAP — Project No. 00-0008-01
Well Location upgradient from lagoon No. 5
Driller/Company Dean/Cunningham
Drilling Method NX core — Hole Diameter nominal 4" — Date(s) Drilled 2/15 - 16/83
Sample Type split spoon/core — Sample Interval 5' spoon — No. Samples Retained 7
Surface Elevation 1787.58' — Casing Top Elevation 1789.55' — Total Well Depth 31.5
Casing Material and Size 2" ID PVC threaded couples — Cased Interval(s) 0 - 16.5 (+2's
Grouting Type sand cement — Grouted Interval 0-15.5 incl. 1'
Screening Material and Size 2" ID PVC 0.010" slots — Screened Interval(s) 16.5 - 31.5
Packing Material and Size No. 1 sand — Packed Interval 15.5 - 31.5
Depth to Static Water 17'4"* — Date 2/18/83 — Approx Well Yield <0.25 gpm
Development Method air — Development Time 3 hours
Logged by: Peter R. Jacobson

Comments

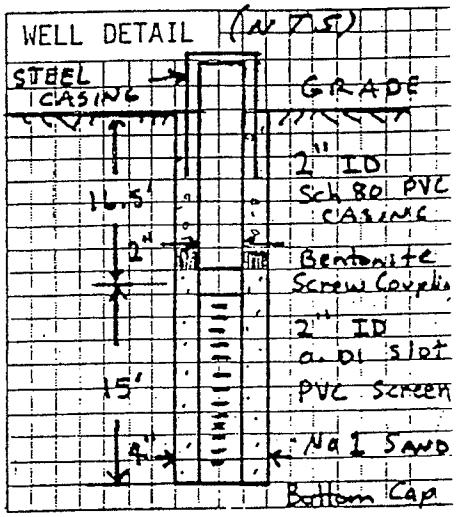
no core recovery

* measured from top of casing

SKETCH MAP



WELL DETAIL (NOT TO SCALE)



Depth Scale	Sample	Spoon Blows	Description of Materials
0 - 1.5	spoon	1-5-6	medium brown to orange brown silty clay with angular pebbles
5 - 6.5	spoon	1-2-2	medium orange brown silty clay with minor fine sand
10 - 11.5	spoon	3-6-14	slightly moist mottled orange brown clay, minor silt and fine sand
14'4"			coarse sand and gravel layer
15 - 16.5	spoon	11-17-45	poorly sorted mix of sand silt gravel clay; coarsening downward; gravel ends at 17.5'
20 - 21.5	spoon	5-5-8	mottled orange/red brown clay, moist
25 - 26.5	spoon	1-2-2	wet soft brown clay with silt and fine sand
30 - 31.5	spoon	1-3-2	wet medium orange brown silty clay, minor sand
end of hole at 31.5'			

Betz-Converse-Murdoch-Inc. BCM

UNIT 5
W-5B

Drilling Log

Well Number W-5B

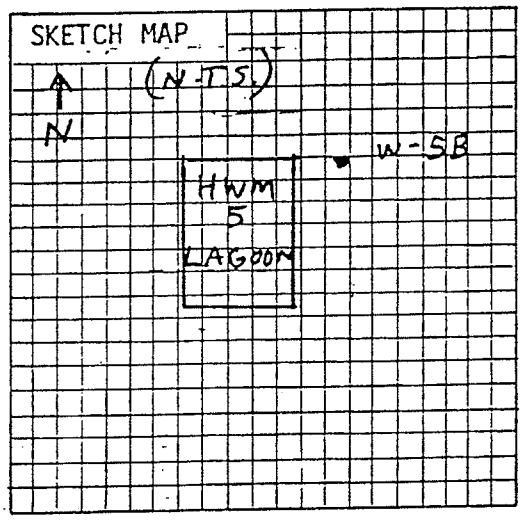
Client Corps of Engineers, RAAP, Radford, VA
Project No. 00-0008-01
Well Location East of HWM 5 Lagoon
Driller/Company M. Dean, Cunningham Core Drilling and Grouting Corp, Salem, VA
Drilling Method Fishtail Hole Diameter 4.5"
Date(s) Drilled 8/17-18/83
Sample Type Split Spoon Sample Interval 5'
No. Samples Retained 4
Surface Elevation 1773.13 Casing Top Elevation 1775.08'* Total Well Depth 22'
Casing Material and Size 2" ID Sch. 80 PVC
Cased Interval(s) 0-10'
Grouting Type Portland Cement with Sand
Grouted Interval 0-6'
Screening Material and Size 2" ID 0.01 Slotted PVC
Screened Interval(s) 10-20'
Packing Material and Size Fine to Coarse Silica Sand
Packed Interval 8-20'
Depth to Static Water 14.31 (T.O.C.) Date 8/19/83
Approx Well Yield < 1 gpm
Development Method Air
Development Time 4 hours
Logged by: D. J. Varner

Comments

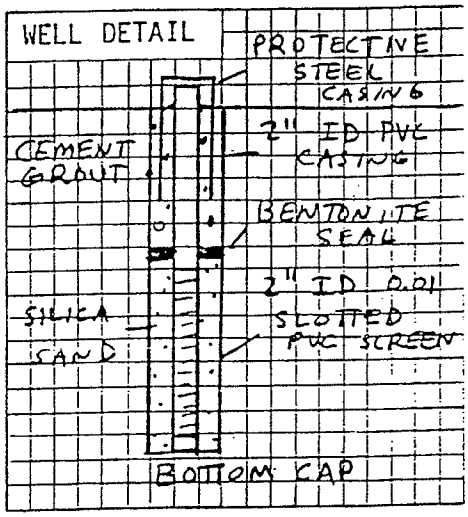
1) Drilling water obtained from RAAP hydrants
2) Replaces well W-5
3) Bentonite pellet seal in the 8-10' annular interval
4) Depth to water table measured from the top of the steel casing

*Top of steel casing

SKETCH MAP



WELL DETAIL



Depth Scale	Sample	Spoon Blows	Description of Materials
5-6.5	Spoon	2-3-4	Somewhat mottled buff to orange-brown fine sandy and silty clay
10-11.5	Spoon	4-7-9	Tan Clay with fine to coarse sand
15-16.5	Spoon	4-5-7	Tan clay with scattered sand
20-21.5	Spoon	2-2-4	Brown sandy clay
22			End of hole

W-7B

Betz·Converse·Murdoch·Inc. BCM

Drilling Log

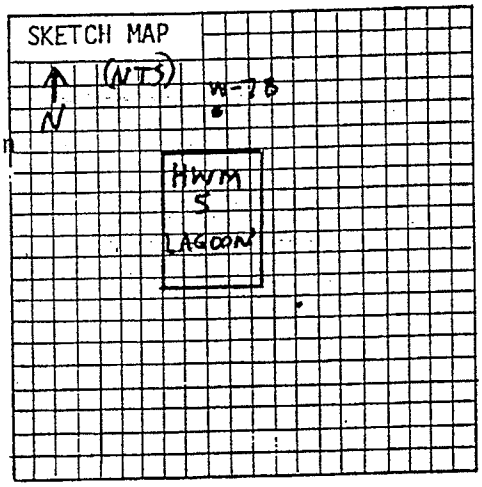
Well Number W-7B

Client Corps of Engineers, RAAP, Radford, VA — Project No. 00-0008-01
Well Location North of HWM5 Lagoon
Driller/Company M. Dean, Cunningham Core Drilling and Grouting Corp, Salem, VA
Drilling Method Fishtail/Core — Hole Diameter 4.5" — Date(s) Drilled 8/18/83
Sample Type Split Spoon — Sample Interval 5' — No. Samples Retained 4
Surface Elevation 1772.78 — Casing Top Elevation 1774.90'* — Total Well Depth 20'
Casing Material and Size 2" ID Sch. 80 PVC — Cased Interval(s) 0-10'
Grouting Type Portland Cement with Sand — Grouted Interval 0-6'
Screening Material and Size 2" ID 0.01 Slotted PVC — Screened Interval(s) 10-20'
Packing Material and Size Fine to coarse silica sand — Packed Interval 8-20'
Depth to Static Water 13.58'(T.O.C.) Date 8/19/83 — Approx Well Yield < 1 gpm
Development Method Air — Development Time 4 hours
Logged by: D. J. Varner

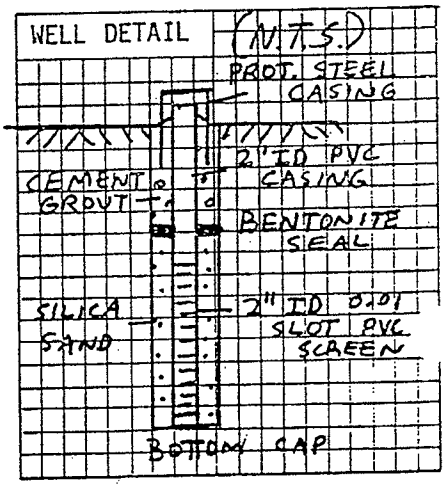
Comments
1) Drilling water obtained from RAAP hydrants
2) Replaces well W-7
3) Bentonite pellet seal in the 6-8' annular interval
4) Depth to water table measured from the top of the steel casing
5) Core size: HW

*Top of steel casing

SKETCH MAP



WELL DETAIL (N.T.S.)



Depth Scale	Sample	Spoon Blows	Description of Materials
5-6.5	Spoon	5-7-4	Light reddish-brown very silty fine sand with mica, black lignite, and some clay
10-11.5	Spoon	2-3-4	Light reddish-brown very silty fine sand with mica, black lignite, and some clay
15-16.5	Spoon	6-9-19	Orange-red and tan brecciated decomposed shale with a clay matrix and some lignite
20-21.5	Spoon	5-2-4	Orange-red and tan brecciated decomposed shale with a clay matrix and some lignite.
20			End of hole.

HWMU 5\ 5-WC2-1

Form No. 500

BORING LOG

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING/CHEMIC
"ONE HUNDRED YEARS OF SERVICE"
1881

Report No. 0-62084 DATE May 1987

Client: Hercules Inc.

Project Radford Army Ammunition Plant Radford, Virginia

Boring No.: 5-WC2-1 | Total Depth: 31.8 ft. | Elevation: -------- | Location: See Location Plan

Type of Boring: Hollow Stem Auger | Started: 5/5/87 | Completed: 5/5/87 | Driller: W. Simmons

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	REMARKS
	0.0	Medium dense red brown silty fine SAND, trace mica (SM)	$^{3}6_{10}$	1.5		GROUNDWATER DATA
				3.0		
			$^{4}5_{9}$	4.5		
		-to-		6.0		
		Very loose to medium dense yellow brown silty medium to fine SAND (SM)	$^{2}2_{2}$	8.5		
				10.0		
		-ALLUVIUM-				
			$^{2}14_{6}$	13.5		
	16.5			15.0		
		Medium dense to very loose yellow brown silty coarse to fine SAND (angular rock Fragments) (SM)	$^{9}14_{8}$	18.5		
				20.0		Subsurface water at: 22 ft. May 5, 1987 at 4:00 p.m. 29 ft, May 5, 1987 4:10 p.m.
		-RESIDUUM-	**1	23.5		*Weight of hammer
				25.0		
			$^{1}2_{3}$	28.5		
				30.0		
	31.8	Boring terminated at 31.8 ft.				

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise specified

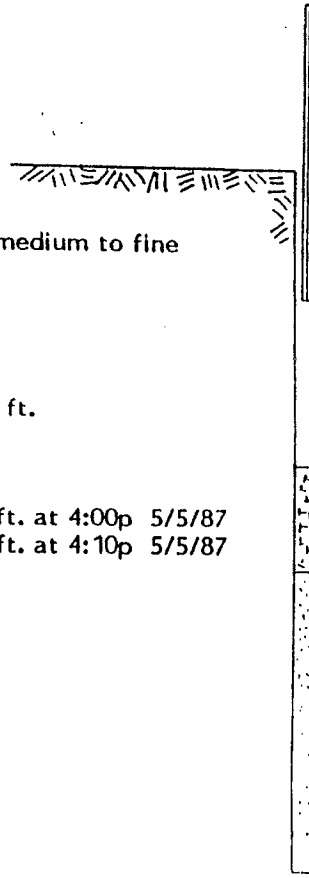
Project: Radford Army Ammunition Plant	Driller: Simmons	WELL No. 5-WC2-1
Location: Radford, Virginia	Inspector: Smith	
Client: Hercules Inc.	Date Installed: 5/6/87	
Screen Description: 0.010" slot, 2.0" I.D. Teflon Screen	Sand Size: D(10)= 0.45-0.55 mm	
Riser Description: 2.0" I.D. Teflon Riser and PVC Riser	Bore/ Core Size: 6 inch/ NX	

Subsurface Conditions Summary

Yellow to Red Brown silty medium to fine SAND (SM)

Cobbles encountered at 8.0 ft.

Subsurface water at; 22.0 ft. at 4:00p 5/5/87
29.0 ft. at 4:10p 5/5/87



Casing Stickup (ft.)= 3.0 ft.
Elev. =
Riser Stickup (ft.) = 3.0 ft.
Elev. =
Ground Elev.=
Depth to Bentonite (ft.)= 14.8 ft.
Elev. =
Depth to Sand Filter(ft.)= --------
Elev. =

10' Screen

Depth to Well Bottom(ft.)= 29.3 ft.
Elev. =
Depth of Hole (ft.) = 31.8 ft.
Elev. =

HWMU5\5-WC2-2

Form No. 500

BORING LOG

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING • CHEMICA
"ONE HUNDRED YEARS OF SERVICE"
1881

Report No. 0-62084 DATE May 1987

Client: Hercules Inc.

Project: Radford Army Ammunition Plant Radford, Virginia

Boring No.: 5-WC2-2 | Total Depth: 43.5 ft. | Elevation: -------- | Location: See Location Plan

Type of Boring: Hollow Stem Auger | Started: 5/6/87 | Completed: 5/6/87 | Driller: W. Simmons

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	REMARKS
	0.0	No sampling conducted, see 5-WC2-1 for subsurface condictions				GROUNDWATER DATA
		Cobbles encountered at 15 ft.				
		Difficult augering at 35 ft. - 40 ft.				
		Boring terminated at 43.5 ft.				

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

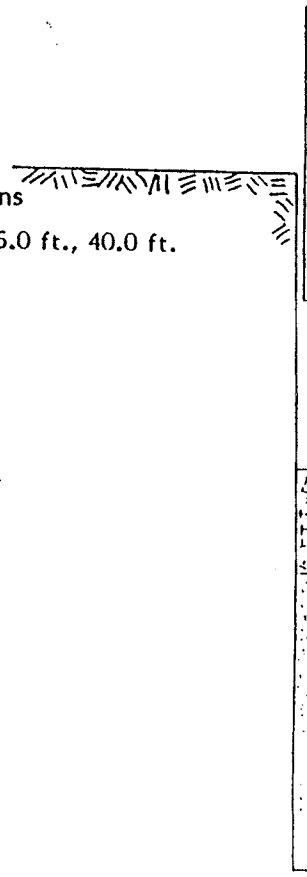
Scale 1"=5' unless otherwise noted

Project: Radford Army Ammunition Plant	Driller: Simmons	WELL No.
Location: Radford, Virginia	Inspector: Smith	5-WC2-2
Client: Hercules Inc.	Date Installed: 5/6/87	
Screen Description: 0.010" slot, 2.0" I.D. Teflon Screen	Sand Size: D(10)= 0.45-0.55 mm	
Riser Description: 2.0" I.D. Teflon Riser and PVC Riser	Bore/ Core Size: 6 inch/ NX	

Subsurface Conditions Summary

See 5-WC2-1 for Conditions

Cobbles encountered at; 15.0 ft., 40.0 ft.



Casing Stickup (ft.)= 3.0 ft.

Elev. = _____

Riser Stickup (ft.) = 3.0 ft.

Elev. = _____

Ground Elev.= _____

Depth to Bentonite (ft.)= 28.0 ft.

Elev. = _____

Depth to Sand Filter(ft.)= -------

Elev. = _____

Depth to Well Bottom(ft.)= 40.5 ft.

Elev. = _____

Depth of Hole (ft.) = 43.5 ft.

Elev. = _____

Form No. 500

BORING LOG

HWMU 5\5-WC2-3

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING/CHEMICA
"ONE HUNDRED YEARS OF SERVICE"
1881

Report No. Q-62084 DATE May 1987

Client: Hercules Inc.

Project: Radford Army Ammunition Plant Radford, Virginia

Boring No. 5-WC2-3 | Total Depth: 55.3 ft. | Elevation: -------- | Location: See Location Plan

Type of Boring: Hollow Stem Auger | Started: 5/6/87 | Completed: 5/6/87 | Driller: W. Simmons

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	REMARKS
	0.0	No sampling conducted, see 5-WC2-1 for subsurface conditions				GROUNDWATER DATA
		Cobbles encountered at 15.0 ft.				
		Difficult augering at 53.0 ft. - 55.0 ft.				
		Boring terminated at 55.3 ft.				

*No. of blows req'd for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

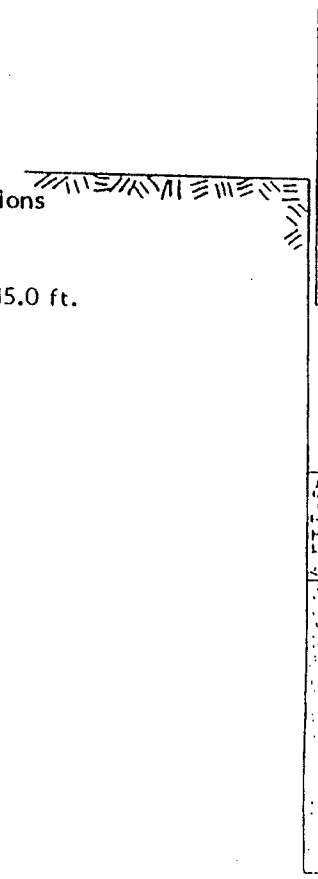
Scale 1"=5' unless otherwise noted

Project: Radford Army Ammunition Plant	Driller: Simmons	WELL No.
Location: Radford, Virginia	Inspector: Smith	5-WC2-3
Client: Hercules Inc.	Date Installed: 5/6/87	
Screen Description: 0.010" slot, 2.0" I.D. Teflon Screen	Sand Size: D(10)= 0.45-0.55 mm	
Riser Description: 2.0" I.D. Teflon Riser and PVC Riser	Bore/ Core Size: 6 inch/ NX	

Subsurface Conditions Summary

See 5-WC2-3 for Conditions

Cobbles encountered at 15.0 ft.



Casing Stickup (ft.)= 3.0 ft.

Elev. =

Riser Stickup (ft.) = 3.0 ft.

Elev. =

Ground Elev.=

Depth to Bentonite (ft.)= --------

Elev. =

Depth to Sand Filter(ft.)= --------

Elev. =

10' SCREEN

Depth to Well Bottom(ft.)= 53.6 ft.

Elev. = ~~55.3 ft.~~

Depth of Hole (ft.) = 55.3ft

Elev. =

55W5
MW-5

US ARMY ENVIRONMENTAL HYGIENE AGENCY

Army Pollution Abatement Program Study, Installation of MOnitoring Wells, Radford Army Ammunition Plant, Radford, VA, 3-9 April 1981, (USAEHA Control No. 81-26-8251-81)

DRILLING LOG

PROJECT RAAP 81-26-8251-81 DATE 5 April 81

LOCATION Site 5, north of lagoon next to building SR 1612 DRILLERS Smithson, Hoddinott Craig, Gates (logger)

DRILL RIG Acker II, w/ 4 in continuous flight auger BORE HOLE MW 5

TD= 25ft.

water level initial 7' 5" 24 hr. 8' 10"

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS	
		Brown sandy silt with some gravel wet, plastic	10 ft of Concrete grout	13 ft of schedule 40, 2 in ID PVC casing
		Perched lense of water		
5 ft.				
	MB 5-10	Yellowish brown silty clay w/ some mica flakes		
10 ft			Bentonite	
		same material		
	MB 10-15		sand pack	
				screen
15 ft				

USAEHA Form 95, 12 Aug 74

US ARMY ENVIRONMENTAL HYGIENE AGENCY

Army Pollution Abatement Program Study, Installation of Monitoring Wells, Radford Army Ammunition Plant, Radford, VA, 3-9 April 1981, (USAEHA Control No. 81-26-8251-81)

DRILLING LOG

PROJECT RAAP 81-26-8251-81

DATE 5 April 81

LOCATION Site 5, north of lagoon next to building S.R.1612

DRILLERS Smithson, Haddinott; Craig, Gates (logger)

DRILL RIG Acker II, w/ 4 in continuous flight auger

BORE HOLE MW 5

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
	MB 10-20		10 ft of slotted 2 in ID, schedule 40, PVC screen (0.008-0.01")
20 ft		water at 20 ft yellow coarse medium sand - saturated	
		change in engine pitch Elbrook FM	2 ft of trap
25 ft		TD 25 feet	Depth of well 25 ft
30 ft			

USAEHA Form 95, 12 Aug 74

5507

MW-7

US ARMY ENVIRONMENTAL HYGIENE AGENCY

Army Pollution Abatement Program Study, Installation of Monitoring Wells, Radford Army Ammunition Plant, Radford, VA, 3-9 April 1981, (USAEHA Control No. 81-26-8251-81)

DRILLING LOG

PROJECT: RAAP 81-26-8251-81

DATE: 5 April 81

LOCATION: Site 5, west of lagoon next to building S.R. 1603

DRILLERS: Smithson, Hoddinott; Craig, Gates (logger)

DRILL RIG: Acker II, w/ 4 in continuous flight Auger

BORE HOLE: MW 7 TD=26 ft

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	water level initial=14'10" 24 hr =10'10" REMARKS	
		Reddish brown silty clay dampmed plastic	Concrete	
			Bentonite	12 ft of schedule 40, 2 in ID PVC casing
			24.5 ft of sand pack	
5ft				
	MB 5-10	same material getting damper and more plastic		
10 ft				
		saturated silty medium coarse sand return on Auger- may have hit a lense of gravel		10 ft of slotted 2 in ID schedule 40 PVC screen
15 ft				

USAEHA Form 95, 12 Aug 74

US ARMY ENVIRONMENTAL HYGIENE AGENCY

Army Pollution Abatement Program Study, Installation of Monitoring Wells, Radford Army Ammunition Plant, 3-9 April 1981, (USAEHA Control No. 81-26-8251-81)

DRILLING LOG

PROJECT RAAP 81-26-8251-81

DATE 5 April 81

LOCATION Site 5, west of lagoon next to building S.R. 1603

DRILLERS Smithson, Hoddinott
Craig, Gates (logger)

DRILL RIG Acker II, w/ 4 in continuous flight Auger

BORE HOLE MW 7

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
	MB 15-20	same material saturated	screen
20 ft			
			3 ft of sediment trap
25 ft		Elbrook FM (weathered gray clay residuum)	depth of well 26 feet
		26 ft TD	
30 ft			

USAEHA Form 95, 12 Aug 74

W9A
HWMU-5

Form No. 500

BORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.

ENGINEERS • LABORATORIES • ENGINEERING CHEMICAL
"ONE HUNDRED YEARS OF SERVICE"

DATE November, 1985

Report No. ROM-62085

Client. Hercules, Inc.

Project Monitoring Wells Radford Army Ammunition Plant Radford, Virginia

Boring No. W-9-A | Total Depth: 49.0' | Elevation: --- | Location: See plan

Type of Boring. Hollow stem auger | Started: 11-6-85 | Completed: 11-6-85 | Driller. W. Simmons, Sr.

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	REMARKS
	0.0	Asphalt and crushed stone				GROUNDWATER DATA
	1.5	Loose to medium dense brown fine sandy SILT little clay -ALLUVIUM-		4.5		
			5 7 9	6.0		
				8.5		
			3 8 1	10.0		
	13.0	Soft orange-brown silty CLAY to clayey SILT (CL/ML) Relict structure -RESIDUUM-		13.5		
			2 1 1	15.0		Water level @ 16.0' Development Data: Sloshed for 2 hrs. Bailed down to 21'. Water level re-established at 16.0' after 1.5 hrs.
	39.0			39.0		Auger refusal @ 39.0'
	40.0					

*No. of blows required for a 140 lb. hammer dropping 30 in. to drive 2 in. O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

Form No 500

BORING LOG

SINCE
1881
FROEHLING & ROBERTSON, INC.
[illegible] LABORATORIES • ENGINEERING CHEMICAL
"ONE HUNDRED YEARS OF SERVICE"

DATE November, 1985

Report No ROM-62085

Client: Hercules, Inc.

Project: Monitoring Wells Radford Army Ammunition Plant Radford, Virginia

Boring No.: W-9-A cont. | Total Depth: 49.0' | Elevation: --- | Location: See plan

Type of Boring: Hollow stem auger | Started: 11-6-85 | Completed: 11-6-85 | Driller: W. Simmons, Sr.

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	RQD %	REMARKS
	40.0	Brown fine to medium grained SANDSTONE, changing to blue-gray fractured saccharoidal LIMESTONE and DOLOMITE			20%	0%	GROUNDWATER DATA
				44.0			
					30%	0%	
	49.0			49.0			
		Coring terminated @ 49.0'					

- 20' TEFLON SCREEN
- 10' PVC. 80
- ADAPTER
- 25' PVC. 40 (3' CUTOFF)

*No. of blows req'd for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

W10A

HWMU-5

Form No 500

BORING LOG

FROEHLING & ROBERTSON, INC.

"ONE HUNDRED YEARS OF SERVICE"

DATE November, 1985

Report No ROM-62085

Client: Hercules, Inc.

Project: Monitoring Wells — Radford Army Ammunition Plant — Radford, Virginia

Boring No.: W-10-A | Total Depth: 45.0' | Elevation: --- | Location: See plan

Type of Boring: Hollow stem auger | Started: 11-6-85 | Completed: 11-6-85 | Driller: W. Simmons, Sr.

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	RQD %	REMARKS
	0.0	Brown fine sandy SILT; roots, organics					GROUNDWATER DATA
	1.0	Loose to medium-dense red brown fine sandy SILT with occasional cobble layers (ML) -ALLUVIUM-		4.5			
			5 10 10	6.0			
				8.5			
			7 5 5	10.0			
				13.5			
			12 11 12	15.0			Water level @ 14.8'
							Development Data: Sloshed for 2 hrs. Bailed down for 1/2 hr. No change in water level.
	17.0	Medium-stiff gray-brown silty CLAY to clayey SILT, shale fragments, relict structure -RESIDUUM-		18.5			
			3 3 3	20.0			
				28.5	28.5		
			30 * *	30.0			* 50/0.5'
	30.0	Gray green brecciated LIMESTONE and DOLOMITE, numerous calcite-healed fractures			20%	0%	
				35.0			
					12%	0%	
	40.0			40.0			

*No. of blows req'd for a 140 lb. hammer dropping 30 in. to drive 2 in. O.D., 1 375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N

Scale 1"=5' unless otherwise noted

Form No 500

BORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.

"ONE HUNDRED YEARS OF SERVICE"

DATE November, 1985

Report No ROM-62085

Client: Hercules, Inc.

Project: Monitoring Wells Radford Army Ammunition Plant Radford, Virginia

Boring No. W-10-A cont. | Total Depth: 45.0' | Elevation: --- | Location: See plan

Type of Boring: Hollow stem auger | Started: 11-6-85 | Completed: 11-6-85 | Driller W. Simmons, Sr.

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	REMARKS
	40.0	Gray sandy LIMESTONE (Calcarenite)			42%	GROUNDWATER DATA 16%
	45.0			45.0		
		Boring terminated @ 45.0'				

- 20' TEFLON SCREEN
- 10' PVC.80
- ADAPTER
- 15' PVC.40

*No. of blows req'd for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1 375 in I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N

Scale 1" = 5' unless otherwise noted

W11A
HWMU-5

Form No. 500

BORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.

REAL ESTATE APPRAISERS • ENGINEERS • CHEMICAL

"ONE HUNDRED YEARS OF SERVICE"

Report No ROM-62085 DATE November, 1985

Client: Hercules, Inc.

Project: Monitoring Wells Radford Army Ammunition Plant Radford, Virginia

Boring No.: W-11-A | Total Depth: 48.0' | Elevation: --- | Location: See plan

Type of Boring: Hollow stem auger | Started: 11-6-85 | Completed: 11-6-85 | Driller: W. Simmons, Sr.

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	RQD %	REMARKS
	0.0	Brown fine sandy SILT; roots, organics					GROUNDWATER DATA
	1.0	Medium-dense to dense brown fine sandy SILT to silty fine SAND (ML/SM) -ALLUVIUM-		4.5			
			9 11 11	6.0			
				8.5			
			4 9 22	10.0			
				13.5			
			12 7 11	15.0			Water level @ 14.8'
	17.0	Very soft yellow-brown coarse to fine sandy CLAY, some silt (CL) relict structure -RESIDUUM-		18.5			Development Data: Sloshed 2 hours. Bailed down to 19.0'. Recovered to 14.8' after 1.5 hrs.
			1 1 1	20.0			
	28.0	Gray-brown vuggy LIMESTONE, calcite healed fractures interbedded with gray-green -FAULT BRECCIA-		28.0			
					72%	30%	
				33.0			
					33%	7%	
				38.0			
	40.0						

*No. of blows req'd for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1 3/8 in I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

Form No 500

BORING LOG

FROEHLING & ROBERTSON, INC.

"ONE HUNDRED YEARS OF SERVICE"

DATE November, 1985

Report No ROM-62085

Client: Hercules, Inc.

Project: Monitoring Wells Radford Army Ammunition Plant Radford, Virginia

Boring No W-11-A cont. Total Depth: 48.0' Elevation: --- Location: See plan

Type of Boring: Hollow stem auger Started: 11-6-85 Completed: 11-6-85 Driller: W. Simmons, Sr.

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	RQD %	REMARKS
	40.0				23%	0%	GROUNDWATER DATA
		Dark gray saccharoidal LIMESTONE		43.0			
					53%	0%	
	48.0			48.0			
		Coring terminated @ 48.0'					

- 20' PVC Screen
- 30' PVC Riser

*No. of blows req'd for a 140 lb. hammer dropping 30 in. to drive 2 in O.D. 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1" = 5' unless otherwise noted

HSWMU 515-WCA

Form No. 500

BORING LOG

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING, CHEMICA
"ONE HUNDRED YEARS OF SERVICE"
1881

Report No. 0-62084 DATE May 1987

Client: Hercules Inc.

Project: Radford Army Ammunition Plant Radford, Virginia

Boring No.: 5-WCA | Total Depth: 40 ft. | Elevation: -------- | Location: See Location Plan

Type of Boring: Hollow Stem Auger | Started: 5/7/87 | Completed: 5/11/87 | Driller: W. Simmons

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	REMARKS
	0.0					GROUNDWATER DATA
		Very loose gray brown medium to fine sandy SILT, trace coarse subrounded sand (ML)	3 2 2	1.5 3.0		
		Very loose gray braown fine sandy SILT (ML)	2 2 1	4.5 6.0		
		-ALLUVIUM-	2 2 4	8.5 10.0		
	11.5					
		Medium stiff gray to tan clayey SILT, manganese stains (ML)	2 3 4	13.5 15.0		
			2 2 3	18.5 20.0		
		Medium stiff to stiff mottled to gray silty fine SAND (SM) manganese stains	2 3 6	23.5 25.0		
		-grading to-				
		Stiff mottled to gray silty CLAY/clayey SILT (CL/ML)	3 5 7	28.5 30.0		
		-RESIDUUM-	3 5 9	33.5 35.0		
			***	38.5 40.0		*Weight of Hammer
	40.0	Boring terminated at 40.0 ft.				

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

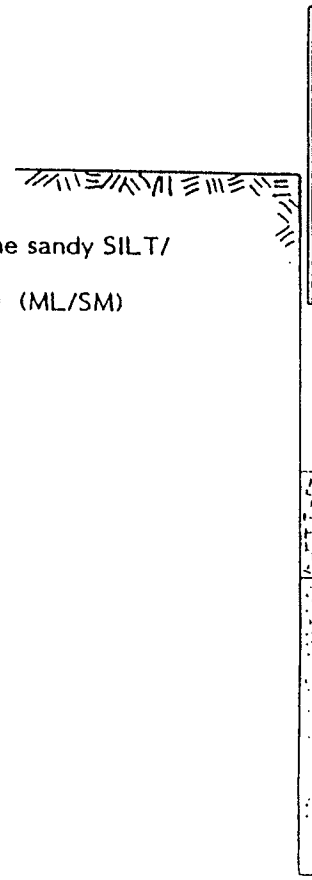
Scale 1"=5' unless otherwise noted

Project: Radford Army Ammunition Plant	Driller: Simmons	WELL No.
Location: Radford, Virginia	Inspector: Smith	5-WCA
Client: Hercules Inc.	Date Installed: 5/11/87	
Screen Description: 0.010" slot, 2.0" I.D. Teflon Screen	Sand Size: D(10)= 0.45-0.55 mm	
Riser Description: 2.0" I.D. Teflon Riser and PVC Riser	Bore/ Core Size: 6 inch/ NX	

Subsurface Conditions Summary

Gray Brown medium to fine sandy SILT/

silty medium to fine SAND (ML/SM)



Casing Stickup (ft.)= 3.0 ft.

Elev. =

Riser Stickup (ft.) = 3.0 ft.

Elev. =

Ground Elev.=

Depth to Bentonite (ft.)= 4.0 ft.

Elev. =

Depth to Sand Filter(ft.)= 25.8 ft.

Elev. =

Depth to Well Bottom(ft.)= 37.1 ft.

Elev. =

Depth of Hole (ft.) = 40.0 ft.

Elev. =

55W6
MW-6

Army Pollution Abatement Program Study, Installation of Monitoring Wells, Radford Army Ammunition Plant, Radford, VA, 3-9 April 1981, (USAEHA Control No. 81-26-8251-81)

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT: RAAP 81-26-8251-81

DATE: 5 April 81

LOCATION: Site 6, northwest of lagoon next to building S.R. 1602

DRILLERS: Smithson, Hoddinott
Craig, Gates (logger)

DRILL RIG: Acker II w/ 4 in continuous flight auger

BORE HOLE: MW 5/6

TD= 25.5 ft

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	Water level initial 9.5 ft 24 hr. 9' 7" REMARKS	
		Brown silty clay, damp plastic	7 ft of concrete grout	13.5 ft of schedule 40, 2 in ID PVC casing
5 ft	MB 5-10	Reddish brown silty clay--slightly damp, tight drilling	4.5 ft of Bentonite (may have a void above sand next to water table)	
10 ft		softer drilling, same material, getter wetter	11.5 ft of sand pack	
		saturated		screen
15 ft				

HSE-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

Army Pollution Abatement Program Study, Installation of Monitoring Wells, Radford Army Ammunition Plant, Radford, VA, 3-9 April 1981, (USAEHA Control No. 81-26-8251-81)

DRILLING LOG

PROJECT: RAAP 81-26-8251-81

DATE: 5 April 81

LOCATION: Site 5,northeast : of lagoon next to building S.R. 1602

DRILLERS: Smithson, Hoddinott; Craig, Gates (logger)

DRILL RIG: Acker II, w/ 4 in continuous flight Auger

BORE HOLE: MW 6

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS	
		Reddish brown silty coarse to medium sand, saturated (water is flowing)	Sand pack	10 ft of slotted schedule 40, 2 in ID PVC screen ((0.008-0.010")
20 ft		Weathered Elbrook FM (red gray clay residuum over dolomite)		
				2 ft of sediment trap
25 ft		25.5 ft TD		Bottom of well 25.5 ft
30 ft				

USAEHA Form 95, 12 Aug 74

5508

MW-8

Army Pollution Abatement Program Study, Installation of Monitoring Wells, Radford Army Ammunition Plant, Radford, VA, 3-9 April 1981, (USAEHA Control No. 81-26-8251-81)

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT RAAP 81-26-8251-81 DATE 5 April 81

LOCATION Site 5, Background well, south of lagoon DRILLERS Smithson Hoddinott; Craig, Gates (logger)

DRILL RIG Acker II, w/ 4 in continuous flight Auger BORE HOLE MW 8 TD= 34ft

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	water level initial=24 ft 24 hr.=14'11" REMARKS	
		gravel fill for road		29 ft of schedule 40, 2 in ID PVC casing
		Reddish brown sandy clay with some small gravels	8 ft of concrete grout	
5 ft				
		same material, wet, med plastic	5 ft of Bentonite	
10 ft				
		same material, getting wetter & sticky	sand pack	
15 ft				

HSE-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

Army Pollution Abatement Program Study, Installation of Monitoring Wells, Radford Army Ammunition Plant, Radford, VA, 3-9 April 1981, (USAEHA Control No. 81-26-8251-81)

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT RAAP 81-26-8251-81 DATE 5 April 81

LOCATION Site 5, background south of lagoon DRILLERS Smithson, Hoddinott Craig, Gates (logger)

DRILL RIG Acker II, w/ 4 in continuous flight Auger BORE HOLE MW 8

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS	
	MB 15-20	same material	21 ft of sandpack	PVC casing
20 ft				
	▽	same material		
25 ft				
30 ft				

HSE-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

Army Pollution Abatement Program Study, Installation of MOnitoring Wells, Radford Army Ammunition Plant, Radford, VA, 3-9 April 1981, (USAEHA Control No. 81-26-8251-81)

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT RAAP 81-26-8251-81 DATE 5 Apr 81

LOCATION Site 5, background south of lagoon DRILLERS Smithson, Hoddinott Craig, Gates (logger)

DRILL RIG Acker II. w/ 4 in continuous flight Auger BORE HOLE MW 8

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS	
		same material		5 ft of slotted schedule 40, 2 in ID PVC screen
35 ft		Refusal Elbrook FM Note: ran short of screen, therefore, 5 ft of screen was installed in the saturated zone instead of 10 feet.	bottom of	well 34 ft.
40 ft				

HSE-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

HWMUS\5-WC1-1

Form No. 500

BORING LOG

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING/CHEMICA
"ONE HUNDRED YEARS OF SERVICE"
1881

Report No. 0-62084 DATE May 1987

Client: Hercules Inc.

Project: Radford Army Ammunition Plant Radford, Virginia

Boring No: 5-WC1-1 | Total Depth: 53.5 ft. | Elevation: -------- | Location: See Location Plan

Type of Boring: Hollow Stem Auger | Started: 5/5/87 | Completed: 5/5/87 | Driller: W. Simmons

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	REMARKS
	40.0				45.0	GROUNDWATER DATA
		5-WC1-1 continued		43.5		RQD = 23
					36.7	RQD = 7
				48.5		
					61.7	RQD = 0
	53.5			53.5		
		Boring terminated at 53.5 ft.				

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

Form No. 500

BORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING/CHEMIC.
"ONE HUNDRED YEARS OF SERVICE"

Report No. Q-62084 DATE May 1987

Client: Hercules Inc.

Project: Radford Army Ammunition Plant Radford, Virginia

Boring No.: 5-WC1-1 | Total Depth: 53.5 ft. | Elevation: -------- | Location: See Location Plan

Type of Boring: Hollow Stem Auger | Started: 5/5/87 | Completed: 5/5/87 | Driller: W. Simmons

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	REMARKS
	0.0	No sampling conducted, see 5-WC1-2 for subsurface conditions				GROUNDWATER DATA
		Cobbles encountered at 13.0 ft. and 17.0 ft.				
	33.5	Auger refusal at 33.5 ft.		33.5		
		Hard light gray dolomite, fractured and vuggy abundant calcareous infill, occasional shale infill: dolomite clasts in calcareous matrix: Probable slump structure		38.5	21 7	RQD - 0

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherw se noted

Project: Radford Army Ammunition Plant

Location: Radford, Virginia

Client: Hercules Inc.

Screen Description: 0.010" slot, 2.0" I.D. Teflon Screen @(10')

Riser Description: 2.0" I.D. Teflon Riser and PVC Riser

Driller: Simmons

Inspector: Smith

Date Installed: 5/5/87

WELL No. 5-WC1-1

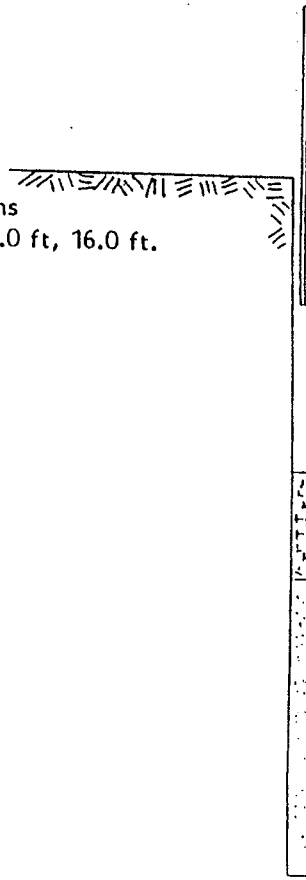
Sand Size: D(10)= 0.45-0.55 mm

Bore/ Core Size: 6 inch/ NX

Subsurface Conditions Summary

See 5-WCI-2 for Conditions

Cobbles encountered at; 13.0 ft, 16.0 ft.



Casing Stickup (ft.)= 3.0 ft.

Elev. = _____

Riser Stickup (ft.) = 3.0 ft.

Elev. = _____

Ground Elev.= _____

Depth to Bentonite (ft.)= ---------

Elev. = _____

Depth to Sand Filter(ft.)= ---------

Elev. = _____

Depth to Well Bottom(ft.)= 49.3 ft.

Elev. = _____

Depth of Hole (ft.) = 53.5 ft.

Elev. = _____

HWMU 5 WC1-1

HWMU 5\ 5-WC1-2

Form No. 500

BORING LOG

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING • CHEMICA
"ONE HUNDRED YEARS OF SERVICE"
1881

Report No. 0-62084 DATE May 1987

Client: Hercules Inc.

Project: Radford Army Ammunition Plant Radford, Virginia

Boring No.: 5-WC1-2 | Total Depth: 76.8 ft. | Elevation: -------- | Location: See Location Plan

Type of Boring: Hollow Stem Auger | Started: 5/1/87 | Completed: 5/1/87 | Driller: W. Simmons

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	REMARKS
	0.0					GROUNDWATER DATA
		Very loose yellow brown silty medium to fine SAND (SM)				
		-to-	1 1	4.5		
		Loose tan to red brown clayey medium to fine SAND, trace rounded coarse sand (SC)		6.0		
			2 2	7 8.5		
		-ALLUVIUM-		10.0		
			11 13	16 13.5		
				15.0		
	16.5					
		Loose orange brown medium to fine sandy SILT, trace angular coarse sand (rock fragments), manganese stains (ML)	6 7	3 18.5		
		-to-		20.0		
		Medium stiff orange brown clayey SILT, little medium to fine sand (rock fragments) (ML/MH)	2 1	3 23.5		
				25.0		
		-RESIDUUM-	15	4 28.5		
				30.0		
				33.5		
			1 1	2 35.0		Subsurface water at 34.5 ft. depth at 11:30 a.m. on May 1, 1987
	39.3	Auger refusal at 39.3 ft.		39.3		

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

Form No. 500

BORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING/CHEMICA
"ONE HUNDRED YEARS OF SERVICE"

Report No. 0-62084 DATE May 1987

Client: Hercules Inc.

Project: Radford Army Ammunition Plant Radford, Virginia

Boring No.: 5-WC1-2 | Total Depth: 76.8 ft. | Elevation: -------- | Location: See Location Plan

Type of Boring: Hollow Stem Auger | Started: 5/1/87 | Completed: 5/1/87 | Driller: W. Simmons

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	REMARKS
	40.0	Hard light gray dolomite, vuggy, fractured, with calcareous infilling, some with moderately developed crystals, occasional shale infill: occasional dolomite clasts in a calcareous matrix: probable flow structure		35.8		GROUNDWATER DATA
				44.3	35.8	RQD = 0
				49.3	46.7	RQD = 7
				54.8	34.9	RQD = 0
				59.8	33.3	RQD = 0
				64.8	25.8	RQD = 0
				69.8	19.2	RQD = 0
				74.8	88.3	RQD = 10
				76.8	33.3	RQD = 0
	76.8	Boring terminated at 76.8 ft.				

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1" = 5' unless otherwise noted

Project: Radford Army Ammunition Plant	Driller: Simmons	WELL No.
Location: Radford, Virginia	Inspector: Smith	5-WC1-2
Client: Hercules Inc.	Date Installed: 5/1/87	
Screen Description: 0.010" slot, 2.0" I.D. Teflon Screen	Sand Size: D(10)= 0.45-0.55 mm	
Riser Description: 2.0" I.D. Teflon Riser and PVC Riser	Bore/ Core Size: 6 inch/ NX	

Subsurface Conditions Summary

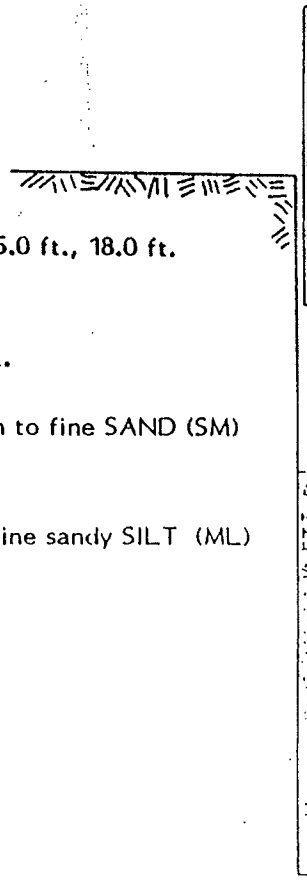
Cobbles encountered at; 15.0 ft., 18.0 ft.

Subsurface water at 34.5 ft.

Yellow Brown silty medium to fine SAND (SM)

to

Orange Brown medium to fine sandy SILT (ML)



Casing Stickup (ft.)= 3.0 ft.

Elev. =

Riser Stickup (ft.) = 3.0 ft.

Elev. =

Ground Elev.=

Depth to Bentonite (ft.)= --------

Elev. =

Depth to Sand Filter(ft.)= --------

Elev. =

Depth to Well Bottom(ft.)= 72.8 ft.

Elev. =

Depth of Hole (ft.) = 76.8 ft.

Elev. =

APPENDIX B

HISTORICAL SOURCE INFORMATION

ATK
ALLIANT TECHSYSTEMS

Fax Cover Sheet

Radford Army Ammunition Plant
PO Box 1, Route 114
Radford, VA 24141-0100

DATE	TIME	PAGES TO FOLLOW	☐ URGENT
1-4-00			

TO	COMPANY
Andy Karsnak	Draper Aden

ADDRESS	

TELEPHONE	FAX
	552 0291

FROM	TELEPHONE	FAX
Jerry Redder		

NOTE: IF YOU DID NOT RECEIVE A CLEAR TRANSMISSION, PLEASE CALL THE SENDER

COMMENTS

Gary did some looking into possible TCE source. Not much but we can continue to look.

AF-447 PC REV 4/99

00-112

c: Jake
Bolden
B. Jennings
ENV file

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

James S. Gilmore, III
Governor

John Paul Woodley, Jr.
Secretary of Natural Resources

Street address: 629 East Main Street, Richmond, Virginia 23219
Mailing address: P.O. Box 10009, Richmond, Virginia 23240
Fax (804) 698-4500 TDD (804) 698-4021
http://www.deq.state.va.us

Dennis H. Treacy
Director

(804) 698-4000
1-800-592-5482

1-04-2001
Spoke w Bill Bryles about Bldg. 1041 Degreaser House,
- said that he had limited personal knowledge because Scale Shop mainly used this bldg. but that sometimes scales would be brought outside if washed off
- reminded me that Bldg. 1034 was once a laboratory
- said best he could recall was that maintenance shops @ B-line did cleaning & washing of equipment
- said people that worked in these areas are "gone"

December 18, 2000

Ms. Carolyn Jake, Environmental Manager
Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114; P.O. Box 1
Radford, VA 24141-0100

RE: October 18 and October 25 Letters From Alliant
October 31 Conference Meeting Between Alliant and the Department
Hazardous Waste Management Unit 5, Radford Army Ammunition Plant (RAAP),
Radford
EPA ID#: VA1210020730

Dear Ms. Jake:

Thank you for talking with the Department's staff on October 31, 2000. As we agreed, RAAP will send the Department more information and materials on the Correction Action Program within the 90 days. After receiving the proposed corrective action program information, the Department will review and offer comments and future recommendations.

Please be advised that if the RAAP believes that TCE was not caused by Unit 5, the RAAP needs demonstrate that fact. Also, emphasizing again, in addition to TCE there are some other hazardous constituents whose concentrations have exceeded their proposed groundwater protection standards. The RAAP has to propose the corrective action methods for all these exceeding constituents in the corrective action program.

Bldg. 1041 Degreaser House

TEC (Trichloroethane 1,1,1) INVESTIGATION
SITE 5

1-4-2001

- Spoke with a senior instrument mechanic this morning about past practices of using Bldg. 1041 Degreaser House. He said that he remembered that the Scale Shop used this to clean scales and that sometimes the scales would be brought outside of the bldg. to be washed off. He reminded me that Bldg. 1034 was once a laboratory.
- Visited Bldg. 1041. Was shown about the bldg. and was pointed out where the old dip tank was located in the floor (now filled with concrete) and where there is now a pit with a grating and a drain that goes to and outside underground tank (RFA 25275). Was shown the Procedure that relates to using Solvents, 4-27-078 (dated 1-13-1999). This procedure mentions Trichloroethane 1,1,1 as a Material.
- Spoke with four Area Mechanics who had worked in B-Line Maintenance. I was told that in the early 1960's and 1970's they cleaned equipment with Varsol and WD-40 and disposed of the used solvents by pouring them down the nearest floor drain. This disposal practice was later changed to pouring used solvents into a barrel to be hauled off by Roads & Ground,
- Located Procedure No. 4-27-78 Rev. O Chg. 0 (dated 5-23-72) which replaced SOP 78, in the Procedure History File at Bldg. 215. This procedure has Trichloroethane 1,1,1 listed in the Materials and Equipment section.
- Marked up a drawing showing the location of buildings that are suspected to have used TEC in the past due to it's degreasing properties:

  The buildings are:

1034	originally used as a laboratory
2549	Area Maintenance Shop
1549	Area Maintenance Shop
525	Tractor Steaming Station
2570	Area Cleaning Station
1041	Degreaser House (note: Sheet 24 of the Sewers & Drains Atlas shows a 4" TC line going out of the west end of the building

HERCULES INCORPORATED
RADFORD ARMY AMMUNITION PLANT
MAINTENANCE DEPARTMENT
MAINTENANCE OPERATING PROCEDURE

AREA: PLANT WIDE - GENERAL
TASK: MAINTENANCE
TITLE: CLEANING SOLVENTS

PROCEDURE NO.: 4-27-78 REV. 0 CHG. 0

TYPE: N/A TOTAL PAGES: 7

This document supersedes: SOP 78

1. SCOPE

1.1 Cleaning solvents, when used properly, are effective tools for cleaning many types of equipment and machinery. However, some solvents, particularly those of the chlorinated hydrocarbon type, can become dangerous if used carelessly or improperly. The solvents approved for use on this plant can be effectively used with a minimum of danger to personnel if basic precautions are observed in their use, handling, and limitations. No solvent, other than those listed in this procedure, shall be used by personnel in the Maintenance Department until approved for use by the Maintenance Superintendent.

1.2 Safety precautions and characteristics of the different types of approved solvents are listed in this procedure.

2. REQUIREMENTS - N/A

3. APPLICABLE DOCUMENTS - N/A

4. MATERIALS AND EQUIPMENT

4.1 Stoddard type solvents
4.2 Trichloroethane 1,1,1 - inhibited)
4.3 DuPont Cleaning Solvent #49
4.4 Acetone
4.5 Ethyl alcohol
4.6 Carbon tetrachoride
4.7 Freon TF
4.8 Benzene
4.9 Butyl alcohol
4.10 Nitroglycerin remover
4.11 Gunk

5. SAFETY

5.1 GENERAL PRECAUTIONS

5.1.1 Skin Protection

5.1.1.1 Solvents, because of their composition, act as "degreasing" agents, which is one of their primary uses. Since they are good degreasers, solvents contacting the skin will remove the natural oil of the skin and thereby cause it to dry out and crack. Rubber gloves provide the best protection.

Prepared By: H. B. Brown III
Approved: 5-23-72

Proc. Number: 4-27-078 Rev No: 5	Title: 4-27-078 Cleaning Solvents
Type:	Approval: Issued Date: Revised Date: 01/13/1999
Area: Maintenance Unit: <All> Section: <All>	

Step Number	Description
 *Revision*	**REASON FOR REVISION** To make PSM compliant.
 *Revision*	**LEVEL OF TRAINING REQUIRED FOR THIS REVISION** Level 1
1.0	**SCOPE**
1.1	Cleaning solvents when used properly are effective tools for cleaning many types of equipment and machinery. However, some solvents, particularly those of the chlorinated hydrocarbon type, can become dangerous if used carelessly or improperly. The solvents approved for use on this plant can be effectively used with a minimum of danger if basic precautions are used.

Step Number	Description

2.0 REQUIREMENTS

2.1

Revision

If at any time the operator feels that any safety/quality requirements are not being met, they have authority to stop operations and notify supervision immediately.

3.0 APPLICABLE DOCUMENTS

3.1 Management Manual Safety Procedure 9-1.13 , Handling Flammable Liquids

4.0 MATERIALS AND EQUIPMENT

4.1 MATERIALS

Revision

a. Stoddard type solvents
b. Trichloroethane 1,1,1 (inhibited)
c. DuPont Cleaning Solvent #49
d. Acetone
e. Ethyl alcohol
f. Inhibisol
g. Intex 827
h. Butyl alcohol
i. Nitroglycerin remover
j. Gunk
k. Paint stripper
l. Varsol
m. Lectra Clean

Step Number	Description
	n. Voltz

WARNING

Trichloroethane or methylene chloride shall not be used in any type of pressurized system due to a reaction between the materials and galvanized or aluminum parts.

5.0 SAFETY

5.1 GENERAL PRECAUTIONS

5.1.1 Skin Protection

5.1.1.1 Solvents, because of their composition, act as "degreasing" agents, which is one of their primary uses. Since they are good degreasers, solvents contacting the skin will remove the natural oil of the skin and thereby cause it to dry out and crack. Rubber gloves provide the best protection.

Step Number	Description
5.1.1.2	Sometimes it is not practical to use gloves and the worker must depend on good hygiene practices for protection. A clean solvent by itself would not normally cause infection but, by causing the skin to crack, it has thus opened a path for infection from other sources. By washing the hands and other affected areas immediately after exposure and applying a hand lotion or other skin oil replacing substance, the cracking of the skin can be prevented or lessened.
5.1.2	Eye Protection
5.1.2.1	Chemical goggles over safety glasses shall be worn when working with quantities of solvent large enough to create a splashing hazard from handling or brushing.
5.1.3	Respirator Protection and Ventilation
5.1.3.1	Solvents shall not be used in tightly closed rooms unless there is sufficient forced ventilation.

Step Number	Description
	WARNING If the concentration of solvent vapors in the working area atmosphere causes headaches, undue fatigue or nausea, inadequate ventilation is indicated.
5.1.3.2	Solvents shall be stored and handled in approved containers and the containers shall remain covered when not in actual use.
5.1.3.3	Solvent containers or washing troughs shall not be located so that the forced or natural air currents carry the vapors into other work areas. Ventilation should carry the vapors to the outside of the building and away from areas in which personnel are working.
5.1.3.4	If sufficient ventilation is not available, Comfo Respirator MSA Ll60968 with Chemical Cartrdige #678D or fresh air mask must be worn.
5.1.3.5	Work shall not be conducted in an explosive concentration of solvent vapors.

Step Number	Description
5.1.3.6	Cleaning solvents having a flashpoint of less than 200 F shall be classified as flammable liquids and shall be handled and stored in accordance with Management Manual Safety Procedure 16, Handling Flammable Liquids.

5.2 APPROVED SOLVENTS

5.2.1 Stoddard Type Solvents

DESCRIPTION:

Clear, colorless liquids of the kerosenenaptha class.

5.2.1.1 Flash Point and Fire Hazard:

The vapors of these solvents, in the proper concentration and ignited by an open flame or spark, will burst into flames at 100 to 110 F. The vapors of these solvents are considered a moderate fire hazard.

5.2.1.1.1 Recommended maximum allowable concentration:

500 parts per million of air.

Step Number	Description
5.2.1.2	Toxicity: Stoddard solvents are a slight irritant to the skin and to the air passages if a heavy concentration of vapors is breathed. Solvents will emit acrid fumes and may explode if heated to decomposition. Moderate ventilation shall be used to clear vapor.
5.2.1.3	Uses: Stoddard solvents may be used as an oil and grease remover in the cleaning of equipment and machinery. They are considered noncorrosive to metal surfaces. Being a petroleum distillate, Stoddard type solvents will leave a thin grease film on the cleaned surface which may be objectionable for certain types of work.
5.2.2	Trichlorethane 1,1,1 (inhibited)
5.2.2.1	Other names: Chlorothene, Vythene, Inhibisol, Methyl Chloroform.

Step Number	Description
5.2.2.2	Description: A colorless liquid of the chlorinatedhydrocarbon class, chemical formula CH3CCL3.
5.2.2.3	Flash Point and Fire Hazard: The vapors of this solvent will not flash; it is not a fire or explosion hazard.

NOTE
Trichloroethane or Methylene Chloride shall not be used in any type of pressurized systems due to reaction between the materials and any galvanized or aluminum parts.

5.2.2.4	Recommended maximum allowable concentration: 500 parts per million in air.
5.2.2.5	Toxicity: This solvent is of slight irritation to the skin and is moderately toxic if the vapors are inhaled or the liquid ingested. When heated to decomposition, this solvent will emit highly toxic fumes of chlorides. Maintain a rate of ventilation sufficient to effectively and continuously remove the vapors when working with this solvent.

Step Number	Description
5.2.2.6	Uses: This solvent may be used for cleaning small, delicate items, such as cleaning wire rope prior to socketing and cleaning electrical and electronic equipment and related items. It should be noted that solvents and their vapors may cause distinct changes to insulation, wiring, and other susceptible parts of critical electronic equipment, and therefore must be used with care.
5.2.3	DuPont Cleaning Solvent #49
5.2.3.1	Description: A clear, colorless liquid compound of a mixture of petroleum distillate and chlorinated hydrocarbons.
5.2.3.2	Composition: 70% Stoddard Solvent, 25% Methylene Chloride, 5% Perchloroethylene.

Step Number **Description**

NOTE
Trichloroethane or Methylene Chloride shall not be used in any type of pressurized systems due to reaction between the materials and any galvanized or aluminum parts.

5.2.3.3 Flash Point and Fire Hazard:

This solvent will not flash unless it is boiled, at which time and after 20% evaporation, a flash point of 132 F is reached. As a fire hazard, this solvent is in the same class as kerosene, a moderate fire hazard.

5.2.3.4 Recommended maximum allowable concentration:

200 parts per million in air.

5.2.3.5 Toxicity:

This solvent is of moderate irritation to the skin and a moderate toxicant when inhaled or ingested. When heated to decomposition, it may emit toxic fumes of phosgene gas and chlorides. Use a high rate of ventilation when working with this solvent. Contact of the skin with this mixture should be avoided because absorption through the pores may produce the same physiological effects as inhalation.

Step Number	Description
5.2.3.6	This material is dangerous to the eyes; they shall be well protected.
5.2.3.7	Uses: This solvent may be used in electric motor cleaning. Most of the common insulating varnishes are inert to the action of this mixture. When using the mixture for the first time, use a small amount until certain whether there is a limit of exposure which must be observed to avoid any tendency of the varnish to soften or lift.
5.2.4	Acetone
5.2.4.1	Description: Colorless liquid, fragrant mint-like odor, chemical formula CH3COCH3.
5.2.4.2	Flash Point and Fire Hazard: The vapors of this solvent will flash at a temperature above 0 F and can be a dangerous fire hazard if exposed to heat or flame.

Step Number	Description
5.2.4.3	Recommended maximum allowable concentration: 1000 parts per million in air.
5.2.4.4	Toxicity: Because of the limited quantity of this solvent used by Maintenance, concentration of vapor will normally present no problem. In large concentrations, acetone fumes will cause irritation of the eyes and mucous membranes of the respiratory tract. Prolonged exposure of the skin to the liquid or vapors may cause irritation.
5.2.4.5	Uses: Acetone is used where a greaseless and fast drying action is desirable, as in cleaning certain instruments. Acetone is also used by various shops to seal and cement acetate together.
5.2.5	Alcohol (Ethyl Alcohol)
5.2.5.1	Description: Clear, colorless, fragrant liquid, chemical formula: CH3CH2OH.

Step Number	Description
5.2.5.2	Flash Point and Fire Hazard: The vapors of this solvent, in proper concentration, will flash at temperatures above 61 F. When exposed to excessive heat or open flame, this solvent can be a dangerous fire hazard.
5.2.5.3	Recommended maximum allowable concentrations: 1000 parts per million in air.
5.2.5.4	Toxicity: Because of the limited quantity of alcohol used by the Maintenance Department, concentration of vapors should present no problem. However, in heavy concentrations, alcohol vapors will cause irritation of the eyes and the mucous membranes of the respiratory tract. A moderate rate of ventilation should keep vapor concentration at a safe level.
5.2.5.5	Ethyl alcohol used on the plant has been "denatured" by chemical additives, making this liquid poisonous if taken internally.

Step Number	Description
5.2.5.6	Uses: Ethyl alcohol is used in small quantities to clean certain type instruments.
5.2.6	Inhibisol
5.2.6.1	Description: Colorless liquid of chlorinated solvents. Chemical formula: CCL4.
5.2.6.2	Flash Point and Fire Hazard: None - this material cannot burn.
5.2.6.3	Threshold limit value is 350 PPM. Effects of overexposure: Anesthetic effects, dizziness, headache. Emergency first aid: Remove to fresh air and obtain medical help. Eye contact: Flush with water and consult a physician. Swallowing: Induce vomiting and obtain medical attention.

Step Number	Description
5.2.6.4	Toxicity: Inhibisol is extremely toxic and can be taken into the body by inhalation to the lungs, ingestion through the mouth, or prolonged and repeated contact with the skin. Prolonged exposure to heavy concentrations causes gastrointestinal disorders.
5.2.6.5	Spill or Leak Procedures: Ventilate the area. Deposit waste in tank at Burning Ground.
5.2.6.6	Avoid contact with skin, eyes, and clothing. Do not store near direct heat. Vent off possible internal pressure.
5.2.6.7	A high rate of ventilation shall always be maintained when using Inhibisol.

WARNING

Avoid breathing vapors. Always use the smallest amount of solvent that will effectively perform the cleaning job.

Step Number	Description
5.2.6.8	Uses: This solvent, in minute quantities, may be used to clean equipment and parts where the thin grease film and dry residue left by other solvents would be objectionable. The Instrument Shop and Ballistics Instrument Shop use small quantities for this reason.
5.2.6.9	Large quantities of Inhibisol shall not be used by personnel anywhere in the Maintenance Department without the approval of supervision. Inhibisol shall be used under carefully controlled conditions.
5.2.7	Nitroglycerin Remover
5.2.7.1	Description: A mixture of sodium sulfide, alcohol, acetone, and water.
5.2.7.2	Flash Point and Fire Hazard: Nitroglycerin remover will have a flash point and fire hazard similar to acetone and alcohol.

Step Number	Description
5.2.7.3	Recommended maximum allowable concentration: 1000 parts per million in air.
5.2.7.4	Toxicity: The toxic properties of nitroglycerin remover will be similar to those of acetone and alcohol.
5.2.7.5	Uses: Nitroglycerin remover is used as a special solvent in the cleaning of equipment contaminated with nitroglycerin or products containing nitroglycerin.
5.2.8	"Gunk"
5.2.8.1	Description: "Gunk" is a trade name for a degreasing-cleaning solvent manufactured by Radiator Specialties Corporation, Gunk Division, Charlotte, North Carolina.

Step Number	Description
5.2.8.2	Flash Point: 178 F.
5.2.8.3	Recommended maximum allowable concentration (cresole): 5 parts per million in air.
5.2.8.4	Gunk contains approximately 16% cresole, which can cause skin burns. Rubber protective gloves, head covering, and goggles shall be worn to prevent contact with the skin or eyes. A fresh air mask shall be worn when inside the paint stripping tank. If Gunk comes into contact with the eyes, wash with flowing water and report to the Plant Hospital for treatment immediately.
5.2.8.5	Uses: Gunk is used in a vat or tank in Building 1041 to clean and paint strip scales for overhaul. See Scale Maintenance, MSOP 4-27-13, paragraph 5.21 through 6.5.1 for correct operation of this tank.

Step Number	Description
5.2.9	Butyl Alcohol
5.2.9.1	Description: A colorless liquid. Chemical formula: C4H9OH.
5.2.9.2	Recommended allowable concentration: 100 parts per million in air.
5.2.9.3	Flash point: 84 F.
5.2.9.4	Small quantities are used by the Electronic Shop for strain gage maintenance.
5.2.9.5	Precautions: Avoid inhalation and skin contact.
5.2.10	Intex #8793 - Paint Stripper

Step Number	Description
5.2.10.1	Description: Brown, 2-layer liquid.
5.2.10.2	Threshold Limit: 500 ppm.
5.2.10.3	This product is used in the Degreasing Shop for removal of paint.
5.2.10.4	Comfo respirator or fresh air mask must be worn when placing work in Intex tank, dashing work up and down, spraying work with steam or water, or changing or adding Intex to tank.

WARNING

Exhaust ventilation shall be used; eye protection and long rubber gloves shall be worn. In case of eye or skin contact, flush with water and soap. Report to Plant Hospital immediately.

Step Number	Description
5.2.11	Intex #827 - Safety Solvent
5.2.11.1	Description: Colorless with odor of chlorinated solvent.
5.2.11.2	Threshold Limit: 500 ppm.
5.2.11.3	This product will be used in the Degreasing Shop for paint removal and cleaning purposes.
5.2.11.4	If Intex 827 is used in open container and cleaned by hand, respirator or fresh air mask must be worn.

WARNING

In case of eye or skin contact, flush with water and report to Plant Hospital immediately. Exhaust ventilation shall be used and eye protection and long rubber gloves shall be worn.

Step Number	Description
5.2.12	Lectra Clean - Cleaner/Degreaser for Electrical Equipment
5.2.12.1	Description: Colorless with irritating odor at high concentrations.
5.2.12.2	Threshold Limits: 350 ppm
5.2.12.3	This product will be used in the Electric Shop for cleaning and degreasing electrical equipment.
5.2.12.4	Product should be used in the presence ventilation if used in concentrations above threshold limit. If ventilation is not available, self contained breathing apparatus should be used for concentrations above threshold limit. Solvent resistant gloves are safety goggles shall be worn during use.

Step Number	Description
5.2.13	Voltz
5.2.13.1	Description: Transparent liquid with a citrus odor.
5.2.13.2	Threshold limit: 300 ppm
5.2.13.3	This product is used in the Electric Shop motor cleaning vat.
5.2.13.4	Normal ventilation is adequate for use of this product unless used in confined or enclosed spaces where supplied-air respiratory protection should be used. Protective chemical resistant gloves, splash goggles, and chemical resistant apron should be used to avoid prolonged skin contact, protect the eyes, and avoid contaminating regular clothing.

2005

Display of Facility for Property Section

PR	Bldg Num	PL	T	Sta	NAME	Location	Ty	Dep	Mass	UM	Volumn	Acq	Ac Yr	Catgy	AC	RPI
D	1013 00		B	08	MOTOR HOUSE	COTTON A	S	511	48	SF	360	0	1942	0022680	05	0101
	1014 00		B	08	EMERGENCY CATCH HOUSE	COTTON A	S	511	161	SF	1449	3074	1942	0022680	05	0101
	1017 00		M	08	FLUME LINES 1012 TO 1019	COTTON A	P	511	756	LF	0	45832	1942	0022680	05	0101
	1019 00		B	06	Property Only	COTTON A	S	511	4139	SF	4139	0	1942	0045210	05	0101
	1020 00		M	06	BOILING TUB SETTLING PIT	COTTON A	P	511	90000	G	0	44091	1942	0022680	05	0102
A	1020 00		B	07	PUMP HOUSE	COTTON A	P	511	182	SF	1517	0	1942	0022680	05	0102
	1022 00		B	06	Property only	COTTON A	S	511	677	SY	677	0	1942	0045210	05	0102
	1024 00		B	06	Property Only	COTTON A	S	511	3201	SY	3201	0	1942	0045210	05	0102
	1025 00		B	07	POACHER & BLENDING SETTLI	COTTON A	P	511	5880	SF	41160	100984	1942	0022680	05	0102
A	1025 00		B	07	PUMP HOUSE	COTTON A	P	511	812	SF	13576	0	1942	0022680	05	0102
	1026 00		B	M	FINAL WRINGER HOUSE	A GREEN LI	S	511	5049	SF	96555	115261	1942	0022680	05	0102
	1030 00		B	06	NITROCELLULOSE AREA OFFIC	COTTON A-B	S	511	1562	SF	12992	12243	1942	0061050	05	0103
	1031 00		B	06	CHANGE HOUSE	COTTON A-B	P	511	2140	SF	21400	31623	1942	0014178	05	0103
	1034 00		B	01	INST, SCALE, REFRIG, AND	COTTON A	P	000	10178	SF	64469	422983	1952	0021910	05	0103
	1035 00		B	08	LUNCH ROOM	COTTON A	S	511	192	SF	1536	1949	1951	0074060	05	0103
	1038 00		B	03	LUNCH ROOM AND STORAGE	COTTON A-B	S	511	1500	SF	12000	15624	1942	0074060	05	0103
	1039 00		B	01	CHANGE HOUSE	COTTON A-B	P	671	1812	SF	18000	26156	1942	0014178	05	0103

2005

Display of Facility for Property Section

PR	Bldg Num	PL	T	Sta	NAME	Location	Ty	Dep	Meas	UM	Volumn	Acq	Ac Yr	Catgy	AC	RPI
	1041 00		B	01	DEGREASER HOUSE	COTTON A	P	576	987	SF	9870	8641	1942	0021910	05	0104
	1042 00		B	01	INSTRUMENT AUXILIARY SHOP	COTTON A	P	575	487	SF	5113	7492	1942	0044220	05	0104
	1044 00		B	01	PURIF. AREA MAINT. OFFICE	COTTON A-B	S	541	1500	SF	15000	9626	1942	0021910	05	0104
	1050 00		M	08	LPG STORAGE TANK FARM	INERT GAS	P	511	5715	BL	0	352482	1979	0041150	05	0105
	1500 00		B	M	DEHY PRESS HOUSE/STORAGE/	A GREEN LI	P	000	5780	SF	84295	213705	1942	0022680	05	0150
A	1500 00		B	07	LOADING STATION	A GREEN LI	P	511	530	SF	4345	0	1942	0022680	05	0150
	1501 00		B	07	ALCOHOL PUMP & ACCUMULATO	A GREEN LI	S	511	281	SF	3120	31424	1942	0022680	05	0150
A	1501 00		B	07	WEAK ALCOHOL STORAGE HOUS	A GREEN LI	S	511	616	SF	10780	0	1942	0022680	05	0150
	1502 00		B	01	ETHER STILL HOUSE NO 1	SOLVENTS	P	745	4574	SF	62535	143010	1942	0022680	05	0150
A	1502 00		B	01	PUMP HOUSE NO 4	SOLVENTS	P	745	245	SF	2307	0	1942	0022680	05	0150
	1503 00		B	01	ALCOHOL RECTIFICATION HOU	SOLVENTS	P	745	4890	SF	61126	36779	1942	0022680	05	0150
A	1503 00		B	01	PUMP HOUSE	SOLVENTS	P	745	25	SF	169	0	1942	0022680	05	0150
	1504 00		B	06	CHANGE HOUSE	A GREEN LI	P	511	2140	SF	21400	31959	1942	0014178	05	0150
	1505 00		B	06	CHANGE HOUSE	A GREEN LI	P	511	2140	SF	21400	32309	1942	0014178	05	0150
	1506 00		B	06	DIPHENYLAMINE MIX HOUSE	A GREEN LI	S	511	597	SF	7623	32300	1942	0022680	05	0150
A	1506 00		B	07	PUMP HOUSE	A GREEN LI	S	511	120	SF	960	0	1942	0022680	05	0150
B	1506 00		B	07	MOTOR HOUSE	A GREEN LI	S	511	47	SF	474	0	1942	0022680	05	0150

RA-85A REV. 6/61

RADFORD ARSENAL
HERCULES POWDER COMPANY INCORPORATED

PROPERTY RECORD

G.L.	1715
CAT.	21910
TYPE	P

DAAA09-77-C-4007

CONTRACT W-11-173-ORD-31

CARD NO. 1

BUILDING NAME Record Sample Store / House No. 1041 REFERENCE TO TRANSFER OF PROPERTY GR-895 290 S/N 5

Building Name changed to Degreaser House

BUILDING DESCRIPTION Cost $8,641

BUILDING SIZE

	LENGTH	WIDTH	CLEAR HEIGHT	SQUARE FEET	CUBIC FEET
B					
1	39'-6"	25'-0"	10'-0"	987	9870
2					
3					
			TOTAL	987	9870

FOUNDATION
1'-0" conc. fdn. wall on conc. footing

STRUCTURE-FLOOR CONST.
concrete & conc. block; 5" conc. slab on cinder fill

WALL COVERING
12" conc. block
¼ masonite ceiling

ROOF CONST.
Rigid asbestos shingles on 1" sheathing

HEATING
Unheated

UTILITIES
Lighting

FIRE PROTECTION
Hydrant

HOT WATER FACILITIES
No

ACCESSIBILITY TO BUILDING
Road

REMARKS

BARRICADES: No. None TYPE SQUARE FEET (FACE)

IN - OUT	DESCRIPTION AND RECORD OF CHANGES		CEV NO.	AMOUNT DEBIT	AMOUNT CREDIT	REVISED COST
IN	3-#6 440 V, 3 phase power service w/15 amp circuit breaker Rev Dwg 6929-1546	WO 3-19-62 Memo	XI-627 5093			
OUT IN	3'x7' Stl door & frame, installed 2-4'x9'6" wood door. 13'0"Lx9'1"Wx2'11" deep pit in floor for degreaser, Conc floor w/8" conc block wall, Dwg 6929-391	3-62 WO	Memo 5233			
IN	1½" 40# steam service w/pressure reductin station, steam to 2-C.I. radiators & 40# service to degreaser. 3/4" air service w/piping for 3 service drops & 2-pressure reducing stations	3-62 WO Memo	AS 574 5233			
IN	Monorail & supports & stl grating around degreaser.	4-16-62 Memo	WO XI-645 5234			

RA-85-REV. 6/61

RADFORD ARSENAL
HERCULES POWDER COMPANY
INCORPORATED

DAAA09-77-C-4007
CONTRACT NO. W-11-173-ORD-37

DAAA09-71-C-2517

PROPERTY RECORD

BUILDING NAME Record Sample Store House BUILDING NO. 1041 CARD NO. 2
Bldg. Name changed to Degreaser House

IN - OUT	DESCRIPTION AND RECORD OF CHANGES	CEV NO.	AMOUNT DEBIT	AMOUNT CREDIT	REVISED COST
IN	Electrical motor starting equipment. Air and water piping for installation of Sand Blaster. Dwg. 6929-391 & 1546	W. O. XS-4374, 4/12/65 Memo 6800, 5/7/65			
IN	Cleaning tank, with circulating pump andelectrical starting equipment.	W. O. # 69126	1/18/67		

Property in Building 1041-00 , Dept All
DEGREASER HOUSE (COTTON A)

Prop #	Description	Dept	FSN	Account	EM	YA	YI	SC	Cost	Repl Val
104509	SCALE MONORAIL TOLEDO 451	576	66700800000S0	017047		1941	2005	05	748	13,585
104515	SCALE MONORAIL TOLEDO 452	576	66700800000S0	017047		1941	2005	05	748	13,585
104746	TEST TBL SS 40X40 HERCULES	576	71950031000S0	017047		1959	2001	05	1,057	8,744
110047	DRILL PRESS DELTA 14	576	34130000000S0	017047		1952	2001	05	137	1,478
112225	HOIST AIR MOD A IR 40268	576	39503020000S0	017047		1962	2001	05	235	1,805
120254	WATER COOLER OASIS 005085	576	41100303000S0	017047		1978	2001	05	408	1,269
123967	GRINDER W/DUST COLL 246865	576	34150000000N0	017047		1983	2001	05	1,709	3,760
125275	TANK,550 GAL,MTL,48X72" VERT.	576	54300000000S0	017047		1986	2001	05	610	1,322
125396	SCALE PLATFORM AH EMERY 24X24IN 300LB CAP	576	66702178030N0	017047		1986	2007	05	9,633	20,881
125802	SCALE,CHLORINE,PENNWALT548	576	66700400000S0	017047		1987	2007	05	500	1,057
226004	SCALE PLATFORM 800LB TOLDO	576	66700400000S0	016503		1951	2001	05	610	7,531
233351	SCALE PLATFORM 800LB TOLDO	576	66700400000S0	016503		1951	2001	05	595	7,346
234022	SCALE, GRAVITYGRAM 839296	576	66700601000S0	016503		1941	2001	05	131	2,379
234029	SCALE, GRAVITYGRAM 839303	576	66700601000S0	016503		1941	2001	05	119	2,161
234123	SCALE, PP, HOWE 1423221	576	66700400000S0	016503		1941	2007	05	25	454
234319	SCALE, PLAT, F-M 1000 LB	576	66700400000S0	016503		1941	2006	05	75	1,362
234324	SCALE, PLAT, F-M 200 LB	576	66700400000S0	016503		1941	2001	05	50	908
234373	SCALE, ZONING 800LB TOLEDO	576	66700000000S0	016503		1952	2001	05	383	4,133
234482	SCALE, BENCH	576	66700300000S0	016503		1941	2001	05	87	1,580
235823	SCALE PLATFORM TOLEDO	576	66700400000S0	016503		1952	2002	05	545	5,881
236660	SCALE, PP, HOWE 1549897	576	66700400000S0	016503		1952	2001	05	54	583
236663	SCALE, PP, HOWE 1549894	576	66700400000S0	016503		1952	2001	05	54	583
239001	SCALE PLAT DIAL TOLEDO	576	66700400000S0	016503		1953	2006	05	547	5,903
241446	SCALE BENCH 200LB TOLEDO	576	66700300000S0	016503		1954	2001	05	540	5,827
255159	SCALE BENCH 150LB TOLEDO	576	66700300000S0	016503		1963	2002	05	721	5,538
257560	SCALE PLAT HOWE 65-11585	576	66700400000S0	016503		1965	2006	05	129	955
257573	SCALE PLAT HOWE 65-11598	576	66700400000S0	016503		1965	2003	05	129	955
257580	SCALE PLAT HOWE 65-11605	576	66700400000S0	016503		1965	2001	05	129	955
257610	SCALE PLAT HOWE 65-11487	576	66700400000S0	016503		1965	2002	05	592	4,382
259441	SCALE, PLAT COLT G617518	576	66700400000S0	016503		1966	2001	05	154	1,041
259442	SCALE, PLAT COLT G617522	576	66700400000S0	016503		1966	2001	05	154	1,041
259489	SCALE DIAL TOLEDO 595870	576	66700000000S0	016503		1966	2003	05	735	4,969
269493	SCALE BENCH HOWE 70-04235	576	66702172022S0	017047		1970	2001	05	1,224	7,080
269510	SCALE BENCH HOWE 70-04238	576	66702172022S0	017047		1970	2001	05	1,224	7,080

Property in Building 1041-00 , Dept All
DEGREASER HOUSE (COTTON A)

Prop #	Description	Dept	FSN	Account	EM	YA	YI	SC	Cost	Repl Val
269513	SCALE BENCH HOWE 70-04239	576	6670217202 2S0	017047		1970	2001	05	1,224	7,080
269514	SCALE BENCH HOWE 70-04240	576	6670217202 2S0	017047		1970	2001	05	1,224	7,080
270210	SCALE BENCH TOLEDO 539589	576	6670212202 0S0	017047		1971	2006	05	1,225	7,086
270211	SCALE BENCH TOLEDO 539588	576	6670212202 0S0	017047		1971	2001	05	1,225	7,086
270212	SCALE BENCH TOLEDO 539587	576	6670212202 0S0	017047		1971	2006	05	1,225	7,086
270625	SCALE BEAM PORTABLE 2496	576	6670030000 0S0	016503		1972	2001	05	180	980
277975	SCALE,TOL.DIAL BENCH 9373	576	6670021700 0N0	017047		1980	2001	05	2,672	7,192
283609	SCALE,BENCH DETECTO 847129	576	6670217208 2N0	017047		1984	2001	05	2,105	4,608
283610	SCALE,BENCH DETECTO 847130	576	6670217208 2N0	017047		1984	2001	05	2,105	4,608
284851	SCALE,DIAL TOLEDO 36475	576	6670000000 0N0	017047		1984	2001	05	2,242	4,908
284856	SCALE,DIAL TOLEDO 36473	576	6670000000 0N0	017047		1984	2006	05	2,242	4,908
284862	SCALE,DIAL TOLEDO 36462	576	6670000000 0N0	017047		1984	2001	05	2,242	4,908
284863	SCALE,DIAL TOLEDO 36456	576	6670000000 0N0	017047		1984	2004	05	2,242	4,908
284907	SCALE,DIAL TOLEDO 36445	576	6670000000 0N0	017047		1984	2006	05	2,242	4,908
284911	SCALE,DIAL TOLEDO 36441	576	6670000000 0N0	017047		1984	2004	05	2,242	4,908
284919	SCALE,DIAL TOLEDO 36419	576	6670000000 0N0	017047		1984	2001	05	2,242	4,908
284928	SCALE,DIAL TOLEDO 36428	576	6670000000 0N0	017047		1984	2001	05	2,242	4,908
284932	SCALE,DIAL TOLEDO 36449	576	6670000000 0N0	017047		1984	2005	05	2,242	4,908
284933	SCALE,DIAL TOLEDO 36433	576	6670000000 0N0	017047		1984	2001	05	2,242	4,908
284937	SCALE,DIAL TOLEDO 36437	576	6670000000 0N0	017047		1984	2001	05	2,242	4,908
292719	TABLE,STEEL,45X42X26	576	7110000000 0S0	016503		1987	2001	05	350	740
293832	SCALE,WALLACE-T,AM28598	576	6670040000 0S0	016503		1987	2001	05	810	1,713
293833	SCALE,WALLACE-T,AM28598	576	6670040000 0S0	016503		1987	2001	05	810	1,713
307033	ELECTRONIC SCALE CAPITOL DUAL CYLINDER,	576	6670000000 0S0	017047		1998	2003	05	1,250	1,411
307056	CABINET, SAND BLAST ECONOLINE MODEL 4X	576	5350000000 0N0	017047		1999	2001	05	1,800	1,973

Items of Property in Bldg:	59	*Cost / Repl Value of Property in Bldg:*	67,658 262,468
Items of Property in Selected Bldgs:	59	*Cost / Repl Value of Property in Selected Bldgs:*	67,658 262,468

RA-85A REV. 6/61

RADFORD ARSENAL
HERCULES POWDER COMPANY INCORPORATED

PROPERTY RECORD

G.L.	1715
CAT.	21910
TYPE	P

DAAA09-77-C-4007
CONTRACT W-11-173-ORD-31

CARD NO. 1

BUILDING NAME Production Engineering Office No. 1034 REFERENCE TO TRANSFER OF PROPERTY GR-1791 290 S/N 187

Bldg Name changed to Scale and Instrument Shop

BUILDING DESCRIPTION

COST 131,381

BUILDING SIZE

	LENGTH	WIDTH	CLEAR HEIGHT	SQUARE FEET	CUBIC FEET
B					
1	96'-9 3/4"	48'-0 3/4"	10'-8"	4656	49665
Wing 2	46'-8½"	29'-9"	10'-8"	1388	14804
3					
*	43'	48'3/4"	10'10"	2067	22,045
**	43'	48'3/4"	10'10"	2067	22,392
			TOTAL	10178	108,906

FOUNDATION
8" conc. fdn. wall on conc. footing

STRUCTURE-FLOOR CONST.
Conc. masonry block
Asphalt tile on 5" conc. slab.

WALL COVERING
8" conc. block. Masonite int. wall lining. WING SECTION

ROOF CONST.
20 yr. bonded roofing on 1" sheathing. Truss type 2" x 12" rafters

HEATING
Steam, cast iron radiation

UTILITIES
Steam, air, water, power & lighting

FIRE PROTECTION
Sprinkler system

HOT WATER FACILITIES
Yes

ACCESSIBILITY TO BUILDING
Road

REMARKS Former Nitro Cotton laboratory.

* Main Floor Addition
** Ground Floor Addition

BARRICADES: No. None TYPE _____ SQUARE FEET (FACE) 52

IN - OUT	DESCRIPTION AND RECORD OF CHANGES		CEV NO.	AMOUNT DEBIT	AMOUNT CREDIT	REVISED COST
IN	Roof ventilator, Penn Power Co, size 19, S/N E3656, RFA 12409 w/¼ HP Westinghouse motor, M4195	Memo Proj	5294 MC-1396			
OUT	Partitions between rooms #1 & 2 and 2 & 3 Replaced double window in Rm. #1 and #9 with 2-4' x 10' x 1-3/4" doors Dwg. 37-6161 By ~~Bldg. Inspection~~	W.O. Memo Date	GEN669, XI-609 5396 2/14/62			
OUT	Westinghouse Water Cooler, RFA 4138 moved to Bldg. 222 10-29-62 PT-4633		CEV 3778 MEMO 5440			
	Enlarged Rm. #6 reduced size women's rest room, removed one water cooler, added 3 fluorescent lighting fixtures. W.O. 1034, 10/22/62, Memo 5506, 11/19/62					

RA-85-REV. 6/61

DAAA09-71-C-4007

RADFORD ARSENAL
HERCULES POWDER COMPANY
INCORPORATED

CONTRACT NO. W-11-173-ORD-37

PROPERTY RECORD

Bldg. Name changed to
BUILDING NAME Scale and Instrument Shop Office BUILDING NO. 1034 CARD NO. 2

IN - OUT	DESCRIPTION AND RECORD OF CHANGES	CEV NO.	AMOUNT DEBIT	AMOUNT CREDIT	REVISED COST
IN	Fibertone acoustical ceiling tile, Class C size 24" x 24" x 3/4" thick, Rooms #4&6 — Memo 5663, W.O. XS-1126, Date 10/25/62				
	Rearrangement of electrical lighting fixtures, receptacles for scale and instrument shop. Dwg. 6929-1200 — W.O. XS-1070, XS-2024, XS-2036, 3/29/64; Memo 6635, 12/22/64				
	Remove (1) receptacle FSQX-23 from circuit 17 and relocate on circuit 18 Rm. 15, Dwg. 6929-1200 — W.O. XS-4388, 6/11/65; Memo 6859, 7/15/65				
IN	220 Volt twist lock receptacle with switch and 30 amp safety switch, Dwg. 6929-1200 — W. O. 59326, 9/7/65; Memo 6881, 10/7/65				
In	American Blower Utility set w/ 1/3 HP 440 volt motor, with motor starting equipment and 4' X 2'-6" exhaust hood, RM #14. Dwg 6929-1200 — W.O.# 59355; Memo No. 7104, 5/6/66				
IN	3 Lockers @ $10.00 Ea. — CEV-5508, 9/8/66				
IN	One Fluorescent lighting fixture added to circuit # 12 room # 7, DWG 6929-1200 W.O.# 69116 7.22.66				
	Removed wall partition between rooms 12 & 13 relocated shop equipment to room # 16 W.O. # 59335 8.31.65				
Room 16	Relocated one fluorescent light fixture and added one — W. O. # 69134 12/20/66				
	Removed partition wall between rooms # 4 and 5. — W. O. # 780547 4/14/67				

RA-85-REV. 6/61

RADFORD ARSENAL
HERCULES POWDER COMPANY
INCORPORATED

CONTRACT NO. W-11-173-ORD-37

PROPERTY RECORD

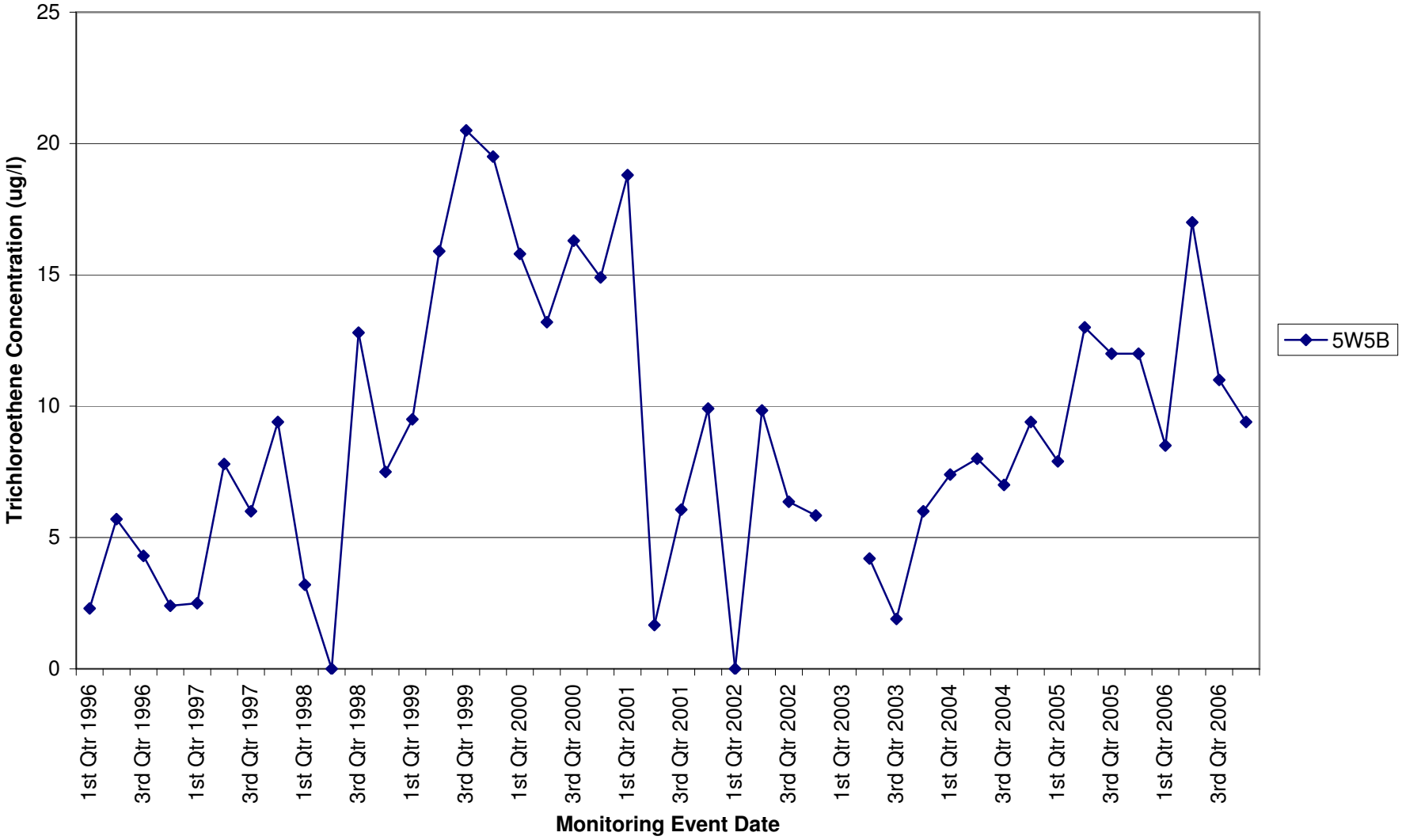
BUILDING NAME Scale and Instrument Shop Office BUILDING NO. 1034 CARD NO. 3

IN - OUT	DESCRIPTION AND RECORD OF CHANGES	CEV NO.	AMOUNT DEBIT	AMOUNT CREDIT	REVISED COST
IN	A 2-story addition to existing Bldg. 1034, concrete footer and slabs on grade CMU walls, water proofed, wood truss roof with built up roof. Approx. dimensions are: main floor - 48' x43'x 10'8". Ground floor-48 x 43 x 10'10". Bldg. includes a monorail system on the upper level storage area, exhaust fans, lights, steam unit heaters on the lower level with steam heat (ductwork) on the upper level. Also included is bituminous paving at the north end of the addition. DD 1354-83-02, CEV 0071-48, FEb. 1983, Memo No. 8803	0071-48 2-83			

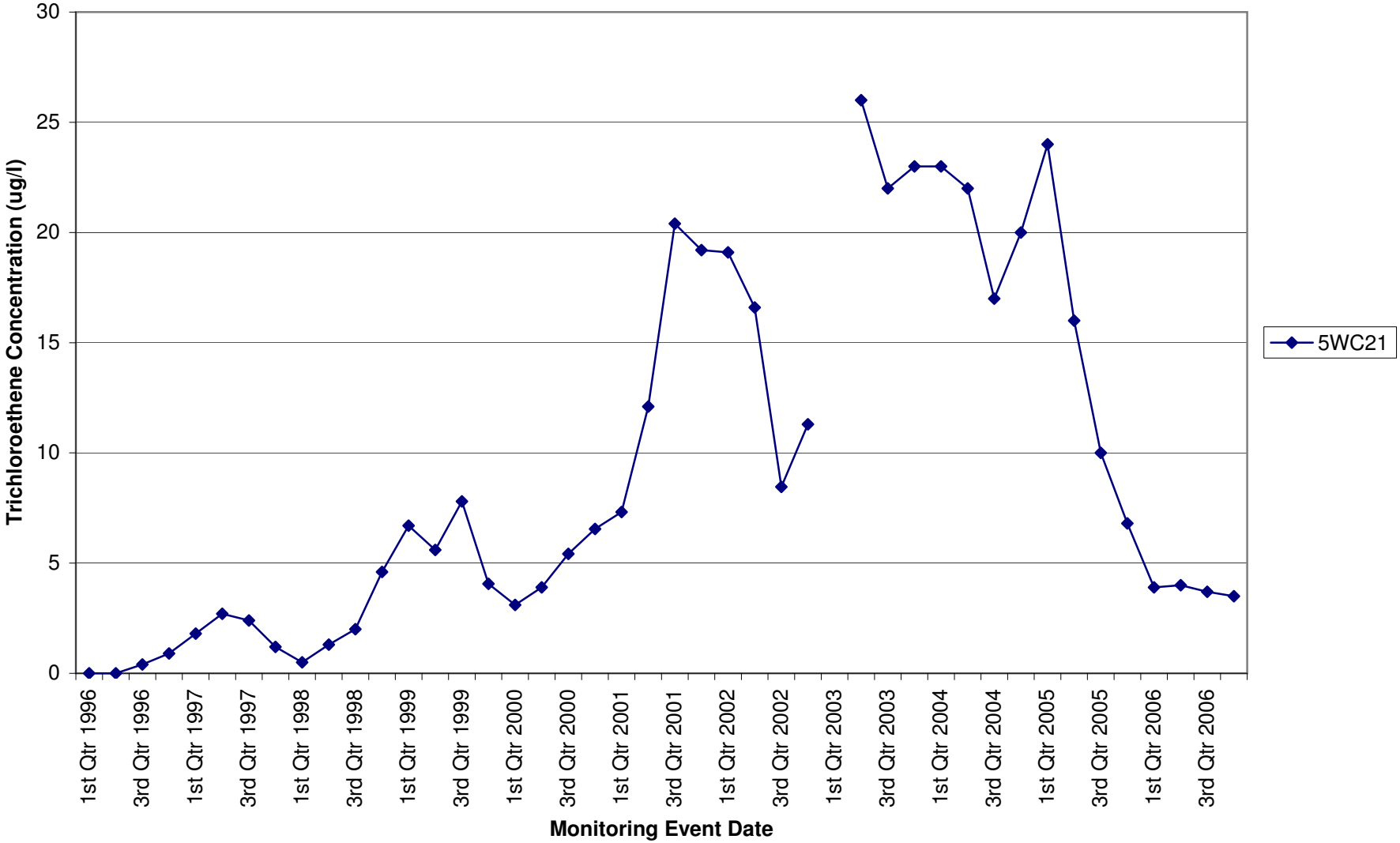
APPENDIX C

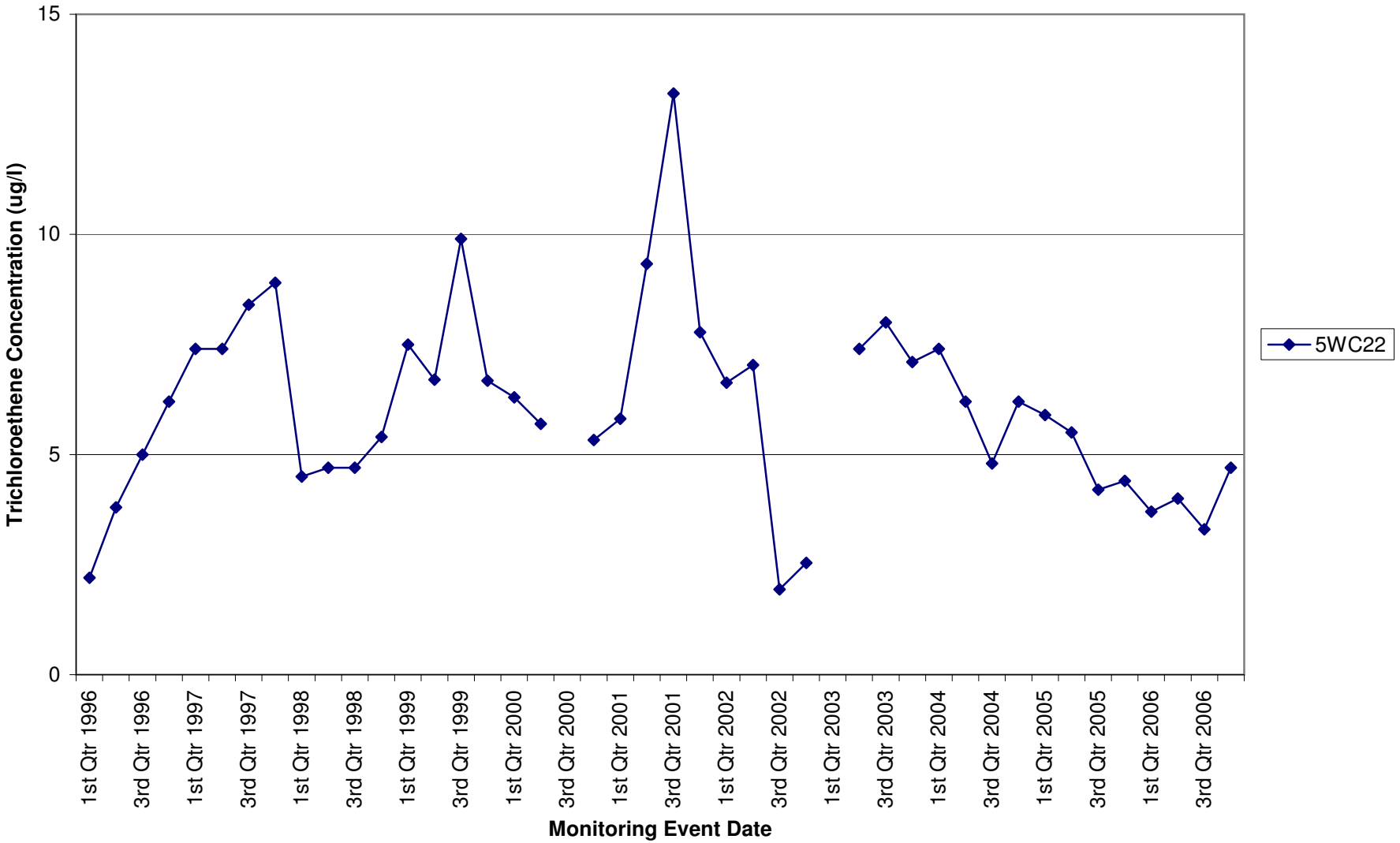
TRICHLOROETHENE HISTORICAL CONCENTRATION GRAPHS

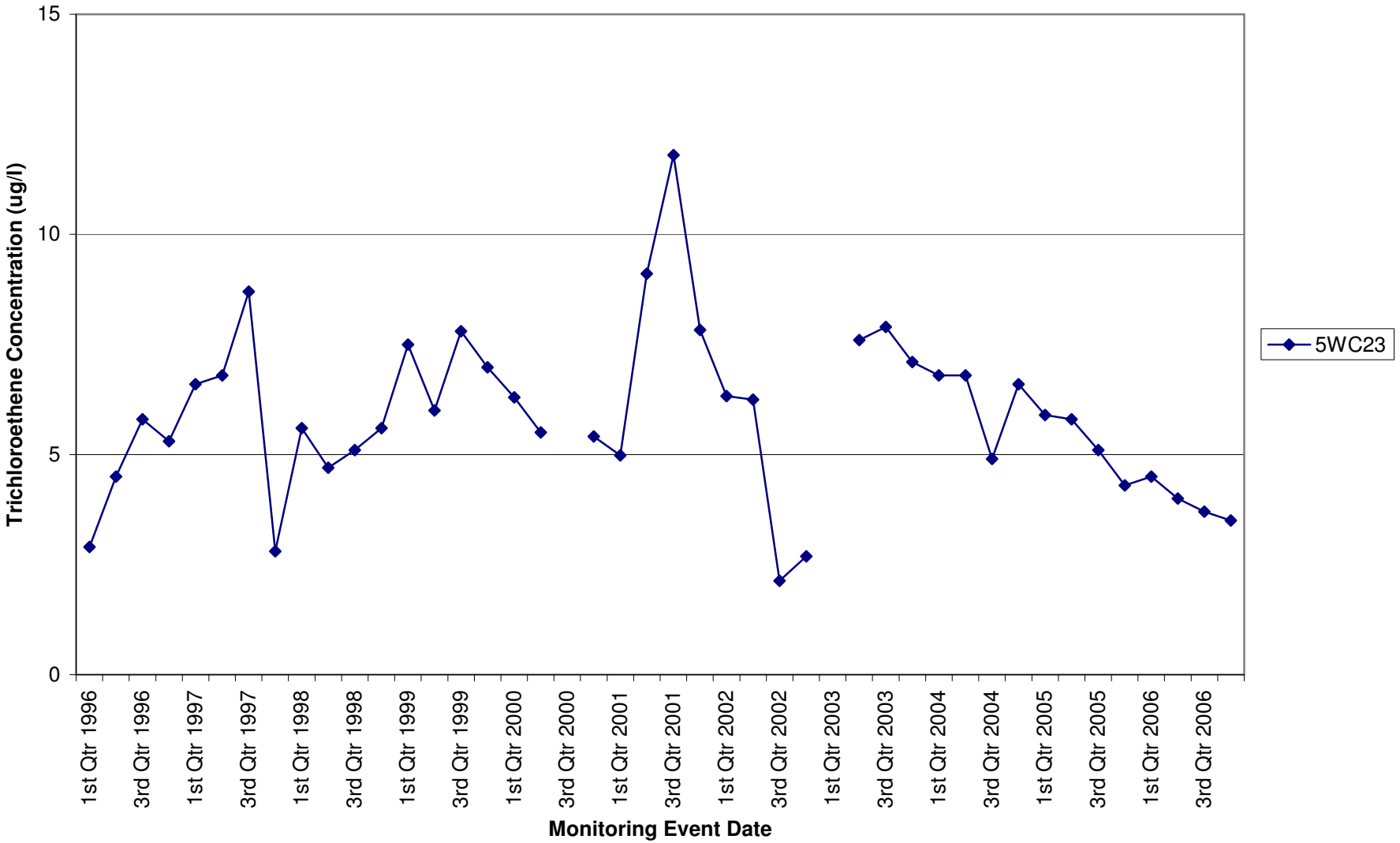
HWMU-5 Trichloroethene Concentrations in Groundwater 1996-2006

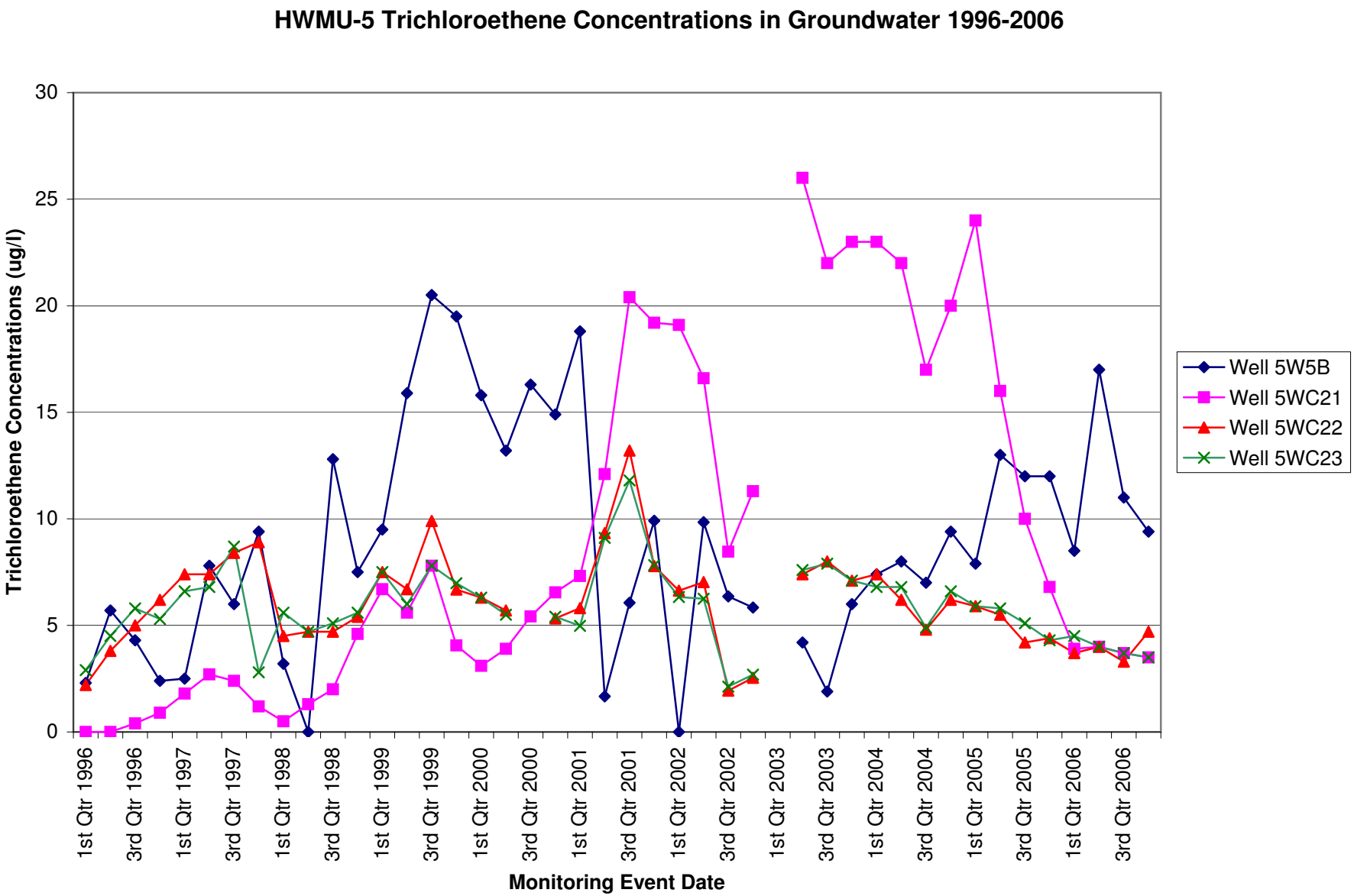


HWMU-5 Trichloroethene Concentrations in Groundwater 1996-2006




HWMU-5 Trichloroethene Concentrations in Groundwater 1996-2006
Trichloroethene Concentration (ug/l)
15
10
5
0
1st Qtr 1996
3rd Qtr 1996
1st Qtr 1997
3rd Qtr 1997
1st Qtr 1998
3rd Qtr 1998
1st Qtr 1999
3rd Qtr 1999
1st Qtr 2000
3rd Qtr 2000
1st Qtr 2001
3rd Qtr 2001
1st Qtr 2002
3rd Qtr 2002
1st Qtr 2003
3rd Qtr 2003
1st Qtr 2004
3rd Qtr 2004
1st Qtr 2005
3rd Qtr 2005
1st Qtr 2006
3rd Qtr 2006
Monitoring Event Date
5WC22


HWMU-5 Trichloroethene Concentrations in Groundwater 1996-2006
Trichloroethene Concentration (ug/l)
15
10
5
0
1st Qtr 1996
3rd Qtr 1996
1st Qtr 1997
3rd Qtr 1997
1st Qtr 1998
3rd Qtr 1998
1st Qtr 1999
3rd Qtr 1999
1st Qtr 2000
3rd Qtr 2000
1st Qtr 2001
3rd Qtr 2001
1st Qtr 2002
3rd Qtr 2002
1st Qtr 2003
3rd Qtr 2003
1st Qtr 2004
3rd Qtr 2004
1st Qtr 2005
3rd Qtr 2005
1st Qtr 2006
3rd Qtr 2006
Monitoring Event Date
5WC23


HWMU-5 Trichloroethene Concentrations in Groundwater 1996-2006
Trichloroethene Concentrations (ug/l)
30
25
20
15
10
5
0
1st Qtr 1996
3rd Qtr 1996
1st Qtr 1997
3rd Qtr 1997
1st Qtr 1998
3rd Qtr 1998
1st Qtr 1999
3rd Qtr 1999
1st Qtr 2000
3rd Qtr 2000
1st Qtr 2001
3rd Qtr 2001
1st Qtr 2002
3rd Qtr 2002
1st Qtr 2003
3rd Qtr 2003
1st Qtr 2004
3rd Qtr 2004
1st Qtr 2005
3rd Qtr 2005
1st Qtr 2006
3rd Qtr 2006
Monitoring Event Date
Well 5W5B
Well 5WC21
Well 5WC22
Well 5WC23

APPENDIX D

SUMMARY OF PCE AND TCE DAUGHTER PRODUCT CONCENTRATIONS IN GROUNDWATER 1996-2006

HAZARDOUS WASTE MANAGEMENT UNIT 5
SUMMARY OF TRICHLOROETHENE CONCENTRATIONS IN GROUNDWATER 1996-2006
RADFORD ARMY AMMUNITION PLANT, RADFORD, VIRGINIA

Monitoring Event	Trichloroethene (TCE) Concentrations in ug/l										
	5W8B	5W5B	5WC21	5WC22	5WC23	5W7B	S5W5	S5W7	5W9A	5W10A	5W11A
1st Qtr 1996	-	2.3	-	2.2	2.9	-	-	-	0.6 J	-	-
2nd Qtr 1996	-	5.7	-	3.8	4.5	-	-	-	0.7 J	-	-
3rd Qtr 1996	-	4.3	0.4 J	5	5.8	-	-	-	0.8 J	-	-
4th Qtr 1996	-	2.4	0.9 J	6.2	5.3	-	-	-	0.6 J	-	-
1st Qtr 1997	-	2.5	1.8	7.4	6.6	0.2 J	-	0.1 J	0.3 J	-	-
2nd Qtr 1997	0.3 J	7.8	2.7	7.4	6.8	0.1 J	0.4 J	-	0.8 J	0.1 J	-
3rd Qtr 1997	-	6	2.4	8.4	8.7	-	0.2 J	-	0.5 J	-	-
4th Qtr 1997	0.8 J	9.4	1.2	8.9	2.8	0.3 J	0.3 J	-	0.3 J	-	-
1st Qtr 1998	-	3.2	0.5	4.5	5.6	-	-	-	0.2 J	-	-
2nd Qtr 1998	-	-	1.3	4.7	4.7	-	0.2 J	-	0.2 J	-	-
3rd Qtr 1998	-	12.8	2	4.7	5.1	-	-	-	0.5 J	-	-
4th Qtr 1998	-	7.5	4.6	5.4	5.6	-	-	-	-	-	-
1st Qtr 1999	-	9.5	6.7	7.5	7.5	-	-	-	-	7.4	-
2nd Qtr 1999	-	15.9	5.6	6.7	6	-	-	-	0.2 J	-	-
3rd Qtr 1999	-	20.5	7.8	9.9	7.8	-	-	-	0.5 J	-	-
4th Qtr 1999	-	19.5	4.06	6.68	6.98	-	-	-	-	-	-
1st Qtr 2000	-	15.8	3.1	6.3	6.3	-	-	-	-	-	-
2nd Qtr 2000	-	13.2	3.9	5.7	5.5	-	-	-	-	-	-
3rd Qtr 2000	-	16.3	5.42	DRY	DRY	-	-	-	-	-	-
4th Qtr 2000	-	14.9	6.55	5.33	5.41	-	-	-	-	-	-
1st Qtr 2001	-	18.8	7.32	5.81	4.98	-	-	-	-	-	-
2nd Qtr 2001	-	1.67	12.1	9.33	9.11	-	-	-	-	-	-
3rd Qtr 2001	-	6.06	20.4	13.2	11.8	-	-	-	-	-	-
4th Qtr 2001	-	9.91	19.2	7.78	7.83	-	-	-	-	-	-
1st Qtr 2002	9.13	-	19.1	6.63	6.33	-	-	-	-	-	-
2nd Qtr 2002	-	9.84	16.6	7.03	6.25	-	-	-	-	-	-
3rd Qtr 2002	-	6.36	8.46	1.94	2.13	-	-	-	-	-	-
4th Qtr 2002	-	5.84	11.3	2.54	2.69	-	-	-	-	-	-
1st Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2003	-	4.2	26	7.4	7.6	-	-	-	-	-	-
3rd Qtr 2003	-	1.9	22	8	7.9	-	-	-	-	-	-
4th Qtr 2003	-	6	23	7.1	7.1	-	-	-	-	-	-
1st Qtr 2004	-	7.4	23	7.4	6.8	-	-	-	-	-	-
2nd Qtr 2004	-	8	22	6.2	6.8	-	-	-	-	-	-
3rd Qtr 2004	-	7	17	4.8	4.9	-	-	-	-	-	-
4th Qtr 2004	-	9.4	20	6.2	6.6	-	-	-	-	-	-
1st Qtr 2005	-	7.9	24	5.9	5.9	-	-	-	-	-	-
2nd Qtr 2005	-	13	16	5.5	5.8	-	-	-	-	-	-
3rd Qtr 2005	-	12	10	4.2	5.1	-	-	-	-	-	-
4th Qtr 2005	-	12	6.8	4.4	4.3	-	-	-	-	-	-
1st Qtr 2006	-	8.5	3.9	3.7	4.5	-	-	-	-	-	-
2nd Qtr 2006	-	17	4	4	4	-	-	-	-	-	-
3rd Qtr 2006	-	11	3.7	3.3	3.7	-	-	-	-	-	-
4th Qtr 2006	-	9.4	3.5	4.7	3.5	-	-	-	-	-	-

NOTES:
Well 5W8B is the upgradient monitoring well for HWMU-5.
-: Not detected.
J: Trichloroethene was detected at a concentration greater than the detection limit but less than the quantitation limit. These results are estimates only.
DRY: Monitoring wells 5WC22 and 5WC23 were dry during 3rd Quarter 2000. No samples were collected.
NA: Not analyzed. The monitoring wells at HWMU-5 were not analyzed for trichloroethene during 1st Quarter 2003.

HAZARDOUS WASTE MANAGEMENT UNIT 5
SUMMARY OF TETRACHLOROETHENE CONCENTRATIONS IN GROUNDWATER 1996-2006
RADFORD ARMY AMMUNITION PLANT, RADFORD, VIRGINIA

Monitoring Event	Tetrachloroethene (PCE) Concentrations in ug/l										
	5W8B	5W5B	5WC21	5WC22	5WC23	5W7B	S5W5	S5W7	5W9A	5W10A	5W11A
1st Qtr 1996	-	-	-	-	-	-	-	-	-	-	-
2nd Qtr 1996	-	-	-	-	-	-	-	-	-	-	-
3rd Qtr 1996	-	-	-	-	-	-	-	-	-	-	-
4th Qtr 1996	-	-	-	-	-	-	-	-	-	-	-
1st Qtr 1997	-	-	-	-	-	-	-	-	-	-	-
2nd Qtr 1997	-	-	-	-	-	-	-	-	-	-	-
3rd Qtr 1997	-	-	-	-	-	-	-	-	-	-	-
4th Qtr 1997	-	-	-	-	-	-	-	-	-	-	-
1st Qtr 1998	-	-	-	-	-	-	-	-	-	-	-
2nd Qtr 1998	-	-	-	-	-	-	-	-	-	-	-
3rd Qtr 1998	-	-	-	-	-	-	-	-	-	-	-
4th Qtr 1998	-	-	-	-	-	-	-	-	-	-	-
1st Qtr 1999	-	-	-	-	-	-	-	-	-	-	-
2nd Qtr 1999	-	-	-	-	-	-	-	-	-	-	-
3rd Qtr 1999	-	-	-	-	-	-	-	-	-	-	-
4th Qtr 1999	-	-	-	-	-	-	-	-	-	-	-
1st Qtr 2000	-	-	-	-	-	-	-	-	-	-	-
2nd Qtr 2000	-	-	-	-	-	-	-	-	-	-	-
3rd Qtr 2000	-	-	-	DRY	DRY	-	-	-	-	-	-
4th Qtr 2000	-	-	-	-	-	-	-	-	-	-	-
1st Qtr 2001	-	-	-	-	-	-	-	-	-	-	-
2nd Qtr 2001	-	-	-	-	-	-	-	-	-	-	-
3rd Qtr 2001	-	-	-	-	-	-	-	-	-	-	-
4th Qtr 2001	-	-	-	-	-	-	-	-	-	-	-
1st Qtr 2002	-	-	-	-	-	-	-	-	-	-	-
2nd Qtr 2002	-	-	-	-	-	-	-	-	-	-	-
3rd Qtr 2002	-	-	-	-	-	-	-	-	-	-	-
4th Qtr 2002	-	-	-	-	-	-	-	-	-	-	-
1st Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2003	-	-	-	-	-	-	NA	NA	NA	NA	NA
1st Qtr 2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2004	-	-	-	-	-	-	NA	NA	NA	NA	NA
3rd Qtr 2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2005	-	-	-	-	-	-	NA	NA	NA	NA	NA
3rd Qtr 2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 2006	-	-	-	-	-	-	NA	NA	NA	NA	NA
4th Qtr 2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES:
Well 5W8B is the upgradient monitoring well for HWMU-5.
-: Not detected.
DRY: Monitoring wells 5WC22 and 5WC23 were dry during 3rd Quarter 2000. No samples were collected.
NA: Not analyzed.

HAZARDOUS WASTE MANAGEMENT UNIT 5
SUMMARY OF 1,1-DICHLOROETHENE CONCENTRATIONS IN GROUNDWATER 1996-2006
RADFORD ARMY AMMUNITION PLANT, RADFORD, VIRGINIA

Monitoring Event	1,1-Dichloroethene (1,1-DCE) Concentrations in ug/l										
	5W8B	5W5B	5WC21	5WC22	5WC23	5W7B	S5W5	S5W7	5W9A	5W10A	5W11A
1st Qtr 1996	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 1996	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 1996	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 1996	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 1997	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 1997	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 1997	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 1997	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 1998	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 1998	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 1998	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 1998	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 1999	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 1999	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 1999	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 1999	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 2000	NA	NA	NA	DRY	DRY	NA	NA	NA	NA	NA	NA
4th Qtr 2000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 2001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2003	-	-	-	-	-	-	NA	NA	NA	NA	NA
1st Qtr 2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2004	-	-	-	-	-	-	NA	NA	NA	NA	NA
3rd Qtr 2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2005	-	-	-	-	-	-	NA	NA	NA	NA	NA
3rd Qtr 2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 2006	-	-	-	-	-	-	NA	NA	NA	NA	NA
4th Qtr 2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES:
Well 5W8B is the upgradient monitoring well for HWMU-5.
-: Not detected.
DRY: Monitoring wells 5WC22 and 5WC23 were dry during 3rd Quarter 2000. No samples were collected.
NA: Not analyzed.

HAZARDOUS WASTE MANAGEMENT UNIT 5
SUMMARY OF CIS-1,2-DICHLOROETHENE CONCENTRATIONS IN GROUNDWATER 1996-2006
RADFORD ARMY AMMUNITION PLANT, RADFORD, VIRGINIA

Monitoring Event	cis-1,2-Dichloroethene (cis-1,2-DCE) Concentrations in ug/l										
	5W8B	5W5B	5WC21	5WC22	5WC23	5W7B	S5W5	S5W7	5W9A	5W10A	5W11A
1st Qtr 1996	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 1996	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 1996	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 1996	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 1997	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 1997	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 1997	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 1997	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 1998	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 1998	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 1998	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 1998	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 1999	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 1999	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 1999	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 1999	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 2000	NA	NA	NA	DRY	DRY	NA	NA	NA	NA	NA	NA
4th Qtr 2000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 2001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2003	-	-	-	-	-	-	NA	NA	NA	NA	NA
1st Qtr 2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2004	-	-	-	-	-	-	NA	NA	NA	NA	NA
3rd Qtr 2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2005	-	-	-	-	-	-	NA	NA	NA	NA	NA
3rd Qtr 2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 2006	-	-	-	-	-	-	NA	NA	NA	NA	NA
4th Qtr 2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES:
Well 5W8B is the upgradient monitoring well for HWMU-5.
-: Not detected.
DRY: Monitoring wells 5WC22 and 5WC23 were dry during 3rd Quarter 2000. No samples were collected.
NA: Not analyzed.

HAZARDOUS WASTE MANAGEMENT UNIT 5
SUMMARY OF TRANS-1,2-DICHLOROETHENE CONCENTRATIONS IN GROUNDWATER 1996-2006
RADFORD ARMY AMMUNITION PLANT, RADFORD, VIRGINIA

Monitoring Event	trans-1,2-Dichloroethene (trans-1,2-DCE) Concentrations in ug/l										
	5W8B	5W5B	5WC21	5WC22	5WC23	5W7B	S5W5	S5W7	5W9A	5W10A	5W11A
1st Qtr 1996	~	~	~	~	~	~	~	~	~	~	~
2nd Qtr 1996	~	~	~	~	~	~	~	~	~	~	~
3rd Qtr 1996	~	~	~	~	~	~	~	~	~	~	~
4th Qtr 1996	~	~	~	~	~	~	~	~	~	~	~
1st Qtr 1997	~	~	~	~	~	~	~	~	~	~	~
2nd Qtr 1997	~	~	~	~	~	~	~	~	~	~	~
3rd Qtr 1997	~	~	~	~	~	~	~	~	~	~	~
4th Qtr 1997	~	~	~	~	~	~	~	~	~	~	~
1st Qtr 1998	~	~	~	~	~	~	~	~	~	~	~
2nd Qtr 1998	~	~	~	~	~	~	~	~	~	~	~
3rd Qtr 1998	~	~	~	~	~	~	~	~	~	~	~
4th Qtr 1998	~	~	~	~	~	~	~	~	~	~	~
1st Qtr 1999	~	~	~	~	~	~	~	~	~	~	~
2nd Qtr 1999	~	~	~	~	~	~	~	~	~	~	~
3rd Qtr 1999	~	~	~	~	~	~	~	~	~	~	~
4th Qtr 1999	~	~	~	~	~	~	~	~	~	~	~
1st Qtr 2000	~	~	~	~	~	~	~	~	~	~	~
2nd Qtr 2000	~	~	~	~	~	~	~	~	~	~	~
3rd Qtr 2000	~	~	~	DRY	DRY	~	~	~	~	~	~
4th Qtr 2000	~	~	~	~	~	~	~	~	~	~	~
1st Qtr 2001	~	~	~	~	~	~	~	~	~	~	~
2nd Qtr 2001	~	~	~	~	~	~	~	~	~	~	~
3rd Qtr 2001	~	~	~	~	~	~	~	~	~	~	~
4th Qtr 2001	~	~	~	~	~	~	~	~	~	~	~
1st Qtr 2002	~	~	~	~	~	~	~	~	~	~	~
2nd Qtr 2002	~	~	~	~	~	~	~	~	~	~	~
3rd Qtr 2002	~	~	~	~	~	~	~	~	~	~	~
4th Qtr 2002	~	~	~	~	~	~	~	~	~	~	~
1st Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2003	~	~	~	~	~	~	NA	NA	NA	NA	NA
1st Qtr 2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2004	~	~	~	~	~	~	NA	NA	NA	NA	NA
3rd Qtr 2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2005	~	~	~	~	~	~	NA	NA	NA	NA	NA
3rd Qtr 2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 2006	~	~	~	~	~	~	NA	NA	NA	NA	NA
4th Qtr 2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES:
Well 5W8B is the upgradient monitoring well for HWMU-5.
~: Not detected.
DRY: Monitoring wells 5WC22 and 5WC23 were dry during 3rd Quarter 2000. No samples were collected.
NA: Not analyzed.

HAZARDOUS WASTE MANAGEMENT UNIT 5
SUMMARY OF VINYL CHLORIDE CONCENTRATIONS IN GROUNDWATER 1996-2006
RADFORD ARMY AMMUNITION PLANT, RADFORD, VIRGINIA

Monitoring Event	Vinyl Chloride (VC) Concentrations in ug/l										
	5W8B	5W5B	5WC21	5WC22	5WC23	5W7B	S5W5	S5W7	5W9A	5W10A	5W11A
1st Qtr 1996	~	~	~	~	~	~	~	~	~	~	~
2nd Qtr 1996	~	~	~	~	~	~	~	~	~	~	~
3rd Qtr 1996	~	~	~	~	~	~	~	~	~	~	~
4th Qtr 1996	~	~	~	~	~	~	~	~	~	~	~
1st Qtr 1997	~	~	~	~	~	~	~	~	~	~	~
2nd Qtr 1997	~	~	~	~	~	~	~	~	~	~	~
3rd Qtr 1997	~	~	~	~	~	~	~	~	~	~	~
4th Qtr 1997	~	~	~	~	~	~	~	~	~	~	~
1st Qtr 1998	~	~	~	~	~	~	~	~	~	~	~
2nd Qtr 1998	~	~	~	~	~	~	~	~	~	~	~
3rd Qtr 1998	~	~	~	~	~	~	~	~	~	~	~
4th Qtr 1998	~	~	~	~	~	~	~	~	~	~	~
1st Qtr 1999	~	~	~	~	~	~	~	~	~	~	~
2nd Qtr 1999	~	~	~	~	~	~	~	~	~	~	~
3rd Qtr 1999	~	~	~	~	~	~	~	~	~	~	~
4th Qtr 1999	~	~	~	~	~	~	~	~	~	~	~
1st Qtr 2000	~	~	~	~	~	~	~	~	~	~	~
2nd Qtr 2000	~	~	~	~	~	~	~	~	~	~	~
3rd Qtr 2000	~	~	~	DRY	DRY	~	~	~	~	~	~
4th Qtr 2000	~	~	~	~	~	~	~	~	~	~	~
1st Qtr 2001	~	~	~	~	~	~	~	~	~	~	~
2nd Qtr 2001	~	~	~	~	~	~	~	~	~	~	~
3rd Qtr 2001	~	~	~	~	~	~	~	~	~	~	~
4th Qtr 2001	~	~	~	~	~	~	~	~	~	~	~
1st Qtr 2002	~	~	~	~	~	~	~	~	~	~	~
2nd Qtr 2002	~	~	~	~	~	~	~	~	~	~	~
3rd Qtr 2002	~	~	~	~	~	~	~	~	~	~	~
4th Qtr 2002	~	~	~	~	~	~	~	~	~	~	~
1st Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2003	~	~	~	~	~	~	NA	NA	NA	NA	NA
1st Qtr 2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2004	~	~	~	~	~	~	NA	NA	NA	NA	NA
3rd Qtr 2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2005	~	~	~	~	~	~	NA	NA	NA	NA	NA
3rd Qtr 2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4th Qtr 2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1st Qtr 2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2nd Qtr 2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3rd Qtr 2006	~	~	~	~	~	~	NA	NA	NA	NA	NA
4th Qtr 2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES:
Well 5W8B is the upgradient monitoring well for HWMU-5.
~: Not detected.
DRY: Monitoring wells 5WC22 and 5WC23 were dry during 3rd Quarter 2000. No samples were collected.
NA: Not analyzed.