ANNUAL GROUNDWATER MONITORING REPORT

CALENDAR YEAR 2019

(INCLUDES FOURTH QUARTER 2019 SEMIANNUAL GROUNDWATER MONITORING REPORT)

HAZARDOUS WASTE MANAGEMENT UNITS 5 AND 16

RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

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EXECUTIVE SUMMARY

This document presents the Annual Groundwater Monitoring Report for calendar year 2019 for Hazardous Waste Management Units (HWMUs) 5 and 16 located at the Radford Army Ammunition Plant (RFAAP) in Radford, Virginia. The Annual Groundwater Monitoring Report was compiled in accordance with the requirements specified in the *Final Hazardous Waste Post-Closure Care Permit for HWMUs 5 and 16* (original effective date October 4, 2002; reissued August 16, 2014 with subsequent Class 1 Permit Modifications). This Annual Groundwater Monitoring Report evaluates the analytical data from Second Quarter 2019 and Fourth Quarter 2019 for each Unit.

The calendar year 2019 groundwater monitoring events were conducted using revised detection limits (DLs) and quantitation limits (QLs) for total antimony, total copper, total lead, total silver, and total vanadium as approved by the Virginia Department of Environmental Quality (VDEQ) in electronic correspondence dated March 29, 2019. RFAAP submitted a Class 1 permit modification to reflect these changes to the VDEQ on February 12, 2020. A unit specific summary for the Second and Fourth Quarter 2019 semiannual groundwater monitoring events is provided below.

HWMU-5

HWMU-5 has been in corrective action (CA) since 2010. Semiannual CA groundwater monitoring events for HWMU-5 were conducted in accordance with Permit Module VI – *Groundwater Corrective Action & Monitoring Program for Unit 5*. Semiannual monitoring is conducted during the second and fourth quarter of each year.

During Second Quarter 2019 and Fourth Quarter 2019, trichloroethene (TCE) was detected in point of compliance wells 5WC21, 5WC22, and 5WC23 at concentrations less than the Groundwater Protection Standard (GPS) of 5 ug/l. TCE was not detected at concentrations greater than the quantitation limit (QL) in any other wells comprising the CA monitoring network during the calendar year 2019 monitoring events. Additionally, no daughter products of TCE were detected in any wells comprising the CA groundwater monitoring network for HWMU-5.

Total cobalt was detected at concentrations greater than the GPS of 7 ug/l in point of compliance well 5WC21 during Second Quarter 2019 and Fourth Quarter 2019. Total cobalt was not detected at concentrations greater than the GPS in the other wells comprising the CA monitoring network.

Overall, evaluation of calendar year 2019 data for the CA Targeted Constituents and comparison with historical data indicates effective progress of groundwater CA

through natural attenuation. TCE remedial endpoints have been achieved. No changes to the continuation of the groundwater CA program are anticipated at this time. Semiannual groundwater monitoring will continue at HWMU-5. The next monitoring event is scheduled for Second Quarter 2020.

HWMU-16

Semiannual Compliance groundwater monitoring for HWMU-16 is conducted during the second and fourth quarter of each year. On October 26, 2018, VDEQ authorized the comparison of total cobalt results in HWMU-16 point of compliance wells to the latest VDEQ alternate concentration limit (ACL; 6 ug/l during calendar year 2019) in addition to the Permit-specified GPS of 5 ug/l. During Second Quarter 2019, total cobalt was detected at concentrations greater than the GPS and the VDEQ ACL in point of compliance wells 16MW9, 16WC1A, and 16WC1B. During Fourth Quarter 2019, total cobalt was detected at concentrations greater than the GPS and the VDEQ ACL in point of compliance wells 16WC1A and 16WC1B. Total cobalt was not detected at concentrations greater than the GPS or latest VDEQ ACL in the other wells comprising the compliance monitoring network during Second Quarter 2019 and Fourth Quarter 2019. No other constituents were detected in the upgradient well or in the point of compliance wells at concentrations greater than their respective GPS during Second Quarter 2019 and Fourth Quarter 2019.

In correspondence to the VDEQ dated January 28, 2019, RFAAP requested an extension for completion of the on-going Alternate Source Demonstration (ASD) for total cobalt at point of compliance wells 16WC1B, 16WC1A, and 16MW9 due to inconclusive data. VDEQ approved the extension request in electronic correspondence dated April 11, 2019. Therefore, a verification event was not conducted for the total cobalt concentrations detected in point of compliance wells 16MW9, 16WC1A, and 16WC1B during the calendar year 2019 monitoring events.

In a teleconference between the VDEQ and RFAAP on February 3, 2020, the VDEQ requested RFAAP collect additional information in support of a status update for the on-going ASD for total cobalt at HWMU-16. This additional requested information is above and beyond information collected and reported during routine semiannual groundwater monitoring activities for the Unit. The VDEQ will use this information to evaluate whether the extended cobalt groundwater monitoring will continue beyond routine semiannual groundwater monitoring for the Unit. The requested information will be compiled and submitted to the VDEQ in a forthcoming document; based on this information, the VDEQ may request submittal of an updated ASD report for total cobalt in point of compliance wells 16MW9, 16WC1A, and 16WC1B.

Evaluation of the plume monitoring well data indicated that concentrations of total barium greater than the site-specific background concentration were detected in plume monitoring wells 16-2 and 16-3 and spring sampling location 16SPRING during Second Quarter 2019 and Fourth Quarter 2019, as well as in upgradient well 16C1 during Fourth Quarter 2019. Higher total barium concentrations in downgradient plume monitoring wells relative to background are likely due to natural variations in trace element distribution in groundwater. Upgradient well 16C1 is screened in limestone while downgradient plume monitoring wells 16-2, 16-3, and 16-5 are screened in shale and fault breccia. Such differing lithologic formations would be expected to contain very different trace element distributions. Similar barium concentrations were observed in the point of compliance wells. Therefore, no further action regarding the 2019 total barium concentrations detected in plume monitoring wells 16-2 and 16-3 and in spring sampling location 16SPRING is recommended at this time.

The Second Quarter 2019 event also served as the annual monitoring event in which the upgradient and point of compliance wells at HWMU-16 were sampled for the 40 CFR Part 264 Appendix IX constituents listed in Permit Attachment 1, Appendix I. Final results for the Second Quarter 2019 groundwater monitoring event indicated no additional Appendix IX constituents were detected at or above their respective DLs at HWMU-16; therefore, no further action is required.

As indicated in VDEQ correspondence dated June 12, 2019, additional action is required regarding analysis of 2-propanol during future annual monitoring of the constituents listed in Appendix I of Permit Attachment 1. The VDEQ authorized continued use of the historical DL of 50 ug/l for 2-propanol. However, VDEQ requested an annual survey of laboratories maintaining accreditation under the VELAP for a period of at least three (3) years (i.e., 2020, 2021, 2022) to verify that the lower DL of 18 ug/l for 2-propanol reported by ELLE of Lancaster, Pennsylvania during the Second Quarter 2019 monitoring event cannot be routinely achieved by other VELAP accredited laboratories. VDEQ also requested including this survey as an appendix in subsequent annual reports.

As stated in Permit Condition I.K.2, the Compliance Period during which the GPS applies to HWMU-16 is 13 years, beginning on the effective date of the Final Permit and continuing until October 4, 2015, or until the Director approves clean closure of the unit. No changes to the continuation of the groundwater program are anticipated at this time. Semiannual groundwater monitoring will continue at HWMU-16. The next monitoring event is scheduled for Second Quarter 2020.

1.0 INTRODUCTION

This document presents the Annual Groundwater Monitoring Report for calendar year 2019 for Hazardous Waste Management Units (HWMUs) 5 and 16 located at the Radford Army Ammunition Plant in Radford, Virginia. The Annual Groundwater Monitoring Report was compiled in accordance with the requirements specified in the *Final Hazardous Waste Post-Closure Care Permit for HWMUs 5 and 16* (Final Permit; original effective date October 4, 2002; reissued August 16, 2014; revised in VDEQ-approved Class 1 Permit Modifications dated September 12, 2014 and December 1, 2016). Additionally, the calendar year 2019 groundwater monitoring events were conducted using revised detection limits (DLs) and quantitation limits (QLs) for total antimony, total copper, total lead, total silver, and total vanadium as approved by the Virginia Department of Environmental Quality (VDEQ) in electronic correspondence dated March 29, 2019.

The Annual Groundwater Monitoring Report presents the following set of information for each Unit: basic information and unit identification, a description of the groundwater monitoring plan, a discussion of groundwater movement, potentiometric surface maps, a table of groundwater elevations, and evaluations of the analytical data.

The groundwater samples collected at HWMUs 5 and 16 during the Second and Fourth Quarter 2019 semiannual monitoring events were evaluated in accordance with the reissued Final Permit dated August 16, 2014 and applicable permit modifications.

1.1 HWMU-5

HWMU-5 is a closed lined neutralization pond. The Unit received certification for closure in 1989. As stated in Permit Condition I.K.1, the Compliance Period during which the GPS applies to HWMU-5 is 19 years, beginning on the effective date of the original Post-Closure Care Permit for HWMU-5 (October 28, 2001) and continuing until October 28, 2020. The Second Quarter 2010 groundwater monitoring event served as the first semiannual Corrective Action (CA) groundwater monitoring event for HWMU-5 conducted in accordance with Permit Module VI – *Groundwater Corrective Action & Monitoring Program for Unit 5*.

1.2 HWMU-16

HWMU-16 is a closed hazardous waste landfill. The Unit received certification for closure in 1993. As stated in Permit Condition I.K.2, the Compliance Period during which the Groundwater Protection Standard applies to HWMU-16 is 13 years, beginning on the effective date of the Permit (October 4, 2002) and continuing until October 4, 2015, or until the Director approves clean closure of the unit.

2.0 HWMU-5 ANNUAL GROUNDWATER MONITORING REPORT

2.1 Waste Management Unit Information

Unit Name: Hazardous Waste Management Unit 5 (HWMU-5)
Owner/Operator: United States Army/BAE Systems, Ordnance Systems Inc.

Unit Location: RFAAP Main Plant Area, Radford, Virginia

Class: Hazardous Waste Management Unit
Type: Closed Lined Neutralization Pond

2.2 Groundwater Monitoring Plan

Monitoring Network:

Upgradient Well:	5W8B
Point of Compliance Wells:	5W5B, 5W7B, 5WC21, 5WC22, 5WC23
Plume Monitoring Wells:	5W12A
Observation Wells:	S5W5, S5W7, 5W9A, 5W10A, 5W11A, 5WCA, S5W6, S5W8, 5WC11, 5WC12

Monitoring Status: Corrective Action Monitoring Program

CY 2019 Monitoring Events:

Second Quarter 2019:	April 9, 2019
Fourth Quarter 2019:	October 23-24, 2019

HWMU-5 has been in corrective action (CA) since 2010. The calendar year 2019 groundwater monitoring events were conducted in accordance with Permit Module VI – *Groundwater Corrective Action & Monitoring Program for Unit 5*. Semiannual monitoring is conducted during the second and fourth quarter of each year.

2.3 Groundwater Movement

The monitoring wells at HWMU-5 are screened entirely within either weathered carbonate bedrock residuum or alluvium or across the weathered residuum/carbonate bedrock interface. The static water level measurements gathered during the 2019 semiannual monitoring events are summarized in **Table 1**. The maximum groundwater elevation fluctuation of approximately 3.58 feet was observed at observation well 5W11A; the minimum groundwater elevation fluctuation of 0.08 feet was observed at observation

well S5W8. On average, the groundwater elevation at Unit 5 fluctuated 1.04 feet, which is less than the expected annual fluctuation (2 to 5 feet) discussed in the Permit. As shown on the HWMU-5 Potentiometric Surface Maps (**Appendix A-1**), groundwater movement beneath the site is generally to the north/northeast.

Darcian flow conditions were assumed for the alluvium, residuum, and carbonate bedrock beneath HWMU-5. As a result, the groundwater velocities were calculated by multiplying the hydraulic conductivity (determined from previously conducted slug tests) by the average hydraulic gradient across the site and dividing by an assumed effective porosity for the aquifer. The average hydraulic gradient was determined by superimposing three evenly spaced flow line vectors over the potentiometric surface map, measuring their lengths, calculating the head differential over the distances measured, and dividing the head differential by the length of the flow line vectors. The three calculated gradients were then averaged to a single value. Using this method, the average groundwater hydraulic gradient across the site based on Fourth Quarter 2019 groundwater elevations was calculated to be 0.0267 ft/ft. Historical slug test data for the site yielded an average hydraulic conductivity of 5.25×10^{-5} ft/second. This value is consistent with literature values for carbonate rock and for clayey, silty sand and gravel alluvium and residuum (Domenico and Schwartz, 1990).

The estimated groundwater velocity across the site was calculated to be approximately 2.42 ft/day or 883 ft/year based on the following:

- Average hydraulic conductivity of 5.25×10^{-5} ft/second.
- Average hydraulic gradient of 0.0267 ft/ft.
- Assumed effective porosity of 0.05, based on a representative range of porosities for carbonate rock, weathered residuum, and clayey, silty sand and gravel alluvium (Domenico and Schwartz, 1990).

The actual groundwater flow velocities in the carbonate bedrock may vary as much as one to two orders of magnitude from the velocity presented above depending on water level conditions and the distribution of solution features.

2.4 Groundwater Analytical Data Evaluation

During Second Quarter 2019 and Fourth Quarter 2019, all of the wells in the CA groundwater monitoring network were sampled for the constituents listed in Appendix J to Permit Attachment 2 (*Groundwater Corrective Action Targeted Constituents - GPS and Semiannual Monitoring List for HWMU-5*). The Second Quarter 2019 event also served as the annual monitoring event in which the point of compliance wells at HWMU-5 were

sampled for the constituents listed in Appendix K to Permit Attachment 2 (*Groundwater Corrective Action Annual Monitoring List*). Additionally, the calendar year 2019 groundwater monitoring events were conducted using revised DLs and QLs for antimony, copper, lead, silver, and vanadium as requested and approved by the VDEQ in electronic correspondence dated March 29, 2019.

The laboratory analytical results for the 2019 monitoring events are summarized in **Appendix A-2** (Groundwater Corrective Action Targeted Constituents - GPS and Semiannual Monitoring List) and in **Appendix A-3** (Groundwater Corrective Action Annual Monitoring List). The complete laboratory certificates of analysis for the 2019 monitoring events are included in **Appendix C**. Results were reported by an accredited laboratory under the Virginia Environmental Laboratory Accreditation Program (VELAP) for the analytes, methods and matrix as reported on the certificate of analysis; a copy of the laboratory VELAP accreditation certificate is presented in **Appendix C**. The analytical data were validated in accordance with SW-846, *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, and *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*; data validation reports for HWMU-5 are included in **Appendix C**. Copies of field notes recorded during sample collection are included in **Appendix D**. Copies of correspondence relating to groundwater monitoring activities conducted at HWMU-5 during calendar year 2019 are included in **Appendix E**.

2.4.1 Semiannual Monitoring for Corrective Action Targeted Constituents

During the Second Quarter 2019 and Fourth Quarter 2019 monitoring events, groundwater samples collected from all of the wells in the CA groundwater monitoring network were analyzed for the CA Targeted Constituents listed in Appendix J to Permit Attachment 2. The CA Targeted Constituents consist of TCE and its daughter products: 1,1-dichloroethene (1,1-DCE), *cis*-1,2-dichloroethene (*c*DCE), *trans*-1,2-dichloroethene (*t*DCE), and vinyl chloride (VC). In addition, the VDEQ added total cobalt to the list of CA Targeted Constituents during a meeting with RFAAP on May 4, 2011. The laboratory analytical results for the CA Targeted Constituents are summarized in **Appendix A-2**.

During Second Quarter 2019, TCE was detected in point of compliance wells 5WC21, 5WC22 and 5WC23 at concentrations of 2.8 ug/l, 2.9 ug/l, and 3.9 ug/l, respectively, which are less than the GPS of 5 ug/l (**Appendix A-2**). TCE was not detected in any of the other wells in the CA groundwater monitoring network. Additionally, the TCE daughter products were not detected in any of the wells comprising the CA groundwater monitoring network.

During Fourth Quarter 2019, TCE was detected in point of compliance wells 5WC21, 5WC22 and 5WC23 at concentrations of 2.0 ug/l, 2.4 ug/l, and 4.0 ug/l, respectively, which are less than the GPS of 5 ug/l (**Appendix A-2**). TCE was detected in point of compliance well 5W7B at a concentration less than the QL of 1.0 ug/l. TCE was not detected in any of the other wells in the CA groundwater monitoring network. Additionally, the TCE daughter products were not detected in any of the wells comprising the CA groundwater monitoring network.

During Second Quarter 2019, total cobalt was detected in point of compliance well 5WC21 at a concentration of 32 ug/l, which is greater than the GPS of 7 ug/l. Total cobalt was detected in point of compliance wells 5WC22, 5WC23, and 5W7B at concentrations less than the QL of 5 ug/l but greater than the DL of 1 ug/l (**Appendix A-2**). Total cobalt was not detected at concentrations greater than the GPS in the other wells comprising the CA monitoring network during Second Quarter 2019.

During Fourth Quarter 2019, total cobalt was detected in point of compliance well 5WC21 at a concentration of 22.2 ug/l, which is greater than the GPS of 7 ug/l. Total cobalt was detected in point of compliance wells 5WC22, 5WC23, and 5W7B at concentrations less than the QL of 5 ug/l but greater than the DL of 1 ug/l (**Appendix A-2**). Total cobalt was not detected at concentrations greater than the GPS in the other wells comprising the CA monitoring network during Fourth Quarter 2019.

2.4.2 Annual Monitoring List – Comparison to Groundwater Protection Standards

During Second Quarter 2019, groundwater samples collected from the point of compliance wells for HWMU-5 were analyzed for the constituents listed in Appendix K to Permit Attachment 2 (*Groundwater Corrective Action Annual Monitoring List*; revised in Class 1 Permit Modification approved December 1, 2016). Annual monitoring for the constituents listed in Appendix K is required in order to evaluate whether additional hazardous constituents that are not the targets for the current Corrective Action (e.g., TCE and its daughter products, total cobalt) are present at concentrations greater than the Groundwater Protection Standards (GPS) for the Unit. No additional hazardous constituents that are not targets for the current Corrective Action for the Unit were detected at concentrations greater than their respective GPS during Second Quarter 2019 (**Appendix A-3**).

2.4.3 Annual Monitoring List – Verification of Estimated Values

A footnote presented in Appendix K to Permit Attachment 2 indicates that verification is required for constituents detected at concentrations less than the QL if their associated GPSs are 1) based on background values equal to the QL, and 2) are greater

than the applicable risk-based concentrations (i.e., ACL or RSL). In these instances, verification must be conducted using an alternate low-level analytical method in order to confirm or refute the observed initial detections if the QL achievable by that method is less than, or equal to, the ACL or RSL for the subject constituent. If a concentration greater than the low-level analytical method QL is observed, then the GPS for that constituent will be updated, if warranted.

During Second Quarter 2019, p-nitroaniline (which has a GPS based on a background value equal to the QL) was initially detected in point of compliance well 5WC23 at a concentration less than the QL of 20 ug/l. Additional sample aliquot for well 5WC23 was collected during the original Second Quarter 2019 sampling event and submitted to an alternate laboratory for potential low-level analysis. The alternate laboratory prepared and held the sample pending the initial analytical result. Low-level analysis was required for p-nitroaniline in well 5WC23 and the alternate laboratory was requested to perform low-level analysis to confirm or refute the observed initial detection. P-nitroaniline was not detected at a concentration greater than the low-level analytical method QL of 1.8 ug/l in point of compliance well 5WC23; therefore, no further action is warranted.

2.4.4 2019 USEPA Regional Screening Levels (RSLs)

The USEPA periodically updates the RSLs (formerly known as RBCs). As stated in section VI.E.3 of Module VI of the Final Permit, "The Permittee shall use the most up-to-date USEPA MCL, the Department ACL, or EPA Region 3 RBC as the GPS. If USEPA implements any changes to MCLs or RBCs, the GPS defined by that MCL or RBC will be updated to reflect the most current value established by USEPA."

At the time of the Second Quarter 2019 groundwater monitoring event, the May 2019 USEPA RSL table reflected the most current RSL values. According to the May 2019 USEPA RSL table, the current RSL for diethyl ether (CAS Number 60-29-7) is 3,900 ug/l (target hazard quotient (THQ)=1.0, target risk (TR) =1E-06); the Permit-specified GPS for diethyl ether listed in Appendix K to Permit Attachment 2 is based on the previous RSL of 7,300 ug/l. The GPS comparison value for diethyl ether listed in Appendix A-2 of this report is the Permit-specified GPS of 7,300 ug/l; however, RFAAP also compared diethyl ether concentrations detected during Second Quarter 2019 to the current USEPA RSL of 3,900 ug/l. Diethyl ether is the only constituent listed in Appendix K to Permit Attachment 2 whose GPS is based on a previous USEPA RSL that has been updated subsequent to the Permit reissuance date of August 16, 2014.

During Second Quarter 2019, diethyl ether was not detected at or above the QL of 12 ug/l. Additionally, diethyl ether was detected below the quantitation limit of 12 ug/l

in point of compliance wells 5WC21, 5WC22, and 5WC23 at estimated values of 2.3 ug/l, 5.3 ug/l and 10 ug/l, respectively. The detected diethyl ether concentrations are less than the GPS listed in Appendix K to Permit Attachment 2 (7,300 ug/l) as well as the May 2019 USEPA RSL of 3,900 ug/l. Diethyl ether was not detected in any other wells comprising the CA groundwater monitoring network.

2.5 Annual Evaluation of Effectiveness of Corrective Action

In accordance with Sections VI.B.6, VI.J.4.f and VI.J.4.g and other applicable sections of the Final Permit, RFAAP is required to perform an annual evaluation of the effectiveness of the Corrective Action Program (CAP) (monitored natural attenuation [MNA] program) for calendar year 2019. MNA is the current remedial measure implemented at the Unit to address TCE in groundwater at concentrations greater than the GPS.

During Second Quarter 2019 and Fourth Quarter 2019, TCE was detected in point of compliance wells 5WC21, 5WC22, and 5WC23 at concentrations less than the GPS of 5 ug/l. TCE was not detected at concentrations greater than the QL in any other wells comprising the CA monitoring network during the calendar year 2019 monitoring events. In accordance with the Final Permit, calculation of the predicted MNA remedial timeframe is not applicable since TCE data remained below the GPS in 2019.

Total cobalt was detected at concentrations greater than the GPS of 7 ug/l in point of compliance well 5WC21 during Second Quarter 2019 and Fourth Quarter 2019. Total cobalt was not detected at concentrations greater than the GPS in the other wells comprising the CA monitoring network.

2.6 Recommendations

Concentrations of TCE at HWMU-5 remained below the GPS throughout calendar year 2019 indicating achievement of remedial endpoints. The current monitoring program is required to continue until the concentrations of TCE have remained below the GPS for a period of three consecutive years; upon which the Permittee may request to end corrective action and return to compliance monitoring which is currently scheduled to end October 28, 2020.

Please note that TCE was last detected at a concentration greater than the GPS at HWMU-5 during Fourth Quarter 2014; therefore, TCE concentrations in groundwater at the Unit have been below the GPS for over three consecutive years. Based on these results, RFAAP may submit a request to end corrective action at HWMU-5.

The calendar year 2019 groundwater monitoring events were conducted using revised DLs and QLs for total antimony, total copper, total lead, total silver, and total vanadium as approved by the VDEQ in electronic correspondence dated March 29, 2019. RFAAP submitted a Class 1 permit modification to reflect these changes to the VDEQ on February 12, 2020. The next monitoring event is scheduled for Second Quarter 2020.

3.0 HWMU-16 ANNUAL GROUNDWATER MONITORING REPORT

3.1 Waste Management Unit Information

Unit Name: Hazardous Waste Management Unit 16 (HWMU-16)
Owner/Operator: United States Army/BAE Systems, Ordnance Systems Inc.

Unit Location: RFAAP Main Plant Area, Radford, Virginia

Class: Hazardous Waste Management Unit
Type: Closed Hazardous Waste Landfill

3.2 Groundwater Monitoring Plan

Monitoring Network:

Upgradient Well:	16C1
Point of Compliance Wells:	16WC1A, 16WC1B, 16MW8, 16MW9
Plume Monitoring Wells:	16-2, 16-3, 16-5, 16WC2B, 16SPRING
Observation Wells:	16-1, 16WC2A, 16C3, 16CDH3

Monitoring Status: Compliance Monitoring Program

CY 2019 Monitoring Events:

Second Quarter 2019:	April 10-11, 2019; June 25, 2019 (verification event)
Fourth Quarter 2019:	October 22-23, 2019

The calendar year 2019 groundwater monitoring events for HWMU-16 were conducted in accordance with Permit Module V – *Groundwater Compliance Monitoring*. Semiannual monitoring is conducted during the second and fourth quarter of each year.

3.3 Groundwater Movement

The monitoring wells at HWMU-16 are screened entirely within either carbonate bedrock or weathered carbonate bedrock residuum, or across the residuum/bedrock interface. The static water level measurements gathered during the 2019 semiannual monitoring events are summarized in **Table 2**. The maximum groundwater elevation fluctuation of 9.78 feet was observed at point of compliance monitoring well 16WC1A; the minimum groundwater elevation fluctuation of 0.86 feet was observed at observation well 16-2. On average, the groundwater elevation at Unit 16 fluctuated 5.8 feet, which is greater than the expected annual fluctuation (2 to 4 feet) discussed in the Permit. As

shown on the HWMU-16 Potentiometric Surface Maps (**Appendix B-1**), groundwater movement beneath the site is generally to the northeast.

Darcian flow conditions were assumed for the weathered residuum and carbonate bedrock beneath HWMU-16. As a result, the groundwater velocities were calculated by multiplying the hydraulic conductivity (determined from previously conducted slug tests) by the average hydraulic gradient across the site and dividing by an assumed effective porosity for the aquifer materials. The average hydraulic gradient was determined by superimposing three evenly spaced flow line vectors over the potentiometric surface map, measuring their lengths, calculating the head differential over the distances measured, and dividing the head differential by the length of the flow line vectors. The three calculated gradients were then averaged to a single value. Using this method, the average groundwater hydraulic gradient across the site based on Fourth Quarter 2019 groundwater elevations was calculated to be 0.091 ft/ft. Historical slug test data for the site yielded an average hydraulic conductivity of 7.87×10^{-5} ft/second. This value is consistent with literature values for carbonate rock and for clay and silt residuum (Domenico and Schwartz, 1990).

The estimated groundwater velocity across the site was calculated to be approximately 12.38 ft/day or 4,520 ft/year based on the following:

- Average hydraulic conductivity of 7.87×10^{-5} ft/second.
- Average hydraulic gradient of 0.091 ft/ft.
- Assumed effective porosity of 0.05, based on a representative range of porosities for carbonate rock and clay and silt residuum (Domenico and Schwartz, 1990).

The actual groundwater flow velocities in the carbonate bedrock may vary as much as one to two orders of magnitude from the velocity presented above depending on water level conditions and the distribution of solution features.

3.4 Groundwater Analytical Data Evaluation

The groundwater samples collected from the compliance monitoring network during the 2019 semiannual monitoring events were analyzed for the constituents listed in Permit Attachment 3, Appendix E – *Groundwater Compliance Monitoring (Semiannual) Constituent List*. In addition, during Second Quarter 2019 groundwater samples were collected from the upgradient well and the point of compliance wells for annual monitoring for the constituents listed in Permit Attachment 1, Appendix I – *Annual Groundwater Sampling Constituent List (Appendix IX 40 CFR Part 264)*. Additionally, the

calendar year 2019 groundwater monitoring events were conducted using revised DLs and QLs for antimony, copper, lead, silver, and vanadium as requested and approved by the VDEQ in electronic correspondence dated March 29, 2019.

The laboratory analytical results for the 2019 monitoring events are included in **Appendix B-2** (point of compliance wells) and in **Appendix B-3** (plume monitoring wells). The complete laboratory certificates of analysis for the 2019 monitoring events are included in **Appendix C**. Results were reported by an accredited laboratory under the VELAP for the analytes, methods and matrix as reported on the certificate of analysis; a copy of the laboratory VELAP accreditation certificate is presented in **Appendix C**. The analytical data were validated in accordance with SW-846, *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, and *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*; data validation reports for HWMU-16 are included in **Appendix C**. Copies of field notes recorded during sample collection are included in **Appendix D**. Copies of correspondence relating to groundwater monitoring activities conducted at HWMU-16 during calendar year 2019 are included in **Appendix E**.

3.4.1 Annual Monitoring – Permit Attachment 1, Appendix I

A verification event was conducted on June 25, 2019, which refuted initially reported detections of vinyl chloride in point of compliance well 16WC1A and total silver in point of compliance well 16MW8. Final results for the Second Quarter 2019 groundwater monitoring event indicated no additional Appendix IX constituents were detected at or above their respective DLs at HWMU-16; therefore, no further action is required. VDEQ notification of the verification event results, which included analysis of a sample, sample duplicate and split sample (vinyl chloride only), are included in **Appendix E**.

Additional required action for the annual monitoring event was provided in VDEQ correspondence dated June 12, 2019 (**Appendix E**). The VDEQ authorized continued use of the historical DL of 50 ug/l for 2-propanol. Additionally, VDEQ requested an annual survey of laboratories maintaining accreditation under the VELAP for a period of at least three (3) years (i.e., 2020, 2021, 2022) to ensure that the lower DL of 18 ug/l for 2-propanol reported by ELLE of Lancaster, Pennsylvania during the Second Quarter 2019 monitoring event is not routinely achieved by other VELAP accredited laboratories. VDEQ also requested including this survey as an appendix in subsequent annual reports.

3.4.2 Comparison to Groundwater Protection Standards

As specified in the Final Permit, the calendar year 2019 groundwater analytical data for the upgradient well and the point of compliance wells were compared to the GPS for HWMU-16 listed in Appendix G of Permit Attachment 3 (modified to add 1,1-dichloroethene in Class 1 Permit Modification approved September 12, 2014; modified to add tetrahydrofuran in Class 1 Permit Modification approved December 1, 2016). In accordance with Permit Condition V.I.2, RFAAP performed a simple empirical comparison of the upgradient well and the point of compliance well data to the GPS (**Appendix B-2**).

On October 26, 2018, VDEQ authorized the comparison of total cobalt results in HWMU-16 point of compliance wells to the latest VDEQ alternate concentration limit (ACL; 6 ug/l during calendar year 2019) in addition to the Permit-specified GPS of 5 ug/l. During Second Quarter 2019, total cobalt was detected at concentrations greater than the GPS of 5 ug/l and the VDEQ ACL of 6 ug/l in point of compliance wells 16MW9, 16WC1A, and 16WC1B. Additionally, total cobalt was initially detected at a concentration greater than the GPS in point of compliance well 16MW8; a verification event conducted on June 25, 2019 detected total cobalt at a concentration below the GPS and no additional action was required. During Fourth Quarter 2019, total cobalt was detected at concentrations greater than the GPS of 5 ug/l and the VDEQ ACL of 6 ug/l in point of compliance wells 16WC1A and 16WC1B. Total cobalt was not detected at concentrations greater than the GPS or latest VDEQ ACL in the other wells comprising the compliance monitoring network during the calendar year 2019 monitoring events.

In correspondence to the VDEQ dated January 28, 2019, RFAAP requested an extension for completion of the on-going ASD for total cobalt at point of compliance wells 16MW9, 16WC1A, and 16WC1B due to inconclusive data (**Appendix E**). VDEQ approved the extension request in electronic correspondence dated April 11, 2019 (**Appendix E**). Therefore, a verification event was not conducted for the total cobalt concentrations detected in point of compliance wells 16MW9, 16WC1A, and 16WC1B during the calendar year 2019 monitoring events.

In a teleconference between the VDEQ and RFAAP on February 3, 2020, the VDEQ requested RFAAP collect additional information in support of a status update for the on-going ASD for total cobalt at HWMU-16. This additional requested information is above and beyond information collected and reported during routine semiannual groundwater monitoring activities for the Unit. The VDEQ will use this information to evaluate whether the extended cobalt groundwater monitoring will continue beyond routine semiannual groundwater monitoring for the Unit. The requested information will be compiled and submitted to the VDEQ in a forthcoming document; based on this information, the VDEQ

may request submittal of an updated ASD report for total cobalt in point of compliance wells 16MW9, 16WC1A, and 16WC1B.

No other constituents were detected in the upgradient well or in the point of compliance wells at concentrations greater than their respective GPS during Second Quarter 2019 and Fourth Quarter 2019.

A footnote presented in Appendix G of Permit Attachment 3 (*Groundwater Protection Standards: Unit 16*) indicates that verification is required for constituents detected at concentrations less than the QL if their associated GPS are equal to the QL and are greater than the applicable risk-based concentrations (i.e., ACL or RSL). In these instances, verification must be conducted using an alternate low-level analytical method in order to confirm or refute the observed initial detections if the QL achievable by that method is less than, or equal to, the ACL or RSL for the subject constituent. If a concentration greater than the low-level analytical method QL is observed, then the GPS for that constituent will be updated, if warranted. During Second Quarter 2019 and Fourth Quarter 2019, no constituents with GPSs equal to their respective QLs and greater than the applicable risk-based concentrations were detected at concentrations less than their respective QLs; therefore, no further action was warranted.

3.4.3 Comparison to Background Concentrations

As specified in Permit Condition V.O, the 2019 groundwater analytical data for the plume monitoring wells were compared to the background concentrations for HWMU-16 listed in Appendix F of Permit Attachment 3. In accordance with Permit Condition V.I.2, RFAAP performed a simple empirical comparison of the plume monitoring well data to the background concentrations (**Appendix B-3**).

As shown in **Appendix B-3**, total barium concentrations detected during Second Quarter 2019 and Fourth Quarter 2019 in plume monitoring wells 16-2 and 16-3 and in spring sampling location 16SPRING, as well as in upgradient well 16C1 during Fourth Quarter 2019, were greater than the background concentration of 175.4 ug/l. All of the total barium concentrations detected in the plume monitoring wells were well below the USEPA MCL for barium of 2,000 ug/l. Higher barium concentrations in downgradient plume monitoring wells relative to background may be the result of natural variations in trace element distribution in groundwater. As illustrated in the boring logs for the compliance network monitoring wells (Appendix H of Permit Attachment 5), upgradient well 16C1 is screened in limestone while downgradient plume monitoring wells 16-2, 16-3, and 16-5 are screened in shale and fault breccia. Such differing lithologic formations would be expected to contain different trace element distributions.

No other constituent concentrations detected in the plume monitoring wells were greater than their respective background concentrations. In accordance with the requirements of Permit Condition V.K.3, the established background values and the computations used to determine the background values are included in **Appendix B-4**.

3.5 Recommendations

In a teleconference between the VDEQ and RFAAP on February 3, 2020, the VDEQ requested RFAAP collect additional information in support of a status update for the on-going ASD for total cobalt at HWMU-16. This additional requested information is above and beyond information collected and reported during routine semiannual groundwater monitoring activities for the Unit. The VDEQ will use this information to evaluate whether the extended cobalt groundwater monitoring will continue beyond routine semiannual groundwater monitoring for the Unit. The requested information will be compiled and submitted to the VDEQ in a forthcoming document; based on this information, the VDEQ may request submittal of an updated ASD report for total cobalt in point of compliance wells 16MW9, 16WC1A, and 16WC1B.

As directed by the VDEQ in electronic correspondence dated October 26, 2018, RFAAP will continue to compare detected total cobalt concentrations to the latest VDEQ ACL for total cobalt.

No further action regarding the 2019 total barium concentrations detected in plume monitoring wells 16-2 and 16-3 and in spring sampling location 16SPRING is recommended at this time.

As indicated in VDEQ correspondence dated June 12, 2019, additional action is required regarding analysis of 2-propanol during future annual monitoring of the constituents listed in Appendix I of Permit Attachment 1. The VDEQ authorized continued use of the historical DL of 50 ug/l for 2-propanol. However, VDEQ requested an annual survey of laboratories maintaining accreditation under the VELAP for a period of at least three (3) years (i.e., 2020, 2021, 2022) to verify that the lower DL of 18 ug/l for 2-propanol reported by ELLE of Lancaster, Pennsylvania during the Second Quarter 2019 monitoring event cannot be routinely achieved by other VELAP accredited laboratories. VDEQ also requested including this survey as an appendix in subsequent annual reports.

The calendar year 2019 groundwater monitoring events were conducted using revised DLs and QLs for total antimony, total copper, total lead, total silver, and total vanadium as approved by the VDEQ in electronic correspondence dated March 29, 2019. RFAAP submitted a Class 1 permit modification to reflect these changes to the VDEQ on February 12, 2020. The next monitoring event is scheduled for Second Quarter 2020.

SIGNATURE/CERTIFICATION

Prepared by:

Name: Ross G. Miller; Senior Project Geologist

Signature: 

Company: Draper Aden Associates

Address: 2206 South Main Street

City/State/Zip: Blacksburg, Virginia 24060-6600

Virginia Professional Certification:

I certify that I have prepared or supervised preparation of the attached report, that it has been prepared in accordance with industry standards and practices, and that the information contained herein is truthful and accurate to the best of my knowledge.

Name: Michael D. Lawless, Environmental Program Manager

Signature: 

Virginia Professional Certification Type and Number: PG 832

Company: Draper Aden Associates

Address: 2206 South Main Street

City/State/Zip: Blacksburg, Virginia 24060-6600

TABLES

TABLE 1
HWMU-5
GROUNDWATER ELEVATIONS - 2019
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

MONITORING WELL ID	ELEVATION TOP OF WELL	APRIL 9, 2019		OCTOBER 23, 2019	
		DTW	GW ELEV	DTW	GW ELEV
5W8B	1789.58	14.80	1774.78	15.79	1773.79
5W5B	1775.13	8.43	1766.70	9.94	1765.19
5W7B	1774.78	9.45	1765.33	10.32	1764.46
5WC21	1774.43	8.77	1765.66	9.54	1764.89
5WC22	1774.45	8.65	1765.80	9.43	1765.02
5WC23	1773.84	8.02	1765.82	8.82	1765.02
5W12A	1772.46	10.94	1761.52	12.38	1760.08
S5W5	1772.31	7.81	1764.50	8.89	1763.42
S5W7	1776.08	11.55	1764.53	11.91	1764.17
5W9A	1762.20	0.02	1762.18	1.49	1760.71
5W10A	1771.40	12.38	1759.02	14.61	1756.79
5W11A	1766.20	9.59	1756.61	13.17	1753.03
5WC11	1788.92	15.72	1773.20	16.00	1772.92
5WC12	1788.96	16.12	1772.84	16.34	1772.62
5WCA	1779.05	12.31	1766.74	12.92	1766.13
S5W6	1771.43	6.25	1765.18	6.91	1764.52
S5W8	1783.68	11.92	1771.76	12.00	1771.68

NOTES:
DTW: Depth to water from top of casing.
GW ELEV: Groundwater elevation.
All elevations in feet above mean sea level.

TABLE 2
HWMU-16
GROUNDWATER ELEVATIONS - 2019
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

MONITORING WELL ID	ELEVATION TOP OF WELL	APRIL 10, 2019		OCTOBER 22, 2019	
		DTW	GW ELEV	DTW	GW ELEV
16C1	1840.14	43.48	1796.66	49.32	1790.82
16MW8	1815.82	68.74	1747.08	75.28	1740.54
16MW9	1808.88	60.16	1748.72	67.35	1741.53
16WC1A	1812.61	61.70	1750.91	71.48	1741.13
16WC1B	1812.95	61.68	1751.27	70.28	1742.67
16-1	1815.82	40.88	1774.94	48.12	1767.70
16-2	1810.99	55.89	1755.10	56.75	1754.24
16-3	1824.77	53.80	1770.97	56.53	1768.24
16-5	1742.60	4.17	1738.43	7.85	1734.75
16WC2B	1818.71	49.35	1769.36	55.15	1763.56
16WC2A	1820.05	61.23	1758.82	DRY	DRY
16C3	1822.22	57.25	1764.97	DRY	DRY
16CDH3	1825.60	DRY	DRY	DRY	DRY
SPRING	na	na	na	na	na

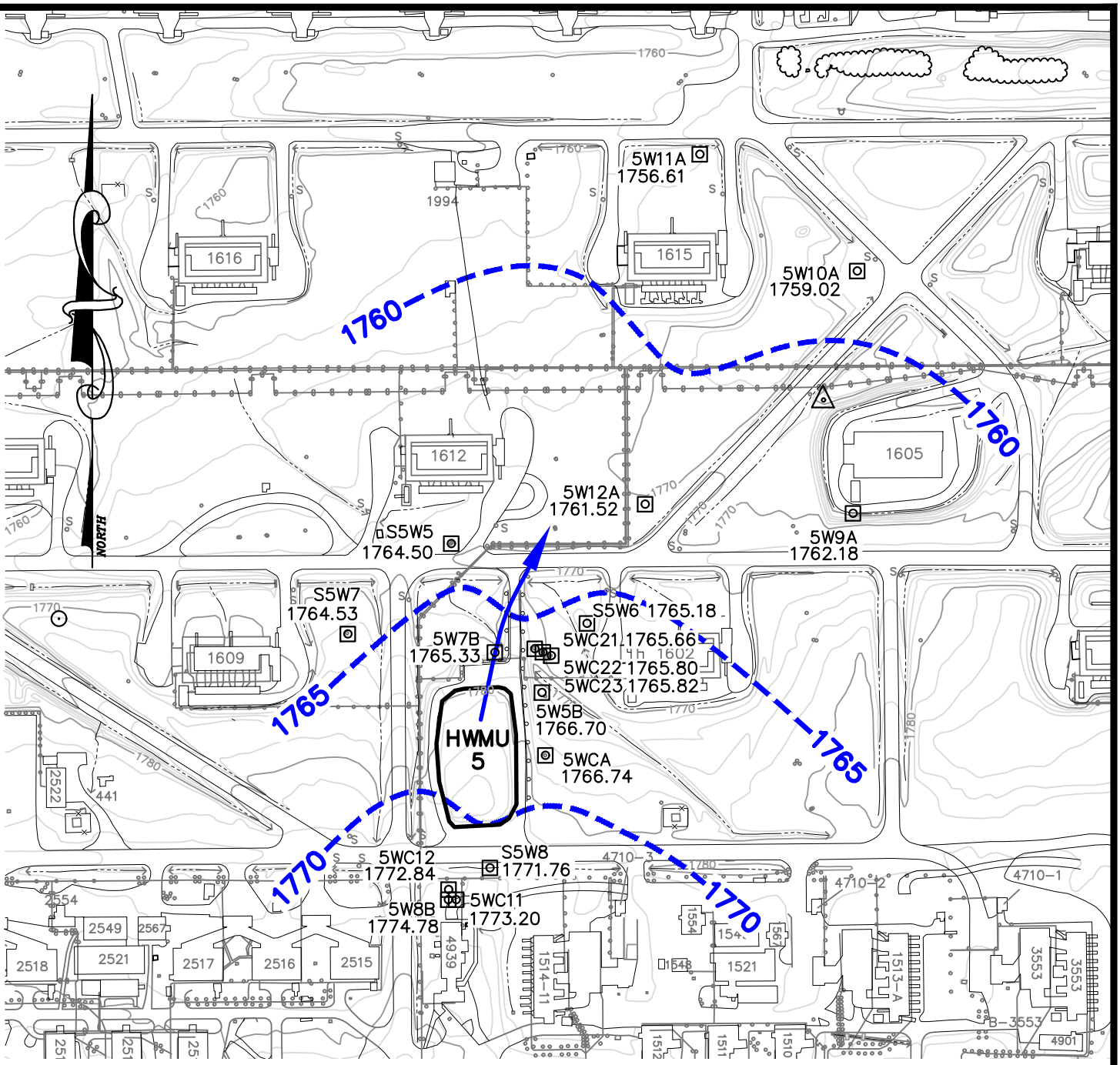
NOTES:
DTW: Depth to water from top of casing.
GW ELEV: Groundwater elevation.
All elevations in feet above mean sea level.
na: Not applicable.

APPENDIX A

HWMU-5

APPENDIX A-1

HWMU-5 POTENTIOMETRIC SURFACE MAPS
SECOND QUARTER 2019
FOURTH QUARTER 2019



GRAPHIC SCALE

200 0 100 200 400

(IN FEET)

1 inch = 200 ft.

LEGEND

5W7B
1765.33 — MONITORING WELL GROUNDWATER ELEVATION (feet above mean sea level)

--1770-- GROUNDWATER CONTOUR

GROUNDWATER FLOW DIRECTION

NOTE: TOPOGRAPHIC CONTOUR INTERVAL 2'

HWMU-5 POTENTIOMETRIC SURFACE MAP (APRIL 09, 2019)

RADFORD ARMY AMMUNITION PLANT

RADFORD, VIRGINIA

SCALE: 1"=200'

PLAN NO. B03204-19A

Draper Aden Associates

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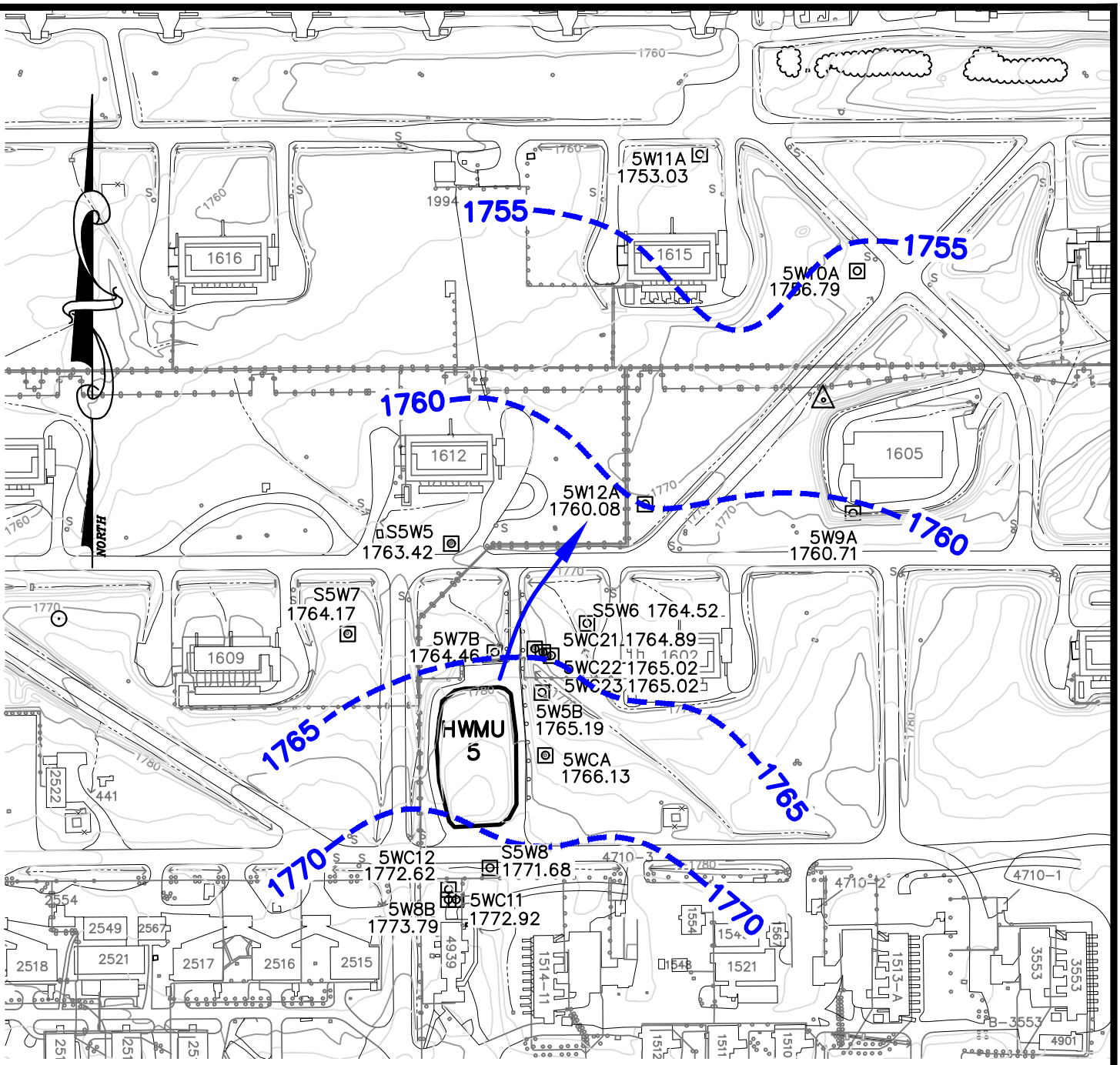
Blacksburg, VA 24060
540-552-0444 Fax: 540-552-0291

Richmond, VA
Charlottesville, VA
Hampton Roads, VA
Raleigh, NC
Fayetteville, NC
Northern Virginia
Virginia Beach, VA

DESIGNED	WMD
DRAWN	DLD
CHECKED	MDL
DATE	07/22/19

FIGURE 1

P:\B03200\B03204\B03204-19A\CAD\B03204-19A_HWMU-5 April 2019.dwg Jul 22, 2019 3:41pm



GRAPHIC SCALE

200 0 100 200 400

(IN FEET)

1 inch = 200 ft.

LEGEND

5W7B ⊡ MONITORING WELL
1764.46 GROUNDWATER ELEVATION (feet above mean sea level)

--1770-- GROUNDWATER CONTOUR

GROUNDWATER FLOW DIRECTION

NOTE: TOPOGRAPHIC CONTOUR INTERVAL 2'

HWMU-5 POTENTIOMETRIC SURFACE MAP (OCTOBER 23, 2019)

RADFORD ARMY AMMUNITION PLANT

RADFORD, VIRGINIA

SCALE: 1"=200'

PLAN NO. B03204-19A

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Hampton Roads, VA

Raleigh, NC
Fayetteville, NC
Northern Virginia
Virginia Beach, VA

DESIGNED	RGM
DRAWN	DLD
CHECKED	MDL
DATE	02/10/2020

FIGURE 1

P:\B03200\B03204\B03204-19A\CAD\B03204-19A_HWMU-5 October 2019.dwg Feb 10, 2020 1:44pm

APPENDIX A-2

HWMU-5 2019 LABORATORY ANALYTICAL RESULTS
GROUNDWATER CORRECTIVE ACTION TARGETED CONSTITUENTS
GPS AND SEMIANNUAL MONITORING LIST

Summary of Semiannual Target Analyte Monitoring Results Appendix J
Corrective Action Monitoring Plan - Targeted Constituents
Hazardous Waste Management Unit 5
Radford Army Ammunition Plant, Radford, Virginia

Upgradient well = 5W8B

Analyte/Quarter	*5W8B Q*	*5W5B Q*	*5W7B Q*	*5WC21 Q*	*5WC22 Q*	*5WC23 Q*	*5W12A Q*	*QL*	*Permit QL*	*GPS*	*DL*	*Permit DL*	*UNIT*	*Method*
Cobalt						*CAS #* 7440-48-4								
Second Quarter 2019	U	U	2.4 J	32	4.8 J	1.7 J	U	5	5	7	1.3	1	ug/L	6020B
Fourth Quarter 2019	U	U	3.2 J	22.2	4.2	1.5 J	U	4	5	7	1	1	ug/l	6020A
1,1-Dichloroethene						*CAS #* 75-35-4								
Second Quarter 2019	U	U	U	U	U	U	U	1	1	7	0.4	0.44	ug/l	8260C
Fourth Quarter 2019	U	U	U	U	U	U	U	1	1	7	0.4	0.44	ug/l	8260C
cis-1,2-Dichloroethene						*CAS #* 156-59-2								
Second Quarter 2019	U	U	U	U	U	U	U	1	1	70	0.1	0.1	ug/l	8260C
Fourth Quarter 2019	U	U	U	U	U	U	U	1	1	70	0.05	0.1	ug/l	8260C
trans-1,2-Dichloroethene						*CAS #* 156-60-5								
Second Quarter 2019	U	U	U	U	U	U	U	1	1	100	0.8	0.8	ug/l	8260C
Fourth Quarter 2019	U	U	U	U	U	U	U	1	1	100	0.8	0.8	ug/l	8260C
Trichloroethene						*CAS #* 79-01-6								
Second Quarter 2019	U	U	U	2.8	2.9	3.9	U	1	1	5	0.2	0.177	ug/l	8260C
Fourth Quarter 2019	U	U	0.2 J	2	2.4	4	U	1	1	5	0.2	0.177	ug/l	8260C
Vinyl chloride						*CAS #* 75-01-4								
Second Quarter 2019	U	U	U	U	U	U	U	1	1	2	0.1	0.1	ug/l	8260C
Fourth Quarter 2019	U	U	U	U	U	U	U	1	1	2	0.1	0.1	ug/l	8260C

See last page of this report for definitions.

Summary of Semiannual Target Analyte Monitoring Results Appendix J
Corrective Action Monitoring Plan - Targeted Constituents
Hazardous Waste Management Unit 5
Radford Army Ammunition Plant, Radford, Virginia

Upgradient well = 5W8B

Analyte/Quarter	*5W8B Q*	*5W5B Q*	*5W7B Q*	*5WC21 Q*	*5WC22 Q*	*5WC23 Q*	*5W12A Q*	*QL*	*Permit QL*	*GPS*	*DL*	*Permit DL*	*UNIT*	*Method*

Definitions:

Results are reported to the permit detection limit.

QL Denotes laboratory quantitation limit.
Permit QL Denotes permit quantitation limit.
DL Denotes laboratory detection limit.
Permit DL Denotes permit detection limit.
U denotes not detected at or above the permit detection limit or QL.
UA denotes not detected at or above the adjusted detection limit or adjusted QL.
J Denotes result is estimated. When used with "U" (i.e., "UJ"), denotes analyte not detected at or above the detection limit or QL and detection limit and QL are estimated. When used with "UA" (i.e., "UAJ"), denotes analyte not detected at or above adjusted detection limit and adjusted detection limit and QL are estimated.
UN Denotes analyte concentration is less than the QL and/or five times the blank concentration. Not reliably detected due to blank contamination.
R Denotes result rejected.
Q Denotes data validation qualifier. **X** Denotes mass spectral confirmation not obtained-result suspect.

CAS# Denotes Chemical Abstract Services registration number.
GPS Denotes Groundwater Protection Standards (2014) listed in Appendix J of Module VI-Groundwater Corrective Action & Monitoring Program for Unit 5 (approved by the VDEQ in the Post-Closure Care Permit for Hazardous Waste Units 5 and 16 (October 4, 2002, reissued August 16, 2014). Dec 2016 Class I Permit Mod.
The first Corrective Action Monitoring Event occurred Second Quarter 2010.
"–" denotes not sampled.

Note:

APPENDIX A-3

HWMU-5 2019 LABORATORY ANALYTICAL RESULTS
GROUNDWATER CORRECTIVE ACTION ANNUAL MONITORING LIST

Summary of Annual Target Analyte Monitoring Results - Appendix K
Corrective Action Monitoring Plan - Targeted Constituents
Hazardous Waste Management Unit 5
Radford Army Ammunition Plant, Radford, Virginia

Upgradient well = 5W8B

Analyte/Quarter	*5W8B Q*	*5W5B Q*	*5W7B Q*	*5WC21 Q*	*5WC22 Q*	*5WC23 Q*	*QL*	*Permit QL*	*GPS*	*DL*	*Permit DL*	*UNIT*	*Method*
Antimony						*CAS #* 7440-36-0							
Second Quarter 2019	-	U	U	U	U	U	2	2	6	0.5	0.4	ug/L	6020B
Arsenic						*CAS #* 7440-38-2							
Second Quarter 2019	-	U	U	U	U	U	10	10	10	2	2	ug/L	6020B
Barium						*CAS #* 7440-39-3							
Second Quarter 2019	-	22	25	14	28	21	10	10	2,000	1.3	1	ug/L	6020B
Beryllium						*CAS #* 7440-41-7							
Second Quarter 2019	-	U J	U J	0.27 J	U J	U J	1	1	4	0.2	0.2	ug/L	6020B
Cadmium						*CAS #* 7440-43-9							
Second Quarter 2019	-	U	U	0.25 J	0.2 J	U	1	1	5	0.2	0.2	ug/L	6020B
Chromium						*CAS #* 7440-47-3							
Second Quarter 2019	-	U	1.7 J	2.1 J	U	U	5	5	100	1.3	1	ug/L	6020B
Cobalt						*CAS #* 7440-48-4							
Second Quarter 2019	U	U	2.4 J	32	4.8 J	1.7 J	5	5	7	1.3	1	ug/L	6020B
Fourth Quarter 2019	U	U	3.2 J	22.2	4.2	1.5 J	4	5	7	1	1	ug/l	6020A
Copper						*CAS #* 7440-50-8							
Second Quarter 2019	-	U	U	U	U	U	40	5	1,300	10	1	ug/L	6020B
Lead						*CAS #* 7439-92-1							
Second Quarter 2019	-	U	U	U	U	U	3	2	15	1	0.2	ug/L	6020B
Mercury						*CAS #* 7439-97-6							
Second Quarter 2019	-	U	U	U	U	U	0.2	2	2	0.12	0.2	ug/L	7470A
Nickel						*CAS #* 7440-02-0							
Second Quarter 2019	-	U	2.8 J	17	4.6 J	3.1 J	10	10	300	2	2	ug/L	6020B
Selenium						*CAS #* 7782-49-2							
Second Quarter 2019	-	U	U	U	U	U	10	10	50	3	3	ug/L	6020B
Silver						*CAS #* 7440-22-4							
Second Quarter 2019	-	U	U	U	U	U	2	2	71	0.3	0.2	ug/L	6020B
Thallium						*CAS #* 7440-28-0							
Second Quarter 2019	-	U	U	U	U	U	1	1	2	0.2	0.2	ug/L	6020B
Vanadium						*CAS #* 7440-62-2							
Second Quarter 2019	-	U	U	U	U	U	10	10	63	2.5	1	ug/L	6020B

See last page of this report for definitions.

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Summary of Annual Target Analyte Monitoring Results - Appendix K
Corrective Action Monitoring Plan - Targeted Constituents
Hazardous Waste Management Unit 5
Radford Army Ammunition Plant, Radford, Virginia

Upgradient well = 5W8B

Analyte/Quarter	*5W8B Q*	*5W5B Q*	*5W7B Q*	*5WC21 Q*	*5WC22 Q*	*5WC23 Q*	*QL*	*Permit QL*	*GPS*	*DL*	*Permit DL*	*UNIT*	*Method*
Zinc						*CAS #* 7440-66-6							
Second Quarter 2019	-	U	10 J	15 J	U	U	30	30	4700	7.3	7.3	ug/L	6020B
Acetone						*CAS #* 67-64-1							
Second Quarter 2019	-	U	U	U	U	U	10	10	12000	3	3	ug/l	8260C
bis(2-Ethylhexyl)phthalate						*CAS #* 117-81-7							
Second Quarter 2019	-	U	U	U	U	U	6	6	10	5	1.5	ug/l	8270D
2-Butanone						*CAS #* 78-93-3							
Second Quarter 2019	-	U	U	U	U	U	10	10	4900	1	1	ug/l	8260C
Chloroform						*CAS #* 67-66-3							
Second Quarter 2019	-	2	20	1.8	1.8	1.4	1	1	80	0.1	0.1	ug/l	8260C
Dichlorodifluoromethane						*CAS #* 75-71-8							
Second Quarter 2019	-	U J	U J	U J	U J	U J	1	1	190	0.3	0.28	ug/l	8260C
1,2-Dichloroethane						*CAS #* 107-06-2							
Second Quarter 2019	-	U	U	U	U	U	1	1	5	0.1	0.147	ug/l	8260C
Diethyl ether						*CAS #* 60-29-7							
Second Quarter 2019	-	U	U	2.3 J	5.3 J	10 J	12	12	7,300	0.4	0.39	ug/l	8260C
Diethyl phthalate						*CAS #* 84-66-2							
Second Quarter 2019	-	U	U	U	U	U	10	10	11000	2	0.5	ug/l	8270D
2,4-Dinitrotoluene						*CAS #* 121-14-2							
Second Quarter 2019	-	U	U	U	1 J	U	10	10	10	1	0.6	ug/l	8270D
2,6-Dinitrotoluene						*CAS #* 606-20-2							
Second Quarter 2019	-	U	U	U	U	U	10	10	10	0.7	0.7	ug/l	8270D
Methylene chloride						*CAS #* 75-09-2							
Second Quarter 2019	-	U	0.4 J	U	U	U	1	1	5	0.2	0.182	ug/l	8260C
o-Nitroaniline						*CAS #* 88-74-4							
Second Quarter 2019	-	U	U	2 J	2 J	3 J	10	10	150	2	0.7	ug/l	8270D
p-Nitroaniline						*CAS #* 100-01-6							
Second Quarter 2019	-	U	U	U	U	U	20	20	20	1.3	1.3	ug/l	8270D
Nitrobenzene						*CAS #* 98-95-3							
Second Quarter 2019	-	U	U	1 J	1 J	1 J	10	10	10	0.8	0.8	ug/l	8270D

See last page of this report for definitions.

Draper Aden Associates
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Summary of Annual Target Analyte Monitoring Results - Appendix K
Corrective Action Monitoring Plan - Targeted Constituents
Hazardous Waste Management Unit 5
Radford Army Ammunition Plant, Radford, Virginia

Upgradient well = 5W8B

Analyte/Quarter	*5W8B Q*	*5W5B Q*	*5W7B Q*	*5WC21 Q*	*5WC22 Q*	*5WC23 Q*	*QL*	*Permit QL*	*GPS*	*DL*	*Permit DL*	*UNIT*	*Method*
Toluene						*CAS #* 108-88-3							
Second Quarter 2019	-	U	U	U	U	U	1	1	1,000	0.1	0.1	ug/l	8260C
Xylenes (Total)						*CAS #* 1330-20-7							
Second Quarter 2019	-	U	U	U	U	U	3	3	10,000	0.2	0.208	ug/l	8260C

Definitions:

Results are reported to the Permit Detection Limit.
First Corrective Action Monitoring Event Second Quarter 2010:

QL: Denotes laboratory quantitation limit.
Permit QL: Denotes permit quantitation limit. (Class 1 Permit Modification Dec 2016).
DL: Denotes laboratory detection limit.
Permit DL: Denotes permit detection limit.
U: Denotes not detected at or above the permit detection limit or QL.
UA: Denotes not detected at or above the adjusted detection limit or adjusted QL.
J: Denotes result is estimated. When used with "U" (i.e., "UJ"), denotes analyte not detected at or above the detection limit or QL and detection limit and QL are estimated. When used with "UA" (i.e., "UAJ"), denotes analyte not detected at or above adjusted detection limit and adjusted detection limit and QL are estimated.
UN: Denotes analyte concentration is less than the QL and/or five times the blank concentration. Not reliably detected due to blank contamination.
R: Denotes result rejected.
Q: Denotes data validation qualifier.
X: Denotes mass spectral confirmation not obtained - result suspect.

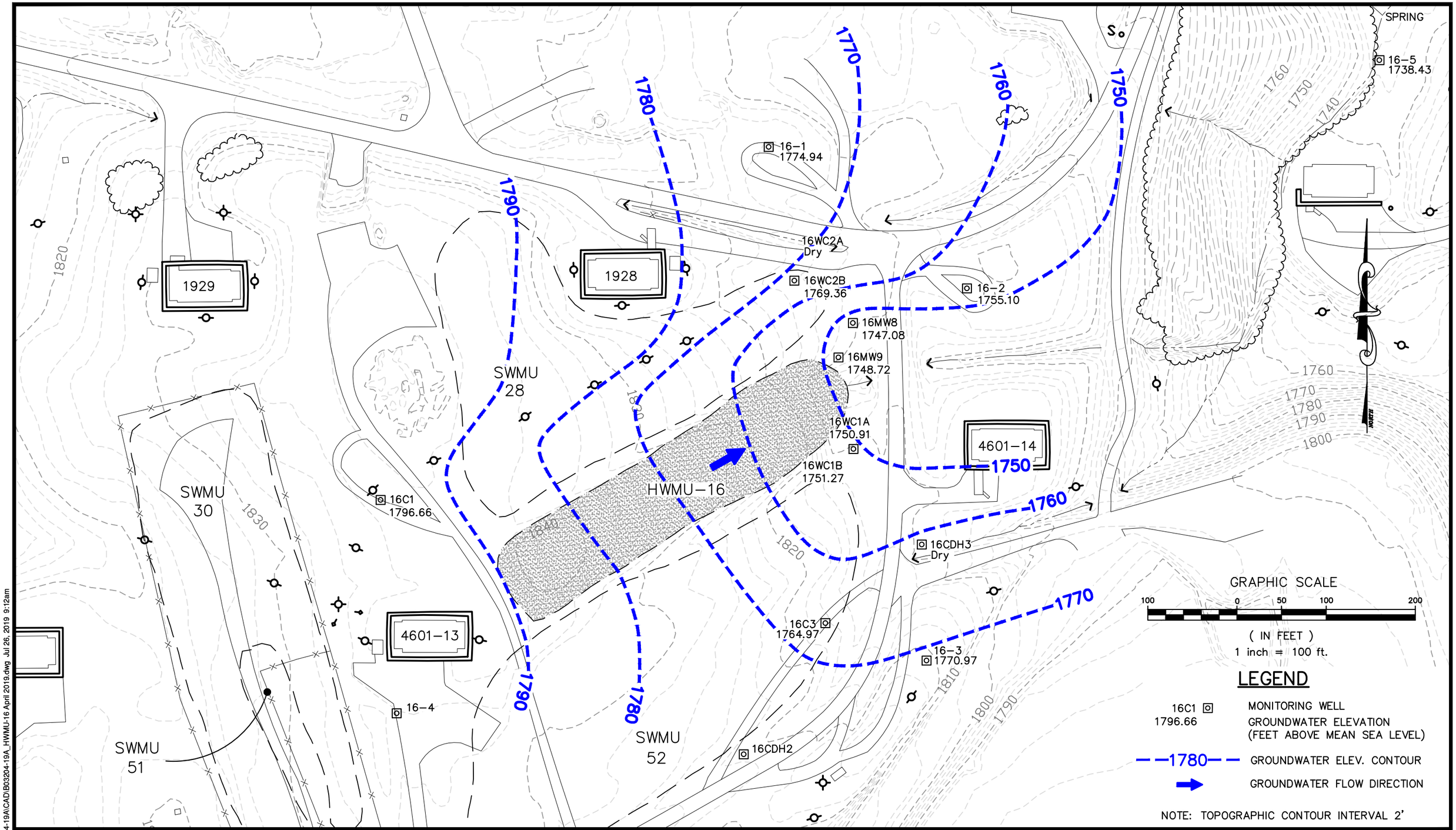
CAS#: Denotes Chemical Abstract Services registration number.
GPS: Denotes Groundwater Protection Standards listed in Appendix K of Module VI-Groundwater Corrective Action & Monitoring Program for Unit 5 (approved by the VDEQ and incorporated into the Final Hazardous Waste Post-Closure Care Permit for Hazardous Waste Units 5 and 16 (original effective date October 4, 2002 and reissued August 16, 2014; Dec 2016 Class I Permit Mod)
"–": Denotes not sampled.

APPENDIX B

HWMU-16

APPENDIX B-1

HWMU-16 POTENTIOMETRIC SURFACE MAPS
SECOND QUARTER 2019
FOURTH QUARTER 2019



P:\B03\200\B03204\B03204-19A\CADD\B03204-19A_HWMU-16 April 2019.dwg Jul 26, 2019 9:12am

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Raleigh, NC
Fayetteville, NC
Northern Virginia
Virginia Beach, VA

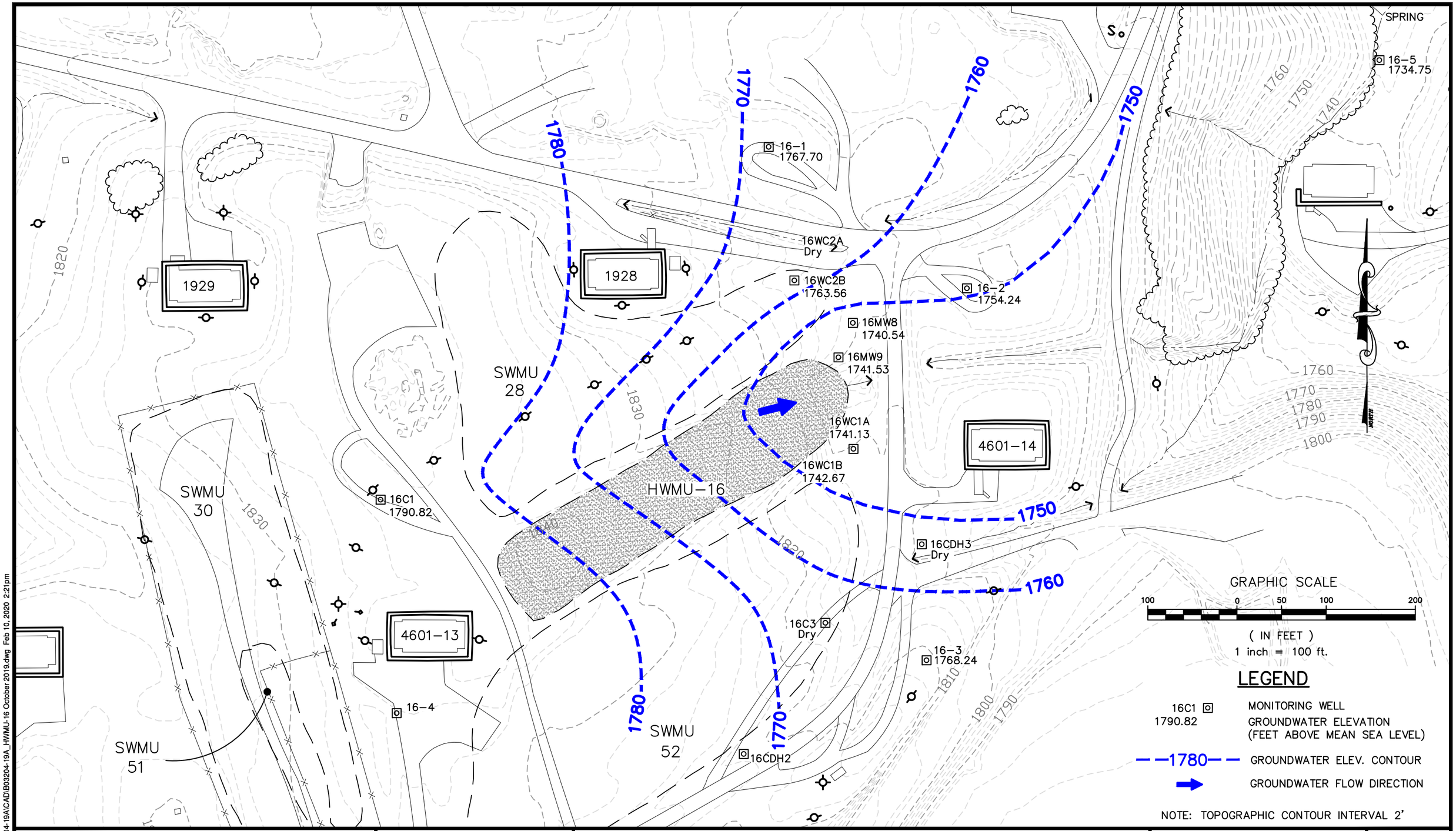
DESIGNED	WMD
DRAWN	DLD
CHECKED	MDL
DATE	07/23/19

HWMU-16 POTENTIOMETRIC SURFACE MAP - APRIL 10, 2019
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

SCALE: 1"=100'

PLAN NO. B03204-19A

FIGURE 2



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Fayetteville, NC
Northern Virginia
Virginia Beach, VA

DESIGNED	RGM
DRAWN	DLD
CHECKED	MDL
DATE	02/10/2020

HWMU-16 POTENTIOMETRIC SURFACE MAP - OCTOBER 22, 2019
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

SCALE: 1"=100'

PLAN NO. B03204-19A

FIGURE 2

P:\B03\2001\B03204\B03204-19A\CAD\B03204-19A_HWMU-16 October 2019.dwg Feb 10, 2020 2:21pm

APPENDIX B-2

HWMU-16 2019 LABORATORY ANALYTICAL RESULTS
POINT OF COMPLIANCE WELLS

Target Analyte Monitoring Results - HWMU-16 Point of Compliance Wells
Radford Army Ammunition Plant, Radford, Virginia
Upgradient well = 16C1

All Results in ug/L.

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
Antimony					*CAS #* 7440-36-0			
Second Quarter 2019	U	U	U	U	U	2	-	6020B
Arsenic					*CAS #* 7440-38-2			
Second Quarter 2019	U	U	U	U	U	10	10	6020B
Fourth Quarter 2019	U	U	U	U	U	10	10	6020B
Barium					*CAS #* 7440-39-3			
Second Quarter 2019	140	110	600	340	130	10	2000	6020B
Fourth Quarter 2019	190	130	650	420	100	10	2000	6020B
Beryllium					*CAS #* 7440-41-7			
Second Quarter 2019	U J	U J	U J	U J	U J	1	4	6020B
Fourth Quarter 2019	U	U	U	U	U	1	4	6020B
Cadmium					*CAS #* 7440-43-9			
Second Quarter 2019	U	0.23 J	U	U	U	1	5	6020B
Fourth Quarter 2019	U	U	U	U	U	1	5	6020B
Chromium					*CAS #* 7440-47-3			
Second Quarter 2019	U	U	U	U	U	5	100	6020B
Fourth Quarter 2019	U	U	U	U	6.6	5	100	6020B
Cobalt					*CAS #* 7440-48-4			
Second Quarter 2019 - Verification	-	3.1 J	-	-	-	5	5	6020B
Second Quarter 2019	U	6.8	6.2	13	18	5	5	6020B
Fourth Quarter 2019	U	U	U	11	16	5	5	6020B
Copper					*CAS #* 7440-50-8			
Second Quarter 2019	U	6.6	U	U	U	5	1300	6020B
Fourth Quarter 2019	U	14	U	U	U	5	1300	6020B
Lead					*CAS #* 7439-92-1			
Second Quarter 2019	U	U	U	U	U	3	15	6020B
Fourth Quarter 2019	U	U	U	U	U	3	15	6020B
Mercury					*CAS #* 7439-97-6			
Second Quarter 2019	U	U	U	U	U	2	2	7470A
Fourth Quarter 2019	U	U	U	U	U	2	2	7470A
Nickel					*CAS #* 7440-02-0			
Second Quarter 2019	4.3 J	7.2 J	16	15	4.9 J	10	300	6020B
Fourth Quarter 2019	U	U	12	11	U	10	300	6020B
Selenium					*CAS #* 7782-49-2			
Second Quarter 2019	U	U	U	U	U	10	-	6020B
Silver					*CAS #* 7440-22-4			
Second Quarter 2019	-	U	-	-	-	2	-	6020B
Second Quarter 2019	U	1.1 J	U	U	U	2	-	6020B
Thallium					*CAS #* 7440-28-0			
Second Quarter 2019	U	U	U	U	U	1	-	6020B
Vanadium					*CAS #* 7440-62-2			
Second Quarter 2019	U	U	U	U	U	10	151	6020B
Fourth Quarter 2019	U	U	U	U	U	10	151	6020B
Zinc					*CAS #* 7440-66-6			
Second Quarter 2019	U	33	U	16 J	U	30	4700	6020B
Fourth Quarter 2019	U	U	U	U	U	30	4700	6020B
Cyanide					*CAS #* 57-12-5			
Second Quarter 2019	U	U	U	U	U	20	-	9012B
Acenaphthene					*CAS #* 83-32-9			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Acenaphthylene					*CAS #* 208-96-8			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Acetone					*CAS #* 67-64-1			
Second Quarter 2019	U N	U N	U JN	U JN	U N	10	-	8260C
Acetonitrile					*CAS #* 75-05-8			
Second Quarter 2019	U	U	U J	U J	U	100	-	8260C

See last page of this report for definitions.

Target Analyte Monitoring Results - HWMU-16 Point of Compliance Wells
Radford Army Ammunition Plant, Radford, Virginia
Upgradient well = 16C1

All Results in ug/L.

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
Acetophenone					*CAS #* 98-86-2			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
2-Acetylaminofluorene					*CAS #* 53-96-3			
Second Quarter 2019	U	U	U	U	U	21	-	8270D
Acrolein					*CAS #* 107-02-8			
Second Quarter 2019	U J	U J	U J	U J	U J	25	-	8260C
Acrylonitrile					*CAS #* 107-13-1			
Second Quarter 2019	U	U	U J	U J	U	10	-	8260C
Allyl chloride					*CAS #* 107-05-1			
Second Quarter 2019	U J	U J	U J	U J	U J	10	-	8260C
4-Aminobiphenyl					*CAS #* 92-67-1			
Second Quarter 2019	U	U	U	U	U	11	-	8270D
Aniline					*CAS #* 62-53-3			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Anthracene					*CAS #* 120-12-7			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Aramite					*CAS #* 140-57-8			
Second Quarter 2019	U	U	U	U	U	15	-	8270D
Benzene					*CAS #* 71-43-2			
Second Quarter 2019	0.227 J	U	0.377 J	0.301 J	U	1	5	8260C
Fourth Quarter 2019	U	U	U	U	U	1	5	8260C
Benzo[a]anthracene					*CAS #* 56-55-3			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Benzo[b]fluoranthene					*CAS #* 205-99-2			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Benzo[k]fluoranthene					*CAS #* 207-08-9			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Benzo[ghi]perylene					*CAS #* 191-24-2			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Benzo(a)pyrene					*CAS #* 50-32-8			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
1,4-Benzenediamine					*CAS #* 106-50-3			
Second Quarter 2019	U J	U J	U J	U J	U J	300	-	8270D
Benzyl alcohol					*CAS #* 100-51-6			
Second Quarter 2019	U	U	U	U	U	30	-	8270D
bis(2-Chloroethoxy)methane					*CAS #* 111-91-1			
Second Quarter 2019	U	U	U	U	U	2	-	8270D
bis(2-Chloroethyl)ether					*CAS #* 111-44-4			
Second Quarter 2019	U	U	U	U	U	2	-	8270D
bis(2-Chloro-1-methylethyl)ether					*CAS #*			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
bis(2-Ethylhexyl)phthalate					*CAS #* 117-81-7			
Second Quarter 2019	U	U	U	U	U	11	-	8270D
Bromodichloromethane					*CAS #* 75-27-4			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
Bromoform					*CAS #* 75-25-2			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
4-Bromophenyl phenyl ether					*CAS #* 101-55-3			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
2-Butanone					*CAS #* 78-93-3			
Second Quarter 2019	U	U	U J	U J	U	10	4900	8260C
Fourth Quarter 2019	U	U	U	U	U	10	4900	8260C
Butyl benzyl phthalate					*CAS #* 85-68-7			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Carbon disulfide					*CAS #* 75-15-0			
Second Quarter 2019	U	U	U J	U J	U	10	-	8260C

See last page of this report for definitions.

Target Analyte Monitoring Results - HWMU-16 Point of Compliance Wells
Radford Army Ammunition Plant, Radford, Virginia
Upgradient well = 16C1

All Results in ug/L.

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
Carbon tetrachloride					*CAS #* 56-23-5			
Second Quarter 2019	U	U	U J	U J	U	1	5	8260C
Fourth Quarter 2019	U	U	U	U	U	1	5	8260C
p-Chloroaniline					*CAS #* 106-47-8			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Chlorobenzilate					*CAS #* 510-15-6			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
p-Chloro-m-cresol					*CAS #* 59-50-7			
Second Quarter 2019	U	U J	U	U	U J	10	-	8270D
Chloroethane					*CAS #* 75-00-3			
Second Quarter 2019	2.94	U	1.91 J	1.56 J	U	1	21000	8260C
Fourth Quarter 2019	3.6	U	1.8	1.7	U	1	21000	8260C
Chloroform					*CAS #* 67-66-3			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
2-Chloronaphthalene					*CAS #* 91-58-7			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
2-Chlorophenol					*CAS #* 95-57-8			
Second Quarter 2019	U	U J	U	U	U J	10	-	8270D
4-Chlorophenyl phenyl ether					*CAS #* 7005-72-3			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Chloroprene					*CAS #* 126-99-8			
Second Quarter 2019	U	U	U J	U J	U	10	-	8260C
Chrysene					*CAS #* 218-01-9			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Diallate					*CAS #* 2303-16-4			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Dibenz(a,h)anthracene					*CAS #* 53-70-3			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Dibenzofuran					*CAS #* 132-64-9			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Dibromochloromethane					*CAS #* 124-48-1			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
1,2-Dibromo-3-chloropropane					*CAS #* 96-12-8			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
1,2-Dibromoethane					*CAS #* 106-93-4			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
Di-n-butyl phthalate					*CAS #* 84-74-2			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
1,2-Dichlorobenzene					*CAS #* 95-50-1			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
1,3-Dichlorobenzene					*CAS #* 541-73-1			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
1,4-Dichlorobenzene					*CAS #* 106-46-7			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
3,3'-Dichlorobenzidine					*CAS #* 91-94-1			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
trans-1,4-Dichloro-2-butene					*CAS #* 110-57-6			
Second Quarter 2019	U	U	U J	U J	U	10	-	8260C
Dichlorodifluoromethane					*CAS #* 75-71-8			
Second Quarter 2019	U J	U J	U J	U J	U J	1	190	8260C
Fourth Quarter 2019	U J	U J	U J	U J	U J	1	190	8260C
1,1-Dichloroethane					*CAS #* 75-34-3			
Second Quarter 2019	4.56	0.285 J	6.98 J	4.94 J	U	1	9.5	8260C
Fourth Quarter 2019	6.3	U	6.5	4.6	U	1	9.5	8260C
1,2-Dichloroethane					*CAS #* 107-06-2			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C

Target Analyte Monitoring Results - HWMU-16 Point of Compliance Wells
Radford Army Ammunition Plant, Radford, Virginia
Upgradient well = 16C1

All Results in ug/L.

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
1,1-Dichloroethene					*CAS #* 75-35-4			
Second Quarter 2019	U	U	U J	U J	U	1	7	8260C
Fourth Quarter 2019	U	U	U	U	U	1	7	8260C
trans-1,2-Dichloroethene					*CAS #* 156-60-5			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
2,4-Dichlorophenol					*CAS #* 120-83-2			
Second Quarter 2019	U J	U J	U J	U J	U J	10	-	8270D
2,6-Dichlorophenol					*CAS #* 87-65-0			
Second Quarter 2019	U	U J	U	U	U J	10	-	8270D
1,2-Dichloropropane					*CAS #* 78-87-5			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
1,3-Dichloropropane					*CAS #* 142-28-9			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
trans-1,3-Dichloropropene					*CAS #* 10061-02-6			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
Diethyl ether					*CAS #* 60-29-7			
Second Quarter 2019	26.6	3.78 J	66.4 J	15.6 J	U	12.5	7300	8260C
Fourth Quarter 2019	47	U	70	23	U	12.5	7300	8260C
Diethyl phthalate					*CAS #* 84-66-2			
Second Quarter 2019	U	U	U	U	U	5	11000	8270D
Fourth Quarter 2019	U	U	U	U	U	5	11000	8270D
O,O-Diethyl O-2-pyrazinyl					*CAS #* 297-97-2			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Dimethoate					*CAS #* 60-51-5			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Dimethyl ether					*CAS #* 115-10-6			
Second Quarter 2019	8.74 J	0.577 J	2.19 J	2.25 J	0.307 J	12.5	17	8260C
Fourth Quarter 2019	U	U	U	U	U	12.5	17	8260C
p-(Dimethylamino)azobenzene					*CAS #* 60-11-7			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
7,12-Dimethylbenz[a]anthracene					*CAS #* 57-97-6			
Second Quarter 2019	U	U	U	U	U	11	-	8270D
3,3'-Dimethylbenzidine					*CAS #* 119-93-7			
Second Quarter 2019	U	U	U	U	U	75	-	8270D
a,a-Dimethylphenethylamine					*CAS #* 122-09-8			
Second Quarter 2019	U	U	U	U	U	50	-	8270D
2,4-Dimethylphenol					*CAS #* 105-67-9			
Second Quarter 2019	U	U J	U	U	U J	10	-	8270D
Dimethyl phthalate					*CAS #* 131-11-3			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
m-Dinitrobenzene					*CAS #* 99-65-0			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
4,6-Dinitro-o-cresol					*CAS #* 534-52-1			
Second Quarter 2019	U	U J	U	U	U J	21	-	8270D
2,4-Dinitrophenol					*CAS #* 51-28-5			
Second Quarter 2019	U	U J	U	U	U J	30	-	8270D
2,4-Dinitrotoluene					*CAS #* 121-14-2			
Second Quarter 2019	U	U	U	U	U	10	10	8270D
Fourth Quarter 2019	U	U	U	U	U	10	10	8270D
2,6-Dinitrotoluene					*CAS #* 606-20-2			
Second Quarter 2019	U	U	U	U	U	10	10	8270D
Fourth Quarter 2019	U	U	U	U	U	10	10	8270D
Di-n-octyl phthalate					*CAS #* 117-84-0			
Second Quarter 2019	U	U	U	U	U	11	-	8270D
1,4-Dioxane					*CAS #* 123-91-1			
Second Quarter 2019	U	U	U J	U J	U	200	-	8260C

Target Analyte Monitoring Results - HWMU-16 Point of Compliance Wells
Radford Army Ammunition Plant, Radford, Virginia
Upgradient well = 16C1 ***All Results in ug/L.***

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
Diphenylamine					*CAS #*			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Disulfoton					*CAS #* *298-04-4*			
Second Quarter 2019	U	U	U	U	U	50	-	8270D
Ethylbenzene					*CAS #* *100-41-4*			
Second Quarter 2019	U	U	U J	U J	U	1	700	8260C
Fourth Quarter 2019	U	U	U	U	U	1	700	8260C
Ethyl methacrylate					*CAS #* *97-63-2*			
Second Quarter 2019	U	U	U J	U J	U	10	-	8260C
Ethyl methanesulfonate					*CAS #* *62-50-0*			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Famphur					*CAS #* *52-85-7*			
Second Quarter 2019	U J	U J	U J	U J	U J	50	-	8270D
Fluoranthene					*CAS #* *206-44-0*			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Fluorene					*CAS #* *86-73-7*			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Hexachlorobenzene					*CAS #* *118-74-1*			
Second Quarter 2019	U J	U J	U J	U J	U J	10	-	8270D
Hexachlorobutadiene					*CAS #* *87-68-3*			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
Hexachlorocyclopentadiene					*CAS #* *77-47-4*			
Second Quarter 2019	U	U	U	U	U	11	-	8270D
Hexachloroethane					*CAS #* *67-72-1*			
Second Quarter 2019	U	U	U J	U J	U	10	-	8260C
Hexachlorophene					*CAS #* *70-30-4*			
Second Quarter 2019	U J	U J	U J	U J	U J	100	-	8270D
Hexachloropropene					*CAS #* *1888-71-7*			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
2-Hexanone					*CAS #* *591-78-6*			
Second Quarter 2019	U	U	U J	U J	U	10	-	8260C
Indeno[1,2,3-cd]pyrene					*CAS #* *193-39-5*			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Isobutyl alcohol					*CAS #* *78-83-1*			
Second Quarter 2019	U	U	U J	U J	U	200	-	8260C
Isodrin					*CAS #* *465-73-6*			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Isophorone					*CAS #* *78-59-1*			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Isosafrole					*CAS #* *120-58-1*			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Kepone					*CAS #* *143-50-0*			
Second Quarter 2019	U	U	U	U	U	50	-	8270D
Methacrylonitrile					*CAS #* *126-98-7*			
Second Quarter 2019	U	U	U J	U J	U	100	-	8260C
Methapyrilene					*CAS #* *91-80-5*			
Second Quarter 2019	U	U	U	U	U	50	-	8270D
Bromomethane					*CAS #* *74-83-9*			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
Chloromethane					*CAS #* *74-87-3*			
Second Quarter 2019	U	U	U J	U J	U	1	190	8260C
Fourth Quarter 2019	U	U	U	U	U	1	190	8260C
3-Methylcholanthrene					*CAS #* *56-49-5*			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Iodomethane					*CAS #* *74-88-4*			
Second Quarter 2019	U	U	U J	U J	U	10	-	8260C

Target Analyte Monitoring Results - HWMU-16 Point of Compliance Wells
Radford Army Ammunition Plant, Radford, Virginia
Upgradient well = 16C1

All Results in ug/L.

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
Methyl methacrylate					*CAS #* 80-62-6			
Second Quarter 2019	U	U	U J	U J	U	10	-	8260C
Methyl methane sulfonate					*CAS #* 66-27-3			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
2-Methylnaphthalene					*CAS #* 91-57-6			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Methyl parathion					*CAS #* 298-00-0			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
4-Methyl-2-pentanone					*CAS #* 108-10-1			
Second Quarter 2019	U	U	U J	U J	U	10	-	8260C
2-Methylphenol					*CAS #* 95-48-7			
Second Quarter 2019	U	U J	U	U	U J	10	-	8270D
3 & 4-Methylphenol					*CAS #*			
Second Quarter 2019	U	U J	U	U	U J	20	-	8270D
Dibromomethane					*CAS #* 74-95-3			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
Methylene chloride					*CAS #* 75-09-2			
Second Quarter 2019	1.39	U	0.24 J	0.21 J	U	1	13.95	8260C
Fourth Quarter 2019	1	U	U	U	U	1	13.95	8260C
Naphthalene					*CAS #* 91-20-3			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
1,4-Naphthoquinone					*CAS #* 130-15-4			
Second Quarter 2019	U J	U J	U J	U J	U J	60	-	8270D
1-Naphthylamine					*CAS #* 134-32-7			
Second Quarter 2019	U	U	U	U	U	21	-	8270D
2-Naphthylamine					*CAS #* 91-59-8			
Second Quarter 2019	U	U	U	U	U	21	-	8270D
o-Nitroaniline					*CAS #* 88-74-4			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
m-Nitroaniline					*CAS #* 99-09-2			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
p-Nitroaniline					*CAS #* 100-01-6			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Nitrobenzene					*CAS #* 98-95-3			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
o-Nitrophenol					*CAS #* 88-75-5			
Second Quarter 2019	U	U J	U	U	U J	10	-	8270D
p-Nitrophenol					*CAS #* 100-02-7			
Second Quarter 2019	U	U J	U	U	U J	30	-	8270D
4-Nitroquinoline-1-oxide					*CAS #* 56-57-5			
Second Quarter 2019	U	U	U	U	U	60	-	8270D
N-Nitrosodi-n-butylamine					*CAS #* 924-16-3			
Second Quarter 2019	U	U	U	U	U	25	-	8270D
N-Nitrosodiethylamine					*CAS #* 55-18-5			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
N-Nitrosodimethylamine					*CAS #* 62-75-9			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
N-Nitrosodiphenylamine					*CAS #* 86-30-6			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
N-Nitrosodipropylamine					*CAS #* 621-64-7			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
N-Nitrosomethylethylamine					*CAS #* 10595-95-6			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
N-Nitrosomorpholine					*CAS #* 59-89-2			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
N-Nitrosopiperidine					*CAS #* 100-75-4			
Second Quarter 2019	U	U	U	U	U	10	-	8270D

See last page of this report for definitions.

Target Analyte Monitoring Results - HWMU-16 Point of Compliance Wells
Radford Army Ammunition Plant, Radford, Virginia
Upgradient well = 16C1 *All Results in ug/L.*

Analtye/Quarter	16C1	16MW8	16MW9	16WC1A	16WC1B	QL	GPS	Method
N-Nitrosopyrrolidine					CAS # 930-55-2			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
5-Nitroso-o-toluidine					CAS # 99-55-8			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Parathion					CAS # 56-38-2			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Pentachlorobenzene					CAS # 608-93-5			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Pentachloroethane					CAS # 76-01-7			
Second Quarter 2019	U	U	U J	U J	U	10	-	8260C
Pentachloronitrobenzene					CAS # 82-68-8			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Pentachlorophenol					CAS # 87-86-5			
Second Quarter 2019	U	U J	U	U	U J	10	-	8270D
Phenacetin					CAS # 62-44-2			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Phenanthrene					CAS # 85-01-8			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Phenol					CAS # 108-95-2			
Second Quarter 2019	U	U J	U	U	U J	10	-	8270D
Phorate					CAS # 298-02-2			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
2-Picoline					CAS # 931-19-1			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Pronamide					CAS # 23950-58-5			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
2-Propanol					CAS # 67-63-0			
Second Quarter 2019	U	U	U J	U J	U	100	-	8260C
Propionitrile					CAS # 107-12-0			
Second Quarter 2019	U	U	U J	U J	U	100	-	8260C
Pyrene					CAS # 129-00-0			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Pyridine					CAS # 110-86-1			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Safrole					CAS # 94-59-7			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
Styrene					CAS # 100-42-5			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
Sulfotep					CAS # 3689-24-5			
Second Quarter 2019	U	U J	U J	U J	U J	10	-	8270D
1,2,4,5-Tetrachlorobenzene					CAS # 95-94-3			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
1,1,1,2-Tetrachloroethane					CAS # 630-20-6			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
1,1,2,2-Tetrachloroethane					CAS # 79-34-5			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
Tetrachloroethene					CAS # 127-18-4			
Second Quarter 2019	0.213 J	U	0.0627 J	0.198 J	U	1	5	8260C
Fourth Quarter 2019	U	U	U	U	U	1	5	8260C
Tetrahydrofuran					CAS # 109-99-9			
Second Quarter 2019	12.1 J	U	U J	2.92 J	U	25	3400	8260C
Fourth Quarter 2019	U	U	U	U	U	25	3400	8260C
2,3,4,6-Tetrachlorophenol					CAS # 58-90-2			
Second Quarter 2019	U J	U J	U J	U J	U J	10	-	8270D
Toluene					CAS # 108-88-3			
Second Quarter 2019	U	U	U J	U J	U	1	1000	8260C
Fourth Quarter 2019	U	U	U	U	U	1	1000	8260C

See last page of this report for definitions.

Target Analyte Monitoring Results - HWMU-16 Point of Compliance Wells
Radford Army Ammunition Plant, Radford, Virginia
Upgradient well = 16C1 *All Results in ug/L.*

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
o-Toluidine					*CAS #* 95-53-4			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
1,2,4-Trichlorobenzene					*CAS #* 120-82-1			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
1,1,1-Trichloroethane					*CAS #* 71-55-6			
Second Quarter 2019	0.19 J	U	U J	U J	U	1	200	8260C
Fourth Quarter 2019	U	U	U	U	U	1	200	8260C
1,1,2-Trichloroethane					*CAS #* 79-00-5			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
Trichloroethene					*CAS #* 79-01-6			
Second Quarter 2019	0.211 J	U	U J	0.189 J	U	1	5	8260C
Fourth Quarter 2019	U	U	U	U	U	1	5	8260C
Trichlorofluoromethane					*CAS #* 75-69-4			
Second Quarter 2019	U	U	U J	U J	U	1	1000	8260C
Fourth Quarter 2019	U J	U J	U J	U J	U J	1	1000	8260C
2,4,5-Trichlorophenol					*CAS #* 95-95-4			
Second Quarter 2019	U J	U J	U J	U J	U J	10	-	8270D
2,4,6-Trichlorophenol					*CAS #* 88-06-2			
Second Quarter 2019	U J	U J	U J	U J	U J	10	-	8270D
1,2,3-Trichloropropane					*CAS #* 96-18-4			
Second Quarter 2019	U	U	U J	U J	U	1	-	8260C
1,1,2-Trichloro-1,2,2-Trifluoroethane					*CAS #* 76-13-1			
Second Quarter 2019	U	U	U J	U J	U	1	59000	8260C
Fourth Quarter 2019	U	U	U	U	U	1	59000	8260C
O,O,O-Triethyl phosphorothioate					*CAS #* 126-68-1			
Second Quarter 2019	U	U	U	U	U	10	-	8270D
sym-Trinitrobenzene					*CAS #* 99-35-4			
Second Quarter 2019	U	U	U	U	U	200	-	8270D
Vinyl acetate					*CAS #* 108-05-4			
Second Quarter 2019	U	U	U J	U J	U	10	-	8260C
Vinyl chloride					*CAS #* 75-01-4			
Second Quarter 2019	U	U	U J	0.184 J	U	1	-	8260C
Second Quarter 2019	-	-	-	U	-	1	-	8260C
Xylenes (Total)					*CAS #* 1330-20-7			
Second Quarter 2019	U	U	U J	U J	U	3	10000	8260C
Fourth Quarter 2019	U	U	U	U	U	3	10000	8260C

Target Analyte Monitoring Results - HWMU-16 Point of Compliance Wells
Radford Army Ammunition Plant, Radford, Virginia

Upgradient well = 16C1 ***All Results in ug/L.***

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*

Definitions:

The following definitions apply to results reported for Appendix IX monitoring events. All Appendix IX monitoring results for compliance wells are reported to the detection limit.

Appendix IX Monitoring Events:
3Q2003, 2Q-2004, 2Q-2005, 3Q2006, 2Q2007, 2Q2008, 2Q2009, 2Q 2010, 2Q 2011, 2Q 2012, 2Q2013, 2Q2014, 2Q2015, 2Q2016, 2Q2017, 2Q2018, 2Q2019

QL Denotes permit required quantitation limit.
U denotes not detected at or above the detection limit.
UA denotes not detected at or above the adjusted detection limit.
J Denotes result is estimated. When used with "U" (i.e., "UJ"), denotes analyte not detected at or above the detection limit and detection limit and QL are estimated. When used with "UA" (i.e., "UAJ"), denotes analyte not detected at or above adjusted detection limit and adjusted detection limit and QL are estimated.
UN Denotes analyte concentration is less than the quantitation limit and/or five times the blank concentration. Not reliably detected due to blank contamination. This qualifier used only for Appendix IX monitoring event when compliance well results are reported to at or above the project detection limit.
R Denotes result rejected.
Q Denotes data validation qualifier. **X** Denotes mass spectral confirmation not obtained-result suspect.
Background Denotes background concentrations listed in Appendix G to Attachment 3 in the Final Hazardous Waste Post-Closure Care Permit for Hazardous Waste Units 5 and 16 (rev 2014, 2016), where applicable.
CAS# Denotes Chemical Abstract Services registration number.
GPS Denotes Groundwater Protection Standards listed in Appendix G to Attachment 3 in the Final Hazardous Waste Post-Closure Care Permit for Hazardous Waste Units 5 and 16 (October 4, 2002) (revised 2014, 2016).
NS denotes not sampled. **NA** denotes not analyzed.
"–" denotes not detected (pre-2nd Quarter 2003) or not available / not sampled (beginning 2nd Quarter 2003).

The following definitions apply to results reported for non-Appendix IX monitoring events. All non-Appendix IX monitoring results for compliance wells are reported at or above the quantitation limit.

QL Denotes permit required quantitation limit.
U Denotes analyte not detected at or above QL.
UA Denotes analyte not detected at or above adjusted sample QL.
J Denotes result is estimated. When used with "U" (i.e., "**UJ**"), denotes analyte not detected at or above QL and QL is estimated. When used with "UA" (i.e., "**UAJ**"), denotes analyte not detected at or above adjusted QL and adjusted QL is estimated.
UN Denotes analyte concentration is less than five times the blank concentration. Not reliably detected due to blank contamination.
R Denotes result rejected.
Q Denotes data validation qualifier.
Background Denotes background concentrations listed in Appendix G to Attachment 3 in the Final Hazardous Waste Post-Closure Care Permit for Hazardous Waste Units 5 and 16 (October 4, 2002), (revised 2014, 2016), where applicable.
CAS# Denotes Chemical Abstract Services registration number.
GPS Denotes Groundwater Protection Standards listed in Appendix G to Attachment 3 in the Final Hazardous Waste Post-Closure Care Permit for Hazardous Waste Units 5 and 16 (October 4, 2002) (revised 2014, 2016).

APPENDIX B-3

HWMU-16 2019 LABORATORY ANALYTICAL RESULTS
PLUME MONITORING WELLS

Target Analyte Monitoring Results At Or Above Permit Quantitation Limit
HWMU-16 Plume Monitoring Wells
Radford Army Ammunition Plant, Radford, Virginia

All Results in ug/L. ***Upgradient well = 16C1***

Analtye/Quarter	*16C1 Q*	*16-2 Q*	*16-3 Q*	*16-5 Q*	*16WC2B Q*	*16SPRING Q*	*QL*	*Background*	*Method*
Arsenic						*CAS #7440-38-2*			
Second Quarter 2019	U	U	U	U	U	U	10	1	6020B
Fourth Quarter 2019	U	U	U	U	U	U	10	1	6020B
Barium						*CAS #7440-39-3*			
Second Quarter 2019	140	180	800	170	120	180	10	175.4	6020B
Fourth Quarter 2019	190	200	1000	170	120	230	10	175.4	6020B
Beryllium						*CAS #7440-41-7*			
Second Quarter 2019	U J	U J	U J	U J	U J	U J	1	0.7	6020B
Fourth Quarter 2019	U	U	U	U	U	U	1	0.7	6020B
Cadmium						*CAS #7440-43-9*			
Second Quarter 2019	U	U	U	U	U	U	1	0.2	6020B
Fourth Quarter 2019	U	U	U	U	U	U	1	0.2	6020B
Chromium						*CAS #7440-47-3*			
Second Quarter 2019	U	U	U	U	U	U	5	6.2	6020B
Fourth Quarter 2019	U	U	U	U	U	U	5	6.2	6020B
Cobalt						*CAS #7440-48-4*			
Second Quarter 2019	U	U	U	U	U	U	5	5	6020B
Fourth Quarter 2019	U	U	U	U	U	U	5	5	6020B
Copper						*CAS #7440-50-8*			
Second Quarter 2019	U	U	U	U	U	U	5	13	6020B
Fourth Quarter 2019	U	U	U	U	U	U	5	13	6020B
Lead						*CAS #7439-92-1*			
Second Quarter 2019	U	U	U	U	U	U	3	10	6020B
Fourth Quarter 2019	U	U	U	U	U	U	3	10	6020B
Mercury						*CAS #7439-97-6*			
Second Quarter 2019	U	U	U	U	U	U	2	0.2	7470A
Fourth Quarter 2019	U	U	U	U	U	U	2	0.2	7470A
Nickel						*CAS #7440-02-0*			
Second Quarter 2019	4.3 J	U	U	U	U	U	10	16	6020B
Fourth Quarter 2019	U	U	U	U	U	U	10	16	6020B
Vanadium						*CAS #7440-62-2*			
Second Quarter 2019	U	U	U	U	U	U	10	151	6020B
Fourth Quarter 2019	U	U	U	U	U	U	10	151	6020B
Zinc						*CAS #7440-66-6*			
Second Quarter 2019	U	U	U	U	U	U	30	51	6020B
Fourth Quarter 2019	U	U	U	U	U	U	30	51	6020B
Benzene						*CAS #71-43-2*			
Second Quarter 2019	0.227 J	U	U	U	U	U	1	1	8260C
Fourth Quarter 2019	U	U	U	U	U	U	1	1	8260C
2-Butanone						*CAS #78-93-3*			
Second Quarter 2019	U	U	U	U	U	U	10	1.1	8260C
Fourth Quarter 2019	U	U	U	U	U	U	10	1.1	8260C
Carbon tetrachloride						*CAS #56-23-5*			
Second Quarter 2019	U	U	U	U	U	U	1	0.2	8260C
Fourth Quarter 2019	U	U	U	U	U	U	1	0.2	8260C
Chloroethane						*CAS #75-00-3*			
Second Quarter 2019	2.94	U	U	U	U	U	1	20.7	8260C
Fourth Quarter 2019	3.6	U	U	U	U	U	1	20.7	8260C

Target Analyte Monitoring Results At Or Above Permit Quantitation Limit
HWMU-16 Plume Monitoring Wells
Radford Army Ammunition Plant, Radford, Virginia
All Results in ug/L.

Upgradient well = 16C1

Analtye/Quarter	*16C1 Q*	*16-2 Q*	*16-3 Q*	*16-5 Q*	*16WC2B Q*	*16SPRING Q*	*QL*	*Background*	*Method*
Dichlorodifluoromethane						*CAS #75-71-8*			
Second Quarter 2019	U J	U J	U J	U J	U J	U J	1	46.5	8260C
Fourth Quarter 2019	U J	U J	U J	U J	U J	U J	1	46.5	8260C
1,1-Dichloroethane						*CAS #75-34-3*			
Second Quarter 2019	4.56	U	U	U	U	U	1	9.5	8260C
Fourth Quarter 2019	6.3	U	U	U	U	U	1	9.5	8260C
1,1-Dichloroethene						*CAS #75-35-4*			
Second Quarter 2019	U	U	U	U	U	U	1	1	8260C
Fourth Quarter 2019	U	U	U	U	U	U	1	1	8260C
Diethyl ether						*CAS #60-29-7*			
Second Quarter 2019	26.6	U	U	U	U	U	12.5	75.5	8260C
Fourth Quarter 2019	47	U	U	U	U	U	12.5	75.5	8260C
Diethyl phthalate						*CAS #84-66-2*			
Second Quarter 2019	U	U	U	U	U	U	5	5	8270D
Fourth Quarter 2019	U	U	U	U	U	U	5	5	8270D
Dimethyl ether						*CAS #115-10-6*			
Second Quarter 2019	8.74 J	U	U	U	U	U	12.5	17.0	8260C
Fourth Quarter 2019	U	U	U	U	U	U	12.5	17.0	8260C
2,4-Dinitrotoluene						*CAS #121-14-2*			
Second Quarter 2019	U	U	U	U	U	U	10	10	8270D
Fourth Quarter 2019	U	U	U	U	U	U	10	10	8270D
2,6-Dinitrotoluene						*CAS #606-20-2*			
Second Quarter 2019	U	U	U	U	U	U	10	10	8270D
Fourth Quarter 2019	U	U	U	U	U	U	10	10	8270D
Ethylbenzene						*CAS #100-41-4*			
Second Quarter 2019	U	U	U	U	U	U	1	0.1	8260C
Fourth Quarter 2019	U	U	U	U	U	U	1	0.1	8260C
Chloromethane						*CAS #74-87-3*			
Second Quarter 2019	U	U	U	U	U	U	1	0.3	8260C
Fourth Quarter 2019	U	U	U	U	U	U	1	0.3	8260C
Methylene chloride						*CAS #75-09-2*			
Second Quarter 2019	1.39	U	U	U	U	U	1	13.95	8260C
Fourth Quarter 2019	1	U	U	U	U	U	1	13.95	8260C
Tetrachloroethene						*CAS #127-18-4*			
Second Quarter 2019	0.213 J	U	U	U	U	U	1	0.7	8260C
Fourth Quarter 2019	U	U	U	U	U	U	1	0.7	8260C
Tetrahydrofuran						*CAS #109-99-9*			
Second Quarter 2019	12.1 J	U	U	U	U	U	25	25	8260C
Fourth Quarter 2019	U	U	U	U	U	U	25	25	8260C
Toluene						*CAS #108-88-3*			
Second Quarter 2019	U	U	U	U	U	U	1	0.1	8260C
Fourth Quarter 2019	U	U	U	U	U	U	1	0.1	8260C
1,1,1-Trichloroethane						*CAS #71-55-6*			
Second Quarter 2019	0.19 J	U	U	U	U	U	1	9.2	8260C
Fourth Quarter 2019	U	U	U	U	U	U	1	9.2	8260C
Trichloroethene						*CAS #79-01-6*			
Second Quarter 2019	0.211 J	U	U	U	U	U	1	0.1	8260C
Fourth Quarter 2019	U	U	U	U	U	U	1	0.1	8260C

See last page of this report for definitions.

Target Analyte Monitoring Results At Or Above Permit Quantitation Limit
HWMU-16 Plume Monitoring Wells
Radford Army Ammunition Plant, Radford, Virginia

All Results in ug/L. ***Upgradient well = 16C1***

Analtye/Quarter	*16C1 Q*	*16-2 Q*	*16-3 Q*	*16-5 Q*	*16WC2B Q*	*16SPRING Q*	*QL*	*Background*	*Method*
Trichlorofluoromethane						*CAS # 75-69-4*			
Second Quarter 2019	U	U	U	U	U	U	1	11.3	8260C
Fourth Quarter 2019	U J	U J	U J	U J	U J	U J	1	11.3	8260C
1,1,2-Trichloro-1,2,2-Trifluoroethane						*CAS # 76-13-1*			
Second Quarter 2019	U	U	U	U	U	U	1	1.2	8260C
Fourth Quarter 2019	U	U	U	U	U	U	1	1.2	8260C
Xylenes (Total)						*CAS # 1330-20-7*			
Second Quarter 2019	U	U	U	U	U	U	3	0.2	8260C
Fourth Quarter 2019	U	U	U	U	U	U	3	0.2	8260C

All plume monitoring wells reported to at or above the permit quantitation limit except for the upgradient well during the Appendix IX monitoring event where results are reported for the upgradient well to at or above the detection limit (DL).

Q Donotes data validation qualifier.
QL Denotes permit required quantitation limit.
U Denotes analyte not detected at or above QL.
UA Denotes analyte not detected at or above adjusted sample QL.
J Denotes result is estimated. When used with "U" (i.e., "**UJ**"), denotes analyte not detected at or above QL and QL is estimated. When used with "UA" (i.e., "**UAJ**"), denotes analyte not detected at or above adjusted QL and adjusted QL is estimated.
UN Denotes analyte concentration is less than five times the blank concentration. Not reliably detected due to blank contamination.
R Denotes result rejected.
Q Denotes data validation qualifier.
Background Denotes background concentrations listed in Appendix F to Attachment 3 in the Final Hazardous Waste Post-Closure Care Permit for Hazardous Waste Units 5 and 16 (October 4, 2002), (revised 2014, Dec 1,2016), where applicable.
CAS# Denotes Chemical Abstract Services registration number.
GPS Denotes Groundwater Protection Standards listed in Appendix G to Attachment 5 in the Final Hazardous Waste Post-Closure Care Permit for Hazardous Waste Units 5 and 16 (October 4, 2002) (revised 2014, 2016).

APPENDIX B-4

ESTABLISHED BACKGROUND VALUES AND COMPUTATIONS FOR HWMU-16

- It was not understood why the majority of fluorescein detections were considered false positive detections. The basis of this observation is unclear considering a lack of background and laboratory confirmation results.

- It was not apparent why certain samples were selected for laboratory confirmation and others were not. There was no apparent consistency in the selection of samples for laboratory confirmation.

- Samples were submitted for confirmation laboratory analyses three months or more following the collection of the samples in the field. No information was provided regarding the custody and/or storage of the samples. The samples were submitted to the analytical laboratory with incomplete chain-of-custody (COC), and the COC documentation was not completed by the laboratory.

In summary, the data from the study do not provide the basis for meaningful interpretation. Any attempt to formulate conclusions from the data as presented regarding the presence of preferred or predominant groundwater flow patterns is not warranted or recommended.

3.3 HWMU-16 GROUNDWATER MONITORING ANALYTE LIST

The groundwater monitoring analyte list for HWMU-16 is presented in **Table 1 (Appendix B)**. The list represents the subset of the constituents listed in Appendix III of 40 CFR Part 261 that previously have been detected in the groundwater and/or that are reasonably expected to be in or derived from waste contained in HWMU-16. As discussed in Section 3.5.2 below, 12 inorganic constituents and two explosive/propellant constituents have been detected in the groundwater monitoring network for HWMU-16 at statistically significant concentrations above the Unit's calculated background concentrations. The inorganic constituents may be derived from the aquifer formation materials; however, the two explosive/propellant constituents (2,4-Dinitrotoluene and 2,6-Dinitrotoluene) are byproducts of wastes derived from explosives. Therefore, the two explosive/propellant constituents detected could only be from HWMU-16.

The concentration limits established for the hazardous constituents also are listed in **Table 1**. The concentration limits represent either background concentrations calculated for the constituents in this GWQAR, Maximum Concentrations of Constituents for Ground-water Protection listed in Table 1 of 40 CFR 264.94, USEPA Drinking Water Standard Maximum Contaminant Levels (MCLs), or alternate concentration limits (ACLs) established by the VDEQ (July 1998). Certain organic constituents on the list do not have USEPA MCLs or VDEQ ACLs; they also do not have calculated background concentrations because they have not been detected in the Unit's upgradient well. Therefore, the concentration limits for these constituents are equal to their respective method detection limits.

As Alliant discussed with the VDEQ in the past, the reliability of previous laboratory analytical data - particularly dissolved metals data - appeared to be questionable in some cases. In an April 9, 1996 letter to C. Jake (Alliant), the VDEQ agreed that only total metals concentrations in groundwater would be measured, as described in a USEPA Region III guidance on groundwater sampling in karst terrain. Therefore, all references to metals concentrations in this GWQAR refer to <u>total</u> metals concentrations.

3.4 HWMU-16 GROUNDWATER BACKGROUND CONCENTRATIONS

Background concentrations were calculated for each constituent in the groundwater monitoring program using the analytical data from 1996 through 1998 for upgradient well 16C1.

The background concentration calculations were based on site wide 95% confidence, 95% coverage upper prediction intervals. The calculated background concentrations are listed in **Table 2 (Appendix B)**. The background concentrations were used to construct the outermost closing contours on the Isoconcentration Maps **(Appendix A)**.

3.5 HWMU-16 STATISTICAL ANALYSIS

Statistical evaluations for HWMU-16 are performed annually and submitted to the VDEQ in accordance with the annual reporting requirements specified in 40 CFR 265.94. As part of this GWQAR, statistical evaluations were performed on Fourth Quarter 1998 analytical data in accordance with the procedures and guidance provided in the following documents:

- Title 40 of the Code of Federal Regulations, 40 CFR 264.97 and 264.98;
- VDEQ Guidance for statistical analysis titled "Data Analysis Plan," undated;
- Interim Final Guidance for Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, USEPA, April 1989;
- Addendum to Interim Final Guidance for Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, USEPA, July 1992; and
- Statistical Methods for Groundwater Monitoring, Gibbons, R.D., 1994.

Statistical threshold values were computed for the 54 constituents for which HWMU-16 is currently monitored based on the concentrations of those constituents in upgradient (background) well 16C1. All data starting with First Quarter 1996 to Fourth Quarter 1998 were used for this purpose. The 1996 through 1998 monitoring data have been submitted previously to the VDEQ by Alliant in quarterly monitoring reports; therefore, the data are not listed in this GWQAR. Statistical comparisons were performed for the Fourth Quarter 1998 data set. Comparison statistical analyses were performed for all constituents which were detected in any downgradient well during that event.

3.5.1 Background Data and Statistical Comparisons

Statistical analyses were performed using the analytical results from upgradient well 16C1 data as background data. Based on the percentage of non-detects and the distribution of the background data, methods of statistical comparisons varied. Background average, standard deviation and other descriptive statistical data were computed for all constituents and are presented in **Appendix C**.

The constituents listed below were 100% non-detected in the background data. The background threshold levels (BTLs) for these constituents were established as equal to their detection limits (DL). Detections of these constituents in the downgradient wells during Fourth Quarter 1998 were compared to these BTLs.

Background Threshold Level (BTL) = Detection Limit (DL)				
Parameter	Sample Size	% Non-Detects	DL (µg/l)	BTL (µg/l)
Antimony	12	100	3	3
Arsenic	12	100	1	1
Bromoform	12	100	0.3	0.3
Carbon tetrachloride	12	100	0.2	0.2
Chlorobenzene	12	100	0.1	0.1
Chloromethane	12	100	0.3	0.3
Cyanide	12	100	10	10

Background Threshold Level (BTL) = Detection Limit (DL)				
Parameter	Sample Size	% Non-Detects	DL (µg/l)	BTL (µg/l)
Di-n-butyl phthalate	12	100	5	5
1,2-Dichloroethane	12	100	0.1	0.1
trans-1,2-Dichloroethene	12	100	0.1	0.1
1,4-Dichlorobenzene	12	100	0.1	0.1
Ethylbenzene	12	100	0.1	0.1
Mercury	12	100	0.2	0.2
Methyl ethyl ketone	12	100	1.1	1.1
Selenium	12	100	1	1
1,1,2,2-Tetrachloroethane	12	100	0.3	0.3
1,1,2-Trichloroethane	12	100	0.5	0.5
Trichloroethene	12	100	0.1	0.1
Toluene	12	100	0.1	0.1
2378-TCDF	12	100	0.0485 ppt	0.0485 ppt
12378-PECDF	12	100	0.0439 ppt	0.0439 ppt
23478-PECDF	12	100	0.0417 ppt	0.0417 ppt
123478-HXCDF	12	100	0.0390 ppt	0.0390 ppt
123678-HXCDF	12	100	0.0377 ppt	0.0377 ppt
234678-HXCDF	12	100	0.0428 ppt	0.0428 ppt
123789-HXCDF	12	100	0.0415 ppt	0.0415 ppt
1234678-HPCDF	12	100	0.0615 ppt	0.0615 ppt
1234789-HPCDF	12	100	0.0709 ppt	0.0709 ppt
OCDF	12	100	0.1307 ppt	0.1307 ppt

Non-parametric prediction intervals were computed for all of the constituents for which the data from background well 16C1 satisfied one of the following two criteria, per VDEQ regulations and guidance as well as USEPA guidance:

- Percentage of non-detects was greater than or equal to 50 and less than 100; or
- Percentage of non-detects was less than 50, but data was not normally distributed in original or log-transformed mode.

The background threshold levels for these constituents were set as equal to their upper prediction limits (UPLs). The background and relevant statistical data for these constituents are summarized below. The confidence level and false positive rate were calculated based on the number of background data points available and number of future comparisons. For all constituents, the confidence level was determined to be equal to 0.933, and the false positive rate was equal to 0.067. Since the upper control limit of a non-parametric interval cannot be adjusted for multiple comparisons and inadequate number of background data, the number of resampling events required was adjusted to account for the high error rates inherent in those situations. The number of confirmation resamples required for all constituents is 2. The background and relevant statistical data for these constituents are summarized below. Associated statistical computations are presented in **Appendix C**.

BTL = Upper Prediction Limit of Non-parametric Prediction Interval w/false positive rate=0.067				
Parameter	Sample Size	% Non-Detects	DL (µg/l)	BTL (µg/l)
Beryllium	12	75	0.2	0.7
Cadmium	12	75	0.1	0.2
Cobalt	12	75	1	5
Copper	12	50	1	13
1,1-Dichloroethane	12	0	0.2	9.5
2,4-Dinitrotoluene	12	92	0.08	0.10

BTL = Upper Prediction Limit of Non-parametric Prediction Interval w/false positive rate=0.067				
Parameter	Sample Size	% Non-Detects	DL (µg/l)	BTL (µg/l)
2,6-Dinitrotoluene	12	75	0.08	0.11
Lead	12	42	1	10
Nickel	12	92	15	16
Silver	12	75	0.2	0.5
Thallium	12	67	1	6
TOC	12	75	1000	7000
1,1,1-Trichloroethane	12	17	0.3	9.2
Vanadium	12	83	4	151
Vinyl Chloride	12	92	0.1	0.1
Xylene (total)	12	92	0.1	0.2
Zinc	12	50	5	51

Chromium exhibited normally distributed data (excluding non-detects) with between 25% and 50% non-detects in the background well. The mean and standard deviation of the background data for chromium were adjusted using Cohen's Maximum Likelihood Estimator Method (1959, 1961). A one-sided parametric prediction interval was then computed for chromium based on the adjusted mean and standard deviation. The Upper Prediction Limit was set as the BTL for chromium. The background and relevant statistical data for chromium are summarized below. Cohen's adjustment computations and prediction interval computations are presented in **Appendix C**.

BTL = Upper Prediction Limit of Prediction Interval w/false positive rate=0.05 Original Mean = 3.54, Original SD = 1.933 Adjusted Mean = 3.642. Adjusted SD = 1.95				
Parameter	Sample Size	% Non-Detects	DL (µg/l)	BTL (µg/l)
Chromium	12	25	1	6.2

The following constituents exhibited normally distributed background data with less than 25% non-detects. One sided parametric prediction intervals were computed on the background data for all of these constituents. The UPLs for these constituents were set as their respective BTLs, with one exception. For pH, a two-sided parametric prediction interval was computed; therefore, the BTL for pH consisted of a range between the lower prediction limit (LPL) and the upper prediction limit. The background concentration calculations were based on a site wide 95% confidence, 95% coverage upper prediction intervals. When adjusted for multiple comparisons of the background data, the minimum required false positive rate was below 1% (0.01). A 99% confidence level (0.01 false positive rate) was used for all individual comparisons, which with the most conservative assumptions provided a site-wide false positive rate of >0.05 for all constituents. The background and relevant statistical data for these constituents are summarized below. The prediction interval computations for these constituents are presented in **Appendix C**.

BTL = UPL of one-sided Prediction Interval (exception pH) w/site-wide false positive rate>0.05 (individual comparisons false positive rate=0.01) BTL for pH = LPL – UPL of two-sided Prediction Interval				
Parameter	Sample Size	% Non-Detects	DL (µg/l)	BTL (µg/l)
Barium	12	0	2	175.4
Dichlorodifluoromethane	12	8	0.3	46.5
Tetrachloroethene	12	17	0.1	0.7
TOX	12	17	5	42.2

BTL = UPL of one-sided Prediction Interval (exception pH) w/site-wide false positive rate>0.05 (individual comparisons false positive rate=0.01) BTL for pH = LPL – UPL of two-sided Prediction Interval				
Parameter	Sample Size	% Non-Detects	DL (µg/l)	BTL (µg/l)
Trichlorofluoromethane	12	0	0.5	11.3
Specific Conductivity	8	0	1 µS/cm	672 µS/cm
pH	8	0	0.1 pH units	5.7 to 7.9 pH units

3.5.2 Results of Statistical Comparisons

The following table lists the constituents which were detected during the Fourth Quarter 1998 event at concentrations exceeding their respective background threshold levels (BTLs), and the downgradient wells in which they were detected.

Parameter	Monitoring Well(s)
Arsenic	16-5, 16WC2B
Barium	16-2, 16-3, 16-5, 16WC1A, 16WC1B, 16WC2B, 16SPRING
Beryllium	16WC1B, 16WC2B
Cadmium	16WC1B
Chromium	16-3, 16-5, 16WC1B, 16WC2B
Cobalt	16-5, 16WC1B, 16WC2B
Copper	16-5, 16WC1B, 16WC2B
Lead	16WC1B
Mercury	16WC1B
Nickel	16-5, 16WC1A, 16WC2B
Selenium	16-5, 16WC1B, 16WC2B
Zinc	16WC1B
2,4-Dinitrotoluene	16-3, 16-5, 16WC1B, 16WC2B, 16SPRING
2,6-Dinitrotoluene	16WC1A, 16WC1B

Any HWMU-16 target constituents not listed above were not detected in the downgradient monitoring wells at concentrations exceeding their respective BTLs.

3.6 HWMU-16 PLUME DELINEATIONS

In accordance with VDEQ instructions presented during the May 19, 1999 meeting between Alliant and the VDEQ, Isoconcentration Maps were produced to depict constituent plumes in the groundwater beneath the site (**Appendix A**). In order to evaluate the shape and position of constituent plumes over time, historical Isoconcentration Maps were developed using the historical maximum concentrations for the constituents monitored at the site for the time periods of 1992 through 1995 and 1996 through 1998. The historical maximum concentrations for these time periods are listed in **Tables 3** and **4**, respectively (**Appendix B**).

Groundwater analytical data collected prior to 1992 were not included in the evaluation of historical maximum concentrations. The data collected prior to 1992 are considered unreliable due to "order-of-magnitude" variations in parameter concentrations from quarter to quarter, as well as a general lack of laboratory QA/QC. Additionally, the groundwater monitoring analyte lists prior to 1992 did not include many of the parameters on the current groundwater monitoring analyte list for HWMU-16.

TABLE 2
HWMU-16
Calculated Background Values

Constituent	Background Concentration (µg/l unless otherwise noted)
Antimony	3
Arsenic	1
Barium	175.4
Beryllium	0.7
Cadmium	0.2
Chromium	6.2
Cobalt	5
Copper	13
Lead	10
Mercury	0.2
Nickel	16
Selenium	1
Silver	0.5
Thallium	6
Vanadium	151
Zinc	51
Bromoform	0.3
Carbon Tetrachloride	0.2
Chlorobenzene	0.1
Chloromethane	0.3
1,4-Dichlorobenzene	0.1
Dichlorodifluoromethane	46.5
1,1-Dichloroethane	9.5
1,2-Dichloroethane	0.1
trans-1,2-Dichloroethene	0.1
Ethylbenzene	0.1
Methyl Ethyl Ketone	1.1
1,1,2,2-Tetrachloroethane	0.3
Tetrachloroethene	0.7
Toluene	0.1
1,1,1-Trichloroethane	9.2
1,1,2-Trichloroethane	0.5
Trichloroethene	0.1
Trichlorofluoromethane	11.3
Vinyl Chloride	0.1
Xylenes (total)	0.2

TABLE 2
HWMU-16
Calculated Background Values

Constituent	Background Concentration (µg/l unless otherwise noted)
Di-n-butylphthalate	5
2,4-Dinitrotoluene	0.10
2,6-Dinitrotoluene	0.11
2378-TCDF	0.0485 ppt
12378-PECDF	0.0439 ppt
23478-PECDF	0.0417 ppt
123478-HXCDF	0.0390 ppt
123678-HXCDF	0.0377 ppt
234678-HXCDF	0.0428 ppt
123789-HXCDF	0.0415 ppt
1234678-HPCDF	0.0615 ppt
1234789-HPCDF	0.0709 ppt
OCDF	0.1307 ppt
Cyanide	10
Total Organic Carbon (x4)	7000
Total Organic Halides (x4)	42.2
Specific Conductivity	672 µS/cm
pH	5.7 to 7.9 pH units

Appendix IX Constituents Detected Since Permit Issuance
HWMUs 5, 7, 10, and 16
Radford Army Ammunition Plant

Unit	Quarter Initially Detected	Constituent	Background--Calculated or QL?	Background (ug/L)	GPS Required? (261 Appendix VIII)	Proposed GPS (ug/L)	Source
HMWU-5	Fourth Quarter 2003	Chromium	QL	5	yes	100	USEPA MCL
		Diethyl Ether	QL	12	no	NA	NA
		2-Nitroaniline	QL	20	no	NA	NA
		4-Nitroaniline	QL	20	yes	20	Background/QL
		Nitrobenzene	QL	10	yes	10	Background/QL
	Third Quarter 2006	Dichlorodifluoromethane	QL	1	yes	125.2	VDEQ ACL
HWMU-7	Third Quarter 2003	Copper	Calculated	49	no	NA	NA
	Second Quarter 2004	Zinc	Calculated	217	no	NA	NA
HWMU-10	First Quarter 2003	Cobalt	QL	5	no	NA	NA
	Second Quarter 2003	Vanadium	QL	10	no	NA	NA
	Second Quarter 2005	Acetone	QL	10	no	NA	NA
		2-Propanol	QL	50	no	NA	NA
HWMU-16	Second Quarter 2003	Chloroethane	Calculated	20.7	yes	20.7	Background/QL
		Diethyl Ether	Calculated	75.5	no	NA	NA
		Dimethyl Ether	Calculated	17.0	no	NA	NA
	Third Quarter 2003	Methylene Chloride	Calculated	13.95	no*	NA	NA
	Second Quarter 2004	1,1,2-Trichloro-1,2,2-trifluoroethane	Calculated	1.2	no*	NA	NA

HWMU-5: The additional Appendix IX constituents detected in the downgradient point of compliance wells were not detected above their respective Quantitation Limits (QLs) in the upgradient well. As a result, background concentrations for those constituents were set as equal to their respective QLs. In accordance with the Permit (Condition V.J.1.g.), GPS are proposed for those additional Appendix IX constituents that are listed in Appendix VIII of 40 CFR Part 261 (chromium, 4-nitroaniline, nitrobenzene, and dichlorodifluoromethane). No GPS are proposed for the additional Appendix IX constituents that are not listed in Appendix VIII of 40 CFR Part 261 (diethyl ether and 2-nitroaniline).

HWMU-7: Background concentrations for the additional Appendix IX constituents detected in the downgradient point of compliance wells (copper and zinc) were previously calculated and submitted to the VDEQ in the August 1998 ***Groundwater Quality Assessment Report for HWMU-7*** prepared by ERM, Inc. In accordance with the Permit (Condition V.J.2.g.), no GPS are proposed for the additional Appendix IX constituents (copper and zinc), as they are not listed in Appendix VIII of 40 CFR Part 261.

HWMU-10: The additional Appendix IX constituents detected in the downgradient point of compliance wells were not detected above their respective Quantitation Limits (QLs) in the upgradient well. As a result, background concentrations for those constituents were set as equal to their respective QLs. In accordance with the Permit (Condition V.J.3.g.), no GPS are proposed for the additional Appendix IX constituents (cobalt, vanadium, acetone, and 2-propanol), as they are not listed in Appendix VIII of 40 CFR Part 261.

HWMU-16: Background concentrations for additional Appendix IX constituents chloroethane, diethyl ether, dimethyl ether, and methylene chloride were calculated using data collected from upgradient well 16C1 during the period from Third Quarter 2003 through Third Quarter 2004. The background concentration for additional Appendix IX constituent 1,1,2-trichloro-1,2,2-trifluoroethane was calculated using data collected from upgradient well 16C1 during the period from Second Quarter 2004 through Third Quarter 2006.
In accordance with the Permit (Condition V.J.4.g.), GPS are proposed for additional Appendix IX constituents that are listed in Appendix VIII of 40 CFR Part 261 (chloroethane). No GPS are proposed for the additional Appendix IX constituents that are not listed in Appendix VIII of 40 CFR Part 261 (diethyl ether and dimethyl ether).
*Methylene chloride and 1,1,2-trichloro-1,2,2-trifluoroethane should not be added to the Groundwater Monitoring List for HWMU-16, as these constituents were only detected in the upgradient well for the Unit, and not in the downgradient point of compliance wells.

Statistical Computations – RAAP HWMU-16 – 1,1,2-Trichloro-1,2,2-Trifluoroethane

In accordance with the facility permit and VHWMR, statistical background concentration is being established for 1,1,1-Trichloro-1,2,2-Trifluoroethane. Inter-well upper prediction limits (UPL) were calculated on the background data for this target parameter in accordance with the facility permit and VHWMR (40 CFR 264.97(h)). Background data for this target parameter consisted of all data for the background well 16C1 collected from 2nd quarter 2004 through 3rd quarter 2006.

Discussion of Tests for Normality

The power of a statistical tool to account for false positive and false negative results, while accurately detecting true statistical variations for a facility under scrutiny depends on numerous factors, one of which is the distribution of the data. A great number of statistical tools are based on the assumption that data are normally distributed. Hence the distribution of the sample population for parameters evaluated under this statistical analysis is first determined. Sample populations are tested for normal distribution using several normality tests. "Groundwater Information Tracking System with Statistical Analysis Capability" (GRITS/STAT) v5.0 was the software used to run these statistical tests. GRITS/STAT is an analytical software package provided by the USEPA. The distributions of the data sets were verified in the original mode as well as in log-transformed mode. The normality of the data set was evaluated using the Shapiro-Wilk test for normality.

Discussion of Prediction Interval Tests

Normality tests are performed prior to running parametric tests (tests that require that the data be normal). Results of the normality tests show that the background data for 1,1,2-Trichloro-1,2,2-Trifluoroethane is non-normally distributed. Non-parametric UPL (NUPL) was constructed on the background data for this parameter. The confidence levels of NUPLs are typically approximate and estimated to be around 91%.

Summary of UPL

Parameter	Background Data Distribution	Type of UPL	Multiple Comparisons/year	UPL (µg/l)
1,1,2-Trichloro-1,2,2-Trifluoroethane	Non-Normal	NUPL	N/A	1.2

Statistical Computations – RAAP HWMU-16

In accordance with the facility permit and VHWMR, statistical background concentrations are being established for the four new target parameters chloroethane, diethyl ether, dimethyl ether and methylene chloride. These four target parameters were added to the facility monitoring program during the 3rd quarter 2003 monitoring event. Inter-well upper prediction limits (UPL) were calculated on the background data for the target parameters in accordance with the facility permit and VHWMR (40 CFR 264.97(h)). Background data for these target parameters consisted of all data for the background well 16C1 collected from 3rd quarter 2003 through 3rd quarter 2004.

Discussion of Tests for Normality

The power of a statistical tool to account for false positive and false negative results, while accurately detecting true statistical variations for a facility under scrutiny depends on numerous factors, one of which is the distribution of the data. A great number of statistical tools are based on the assumption that data are normally distributed. Hence the distribution of the sample population for parameters evaluated under this statistical analysis is first determined. Sample populations were tested for normal distribution using several normality tests. "Groundwater Information Tracking System with Statistical Analysis Capability" (GRITS/STAT) v5.0 was the software used to run these statistical tests. GRITS/STAT is an analytical software package provided by the USEPA. The distributions of the data sets were verified in the original mode as well as in log-transformed mode. The normality of the data sets was evaluated using the Shapiro-Wilk test for normality.

Discussion of Prediction Interval Tests

Normality tests are performed prior to running parametric tests (tests that require that the data be normal). A 99% confidence parametric inter-well UPL was computed for each of the four target parameters that showed normally distributed background data. Results of the normality tests show that the background data for chloroethane, diethyl ether and methylene chloride are normally distributed, and the background data for dimethyl ether is non-normally distributed. Non-parametric UPL (NUPL) was constructed on the background data for dimethyl ether, and parametric UPLs (PUPL) were constructed on the background data for chloroethane, diethyl ether and methylene chloride. No adjustments to the error rates were made to the NUPLs for multiple comparisons. Adjustment for 10 comparisons per year (considering 10 compliance monitoring wells at the facility and 4 quarters of data for each year, and considering historic detects, 10 is considered a representative number for multiple comparisons per year) was made to the PUPLs. The confidence levels of NUPLs are well less than 95%. Any statistically significant increase (SSI) must be confirmed by verification sampling.

Summary of UPLs

Parameter	Background Data Distribution	Type of UPL	Multiple Comparisons/year	UPL (µg/l)
Chloroethane	Normal	PUPL	10	20.7
Diethyl ether	Normal	NUPL	10	75.5
Dimethyl ether	Non-normal	PUPL	N/A	17.0
Methylene Chloride	Normal	PUPL	10	13.95

RAAP-HWMU-16 - Statistical Analysis - Notes

1) Y2K Correction dates are as shown in table below.

Actual Event	Date Used in Stat Software
2000-Qtr1	12/13/1999
2000-Qtr2	12/14/1999
2000-Qtr3	12/15/1999
2000-Qtr4	12/16/1999
2001-Qtr1	12/17/1999
2003-Qtr3	12/18/1999
2003-Qtr4	12/19/1999
2004-Qtr1	12/20/1999
2004-Qtr2	12/21/1999
2004-Qtr3	12/22/1999

Interwell Tests:
2) Background data for target parameters chloroethane, diethyl ether, dimethyl ether and methylene chloride were evaluated using Shapiro-Wilk test. Background data showed normal distribution for chloroethane, diethyl ether and methylene chloride. Parametric interwell 99% confidence upper prediction limits were computed for parameters with normally distributed background data. Dimethyl ether background data was non-normally distributed. Therefore non-parametric Upper Prediction Limit (UPL) was computed for dimethyl ether.

3) No adjustments for multiple comparisons could be made for non-parametric UPLs. Adjustments were made to the parametric UPLs for 10 future comparisons per year to account for multiple compliance monitoring wells and quarterly event data.
Any Statistically significant increase (SSI) must be confirmed by verification sampling.

E:\Ross Work\Radford AAP Archives\HWMU-16\[HWMU16StatDate correction.xls]Sheet1

Normality Tests

Report Printed: 02-02-2005 13:49

Facility:RAAPHWMU16 Haz. Waste Unit 16 - RAAP

Address:

City:Radford ST:VA Zip:24141
County:PULASKI

Contact:
Phone:( ) -

Permit Type:Detection

Constituent:ClEthane Chloroethane

CAS Number: 75-00-3
MCL: 0.000 ppb
ACL: 0.000 ppb
Detect Limit: 2.000 ppb

Start Date:Mar 31 1996
End Date:Dec 22 1999

Normality Test on Observations for wells listed below:

Well:16C1 Position:Upgradient Observations:5

Scale	Minimum	Maximum	Mean	Std Dev
Original:	1.000	6.400	4.340	2.078
Log:	0.000	1.856	1.303	0.749

Pooled Statistics
Observations: 5

Statistic	Original Scale	Log Scale
Mean:	4.340	1.303
Std Dev:	2.078	0.749
Skewness:	-0.810	-1.296*
Kurtosis:	-0.555	-0.011
Minimum:	1.000	0.000
Maximum:	6.400	1.856
CV:	0.479	0.575

Shapiro-Wilk Statistics

Scale	Test Statistic	5% Critical Value	1% Critical Value
Original:	0.9037	0.7620	0.6860

Log:	0.7615*	0.7620	0.6860

* Indicates statistically significant evidence of non-normality.
GRIT/STAT Version 5.0

Parametric Prediction Interval
Report Printed February 2,2005

Facility:Haz. Waste Unit 16 - RAAP
Parameter:Chloroethane(CAS Number:75-00-3)

ONE-TAILED UPPER PARAMETRIC PREDICTION INTERVAL

Observations (n):	5
Shapiro-Wilk (W):	0.9037
Critical W,α=0.01:	0.6860
Mean:	4.340 ppb
Std Dev:	2.078 ppb
DF:	4
Conf. Level (1-α):	~~0.9500~~ 0.99
Future Samples (k):	10
$t_{\left[1-\frac{\alpha}{k}\right]}$:	7.1732
Kappa:	7.8579
UL:	20.669 ppb
LL:	-∞

Report Produced by GRITS/STAT 5.01

Normality Tests

Report Printed: 02-02-2005 13:49

Facility:RAAPHWMU16 Haz. Waste Unit 16 - RAAP

Address:

City:Radford ST:VA Zip:24141
County:PULASKI

Contact:
Phone:( ) -

Permit Type:Detection

Constituent:DEthEth Diethyl ether

CAS Number: - -
MCL: 0.000 ppb
ACL: 0.000 ppb
Detect Limit: 24.000 ppb

Start Date:Mar 31 1996
End Date:Dec 22 1999

Normality Test on Observations for wells listed below:

Well:16C1 Position:Upgradient Observations:5

Scale	Minimum	Maximum	Mean	Std Dev
Original:	12.000	30.000	21.200	6.907
Log:	2.485	3.401	3.007	0.355

Pooled Statistics
Observations: 5

Statistic	Original Scale	Log Scale
Mean:	21.200	3.007
Std Dev:	6.907	0.355
Skewness:	-0.122	-0.491
Kurtosis:	-1.140	-1.024
Minimum:	12.000	2.485
Maximum:	30.000	3.401
CV:	0.326	0.118

Shapiro-Wilk Statistics

Scale	Test Statistic	5% Critical Value	1% Critical Value
Original:	0.9768	0.7620	0.6860

Log:	0.9507	0.7620	0.6860

* Indicates statistically significant evidence of non-normality.
GRIT/STAT Version 5.0

Parametric Prediction Interval
Report Printed February 2,2005

Facility:Haz. Waste Unit 16 - RAAP
Parameter:Diethyl ether(CAS Number:- -)

ONE-TAILED UPPER PARAMETRIC PREDICTION INTERVAL

Observations (n):	5
Shapiro-Wilk (W):	0.9768
Critical W, α=0.01:	0.6860
Mean:	21.200 ppb
Std Dev:	6.907 ppb
DF:	4
Conf. Level (1-α):	~~0.9500~~ 0.99
Future Samples (k):	10
$t_{\left[1-\frac{\alpha}{k}\right]}$:	7.1732
Kappa:	7.8579
UL:	75.470 ppb
LL:	-∞

Report Produced by GRITS/STAT 5.01

Normality Tests

Report Printed: 02-02-2005 13:53

Facility:RAAPHWMU16 Haz. Waste Unit 16 - RAAP

Address:

City:Radford ST:VA Zip:24141
County:PULASKI

Contact:
Phone:( ) -

Permit Type:Detection

Constituent:DMethEth Dimethyl ether

CAS Number: - -
MCL: 0.000 ppb
ACL: 0.000 ppb
Detect Limit: 24.000 ppb

Start Date:Mar 31 1996
End Date:Dec 22 1999

Normality Test on Observations for wells listed below:

Well:16C1 Position:Upgradient Observations:5

Scale	Minimum	Maximum	Mean	Std Dev
Original:	12.000	17.000	13.000	2.236
Log:	2.485	2.833	2.555	0.156

Pooled Statistics
Observations: 5

Statistic	Original Scale	Log Scale
Mean:	13.000	2.555
Std Dev:	2.236	0.156
Skewness:	1.500*	1.500*
Kurtosis:	0.250	0.250
Minimum:	12.000	2.485
Maximum:	17.000	2.833
CV:	0.172	0.061

Shapiro-Wilk Statistics

Scale	Test Statistic	5% Critical Value	1% Critical Value
Original:	0.5521*	0.7620	0.6860

Log:	0.5521*	0.7620	0.6860

* Indicates statistically significant evidence of non-normality.
GRIT/STAT Version 5.0

Nonparametric Prediction Interval
Report Printed February 2,2005

Facility:Haz. Waste Unit 16 - RAAP
Parameter:Dimethyl ether(CAS Number:- -)

ONE-TAILED UPPER PARAMETRIC PREDICTION INTERVAL

Observations (n):	5
Conf. Level (1-α):	33.330%

UL: 17.000 ppb
LL: 0.000

Report Produced by GRITS/STAT 5.01

Normality Tests

Report Printed: 02-02-2005 13:54

Facility:RAAPHWMU16 Haz. Waste Unit 16 - RAAP

Address:

City:Radford ST:VA Zip:24141
County:PULASKI

Contact:
Phone:( ) -

Permit Type:Detection

Constituent:MeCl Dichloromethane (Methylene chloride)

CAS Number: 75-09-2
MCL: 0.000 ppb
ACL: 0.000 ppb
Detect Limit: 2.000 ppb

Start Date:Mar 31 1996
End Date:Dec 22 1999

Normality Test on Observations for wells listed below:

Well:16C1 Position:Upgradient Observations:5

Scale	Minimum	Maximum	Mean	Std Dev
Original:	4.100	6.800	5.800	1.037
Log:	1.411	1.917	1.743	0.197

Pooled Statistics
Observations: 5

Statistic	Original Scale	Log Scale
Mean:	5.800	1.743
Std Dev:	1.037	0.197
Skewness:	-0.925	-1.088*
Kurtosis:	-0.436	-0.263
Minimum:	4.100	1.411
Maximum:	6.800	1.917
CV:	0.179	0.113

Shapiro-Wilk Statistics

Scale	Test Statistic	5% Critical Value	1% Critical Value
Original:	0.8964	0.7620	0.6860

Log:	0.8519	0.7620	0.6860

* Indicates statistically significant evidence of non-normality.
GRIT/STAT Version 5.0

Parametric Prediction Interval
Report Printed February 2,2005

Facility:Haz. Waste Unit 16 - RAAP
Parameter:Dichloromethane (Methylene chloride(CAS Number:75-09-2)

ONE-TAILED UPPER PARAMETRIC PREDICTION INTERVAL

Observations (n):	5
Shapiro-Wilk (W):	0.8964
Critical W, α=0.01:	0.6860
Mean:	5.800 ppb
Std Dev:	1.037 ppb
DF:	4
Conf. Level (1-α):	~~0.9500~~ 0.99
Future Samples (k):	10
$t_{\left[1-\frac{\alpha}{k}\right]}$:	7.1732
Kappa:	7.8579
UL:	13.947 ppb
LL:	-∞

Report Produced by GRITS/STAT 5.01

Target Analyte Monitoring Results - HWMU-16 Point of Compliance Wells
Radford Army Ammunition Plant, Radford, Virginia
Upgradient well = 16C1

All Results in ug/L.

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
Chloroethane					*CAS #*	*75-00-3*		
Third Quarter 2003	6.4	U	4.8	U	U	1	20.7	8260B
Fourth Quarter 2003	5.7	U	2.6	1.1	U	1	20.7	8260B
First Quarter 2004	U J	U J	U J	U J	U J	1	20.7	8260B
Second Quarter 2004	4.4	U	2.4	0.63 J	U	1	20.7	8260B
Third Quarter 2004	4.2	U	2	U	U	1	20.7	8260B
Fourth Quarter 2004	4.9	U	2.5	U	U	1	20.7	8260B
First Quarter 2005	7.6 J	U J	3.7 J	U J	U J	1	20.7	8260B
Second Quarter 2005	U J	U	U J	U	U	1	20.7	8260B
Third Quarter 2005	4.7 J	U J	U	U J	U J	1	20.7	8260B
Fourth Quarter 2005	4.6 J	U	2.6 J	U	U	1	20.7	8260B
First Quarter 2006	5.3	U	U	U	U	1	20.7	8260B
Second Quarter 2006	5 J	U	2 J	U	U	1	20.7	8260B
Third Quarter 2006	5	U	0.7 J	0.7 J	U	1	20.7	8260B
Fourth Quarter 2006	5.8	U	1	U	U	1	20.7	8260B
First Quarter 2007	6.1	U	1	U	U	1	20.7	8260B
Second Quarter 2007	5.2	U	1.4	U	U	1	20.7	8260B
Diethyl ether					*CAS #*	*60-29-7*		
Third Quarter 2003	12 J	U	12 J	U	U	12	-	8260B
Fourth Quarter 2003	30	U	14	U	U	12	-	8260B
First Quarter 2004	24	U	U	U	U	12	-	8260B
Second Quarter 2004	23 J	U J	13 J	U J	U J	12	-	8260B
Third Quarter 2004	17	U	U	U	U	12	-	8260B
Fourth Quarter 2004	24	U J	U	U	U J	12	-	8260B
First Quarter 2005	29	U	14	U	U	12	-	8260B
Second Quarter 2005	20	U J	9.2	U J	U J	12	-	8260B
Third Quarter 2005	30	U	15	U	U	12	-	8260B
Fourth Quarter 2005	25	U	18	U	U	12	-	8260B
First Quarter 2006	19	U	U	U	U	12	-	8260B
Second Quarter 2006	17	U	U	U	U	12.5	-	8260B
Third Quarter 2006	33	1.5 J	4.3 J	4.6 J	U	12.5	-	8260B
Fourth Quarter 2006	20	U	U	U	U	12.5	-	8260B
First Quarter 2007	21	U	U	U	U	12.5	-	8260B
Second Quarter 2007	17 J	1.5 J	5.7 J	2.1 J	U J	12.5	-	8260B
Dimethyl ether					*CAS #*	*115-10-6*		
Third Quarter 2003	6.6 J	U	9.9 J	U	U	12	-	8260B
Fourth Quarter 2003	U	U	U	U	U	12	-	8260B
First Quarter 2004	17 J	U J	13 J	U J	U J	12	-	8260B
Second Quarter 2004	U J	U J	6.6 J	U J	U J	12	-	8260B
Third Quarter 2004	U J	U J	U J	U J	U J	12	-	8260B
Fourth Quarter 2004	16 J	U J	12 J	U	U J	12	-	8260B
First Quarter 2005	26	U	25	U	U	12	-	8260B
Second Quarter 2005	15	U	14	U	U	12	-	8260B
Third Quarter 2005	13	U	U	U	U	12	-	8260B
Fourth Quarter 2005	U	U	U	U	U	12	-	8260B
First Quarter 2006	U	U	U	U	U	12	-	8260B
Second Quarter 2006	U	U	U	U	U	12.5	-	8260B
Third Quarter 2006	11 J	U J	3.2 J	2.8 J	U J	12.5	-	8260B
Fourth Quarter 2006	U	U	U	U	U	12.5	-	8260B
First Quarter 2007	U	U	U	U	U	12.5	-	8260B
Second Quarter 2007	11 J	U	7 J	2.6 J	1.2 J	12.5	-	8260B

See last page of this report for definitions.

Target Analyte Monitoring Results - HWMU-16 Point of Compliance Wells
Radford Army Ammunition Plant, Radford, Virginia

Upgradient well = 16C1 *All Results in ug/L.*

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
Methylene chloride					*CAS #* 75-09-2			
Third Quarter 2003	4.1	U	U	U	U	1	13.95	8260B
Fourth Quarter 2003	6.8	U	U	U	U	1	13.95	8260B
First Quarter 2004	6.4	U	U	U	U	1	13.95	8260B
Second Quarter 2004	5.7	U	U	U	U	1	13.95	8260B
Third Quarter 2004	6	U A	U A	U A	U A	1	13.95	8260B
Fourth Quarter 2004	6.4	U	U	U	U	1	13.95	8260B
First Quarter 2005	6.8 J	U	U	U	U	1	13.95	8260B
Second Quarter 2005	6.3	U	U	U	U	1	13.95	8260B
Third Quarter 2005	6.2	U	U	U	U	1	13.95	8260B
Fourth Quarter 2005	4.7	U	U	U	U	1	13.95	8260B
First Quarter 2006	4.9	U	U	U	U	1	13.95	8260B
Second Quarter 2006	7	U	U	U	U	1	13.95	8260B
Third Quarter 2006	U N	U N	U N	U N	U N	1	13.95	8260B
Fourth Quarter 2006	U A	U	U	U A	U	1	13.95	8260B
First Quarter 2007	6.3	U	U	U	U	1	13.95	8260B
Second Quarter 2007	3.4	U	U	U	U	1	13.95	8260B
1,1,2-Trichloro-1,2,2-Trifluoroethane					*CAS #* 76-13-1			
Third Quarter 2003	U	U	U	U	U	1	-	8260B
Second Quarter 2004	1.2	U J	U J	U J	U J	1	-	8260B
Third Quarter 2004	U	U	U	U	U	1	-	8260B
Fourth Quarter 2004	U	U	U	U	U	1	-	8260B
First Quarter 2005	1	U	U	U	U	1	-	8260B
Second Quarter 2005	U	U	U	U	U	1	-	8260B
Third Quarter 2005	U	U	U	U	U	1	-	8260B
Fourth Quarter 2005	U	U	U	U	U	1	-	8260B
First Quarter 2006	U	U	U	U	U	1	-	8260B
Second Quarter 2006	U	U	U	U	U	1	-	8260B
Third Quarter 2006	U	U	U	U	U	1	-	8260B
Fourth Quarter 2006	U	U	U	U	U	1	-	8260B
First Quarter 2007	U	U	U	U	U	1	-	8260B
Second Quarter 2007	U	U	U	U	U	1	-	8260B

See last page of this report for definitions.

Target Analyte Monitoring Results - HWMU-16 Point of Compliance Wells
Radford Army Ammunition Plant, Radford, Virginia

Upgradient well = 16C1 *All Results in ug/L.*

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*

Definitions: **QL** Denotes permit required quantitation limit. **U** Denotes analyte not detected at or above QL. **UA** Denotes analyte not detected at or above adjusted sample QL. **J** Denotes associated result is estimated. When used with "U" (i.e., "**UJ**"), denotes analyte not detected at or above QL and QL is estimated. When used with "UA" (i.e., "**UAJ**"), denotes analyte not detected at or above adjusted QL and adjusted QL is estimated. **UN** Denotes analyte concentration is less than the quantiation limit and five times the blank concentration. Not reliably detected due to blank contamination. This qualifier used only for Appendix IX monitoring event when results are reported to at or above the project detection limit. **R** Denotes result rejected. **Q** Denotes data validation qualifier. **CAS#** Denotes Chemical Abstract Services registration number. **X** Denotes mass spectral confirmation not obtained-result suspect.

GPS Denotes Groundwater Protection Standards listed in Appendix G to Attachment 5 in the Final Hazardous Waste Post-Closure Care Permit for Hazardous Waste Units 5, 7, 10, and 16 (October 4, 2002).
NS denotes not sampled. **NA** denotes not analyzed. "–" denotes not detected (pre-2nd Quarter 2003) or not available / not sampled (beginning 2nd Quarter 2003).

Notes:
-Appendix IX Groundwater Monitoring Events:
Third Quarter 2003, Second Quarter 2004, Second Quarter 2005, Third Quarter 2006, Second Quarter 2007
For Appendix IX monitoring events, all results evaluated to detection limit. See laboratory data deliverable for detection limit.

-9/30/2003: Verification sampling event for 16C1 (heptachlor) and 16C1B (Endrin). Verification results: all results reported not detected to detection limit. Original results 0.067 µg/l and 0.39 µg/l, respectively. Confirmation results reported in this table.
-9/30/2003: Verification sampling event for 16C1 (chloroethane, ethyl ether, methyl ether, methylene chloride) and 16MW9 (chloroethane, ethyl ether, methyl ether). Verification results: all results confirmed original analysis. Original results reported in this table.
-June 21, 2004: Verification event for 8260B 16C1 (1,1-dichloroethene and 1,1,2-trichloro-1,2,2-trifluoroethane). Verification results: all not detected except 1,1,2-trichloro-1,2,2-trifluoroethane added to quarterly analyte list beginning 3Q 2004. Due to laboratory error, Appendix IX results for semivolatiles (Method 8270C) will be presented in 3Q 2004. Verification event results for 16WC1B and 16C1 (8081A) – all verification results were not confirmed.
-07/27-28/2005. Verification event for 16WC1B (Mercury Method 7470A.) Not detected in verification sample. Also, verification event for 16C1, 16WC1B-8081A. and 16C1, 16MW9, 16WC1A-ethanol. All verification results not detected. Verification results used.
-06/19/2007. Verification event for 16WC1B and 16MW9 thallium Not detected in verification sample. Verification results used.

Ross Miller

From: Flint, Jeremy <Jeremy.Flint@ATK.COM>
Sent: Friday, January 20, 2012 2:23 PM
To: Powers, Loretta
Cc: Janet Frazier; Kathy Olsen; Mike Lawless; Ross Miller
Subject: FW: VA1210020730, RAAP, Additional App. IX GW Mont Results PCC HWMU 5,7,10,16, Final Notification

Loretta,
Please file the attached e-mail as an answer to ATK letter number 11-815-106

Thank You
Jeremy Flint
Lead Compliance Engineer
Environmental Affairs Department
Alliant Techsystems Inc.
P.O. Box 1
Radford, VA 24143
Phone: 540 - 639 - 7668
Fax: 540 - 639 - 8109
"Together Everyone Accomplishes More." (TEAM)

From: Maiden, Vince (DEQ) [mailto:Vincent.Maiden@deq.virginia.gov]
Sent: Friday, January 20, 2012 10:26 AM
To: Flint, Jeremy
Cc: McKenna, Jim; Schneider, Jutta (DEQ)
Subject: VA1210020730, RAAP, Additional App. IX GW Mont Results PCC HWMU 5,7,10,16, Final Notification

Jeremy:

The Department has received the referenced August 1, 2011 document. The notification indicates the benzene was confirmed in 16MW and recommended that this contituent be added to the compliance monitoring list for HWMU-16. In addition, the facility recommeded that the background for benzene be estalished at the LOQ of 1µg/l and the groundwater protection standard be set at 5µg/l based on the MCL. The Department agrees with the recommedations. It appears that these changes were included in the permit renewal application dated September 15, 2011. The Department will formally address those changes along with others in the permit renewal process. If you have any questions please feel free to contact me.

Vincent Maiden
Corrective Action Project Manager
Virginia Department of Environmental Quality
Office of Remediation Programs
629 East Main Street or P.O. Box 1105
Richmond, VA 23218 Richmond, VA 23219
(276) 676-4867
Vincent.Maiden@deq.virginia.gov

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY
Street address: 629 East Main Street, Richmond, Virginia 23219
Mailing address: P.O. Box 1105, Richmond, Virginia 23218
www.deq.virginia.gov

Molly Joseph Ward
Secretary of Natural Resources

David K. Paylor
Director

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

Office of Waste Permitting and Compliance

Land Protection and Remediation Division

September 12, 2014

VIA ELECTRONIC MAIL
Mr. Jay Stewart
Environmental Manager
BAE Systems, Ordnance Systems, Inc.
Radford Army Ammunition Plant
4050 Pepper's Ferry Road
Radford, Virginia 24141

Re: Radford Army Ammunition Plant, Radford, VA
EPA ID No.VA1210020730, Approval of Class 1 Permit Modifications
Hazardous Waste Management Units 5 and 16, Post Closure-Care Permit

Dear Mr. Stewart:

Enclosed are the final Class 1 Modifications to the Hazardous Waste Permit for Post Closure-Care of two hazardous waste management units (HWMUs) 5 and 16 at the Radford Army Ammunition Plant (RAAP), Radford, Virginia facility. The final Class 1 Modifications to the Permit have been approved.

The Virginia Department of Environmental Quality (DEQ) received the Class 1 Permit groundwater related modification request addressing the HWMU 16 that was communicated to the DEQ in an e-mail dated August 13, 2014, from the RAAP, Radford, Virginia facility. RAAP requested that 1,1-dichloroethene (1,1-DCE) be added to the Groundwater Compliance Monitoring Constituent List for HWMU-16.

1,1-DCE was detected in the most recent annual groundwater sampling event required under the Post-Closure Permit, and in a letter dated July 21, 2014, the VDEQ supported the RAAP's July 1, 2014, proposal that 1,1-DCE be added to the Groundwater Compliance Monitoring Constituent List and also the setting of the background value for 1,1-DCE at the Limit of Quantitation (LOQ) value of 1

ug/1 and the Groundwater Protection Standard (GPS) at the USEPA Maximum Contaminant Level (MCL) of 7 ug/l.

In the e-mail letter dated August 13, 2014, RAAP submitted the following requested changes to the facility's hazardous waste Post Closure-Care Permit as marked–up files comprising the Class 1 Permit modification:

- Permit Attachment 3, Appendix E (HWMU-16 Groundwater Compliance Monitoring Constituent List) from the Post-Closure Care Permit to add 1,1-DCE to the groundwater Compliance Monitoring Program for HWMU-16, and
- Permit Attachment 3, Appendix G (HWMU-16 Groundwater Protection Standards) from the Post-Closure Care Permit to add 1,1-DCE to the groundwater Compliance Monitoring Program for HWMU-16.

The requested changes represent a Class 1 permit modification under 40 CFR § 270.42, Appendix I.C.2 – *Changes in groundwater sampling or analysis procedures or monitoring schedule, with prior approval of the Director.*

Based on the above justification, this August 13, 2014, e-mailed letter requesting changes in the groundwater compliance monitoring program including the addition of 1,1-DCE and its associated background concentration and GPS; the RAAP has established sufficient documentation for approval of all requested changes. In accordance with the VHWMR, under 40 CFR § 270.42, Appendix I, Section C.2 and based upon the accuracy of the information contained in the Permittee's correspondence dated August 13, 2014, the requested Class 1 modifications to the permit are approved.

Enclosed are the final modified pages in electronic format to be inserted into the RAAP's copy of the hazardous waste permit.

All conditions and requirements of the facility Permit shall remain in effect for the duration of the Permit unless the existing Permit is modified, revoked and reissued, or terminated in accordance with 40 CFR § 124.5, and 40 CFR § 270.41 through 270.42, or continued in accordance with 9 VAC 20-60-270.B.5.

As provided by Rule 2A:2 of the Supreme Court of Virginia, you have 30 days from the date of service of this decision to initiate a legal appeal by filing a notice of appeal with:

David K. Paylor, Director
Department of Environmental Quality
629 East Main Street
P.O. Box 1105
Richmond, VA 23218

In the event that this decision is served to you by mail, the date of service will be calculated as three days after the postmark date. Please refer to Part 2A of the Rules of the Supreme Court of Virginia, which describes the required content of the Notice of Appeal, including specifications

of the Circuit Court to which the appeal is taken, and additional requirements concerning appeals from decisions of administrative agencies.

This above Class 1 permit modification under 40 CFR § 270.42(a)(1) requires the Permittee to send a notice of the modification to all persons on the facility mailing list (attached) within 90 days after the change is put into effect. In addition, RAAP must provide documentation to this Office regarding compliance with the public notice requirement. Please submit evidence of this mailing (return receipts, copy of the notification letter) when it is available.

If you should have any questions regarding these matters, please contact Russell McAvoy, Jr., PE, Environmental Engineer Senior, at (804) 698-4194 or by e-mail at russell.mcavoy@deq.virginia.gov.

Sincerely,

Leslie A. Romanchik
Hazardous Waste Program Manager
Office of Waste Permitting and Compliance

Enclosures: Facility Mailing List, Modified Permit Pages

cc: Andrea Barbieri – EPA, Region III (3LC50) e/enclosures
Jutta Schneider – DEQ, CO
Kurt Kochan – DEQ, CO
Aziz Farahmand – DEQ, BRRO
Elizabeth Lohman – DEQ, BRRO
Julia King–Collins – DEQ, CO
Central Hazardous Waste Files

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Street address: 629 East Main Street, Richmond, Virginia 23219
Mailing address: P.O. Box 1105, Richmond, Virginia 23218
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Molly Joseph Ward
Secretary of Natural Resources

David K. Paylor
Director

(804) 698-4020
1-800-592-5482

July 19, 2016

Mr. Jay Stewart
Environmental Manager
BAE Systems, Ordnance Systems Inc.
4050 Pepper's Ferry Road
Radford, Virginia 24141

VIA ELECTRONIC MAIL

Re: Annual Corrective Action Groundwater Monitoring Event Notification - HWMU-5
Semiannual Detection Notification – HWMU-16
Notification of Groundwater Verification Sampling Results for Post Closure Care Permit
HWMUs 5 & 16
Radford Army Ammunitions Plant
Route 114, Radford, Virginia 24141
EPA ID#: VA1210020730

Dear Mr. Stewart:

This letter acknowledges the receipt and review of the Annual Corrective Action Groundwater Monitoring Event - HWMU-5, Semiannual Detection Notification – HWMU-16 dated June 14, 2016, and Notification of Groundwater Verification Sampling Results for Post Closure Care Permit HWMUs 5 & 16 dated June 5, 2015, submitted to the Virginia Department of Environmental Quality, Office of Remediation Programs (Department) by BAE Systems on behalf of the Radford Army Ammunitions Plant (RFAAP).

It appears that no new targeted constituents were detected during the groundwater monitoring activities conducted during the Second Quarter of 2016 for HWMUs 5. However, total cobalt was detected in Point of Compliance (POC) monitoring wells 16WC1B and 16WC9 at concentrations of 35 micrograms per liter (ug/L) and 5.5 ug/L, respectively. These concentrations are greater than the Groundwater Protection Standard (GPS) of 5 ug/L for total cobalt for this unit. RAAP had previously submitted an Alternate Source Demonstration (ASD) to the Department indicating that the detections of cobalt in this well were due to natural variation. As the report points out, the Department requested a minimum of one year of additional monitoring of this well prior to making a decision on this ASD request. Further, tetrahydrofuran and cyanide were detected in POC monitoring well 16WC8 and tetrahydrofuran, vinyl chloride, and cyanide were detected in POC monitoring well 16WC1A.

Tetrahydrofuran was detected in the verification sample from 16WC1A at an estimated concentration of 2.2 ug/l, which is greater than the detection limit of 2.0 ug/1; therefore, the original estimated tetrahydrofuran concentration of 4.6 ug/1was confirmed. A Class 1 Permit Modification to add tetrahyrofuran to the Groundwater Compliance Monitoring List for the Unit is required. The Department concurs with RFAAP that the background value for tetrahydrofuran is the permit specified QL of 25 ug/l and that the Groundwater Protection Standard (GPS) be the May 2016 USEPA Regional Screening Level (RSL) of 3,400 ug/l since there is no USEPA Maximum Contaminant Level (MCL) or VDEQ Alternate Concentration Limit (ACL) for tetrahydrofuran.

On June 16, 2016, verification samples were collected from HWMU-16 POC monitoring well 16MW9 to confirm or refute the initial sampling results of cobalt at concentrations greater than the unit specific GPS of 5 ug/L. Total cobalt was detected at concentrations greater than the GPS during the verification sampling. The Department understands that for confirmation, a split sample and split sample duplicate were collected and sent to different laboratories to verify the initial detection. The sample and sample duplicate result concentrations from Test America, the primary laboratory, were 4.7 ug/1 and 4.8 ug/l, respectively, which are less than the GPS of 5 ug/1. The split sample and split sample duplicate result concentrations from Eurofins were 5.6 ug/l and 6.0 ug/l, respectively, which are greater than the GPS of 5 ug/l. The Department respectfully disagrees with the Facility and considers this a confirmed detection.

RFAAP should continue to collect data as previously discussed for the Alternate Source Demonstration (ASD) for the cobalt detected above the applicable Groundwater Protection Standard in point of compliance well 16WC1B at HWMU-16 and now 16MW9.

As previously discussed, the Department acknowledges the presence of barium above the site-specific background concentration. The Department recognizes the variability of the lithology in the area of HWMU-16 that could potentially account for the natural variation of this trace element. No further investigation is required at this time; however, the Department may request further investigation if the barium levels in groundwater increase in the future.

EPA ID#: VA1210020730
Radford Army Ammunitions Plant
Radford, Virginia
July 19, 2016

If you have any additional technical questions, you may contact me at 703-583-3825 or by email at Kurt.Kochan@deq.virginia.gov.

Sincerely,

Kurt W. Kochan
Corrective Action Project Manager
Office of Remediation Programs

cc: RFAAP Correspondence File
Brett Fisher, VDEQ-CO
Russ McAvoy, VDEQ-CO
Cassie McGoldrick, EPA Region 3
Jim McKenna, ACO Staff
Matt Albers, BAE
Aziz Farahmand, VDEQ-BRRO
Mike Lawless, DAA

APPENDIX C
LABORATORY ANALYTICAL RESULTS – YEAR 2019
Submitted as separate file due to file size

APPENDIX D

FIELD NOTES

- Weather - Overcast & 50°-60°s
- PPE - Nitrile gloves & eye protection
- Calibrations - YSI Pro Plus / DO% = 98.3 %
  pH: 4.00 = 4.00, 7.00 = 7.00, 10.00 = 10.00
  Conductivity reads 1413 μs in a 1413 μs standard
  HACH 2100P Turbidimeter = Range - 0.02 - 1000 NTU
- Dedicated well skirts & tubing used at each well.
- All equipment decon'ed before & after event and between use at each sample location.
- All purge water collected & disposed at dedicated on site location.
- All samples collected, transported & stored on ice in coolers.
- Sample collection order = 8260C, 8270D & TM
- All wells purged and sampled at 0.25 L/min.

Sample Analysis	Preservative
8260C	HCL
8270D	—
TM	HNO_3

- VOAs collected from one pulse from bladder pump.
- Bladder pump settings @ 4 cycles/min: 5 sec. discharge / 10 sec. re-charge.

STATIC WATER LEVEL TABLE (UNIT-5)

WELL	DTW	P/P DTW	NOTES	WELL	DTW	~~P/P DTW~~	NOTES
5W8B	14.80	—		5W10A	12.38		
5W12A	10.94	10.98		5W11A	9.59		
5W7B	9.45 ✓	9.45	SIGN NOT ATTACHED	5WCA	12.31		NO SIGN
5W5B	8.43 ✓	8.57	SIGN NOT ATTACHED	5WC11	15.72		
5WC21	8.77	8.82		5WC12	16.12		
5WC22	8.65	8.67		S5W5	7.81		
5WC23	8.02	8.06		S5W6	6.25		
SWL'S ONLY				S5W7	11.55		
5W9A	0.02	—		S5W8	11.92		

Confidence Solution (YSI 5580) Parameters - Taken on YSI Pro Plus meter

Temp (°C)	Cond (μs)	*ORP (mv)	pH
16.2	7848	450.7	6.81

*ORP out of range

5W8B

DTW: 14.80

CB Setting: 20 psi

Begin Purge: (0854)

Initial Purge - CLEAR

POST PURGE DTW: *

(TIME)	Temp (C)	Cond (us)	DO mg/L	pH	ORP (mV)	TURB (NTU)	DTW	Desc.
(0855)	14.7	65.3	3.98	4.70	499.1	3.47	*	Clear
(0900)	14.6	64.9	3.98	4.69	489.1	3.26		Clear
(0905)	14.5	65.0	4.04	4.71	485.7	2.46		Clear
(0910)	14.6	64.8	3.96	4.70	483.7	2.32		Clear
(0915)	14.6	64.9	4.12	4.69	482.9	3.03		Clear
(0920)	14.7	65.1	4.11	4.71	481.7	3.42		Clear
(0920)	Readings Stable							
(0930)	14.7	65.0	4.57	4.71	484.1	4.25		Clear

* SWL METER NOT OPER CORRECTLY/UNABLE TO READ DTW. NWC 4-25-19

Sample Time (0925)

Samples Collected: (3) 8260C, (1) TM

5W12A

DTW: 10.94

CB Setting: 20 psi

Begin purge (0944)

Initial purge clear

post purge DTW: 10.98

(Time)	Temp (C)	Cond (us)	DO mg/L	pH	ORP (mV)	Turb (NTU)	DTW	Desc.
(0945)	13.9	509.3	3.29	6.27	421.0	1.92	11.08	Clear
(0950)	14.1	519.9	2.39	6.40	422.5	1.96	11.75	Clear
(0955)	14.1	521.7	2.32	6.47	425.1	2.00	11.02	Clear
(1000)	14.1	522.2	2.30	6.49	425.7	1.62	11.03	Clear
(1005)	14.1	522.3	2.25	6.50	428.1	1.36	10.97	Clear
(1010)	14.1	522.3	2.25	6.55	424.4	1.23	10.99	Clear
(1010)	Readings Stable							
(1020)	14.1	522.1	2.17	6.56	420.5	~~1.4~~ 1.41	10.98	Clear

Sample Time (1015)

Samples Collected: (3) 8260C, (1) TM

*Calibration Addendum (7/26/19 - KJC)

YSI 5580 Confidence Solution

TEMP (°C) RANGE	SP. COND (us/cm)	ORP (mV)	pH
16-20	7630-7970	222-252	6.8-7.2

4/09/19

RFAAP (Unit-5)
B03204-19A
KFC/GMS

5W7B

DTW: 9.45
Post purge DTW: 9.45

[CB setting: 15 psi]

Begin purge (1028)
Initial purge Clear

(Time)	Temp(°C)	Cond(ms)	DO(mg/L)	pH	ORP(mv)	Turb (NTU)	DTW	Desc
(1030)	11.4	214.0	4.51	4.47	505.5	1.23	10.03	Clear
(1035)	11.5	142.2	5.91	4.88	482.8	1.49	9.45	Clear
(1040)	11.6	141.5	5.90	4.84	483.4	1.43	9.38	Clear
(1045)	11.6	140.9	6.15	4.85	483.6	1.22	9.41	Clear
(1050)	12.1	140.2	5.94	4.87	484.6	1.34	9.59	Clear
(1055)	12.1	139.8	5.95	4.87	485.5	1.47	9.45	Clear

(1055) Readings stable

Sample Time (1100)

Samples Collected: (4) 8260, (3) TM, (2) 8270D

(1115)	13.7	141.8	6.05	4.89	489.5	1.70	9.45	Clear

5W5B

DTW: 8.43
Post purge DTW: 8.57

[CB setting: 15 psi]

Begin purge (1126)
Initial purge Clear

(Time)	Temp(°C)	Cond(ms)	DO(mg/L)	pH	ORP(mv)	Turb (NTU)	DTW	Desc.
(1130)	12.5	353.0	3.27	5.15	478.7	1.32	8.65	Clear
(1135)	12.3	354.7	3.46	5.12	474.8	1.33	8.66	Clear
(1140)	12.6	355.7	3.48	5.12	472.1	1.26	8.70	Clear
(1145)	12.6	355.9	3.40	5.12	471.4	1.29	8.59	Clear
(1150)	12.4	355.8	3.41	5.10	471.5	1.52	8.58	Clear
(1155)	12.4	355.8	3.35	5.11	471.6	1.23	8.60	Clear

(1155) Readings stable

Sample Time (1200)

Samples Collected: (3) 8260, (1) TM, (4) 8270D

(1205)	13.8	355.7	3.39	5.20	466.7	1.62	8.57	Clear

4/09/19 RFAAP (Unit-5) F.R. #13

B083204-19A
KFE/GMS

5WC22

DTW: 8.65 [CB Setting: 23 PSI] Begin purge (1219)

Post purge DTW: 8.67 Initial purge: Clear

(Time)	Temp(C)	Cond(ms)	DO(mg)	pH	ORP(mV)	Turb (NTU)	DTW	Desc
(1220)	13.2	1119	1.65	6.42	434.1	1.69	8.65	Clear
(1225)	13.6	1074	1.42	6.39	433.7	1.54	8.71	Clear
(1230)	13.6	1064	1.54	6.38	431.8	1.56	8.66	Clear
(1235)	13.7	1063	1.52	6.38	430.7	1.50	8.68	Clear
(1240)	13.7	1064	1.53	6.37	430.9	1.35	8.68	Clear
(1245)	13.8	1065	1.51	6.38	430.8	1.36	8.67	Clear
(1245)		Readings stable						
(1255)	14.0	1069	1.36	6.41	429.3	1.36	8.67	Clear

Sample Time (1250)

Samples Collected: (3) 8260, (1) TM, (4) 8270D

5WC23

DTW: 8.02 [CB Setting: 28 PSI] Begin purge (1254)

Post purge DTW: 8.06 Initial purge: Clear

(Time)	Temp(C)	Cond(ms)	DO(mg)	pH	ORP(mV)	Turb (NTU)	DTW	Desc.
(1300)	11.5	1153	4.57	6.44	427.4	1.22	8.05	Clear
(1305)	12.7	1210	1.90	6.44	434.2	1.29	8.05	Clear
(1310)	12.7	1197	1.76	6.42	433.7	1.28	8.05	Clear
(1315)	12.8	1179	1.74	6.42	432.3	1.16	8.05	Clear
(1320)	13.0	1170	1.79	6.42	432.3	1.29	8.05	Clear
(1325)	12.9	1163	1.80	6.41	431.0	1.29	8.05	Clear
(1325)		Readings stable						
(1335)	13.2	1163	1.82	6.45	430.2	1.47	8.06	Clear

Sample Time (1330)

Samples Collected: (3) 8260, (1) TM, (4) 8270D

4/09/19 RFAAP(Unit-5) FB#13
B03204-19A
KFL/GMS

SWC21

DTW: 8.77

Post purge DTW: 8.82

[CB Setting: 20 PSI]

Begin purge (1341)
Initial purge: Clear

(Time)	Temp(c)	Cond(us)	DO(mg)	pH	ORP(mv)	Turb (NTU)	DTW	Desc.
(1345)	14.3	817	1.13	5.54	461.0	4.37	8.79	Clear
(1350)	14.3	758	0.64	5.28	461.6	3.25	8.85	Clear
(1355)	14.3	753	0.61	5.26	460.9	3.05	8.82	Clear
(1400)	14.5	744	0.54	5.24	457.7	3.45	8.83	Clear
(1405)	14.6	738	0.54	5.23	455.8	2.77	8.81	Clear
(1410)	14.6	734	0.56	5.22	453.6	2.68	8.82	Clear
(1410)	Readings Stable							
(1430)	15.5	731	1.29	5.30	449.6	2.63	8.82	Clear

Sample Time (1415)

Samples Collected: (3) 8260, (1) TM, (4) 8270D

SWDUP (taken from SWC21)

Sample Time (1425)

Samples Collected: (3) 8260, (1) TM, (4) 8270D

APPROVED BY AH

DATE 9/24/19

10/23/19 RFAAP (UNIT-5) F.B. #14
B03204-19KT
KFC/

General Notes
- Weather: Sunny & 50°-60°'s
- PPE - Nitrile gloves, eye protection & steel toe boots
- Calibrations: YSI Pro Plus / DO% = 94.3 %
pH: 4.00 = 4.00, 7.00 = 7.00 10.00 = 10.00 %
Conductivity reads 1413 $\frac{cm}{ms}$ in a 1413 $\frac{cm}{ms}$ std.
HACH 2100Q Turbidimeter: 0.02-1000 NTU
- Dedicated well skirts & tubing used at each well.
- All equipment decon'ed before & after event and between use at each sample location.
- All purge water collected & disposed at dedicated on-site location.
- All Samples collected, transported & stored on ice in coolers.
- Sample collection order: 8260C, TM.
- All wells purged and sampled at 0.25 L/min
- All DTW's measured in feet.

Sample Analysis	Preservative
8260C	HCL
TM	HNO_3

- VOAs collected from one pulse from bladder pump.
- Bladder pump settings @ 4 cycles/min: 5 sec. discharge/10 sec. recharge

STATIC WATER LEVEL TABLE (UNIT-5)

WELL	DTW	P/PDTW	NOTE	WELL	DTW	P/PDTW	NOTE
SW8B	15.79	16.54		SW10A	14.61		
SW12A	12.38	12.41		SW11A	13.17		
SW7B	10.32	10.39		SWCA	12.92		
SW5B	9.94	9.78		SWC11	16.00		
SWC21	9.54	9.58		SWC12	16.34		
SWC22	~~9.54~~ 9.43	9.49		SSW5	8.89		
SWC23	8.82	8.86		SSW6	6.91		
	SWL's ONLY			SSW7	11.91		
SW9A	1.49			SSW8	12.00		

Confidence Solution Parameter (END OF DAY)

Temp(C)/Range	Cond $\frac{cm}{ms}$/Range	ORP(mv)/Range	pH/Range
14.8 / 11-15	7790 / 7600-7970	213 / 229-261	7.18 / 6.8-7.2

Lot # 19C1L Date Opened 10/23/19 (40)

SW8B

DTW - 15.79

Post purge DTW - 16.54

CB Setting 25 psi

Begin Purge (1252)

Initial Purge - Clear

Time	Temp (C)	Cond (uS/cm)	DO (mg/L)	pH	TURB (NTU)	ORP (mV)	DTW	Desc.
(1255)	16.2	61.4	3.48	4.95	0.47	276.4	16.52	Clear
(1300)	16.3	61.2	3.31	4.93	0.64	304.2	16.55	Clear
(1305)	16.4	60.9	3.31	4.92	0.42	316.9	16.52	Clear
(1310)	16.4	60.8	3.29	4.91	0.55	324.0	16.65	Clear
(1315)	16.4	60.7	3.28	4.92	0.79	329.4	16.63	Clear
(1320)	16.5	60.9	3.32	4.92	0.64	332.4	16.59	Clear
(1320)	Readings Stable							
(1326)	16.5	61.3	3.39	4.88	0.71	333.3	16.54	Clear

Sample Time (1325)

Samples Collected: (3) 8260C, (1) TM

SW12A

DTW: 12.38

Post Purge DTW: 12.41

CB Setting: 20 PSI

Begin purge (1334)

Initial purge: Clear

Time	Temp (C)	Cond (uS/cm)	DO (mg/L)	pH	Turb (NTU)	ORP (mV)	DTW	Desc
(1335)	15.0	537.0	2.84	6.82	0.62	276.1	12.39	Clear
(1340)	14.7	550.8	1.39	6.83	0.68	264.2	12.38	Clear
(1345)	14.6	551.2	1.25	6.83	0.43	251.2	12.41	Clear
(1350)	14.6	551.6	1.19	6.84	0.48	242.5	12.41	Clear
(1355)	14.6	550.4	1.21	6.84	1.67	234.7	12.41	Clear
(1400)	14.7	547.9	1.23	6.84	6.86	230.3	12.40	Clear
(1400)	Readings Stable							
(1408)	14.8	550.4	1.28	6.84	5.75	228.2	12.41	Clear

Sample Time (1405)

Samples Collected: (3) 8260C, (1) TM

10/24/19 RFAAAP (UNIT-5) B03204-19A KFC/15m F.B.#14

General Notes

- Weather - clear, early morning fog, 30°-50°'s
- PPE - Nitrile gloves, eye protection and steel toe boots
- Calibrations - YSI Pro Plus / DO% = 99.9 %

pH: 4.00 = 4.00, 7.00 = 7.00, 10.00 = 10.00

- Conductivity reads 1413 us/cm in a 1413 us/cm standard

HACH 2100Q Turbidimeter: Range 0.02-1000 ntu

- All DTW's measured in feet

* Please see page 40 for specific Unit-5 field book note details.

Confidence Solution (YSI-Pro Plus)

Temp(°C)/Range	Cond(us/cm)/Range	ORP(mv)/Range	pH/Range
7.4 / 5-10	7747 / 7600-7950	223 / 238-268	7.19 / 6.8-7.2

5W7B

DTW: 10.32

CB Settings: 16 psi

Begin Purge (0839)

POST PURGE DTW: 10.39

Initial Purge - CLEAR

TIME	Temp(°C)	Cond(us/cm)	DO mg/L	pH	ORP(mv)	TURB (NTU)	DTW	Desc.
(0840)	15.4	177.0	2.81	5.17	235	0.21	10.32	Clr.
(0845)	15.2	181.4	2.55	5.09	221	0.26	10.37	Clr.
(0850)	15.5	180.1	2.60	5.07	250	0.29	10.39	clr
(0855)	15.5	181.2	2.55	5.04	259	0.50	10.39	clr
(0900)	15.5	180.2	2.58	5.03	267	0.42	10.34	clr
(0905)	15.5	181.7	2.58	5.01	277	0.59	10.37	clr
(0905)	Readings stable							
(0913)	15.3	183.5	2.58	5.00	284	0.63	10.39	Clear

Sample Time (0910)

Samples Collected: (9) 8260C, (3) TM

* POST Confidence Solution (Myron L) Beginning of DAY

Temp(°C)/Range	Cond(us/cm)/Range	ORP(mv)/Range	pH/Range
19.0 / 16-20	7668 / 7630-7970	244 / 222-252	7.01 / 6.8-7.2

(END OF DAY) * Confidence Solution (Myron L)

Temp(°C)/Range	Cond(us/cm)/Range	ORP(mv)/Range	pH/Range
7.2 / 5-10	7613 / 7600-7950	265 / 238-268	6.83 / 6.8-7.2

10/24/19 RAAP (UNIT-5) B03204-19IA KJFC/TSM F.B.#14

5WSB

DTW: 9.94

CB Setting 15 psi

Post Purge DTW: 9.78

Begin Purge (0924)

Initial Purge: Clear

Time	Temp °C	Cond (mS/cm)	DO mg/L	PH	ORP (mv)	Turb (NTU)	DTW	Desc
(0925)	15.1	298.8	6.51	5.60	279	0.58	9.81	Clear
(0930)	15.6	280.6	6.50	5.57	278	0.63	9.85	Clear
(0935)	15.8	272.9	6.49	5.57	281	0.97	10.00	Clear
(0940)	15.9	276.1	6.46	5.58	283	1.11	10.01	Clear
(0945)	15.9	278.5	6.39	5.58	286	0.75	10.00	Clear
(0950)	15.9	280.6	6.32	5.58	289	0.70	10.02	Clear
(0950)	Readings Stable							
(0957)	15.7	281.6	6.31	5.58	292	0.65	~~10.73~~ 9.78 (TSM)	Clear

Sample Time (0955)

Samples Collected: (3)8260C, (1)TM

5WC22

DTW: 9.43

CB Setting 22 psi

Post Purge DTW: 9.49

Begin Purge (1004)

Initial Purge: Clear

Time	Temp °C	Cond (mS/cm)	DO mg/L	PH	ORP (mv)	Turb (NTU)	DTW	Desc
(1005)	14.7	1028	2.44	6.81	301	0.32	9.46	Clear
(1010)	14.2	996	1.64	6.79	273	0.43	10.49	Clear
(1015)	14.2	977	1.46	6.78	264	1.09	9.46	Clear
(1020)	14.3	974	1.23	6.78	262	0.65	9.47	Clear
(1025)	14.4	975	1.06	6.78	255	0.61	9.46	Clear
(1030)	14.5	981	0.96	6.79	248	0.68	9.46	Clear
(1035)	14.6	983	0.36	6.78	244	0.56	9.48	Clear
(1040)	14.5	985	0.22	6.79	239	1.56	9.49	Clear
(1043)	14.5	986	0.19	6.79	235	0.49	9.49	Clear
(1046)	14.6	989	0.17	6.79	235	0.45	9.49	Clear
(1048)	Readings Stable							
(1053)	14.6	992	0.20	6.82	232	0.63	9.49	Clear

Sample Time (1050)

Samples Collected: (3)8260C, (1)TM

10/24/19 RFAAP (UNIT-5) B03204-19A KFC/ISM F.B #1

SWC2-3 CBS-28

DTW: 8.82 Begin Purge (1056)

Post Purge DTW: 8.86 Initial Purge: clear

Time	Temp °C	Cond (µS/cm)	DO mg/L	PH	ORP	Turb (NTU)	DTW	Desc
(1100)	14.7	1183	1.75	7.00	234	0.40	8.86	clear
(1105)	14.7	1199	2.33	6.95	232	0.85	8.86	clear
(1110)	14.6	1188	1.15	6.95	227	0.68	8.86	clear
(1115)	14.6	1181	~~3.19~~ 1.19	6.91	226	0.38	8.86	clear
(1120)	14.6	1176	1.14 1.14	6.94	224	0.85	8.86	clear
(1125)	14.7	1177	1.13	6.98	222	0.51	8.86	clear
(1125)	Readings stable							
(1133)	14.7	1170	1.21	6.94	214	1.25	8.86	clear

Sample Time (1130)

Samples Collected: (3) 8260C, (1) TM

SWC2-1 CBS: 20

DTW: 9.54

Post Purge DTW: 9.58 Begin Purge (1134)

Initial Purge: Clear

Time	Temp °C	Cond (µS/cm)	DO mg/L	PH	ORP	Turb (NTU)	DTW	Desc
(1135)	14.5	830	1.81	6.21	210	5.00	9.56	clear
(1140)	14.4	812	1.32	6.11	222	3.92	9.57	clear
(1145)	14.4	785	1.30	6.03	229	3.43	9.58	clear
(1150)	14.4	768	1.22	5.97	228	2.24	9.58	clear
(1155)	14.5	759	1.20	5.95	233	2.34	9.58	clear
(1200)	14.5	759	1.19	5.94	231	1.96	9.58	clear
(1200)	Readings stable							
(1212)	14.6	756	1.84	5.94	226	2.45	9.58	clear

Sample Time (1205)

Samples Collected: (3) 8260C, (1) TM

SWDup-

Sample Time (1210)

Samples collected: (3) 8260C, (1) TM

#H 10/29/19 RFAAP (UNIT-5)/B03204-19A/KFC/USM F.B# 14

(End of Day) Post Conference Solutions (YSI)

Temp (C)/Range	Conductivity/Range	ORP (mV)/Range	pH/Range
10.7 / 16-20	7702 / 3630-7700	213.8 / 222-252	7.11 / 6.8-7.2

APPROVED BY [signature]

DATE 11/25/19

4/10/19 RFAAP (UNIT-16) B03204-19M KFC/KLV F.B#13

General Notes
- Weather- Sunny, clear & 40°-60°s
- PPE-Nitrile gloves & eye protection
- Calibrations- YSI Pro Plus/ DO% = 92.8 %
  pH: 7.00 = 7.00, 4.00 = 4.00, 10.00 = 10.00
  HACH 2100P Turbidimeter- 0.02-1000 NTU
  Conductivity reads 1413 µs in a 1413 µs stnd.
- Dedicated well-skirts & tubing used at each well.
- All equipment deconned before & after each event and between use at each sample location.
- Purge water collected and disposed of at dedicated on-site location.
- All samples collected, stored & transported on ice in coolers.
- Sample collection order: 8260C, 8270D & TM & Cyanide
- All wells purged & sampled at 0.25 L/min.

Sample Analysis	Preservative	Sample Analysis	Preservative
8260C	HCL	TOTAL METALS	HNO_3
8270D	—	CYANIDE	NaOH

- VOA's collected from one pulse from bladder pump.
- Bladder pump setting @ 4 cycles/min. w/ 5 sec discharge 10 sec recharge.

STATIC WATER LEVEL TABLE (UNIT-16)

WELL	DTW	POST PURGE DTW	NOTES	WELL	DTW	POST PURGE DTW	NOTES
16-2	55.89	55.85		16MW9	60.16		
16-3	53.80	64.82		16C1	43.48		
16-5	4.17	14.11		SWL's ONLY			
16WC2B	49.35	63.12		16C3	57.25		
16WC1B	61.68			16CDH3	68.72 -		DRY
16WC1A	61.70			16WC2A	61.23		
16MW8	68.74	70.81		16-1	~~61.23~~ KLV 4/10/19 40.88		

Confidence Solution (YSI 5580) - Myron L Ultrameter #6257574

Temp(C)	Cond(µs)	ORP(mv)	pH
19.3	7851	233	6.99

* all parameters w/in range.

4/10/19 — RFAAP (UNIT-16) B03204-19A KFC/KLW — F.B. #13

16-5

DTW: 4.17

POST PURGE DTW: 14.11

Cont. Box Setting 30 psi

Begin Purge (0833)

Initial Purge: clear

Time	Temp(C)	Cond(ms)	DO mg/L	pH	ORP(mV)	TURB (NTU)	DTW	Desc.
(0840)	11.3	528.9	10.21	7.40	246	1.96	6.09	clear
(0845)	11.9	529.4	3.52	7.41	249	3.19	7.51	clear
(0850)	12.0	529.9	3.14	7.40	233	2.73	9.03	clear
(0855)	12.0	530.0	2.94	7.40	214	3.13	10.14	clear
(0900)	12.1	530.2	2.76	7.39	204	2.05	10.77	clear
(0905)	12.1	530.2	2.67	7.39	195	2.84	11.67	clear
(0905)	Readings Stable							
(0915)	12.2	530.5	2.37	7.38	192	2.33	14.11	clear

Sample Time (0910)

Samples Collected: (3)8260C, (2)8270D, (1)TM

16 Spring

Temp(C)	Cond(us)	Do mg/L	pH	ORP(mV)	Turb (NTU)
12.6	554.3	6.89	7.23	197	

Sample Time (0920)

Samples Collected: (3)8260C, (2)8270D, (1)TM

16WC2B

DTW: 49.35

PP DTW: 63.12

CBS = 57 psi

Begin Purge (1031)

Initial Purge: clear

Time	Temp(C)	Cond(ms)	DO mg/L	pH	ORP(mV)	Turb (NTU)	DTW	Desc.
(1035)	14.0	311.3	3.56	8.13	236	1.30	51.71	clear
(1040)	13.8	315.0	1.96	7.90	KLW ~~173~~ 152	0.92	53.35	clear
(1045)	13.8	315.2	1.75	7.88	93	1.13	55.21	clear
(1050)	13.8	315.7	1.70	7.88	83	1.06	56.77	clear
(1055)	13.7	315.9	1.69	7.87	69	1.54	58.18	clear
(1100)	13.8	315.7	1.72	7.86	54	1.17	59.78	clear
(1105)	13.9	315.9	1.73	7.86	59	1.10	62.22	clear
(1110)	13.9	316.0	1.73 ~~2.96~~ KLW	7.86	52	1.05	62.25	clear
(1110)	Readings Stable							

16MW28 cont'd

Time	Temp(°C)	Cond(µS)	DO mg/L	pH	ORP(mV)	Turb (NTU)	DTW	Desc.
(1120)	13.9	316.0	1.74	7.89	53	0.99	63.12	clear

Sample Time (1115)

Samples Collected: (3) 82600C, (2) 82700D, (1) TM

16-2

DTW: 55.89 CBS = 45psi Begin Purge (1130)

P-P DTW: 55.85 Initial Purge: clear

Time	Temp(°C)	Cond(µS)	DO mg/L	pH	ORP(mV)	Turb (NTU)	DTW	Desc.
(1135)	13.4	544.3	6.74	7.13	37	1.89	56.69	clear
(1140)	13.4	533.2	6.89	7.08	53	1.52	56.69	clear
(1145)	13.5	522.1	7.29	7.09	87	1.24	55.77	clear
(1150)	13.5	510.5	7.50	7.09	100	1.11	55.82	clear
(1155)	13.5	501.7	7.70	7.07	106	1.72	55.79	clear
(1200)	13.5	496.9	7.87	7.03	105	2.24	55.81	clear
(1200)	Readings Stable							
(1210)	13.5	491.0	7.93	7.01	92	3.33	55.85	clear

Sample Time (1205)

Samples Collected: (3) 82600C, (2) 82700D, (1) TM

16MW8

DTW: 68.74 CBS: 50 psi Begin Purge ( )

P-P DTW: 70.81 Initial Purge:

Time	Temp(°C)	Cond(µS)	DO mg/L	pH	ORP(mV)	Turb (NTU)	DTW	Desc.
(1215)	13.9	151.7	7.02	4.73	166	1.62	68.99	clear
(1220)	13.9	146.4	2.20	5.19	145	2.59	69.12	clear
(1225)	13.9	141.0	2.37	5.24	120	2.78	69.52	clear
(1230)	13.9	150.0	2.15	5.30	122	2.87	70.10	clear
(1235)	13.9	153.4	2.23	5.52	114	2.45	70.17	clear
(1240)	13.9	148.6	2.42	5.34	113	2.39	70.43	clear
(1240)	Readings Stable							
(1300)	13.9	140.2	2.50	5.38	116	2.52	70.81	clear

16MW8 cont'd

Sample Time (1248)

Samples Collected: (6) 8260C, (4) 8270D, (1) Cyanide, (1) TM

16-3 ~~16WC1B~~

DTW: 61.68 | CBS: 40 psi | Begin Purge (1305)

P-P DTW: 64.82 | Initial Purge: clear

Time	Temp(°C)	Cond(uS)	DO mg/L	pH	ORP(mV)	Turb (NTU)	DTW	Desc.
(1305)	14.0	245.9	9.25	7.74	84	1.22	55.02	clear
(1310)	14.0	248.0	9.62	7.93	17	1.64	58.28	clear
(1315)	14.0	247.6	9.40	7.99	23	1.49	60.25	clear
(1320)	14.0	246.9	9.66	8.01	40	1.24	61.30	clear
(1325)	14.0	246.2	9.84	8.00	47	149	61.96	clear
(1330)	14.0	244.8	10.24	7.92	44	1.45	62.89	clear
(1330)	Readings Stable							
(1340)	14.0	245.0	10.23	7.89	56	1.89	64.82	clear

Sample Time (1335)

Samples Collected: (3) 8260C, (2) 8270D, (1) TM

4/11/19 RFAAP (UNIT-16) 303204.19A KFC/GMS F.B.#13

General Notes:
- Weather - Mostly sunny, 50's 60's
- PPE - Nitrile gloves & eye protection
- Calibrations - YSI Pro Plus & Myron L Ultrameter
  DO% = 93.8 %
Please refer to page 149 for Unit 16 specifics.

16WC1B
DTW: 61.68
Post purge DTW: 62.51
Control Box Setting: 45 psi
Begin Purge (0939)
Initial Purge - Clear

Time	Temp (°C)	Cond (µs)	DO (mg/L)	pH	ORP (mv)	Turb (NTU)	DTW	Desc
(0940)	13.2	387.8	5.43	6.41	294	2.20	62.39	Clear
(0945)	13.2	370.5	4.31	6.32	262	1.72	62.45	Clear
(0950)	13.4	372.5	4.13	6.33	179	1.44	62.43	Clear
(0955)	13.4	378.0	3.81	6.34	131	1.36	62.46	Clear
(1000)	13.4	384.0	3.20	6.35	110	1.32	62.47	Clear
(1005)	13.5	387.3	3.24	6.36	100	1.56	62.46	Clear
(1010)	13.5	389.2	3.32	6.37	94	1.46	62.51	Clear
(1010)	Readings stable							
(1020)	13.9	396.9	3.23	6.39	76	1.80	62.51	Clear

Sample Time (1015)
Samples Collected: (6) 8260C, (4) 8270D, (1) TM, (1) CN

16WC1A
DTW: 61.70
Post purge DTW: 63.64
CB Setting: 50psi
Begin purge (1029)
Initial purge Clear

Time	Temp (°C)	Cond (µs)	DO (mg/L)	pH	ORP (mv)	Turb (NTU)	DTW	Desc
(1030)	13.1	598.4	9.58	7.25	63	1.27	62.84	Clear
(1035)	13.5	756	5.28	6.93	142	0.64	63.47	Clear
(1040)	13.3	762	4.94	6.92	20	0.50	63.65	Clear
(1045)	13.4	779	4.88	6.71	25	0.55	63.67	Clear
(1050)	13.4	784	4.80	6.65	22	0.53	63.65	Clear
(1055)	13.5	786	4.60	6.64	23	0.64	63.63	Clear
(1055)	Readings Stable							
(1145)	13.7	795	3.50	6.62	~~22~~ 53	0.51	63.64	Clear

16WC1A Cont'd

Sample Time (1100)

Samples Collected: (18) 8260C, (12) 8270D, (3) TM, (3) CN

~~(1145)~~ BZ 4/11/19

16WDUP

Sample Time (1115)

Samples Collected: (6) 8260C, (4) 8270D, (1) TM, (1) CN

16MW-9

DTW: 60.16

Post purge DTW: 61.68

CB Setting: 45 psi

Begin purge (1153)

Initial purge: Clear

(Time)	Temp(°C)	Cond(µS)	DO(mg/L)	pH	ORP(mV)	Turb (NTU)	DTW	Desc.
(1155)	13.5	922	5.80	6.67	-6	1.04	61.23	Clear
(1200)	13.6	975	4.00	6.62	-1	0.76	61.41	Clear
(1205)	13.8	965	3.63	6.63	-3	0.72	61.46	Clear
(1210)	14.0	967	3.54	6.63	0	0.65	61.38	Clear
(1215)	13.8	969	3.34	6.64	3	0.58	61.48	Clear
(1220)	13.8	968	3.09	6.63	0	0.75	61.46	Clear
(1220)	Readings Stable							
(1230)	14.2	984	3.65	6.65	-8	0.44	61.68	Clear

Sample Time (1225)

Samples Collected: (6) 8260C, (4) 8270D, (1) TM, (1) CN

16C1

DTW: 43.48

Post purge DTW: 43.64

CB Setting: 40 psi

Begin purge (1247)

Initial purge: Clear

(Time)	Temp(°C)	Cond(µS)	DO(mg/L)	pH	ORP(mV)	Turb (NTU)	DTW	Desc.
(1250)	13.9	880	7.22	6.73	82	6.45	43.62	Clear
(1255)	14.0	897	6.35	6.72	120	1.19	43.63	Clear
(1300)	13.9	526.0	6.26	6.37	171	1.64	43.64	Clear
(1305)	13.8	465.0	~~464.0~~ 5.90	6.30	217	1.19	43.64	Clear
(1310)	13.9	460.0	5.62	6.29	226	1.10	43.63	Clear
(1315)	13.8	464.7	5.47	6.30	236	0.85	43.65	Clear

1CC1 Cont'd

(1315) Readings stable

(Time)	~~Temp Cond~~ DS	DO (mg/L)	pH	ORP (mV)	Turb (NTU)	DTW	Desc
(1325)	13.9 4934	5.14	6.34	278	0.80	43.64	Clear

Sample time (1320)

Samples Collected: (6) 8260c, (4) 8270D, (1) TM, (1) CN

General Notes:

- Weather - Mostly sunny; 60°-80°s
- PPE - Nitrile gloves, steel toe boots, eye protection and safety vests.
- Calibrations - YSI Pro Plus / DO% = 100.0

  pH: 4.00 = 4.00 7.00 = 7.00 10.00 = 10.00

  Conductivity reads 1413 µs in a 1413 µs standard

  HACH 2100Q Turbidimeter: 0.02 - 1000 NTU range
- Dedicated well skirts & tubing used at each well.
- All equipment deconned before & after each event and between use at each sample location.
- All purge water collected and disposed of at dedicated on-site location.
- All samples collected, stored & transported on ice in coolers.
- Sample order collection: 8260C & TM
- All wells purged & sampled at 0.25 L/min

Sample Analysis	Preservative
8260C	HCL
TOTAL METALS	HNO_3

- VOA's collected from one pulse from bladder pump.
- Bladder pump setting @ 4 cycles/min w/ 5 sec. discharge 10 sec. recharge

16MW8

DTW: 72.22 CBS: 45 Begin Purge: 0848

POST PURGE DTW - 74.74 Initial Purge - CLEAR

TIME	Temp (°C)	Cond (µs)	DO mg/L	pH	ORP (mv)	TURB (NTU)	DTW	Desc
(0850)	15.0	118.5	1.60	4.33	486.6	8.19	72.68	clear
(0855)	14.9	87.8	0.32	4.57	446.9	1.08	73.12	Clear
(0900)	14.8	89.4	0.31	4.76	442.4	1.17	73.26	Clear
(0905)	14.7	93.9	0.28	4.82	451.8	0.97	73.69	clear
(0910)	14.6	93.3	0.24	4.86	432.0	0.99	74.03	clear
(0915)	14.5	95.6	0.22	4.80	428.1	0.93	74.33	clear
(0915)	~~wet~~ Readings Stable							
~~(0927)~~	~~14.8~~	~~109.7~~	~~0.21~~	~~4.83~~	~~429.8~~	0.97	74.81	Clear

Sample Time (0920)

Samples Collected: 2 (TM)

16MW8 Dup - Sample Time (0925) (1) TM

4 6/25/19 ~~16MW~~ (initialed 6/25/19) RFAAP (HMLT-16) B03204-19A F.B.#14

16WCIA -

DTW: 67.11

CBS: 45

Begin Purge: 0934

Post Purge DTW: 67.79

Initial Purge: clear

Time	Temp °C	Cond (mS)	DO mg/%	PH	ORP (mV)	Turb (NTU)	DTW	Desc
(0935)	14.6	601	2.61	6.18	412.9	0.75	67.19	clear
(0940)	14.4	596	1.52	6.39	416.5	0.54	67.61	clear
(0945)	14.3	596	1.40	6.52	408.6	0.59	67.71	clear
(0950)	14.3	619	1.22	6.51	345.6	0.51	67.85	clear
(0955)	14.2	629	1.27	6.51	237.4	0.43	67.81	clear
(1000)	14.2	631	1.21	6.52	219.2	0.40	67.80	clear
(1005)	14.3	634	1.21	6.54	205.6	0.44	67.81	clear
(1010)	14.1	631	1.08	6.54	201.6	0.60	67.86	clear
(1015)	14.2	633	0.99	6.55	198.3	0.79	67.84	clear
(1020)	14.1	636	1.07	6.56	195.6	0.46	67.84	clear
(1020)	Readings stable							
(1032)	14.6	644	0.98	6.63	191.7	0.63	67.79	clear

Sample Time: (1025)

Samples Collected: (6) 8260D

16WCIA Dup - Sample Time (1030) (3) 8260D

AT 9/24/19

10/22/19 RFAAP (UNIT-16) F.B#14
BO3204-19A
KFC/GMS

General Notes

- Weather - Rainy, 60°F
- PPE - Nitrile gloves, eye protection & steel toed boots
- Cal. bvattans - YSI ProPlus / DO% = 93.2%
  - pH: 4.00 = 4.00, 7.00 = 7.00, 10.00 = 10.00
  - Conductivity reads 1413 $\frac{\mu m}{ms}$ in 1413 $\frac{\mu m}{ms}$ stnd.
  - HACH 2100Q Turbidimeter: 0.02-1000 NTU
- Dedicated well skirts & tubing used at each well.
- All equipment decon'ed before & after event and between use at each sample location.
- All purge water collected & disposed at dedicated on-site location.
- All samples collected, transported & stored on ice in coolers.
- Sample collection order: 8260C, 8270D & TM
- All wells purged and sampled at 0.25 L/min.
- All DTW's measured in feet.

Sample Analysis	Preservative
8260C	HCL
8270D	—
Total Metals	HNO_3

- VOA's collected from one pulse from bladder pump.
- Bladder pump setting @ 4 cycles/min. 5 sec. discharge/10 sec. recharge
- Confidence Solution (YSI 5580) Parameters

Temp (°C)/Range	Cond ($\frac{\mu m}{ms}$)/Range	ORP (mv)/Range	pH/Range
11.8/11-15	7677/7600-7970	232/229-261	7.02/6.8-7.2

STATIC WATER LEVEL TABLE

WELL	DTW	P/P DTW	NOTES	WELL	DTW	P/P DTW	NOTES
16-2	56.75	56.03		16MW9	67.35	67.53	
16-3	56.53	65.11		16C1	49.32	50.12	
16-5	4.85	12.01		SWLs Only			
16WC2B	55.15	67.02		16C3	Dry		
16WC1B	70.88	71.59		16CDH3	Dry		
16WC1A	71.48	71.13		16WC2A	Dry at 61.95		
16MW8	75.28	T.O.P.		16-1	48.12		

10/22/19 RFAAP (UNIT-16) B03204-19A KFC/CIMS F.B #14

16-5

DTW: 4.85

Post Purge DTW: 12.01

CB Setting 30 psi

Begin Purge (1004)

Initial Purge - Clear

TIME	Temp (C)	Cond (µS/cm)	DO (mg/L)	pH	ORP (mV)	TURB (NTU)	DTW	Desc.
(1005)	14.6	524.3	4.90	7.60	-159.1	0.78	5.41	Clear
(1010)	13.9	522.6	3.01	7.46	-134.1	0.79	6.29	Clear
(1015)	13.8	520.6	2.79	7.37	-83.3	2.43	7.58	Clear
(1020)	13.8	519.3	2.76	7.35	-90.5	0.45	9.03	Clear
(1025)	13.8	518.3	2.70	7.34	-94.6	0.49	10.48	Clear
(1030)	13.8	517.6	2.71	7.35	-86.9	0.44	11.63	Clear
(1030)	Readings Stable							
(1038)	13.9	517.3	2.70	7.31	-94.3	0.72	12.01	Clear

Sample Time (1035) / Samples Collected: (3) 8260L, (2) 8270D, (1) TM

16 Spring

Temp (C)	Cond (µS/cm)	DO (mg/L)	pH	ORP (mV)	Turb (NTU)
14.2	570.0	6.70	7.29	-83.6	3.62

Sample Time (1045)

Samples Collected: (3) 8260L, (2) 8270D, (1) TM

purge 8-7.2

16WC2B

CB Setting: 55 psi

DTW: 55.15

Post Purge DTW: 67.02

Begin Purge (1055)

Initial Purge: Clear

Time	Temp (C)	Cond (µS/cm)	DO (mg/L)	pH	ORP (mV)	Turb (NTU)	DTW	Desc.
(1100)	14.3	318.1	2.40	8.01	-159.2	0.89	56.70	Clear
(1105)	13.9	322.1	0.55	7.99	-156.5	0.70	56.40	Clear
(1110)	13.9	323.2	0.51	7.63	-109.6	0.30	60.83	Clear
(1115)	13.9	323.3	0.56	7.84	-90.7	0.66	62.79	Clear
(1120)	13.9	322.9	0.63	7.86	-103.4	0.42	64.11	Clear
(1125)	13.8	322.4	0.71	7.88	-103.4	0.51	62.30	Clear
(1130)	13.8	323.6	0.79	7.78	-102.1	0.71	67.02	Clear
(1130)	Readings Stable					0.38		
(1138)	13.9	323.6	0.83	7.78	-67.9	0.38	67.99	Clear

Sample Time (1135) / Samples Collected: (3) 8260L, (2) 8270D, (1) TM

10/22/19 RFAAP (UNIT-16) B032-19A KFC/AMJ F.B.T4

16-2

DTW: 56.75

Post Purge DTW: 56.03

CB Setting	Begin Purge (1148)
40 psi	Initial Purge - Clear

TIME	Temp (°C)	Cond (µS/cm)	DO (mg/L)	pH	ORP (mV)	TURB (NTU)	DTW	Desc
(1150)	13.6	552.3	6.48	7.63	-50.4	1.48	55.90	Clr.
(1155)	13.4	583.8	6.35	7.51	-43.9	1.05	56.70	Clr.
(1200)	13.4	582.1	6.58	7.32	-42.6	1.05	56.76	Clr
(1205)	13.4	574.5	6.98	7.24	-47.6	0.52	56.81	Clr
(1210)	13.4	568.5	6.93	7.23	-57.1	0.48	56.83	Clr
(1215)	13.4	560.4	6.94	7.15	-52.6	1.36	56.01	Clr
(1215)	Readings stable							
(1223)	13.4	554.6	6.91	7.20	-49.1	0.92	56.03	Clr

Sample Time (1220)

Samples Collected: (3) 8260s, (2) 8270D, (1) TM

• VOl
• Blo
• C

This half of page left intentionally blank due to rip in page on side. KFC 10/22/19

10/22/19 RFAAP (UNIT-16) F.B # 14
BC3204-19A
KFC / GMS

16MW-8

DTW: 75.28

CB Setting:
50 psi

Post purge DTW:

Begin Purge (1234)
Initial purge Clear

Time	Temp (C)	Cond (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turb (NTU)	DTW	Desc.
(1235)	13.8	146.3	0.55	6.48	-42.3	1.10	75.48	Clear
(1240)	13.6	117.5	0.30	6.78	-57.2	4.08	75.39	Clear
(1245)	13.6	120.4	0.19	6.29	-65.5	3.95	75.83	Clear
(1250)	13.6	129.8	0.16	6.07	-46.4	2.23	Top of pump	Clear
(1255)	14.1	133.6	0.15	6.32	-80.0	2.67	"	Clear
(1300)	14.1	134.3	0.20	6.84	-80.6	4.21	"	Clear
(1305)	14.3	132.1	0.16	5.95	-23.0	11.7	"	Clear

(1310) Well purged dry.

Will return tomorrow A.M. to collect samples.
[initials] 10/22/19

Confidence Solution (End of event day)

Temp (C) / Range	Cond (mS/cm) / Range	ORP (mV) / Range	pH / Range
16.4 / 16-20	7668 / 7630-7970	205 / 222-252	7.23 / 6.8-7.2

10/23/19 RFAAP (UNIT-16) F.B. #14
180324-19A
KFC/CMS

General Notes

- Weather-
- PPE- Nitrile gloves, eye protection & steel toe boots
- Calibrations- YSI Pro Plus / DO_2 = 94.3 %
  pH: 4.00 = 4.00, 7.00 = 7.00, 10.00 = 10.00
  Conductivity reads 1413 mS/cm in a 1413 mS/cm stnd
  HACH 2100Q Turbidimeter range: 0.02 - 1000 NTU
  * Please see pg. 38 for ~~Ref~~ specific Unit-16 field book notes. All DTWs measured in feet.

CONFIDENCE SOLUTION

Temp(C)/Range	Cond mS/cm/Range	ORP(mV)/Range	pH/Range
12.1/11-15	7744/7000-7970	218.6/229-261	7.17/6.8-7.2

16MW8 - Sample Time (0820)
Samples collected: (3) 8260C, (2) 8270D-SIM(1) TM

Time	Temp °C	Cond µS/cm	DO mg/L	pH	ORP mV	TURB NTU	DTW	DESC.
(0822)	13.2	137.0	0.66	5.92	195.3	2.76	75.95	Clear

16WC1B
DTW: 70.88
Post purge DTW: 71.59

CB setting: 45 psi

Begin purge (0834)
Initial purge: Clear

Time	Temp °C	Cond mS/cm	DO mg/L	pH	ORP(mV)	TURB (NTU)	DTW	DESC.
(0835)	13.1	347.7	2.56	6.56	154.4	4.48	71.40	clear
(0840)	13.1	495.5	0.78	6.63	150.7	33.3	71.85	Clear
(0845)	13.2	454.6	0.78	6.57	143.4	83.4	71.63	Sl. Cloudy
(0850)	13.3	419.8	0.93	6.55	98.4	56.6	71.36	Sl. Cloudy
(0855)	13.3	422.2	0.73	6.53	59.0	49.9	71.48	Sl. cloudy
(0900)	13.4	424.0	0.61	6.52	42.5	31.8	71.50	Clear
(0905)	13.4	427.1	0.55	6.52	37.1	62.4	71.55	Sl. Cloudy
(0910)	13.5	431.1	0.47	6.52	23.9	27.5	71.58	Clear
(0913)	13.5	426.9	0.43	6.50	22.9	38.4	71.56	Clear
(0916)	13.5	426.0	0.42	6.50	19.1	27.8	71.59	Clear
(0916)	Readings stable							

10/23/19 RFAAA (UNIT-16) B03204-19A KFC/KMJ F.B.#14

16WC1B (Cont'd)

(0927) 13.5 423.9 0.39 6.49 15.3 21.6 71.58 Clear

Sample Time (0920)

Samples Collected: (3)8260C, (2)8270D, (1)TM

16WC1A

CB setting: 45 psi

DTW: 69.88

Post purge DTW: 71.13

Begin purge (0932)

Initial purge: Clear

Time	Temp °C	Cond mS/cm	DO mg/L	pH	ORP mV	Turb NTU	DTW	Desc.
(0935)	13.6	737	2.84	7.03	-9.4	1.23	70.77	clear
(0940)	13.5	757	0.90	7.03	-0.9	0.38	71.09	clear
(0945)	13.4	769	2.49	6.93	-34.7	0.22	71.09	clear
(0950)	13.5	796	2.23	6.80	-53.6	0.23	71.14	clear
(0955)	13.6	802	2.08	6.78	-56.1	0.22	71.15	clear
(1000)	13.5	805	2.05	6.78	-54.4	0.28	71.13	Clear

Sample Time (1005) Readings stable

Samples Collected: ~~(5)~~ (4)8260C, (6)8270D, 3(TM)

(1025) 13.4 812 0.57 6.77 -45.4 0.51 71.22 clear

16W Dup Dup taken From 16WC1A

Sample Time (1015)

Samples Collected: (3)8260C, (2)8270D, (1)TM

16MW-9

CB setting: 45 psi

DTW: 67.35

Post purge DTW: 67.53

Begin purge (1033)

Initial purge: Clear

Time	Temp °C	Cond mS/cm	DO mg/L	pH	ORP mV	Turb NTU	DTW	Desc
(1035)	13.6	953	1.23	6.71	-8.5	1.14	67.35	clear
(1040)	13.6	963	0.55	6.76	-20.3	0.49	67.51	clear
(1045)	13.7	956	0.43	6.70	-22.5	0.61	67.46	clear
(1050)	13.6	945	0.38	6.70	-21.5	0.37	67.53	clear
(1055)	13.6	938	0.34	6.70	-22.0	0.28	67.50	clear
(1100)	13.7	936	0.31	6.69	-23.2	0.25	67.50	Clear
(1100)	Readings stable							

Notes Cont'd on next page

16MW9 (Contd.)

Time	Temp °C	Cond uS/cm	DO mg/L	pH	ORP mV	Turb NTU	DTW	Desc
(1108)	13.6	932	0.35	6.69	-24.1	0.78	67.53	Clear

Sample Time (1105)

Samples Collected: (4) 8260C, (2) 8270D, (1) TM

16-3

~~Time Te~~

CB Setting 40 psi

DTW: 56.53

post purge DTW: 65.11

Begin purge (1117)

Initial purge: Clear

Time	Temp °C	Cond uS/cm	DO mg/L	pH	ORP mV	Turb NTU	DTW	Desc
(1120)	14.7	234.3	7.12	8.05	-4.9	0.67	58.82	Clear
(1125)	14.2	234.2	6.27	8.10	14.3	0.90	59.10	Clear
(1130)	14.2	233.7	6.23	8.12	23.8	1.22	61.02	Clear
(1135)	14.3	233.1	6.26	8.13	29.8	0.83	62.64	Clear
(1140)	14.3	232.6	6.23	8.14	36.0	0.59	63.34	Clear
(1145)	14.3	231.8	6.37	8.13	40.4	0.37	64.04	Clear
(1145) Readings stable								
(1153)	14.3	231.0	6.48	8.17	47.1	0.66	65.11	Clear

Sample Time (1150) / Samples Collected: (3) 8260C, (2) 8270D, (1) TM

16C1

CB Setting: 40 psi

DTW: 49.32

post purge DTW: 50.12

Begin purge (1159)

Initial purge: Clear

Time	Temp °C	Cond uS/cm	DO mg/L	pH	ORP mV	Turb NTU	DTW	Desc
(1200)	15.5	520.6	7.03	6.77	111.9	0.54	50.08	Clear
(1205)	13.7	802	1.58	6.68	96.9	0.44	50.10	Clear
(1210)	13.7	768	1.24	6.63	95.9	0.51	50.12	Clear
(1215)	13.7	704	1.17	6.55	106.1	0.43	50.12	Clear
(1220)	13.7	708	1.08	6.55	112.1	0.24	50.14	Clear
(1225)	13.7	715	1.01	6.55	115.6	0.25	50.24	Clear
(1225) Readings stable								
(1233)	13.8	715	1.15	6.54	117.7	0.46	50.12	Clear

1601 (Cont'd)

Sample Time (1230)

Samples Collected: (4) 8260C, (2) 8270D, (1) TM

APPROVED BY AT

DATE 11/26/19

APPENDIX E

CORRESPONDENCE

BAE SYSTEMS

ORDNANCE SYSTEMS INC.
Radford Army Ammunition Plant
P.O. Box 1
Radford, VA 24143
Telephone (540) 639-7631
Fax (540) 639-8588

January 28, 2019

Mr. Kurt Kochan
Office of Remediation Programs
Virginia Department of Environmental Quality
1111 East Main Street, Suite 1400
Richmond, Virginia 23218

Subject: **Status Update and Extension Request for ongoing –
Combined Cobalt Alternate Source Demonstration (ASD) Report and
Proposed Sampling and Evaluation Schedule for Cobalt ASD
Post Closure Care Permit HWMU 16
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730**

Dear Mr. Kochan:

During Fourth Quarter 2018, Radford Army Ammunition Plant (RFAAP) completed one additional year of groundwater monitoring at Hazardous Waste Management Unit 16 (HWMU-16) in support of the combined Alternate Source Demonstration (ASD) for total cobalt concentrations detected above the applicable Groundwater Protection Standard (GPS) at the Unit. RFAAP completed this additional year of monitoring for total cobalt in accordance with the schedule presented in correspondence to the Virginia Department of Environmental Quality (VDEQ) dated December 21, 2017, and as approved in electronic correspondence from the VDEQ to RFAAP dated January 9, 2018.

The combined ASD addresses total cobalt concentrations detected above the GPS of 5 ug/l in HWMU-16 point of compliance (POC) wells 16WC1A, 16WC1B, and 16MW9. Total cobalt concentrations detected in the HWMU-16 upgradient well and POC wells are summarized in Table 1 (attached); a graph of total cobalt concentrations detected in POC wells 16WC1A, 16WC1B, and 16MW9 compared with the Permit-specified GPS of 5 ug/l is presented in Figure 1 (attached). The GPS for total cobalt at HWMU-16 was revised from the former VDEQ Alternate Concentration Limit (ACL) of 313 ug/l to the calculated Unit-specific background concentration of 5 ug/l in the VDEQ-approved Class 3 Permit Modification dated September 27, 2011. Additionally, in electronic correspondence dated November 14, 2018, the VDEQ directed RFAAP to compare detected cobalt concentrations to the latest (effective January 2, 2018) ACL of 6 ug/l for cobalt. As shown in Table 1, total cobalt was detected at concentrations greater than the revised GPS of 5 ug/l in POC well 16WC1B beginning in Fourth Quarter 2013, in POC well 16WC1A beginning in Fourth Quarter 2015, and in POC well 16MW9 in Second Quarter 2016. During the recent Fourth Quarter 2018 monitoring event, total cobalt was detected at a concentration greater than the GPS of 5 ug/l and the latest VDEQ ACL of 6 ug/l in POC well 16WC1A only; total cobalt was not detected at concentrations greater than the GPS of 5 ug/l or the latest VDEQ ACL of 6 ug/l at POC wells16MW9 and 16WC1B during Fourth Quarter 2018.
Based on a review of Table 1 and Figure 1, the total cobalt data collected to-date in support of the combined ASD appear to be inconclusive. Therefore, RFAAP recommends continued monitoring for

total cobalt to further evaluate concentration trends. RFAAP requests an extension to the ASD report which is currently due First Quarter of 2019, and proposes an updated sampling and evaluation schedule as detailed below. The updated schedule is consistent with previous correspondence from the VDEQ that approved at least a minimum of one additional year of monitoring total cobalt concentrations before the revised combined ASD report is submitted.

Proposed Sampling and Evaluation Schedule for Cobalt Alternate Source Demonstration (ASD) RFAAP – HWMU 16 – 16WC1A, 16WC1B, 16MW9		
Proposed Date	**Quarter**	**Comment**
April 2019	2nd Quarter 2019	Sampling conducted as part of routine semiannual groundwater monitoring.
October 2019	4th Quarter 2019	
November 2019	4th Quarter 2019	Receipt of 4th Quarter 2019 sample results from laboratory (i.e., approximately 30 days from 4th Quarter 2019 sample collection date).
January 2020	1st Quarter 2020	Re-evaluate total cobalt data collected to-date (through 2019) and propose path forward. Path forward may include additional monitoring and evaluation, or preparation and submittal of the ASD report.

If you have any questions or concerns, please contact me at 540.639.7701 or at (jody.hawks@baesystems.com).

Sincerely,

Jody Hawks, CHMM
Sr. Environmental Specialist
BAE Systems, Ordnance Systems Inc.

Attachments:
Table 1 – HWMU 16 - SUMMARY OF TOTAL COBALT CONCENTRATIONS IN GROUNDWATER 2010-2018
Figure 1 - HWMU 16 - SUMMARY OF TOTAL COBALT CONCENTRATIONS IN GROUNDWATER 2010-2018

c:
Beth Lohman, VDEQ-BRRO
Brett Fisher, VDEQ-CO

Coordination: J. McKenna

bc: Env. File – 19-0900-017
Brett Fisher, Ashby Scott, VDEQ-CO
J. McKenna, Army Staff
Mary McCoy, BAE Staff
Jody Hawks, BAE Staff
Mike Lawless, Draper Aden Associates

Concerning the following:

CY 2018 Fourth Quarter Semiannual Monitoring Event -
Status Update and Extension Request for Cobalt Alternate Source Demonstration and
Proposed Sampling and Evaluation Schedule for Cobalt ASD
Hazardous Waste Management Unit 16 – Compliance Groundwater Monitoring
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

SIGNATURE: _____

PRINTED NAME: James H. Scott, III
TITLE: Lieutenant Colonel, US Army
Commanding

SIGNATURE: _____

PRINTED NAME: Michael Bocek
TITLE: General Manager
BAE Systems

19-0900-017
J. Hawks

From: Hawks, Jody (US) <jody.hawks@baesystems.com>
Sent: Friday, March 29, 2019 3:19 PM
To: Janet Frazier <jfrazier@daa.com>
Cc: McKenna, Jim <james.j.mckenna16.civ@mail.mil>
Subject: RE: HWMU 5 & 16 QL/DL Use Approval

Please proceed with using the proposed QLs/DLs for the upcoming GWM event.

Jody Hawks, CHMM
Sr. Environmental Engineer
BAE Systems, Inc. | OSI

T: +1 540 639 7701 | **M:** +1 540 589 7599 | **E:** jody.hawks@baesystems.com

From: Kochan, Kurt [mailto:kurt.kochan@deq.virginia.gov]
Sent: Friday, March 29, 2019 3:03 PM
To: Hawks, Jody (US)
Cc: McKenna, Jim
Subject: Re: HWMU 5 & 16 QL/DL Use Approval

Yes, thanks....you too.

On Fri, Mar 29, 2019 at 2:37 PM Hawks, Jody (US) <jody.hawks@baesystems.com> wrote:

> Thanks Kurt. Do we have permission to go ahead and utilize the proposed QLs/DLs for the upcoming GWM event while concurrently submitting the modification request? Have a great weekend.
>
> Regards,
>
> Jody Hawks, CHMM
> Sr. Environmental Engineer
> BAE Systems, Inc. | OSI

T: +1 540 639 7701 | **M:** +1 540 589 7599 | **E:** jody.hawks@baesystems.com

---

From: Kurt Kochan [mailto:kurt.kochan@deq.virginia.gov]
Sent: Friday, March 29, 2019 2:07 PM
To: Hawks, Jody (US)
Cc: McKenna, Jim
Subject: RE: HWMU 5 & 16 QL/DL Use Approval

Jody-

Thank you for the explanation. I do not have any further questions or comments. The permit mod can be sent to Ashby and copied to me. Thanks.

Kurt

From: Hawks, Jody (US) <jody.hawks@baesystems.com>
Sent: Friday, March 29, 2019 12:21 PM
To: 'Kochan, Kurt' <kurt.kochan@deq.virginia.gov>
Cc: McKenna, Jim <james.j.mckenna16.civ@mail.mil>
Subject: RE: HWMU 5 & 16 QL/DL Use Approval

Kurt –

The revised laboratory QLs/DLs resulted from EPA's recent changes to the MDL determination (40CFR Part 136) - effective on September 27, 2017, which were implemented over the last year. For 2019 GW monitoring at HWMU 5 and 16, a permit mod is needed, as required by the permit, as labs had MDL/QL increases. The higher value of the three labs typically used was proposed for the HWMU 5/16 permit mod request. A summary of each lab's 2019 QL for copper and 2019 DL for vanadium is below and reflects known lab variability. All proposed values are well below permit GPS, where applicable.

We typically use two-three qualified labs to be able to provide flexibility for the GW monitoring programs for the following reasons: (1) to meet varied analyte permit limits (2) to have a single lab analyze all metals for the specific unit/specific event (3) have a second lab in place if a verification event was required or if primary lab was unable to accept samples due to instrument breakdown or other lab issues (4) to meet permit required deliverable requirements.

Summary of 2019 QL-DL – RAAP – Current Laboratories – Copper and Vanadium

Total Copper ug/l			
LAB	**2019 Lab QL** **Quantitation Limit**	Proposed QL (HWMU 5)	Permit QL (HWMU 5)
ELLE, Lancaster, PA	40		
Shealy, Columbia, SC	5		
TestAmerica, NC - ELLE, North Canton, OH	2	40	5

Total Vanadium ug/l			
LAB	**2019 Lab DL** **Detection Limit**	Proposed DL (HWMU 5/HWMU 16)	Permit DL (HWMU 5/HWMU 16)
ELLE, Lancaster, PA	0.23		
Shealy, Columbia, SC	2.1		
TestAmerica, NC - ELLE, North Canton, OH	0.81	2.5	1

Let me know if this answers your question. Thanks.

Regards,

Jody Hawks, CHMM
Sr. Environmental Engineer
BAE Systems, Inc. | OSI

T: +1 540 639 7701 | **M:** +1 540 589 7599 | **E:** jody.hawks@baesystems.com

From: Kochan, Kurt [mailto:kurt.kochan@deq.virginia.gov]
Sent: Friday, March 29, 2019 7:19 AM
To: Hawks, Jody (US)
Subject: Re: HWMU 5 & 16 QL/DL Use Approval

Hi Jody-

One question:

What is the reason behind the increase in the QL for Copper and Vanadium?

Thanks

Kurt

On Tue, Mar 19, 2019 at 2:04 PM Hawks, Jody (US) <jody.hawks@baesystems.com> wrote:

Mr. Kochan - Regarding Permit VA1210020730, due to recent laboratory Method Detection Limit (MDL) studies, quantitation limits (QLs) and detection limits (DLs) for select analytes increased and the respective values are greater than the Permit-specified limits. As required by the Permit, RFAAP requests VDEQ's permission to utilize the following proposed QLs/DLs during the upcoming April 2019 semiannual groundwater monitoring event at HWMU-5 (Corrective Action) and HWMU-16 (Compliance Monitoring).

The revised laboratory QLs/DLs resulted from EPA's recent changes to MDL determination (40CFR Part 136). In addition to using the revised QLs/DLs in the upcoming event, RFAAP intends to submit a Class I permit modification to update select constituent QLs/DLs as detailed below in *red*. This request follows the process required by VDEQ in 2016 for similar changes to QLs/DLs and is provided in the email string below for reference if needed. The laboratories utilized in the sampling event will be accredited under the Virginia Environmental Laboratory Accreditation Program (VELAP).

Please let me know if you have any questions.

HWMU 5 – Proposed changes presented in *red*

Analyte	GPS ug/l	Permit Quantitation Limit (QL) ug/l	Proposed QL ug/l	Permit Detection Limit (DL) ug/l	Proposed DL ug/l
Antimony, Total	6	2	-	0.4	*0.5*
Copper, Total	1300	5	*40*	1	*10*
Lead, Total	15	2	*3*	0.2	*1*
Silver, Total	71	2	-	0.2	*0.3*
Vanadium, Total	63	10	-	1	*2.5*

"-" denotes no change requested

HWMU 16 – Proposed changes presented in *red*

Analyte	GPS ug/l	Background ug/l	Permit Quantitation	Proposed QL ug/l	Permit Detection	Proposed DL ug/l

			Limit (QL) ug/l		Limit (DL) ug/l	
Antimony, Total	NE	3	2	-	0.4	*0.5*
Lead, Total	15	10	2	*3*	0.2	*1*
Silver, Total	NE	0.5	2	-	0.2	*0.3*
Vanadium, Total	151	151	10	-	1	*2.5*

"-" denotes no change requested; NE denotes not established (constituent is not on semiannual groundwater compliance monitoring list)

Jody Hawks, CHMM
Sr. Environmental Engineer
BAE Systems, Inc. | OSI

T: +1 540 639 7701 | **M:** +1 540 589 7599 | **E:**jody.hawks@baesystems.com

---

From: Kochan, Kurt (DEQ) [mailto:Kurt.Kochan@deq.virginia.gov]
Sent: Tuesday, April 26, 2016 11:58 AM
To: Patton, Mark (US) <mark.patton@baesystems.com>
Cc: Stewart, Jay (US) <jay.stewart@baesystems.com>; Hendon, Bill (US) <bill.hendon@baesystems.com>; McKenna, Jim <james.j.mckenna16.civ@mail.mil>; Mike Lawless <mlawless@daa.com>; Janet Frazier <jfrazier@daa.com>; Ross Miller <rmiller@daa.com>
Subject: RE: RAAP HWMU-16 - Request to change lab for total zinc analysis - Groundwater

Mark-

As long as you can quantify results that are below the GPS for all COCs analyzed and the laboratory is VELAP certified for this analysis then I do not see issue with this. However, if the MDLs and RLs are in the permit and need to be modified to reflect the updated values, then a Class 1 would be appropriate. Please let me know if you have any questions.

Kurt

Kurt W. Kochan

Corrective Action Project Manager

Virginia Department of Environmental Quality

Office of Remediation Programs

P.O. Box 1105

Richmond, VA 23218

(703) 583-3825

From: Patton, Mark (US) [mailto:mark.patton@baesystems.com]
Sent: Wednesday, April 20, 2016 3:21 PM
To: Kochan, Kurt (DEQ)
Cc: Stewart, Jay (US); Hendon, Bill (US); McKenna, Jim; Mike Lawless (mlawless@daa.com); Janet Frazier (jfrazier@daa.com); rmiller@daa.com
Subject: RAAP HWMU-16 - Request to change lab for total zinc analysis - Groundwater

Mr. Kochan,

Permit VA1210020730. Radford Army Ammunition Plant (RFAAP) must change the laboratory that conducts total metals analysis for the upcoming semiannual Compliance groundwater monitoring event at HWMU-16. The laboratory historically performing the analysis is no longer in business. As specified in the Permit, the selected laboratory – TestAmerica Laboratories (TestAmerica) of North Canton, Ohio – will analyze the groundwater samples for total metals constituents using USEPA SW-846 Method 6020. TestAmerica can achieve the Permit-specified method detection limits (MDLs) and quantitation limits

(QLs) for all constituents except total zinc: the Permit-specified MDL and QL for total zinc are 3 ug/l and 10 ug/l, respectively, while the TestAmerica MDL and QL for total zinc are 7.3 ug/l and 20 ug/l, respectively. However, the groundwater protection standard (GPS) for total zinc at HWMU-16 is 4,700 ug/l, and the site-specific background concentration is 51 ug/l. The TestAmerica MDL of 7.3 ug/l and QL of 20 ug/l for total zinc are less than the HWMU-16 GPS and site-specific background concentration. Therefore, RFAAP requests VDEQ's permission to utilize TestAmerica to perform the total zinc analysis using USEPA SW-846 Method 6020 during the upcoming semiannual Compliance groundwater monitoring event at HWMU-16. Total zinc is monitored semiannually at HWMU-16.

Thank you

Allen Patton

BAE Systems - RFAAP

Environmental Department

Office: 540-639-8504

Cell: 540-685-3670

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Kurt W. Kochan
Corrective Action Project Manager
Virginia Department of Environmental Quality
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P.O. Box 1105
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Kurt W. Kochan
Corrective Action Project Manager
Virginia Department of Environmental Quality
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Richmond, VA 23218
(703) 583-3825

From: Kurt Kochan [mailto:kurt.kochan@deq.virginia.gov]
Sent: Thursday, April 11, 2019 9:16 AM
To: Hawks, Jody (US)
Cc: McKenna, Jim
Subject: RE: HWMU 16 Cobalt AST Ext. Rqst.

Hi Jody-

I have addressed this formally in the letter in response to the annual report for HWMUs 5 & 16. I am concurring with your recommendation to continue the ASD through 2019.

Kurt

From: Hawks, Jody (US) <jody.hawks@baesystems.com>
Sent: Monday, February 11, 2019 2:02 PM
To: kurt.kochan@deq.virginia.gov
Cc: Brett Fisher <brett.fisher@deq.virginia.gov>; Elizabeth Lohman <elizabeth.lohman@deq.virginia.gov>; Ashby.Scott@deq.virginia.gov
Subject: HWMU 16 Cobalt AST Ext. Rqst.

Mr. Kochan – Please find attached extension request concerning the Cobalt ASD Report associated with HWMU 16 at the RFAAP. Should you have any questions, please don't hesitate to contact me.

Regards,

Jody Hawks, CHMM
Sr. Environmental Specialist
BAE System - OSI
RFAAP
T: 540-639-7701 | **M:** 540-589-7599

“Strive not to be a success, but rather be of value.” ~A. Einstein

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

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Matthew J. Strickler
Secretary of Natural Resources

David K. Paylor
Director

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

April 11, 2019

Mr. Jim McKenna
Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, Virginia 24143-0100

VIA ELECTRONIC MAIL

Re: 2018 Annual Groundwater Monitoring Report for HWMUs 5 & 16
Radford Army Ammunitions Plant
Route 114, Radford, Virginia 24141
EPA ID#: VA1210020730

Dear Mr. McKenna:

This letter acknowledges the receipt and review of the 2018 Annual Groundwater Monitoring Report for HWMUs 5 & 16 dated March 2018, submitted to the Virginia Department of Environmental Quality (Department), Office of Remediation Programs (Department) by BAE Systems on behalf of the Radford Army Ammunitions Plant (RFAAP).

There reportedly no new-targeted constituents were detected during the groundwater monitoring activities conducted during the second or fourth quarters of 2018 for Hazardous Waste Management Unit (HWMU) 5. However, total cobalt was detected in point of compliance wells 16CW1A and 16MW9 during second quarter of 2018 and only in 16WC1A during the fourth quarter of 2018 at concentrations greater than the GPS of 6 ug/L.

RFAAP had previously submitted an Alternate Source Demonstration (ASD) to the Department indicating that the detections of cobalt in this well were due to natural variation. As the report points out, the Department has approved the combination of the ASD for wells 16WC1A, 16WC1B, and 16MW9. RFAAP has recommended continued monitoring of these three wells through 2019 with a revised ASD to be submitted in spring 2020. The Department concurs with this recommendation.

As previously discussed, the Department acknowledges the presence of barium above the site-specific background concentration. The Department recognizes the variability of the lithology in the area of HWMU-16 that could potentially account for the natural variation of this trace element. No further investigation is required at this time; however, the Department may request further investigation if the barium levels in groundwater increase in the future.

EPA ID#: VA1210020730
Radford Army Ammunitions Plant
Radford, Virginia
April 11, 2019

The Department concurs with the recommendation of continued monitoring at both units with no further actions being warranted at this time. If you have any additional technical questions, you may contact me at 703-583-3825 or by email at Kurt.Kochan@deq.virginia.gov.

Sincerely,

Kurt W. Kochan
Corrective Action Project Manager
Office of Remediation Programs

cc: RFAAP Correspondence File
Ashby Scott, VDEQ-CO
Beth Lohman, VDEQ-BRRO
Jody Hawks, BAE
Mike Lawless, DAA

ORDNANCE SYSTEMS INC.
Radford Army Ammunition Plant
P.O. Box 1
Radford, VA 24143
Telephone (540) 639-7631
Fax (540) 639-8588

May 23, 2019

VIA ELECTRONIC MAIL
Mr. Kurt Kochan
Office of Remediation Programs
Virginia Department of Environmental Quality
1111 East Main Street, Suite 1400
Richmond, Virginia 23218

Subject: **Annual Corrective Action Groundwater Monitoring Event Notification – HWMU-5**
Semiannual Detection Notification – HWMU-16
Post Closure Care Permit HWMUs 5 & 16
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730

Dear Mr. Kochan:

The following information pertains to routine detection notification for the recent semiannual groundwater monitoring event for Hazardous Waste Management Units (HWMUs) 5 and 16.

Groundwater Monitoring Event Notification - HWMU-5 and HWMU-16

During Second Quarter 2019, BAE Systems, Ordnance Systems Inc. (BAE) completed semiannual groundwater monitoring for HWMUs 5 and 16 located at the Radford Army Ammunition Plant (RFAAP) in Radford, Virginia. The Second Quarter 2019 event served as the semiannual Corrective Action (CA) groundwater monitoring event for HWMU-5 conducted in accordance with the *Final Hazardous Waste Post-Closure Care Permit for HWMUs 5 and 16* (reissued August 16, 2014). The Second Quarter 2019 groundwater monitoring event also served as annual monitoring under 40 CFR 264 Appendix IX for HWMU-16. The laboratory analytical data packages for this event were received on May 21, 2019. The Second Quarter 2019 groundwater monitoring event was conducted using revised detection limits (DLs) and quantitation limits (QLs) for antimony, copper, lead, silver, and vanadium as approved by the Virginia Department of Environmental Quality (VDEQ) in electronic correspondence dated March 29, 2019. The following information summarizes the findings of the Second Quarter 2019 semiannual activities at each Unit. A verification groundwater monitoring event will be conducted for HWMU-16 as discussed below.

HWMU-5

For this event, all wells in the CA groundwater monitoring network were sampled for the constituents listed in Appendix J to Permit Attachment 2 (Groundwater Corrective Action Targeted Constituents - GPS and Semiannual Monitoring List for HWMU-5). The CA groundwater monitoring network for HWMU-5 consists of upgradient well 5W8B, point of compliance (POC) wells 5W5B, 5W7B, 5WC21, 5WC22, and 5WC23, and plume monitoring well 5W12A. During Second Quarter 2019, groundwater samples collected from all of the wells in the CA groundwater monitoring network were analyzed for the CA Targeted Constituents: trichloroethene (TCE) and its daughter products 1,1-dichloroethene (1,1-DCE), *cis*-1,2-dichloroethene (*c*DCE), *trans*-1,2-dichloroethene (*t*DCE), and vinyl chloride (VC). Additionally, samples collected from all of the wells in the CA groundwater monitoring network were analyzed for total cobalt, which was added to the list of CA Targeted Constituents as directed by the VDEQ on May 4, 2011.

TCE was detected in POC wells 5WC21, 5WC22, and 5WC23 at concentrations of 2.8 ug/l, 2.9 ug/l, and 3.9 ug/l respectively, which are less than the GPS of 5 ug/l.

Total cobalt was detected in POC well 5WC21 at a concentration of 32 ug/l, which is greater than the GPS of 7 ug/l. Total cobalt was detected in POC wells 5W7B, 5WC22, and 5WC23 at concentrations less than the QL of 5 ug/l.

TCE and total cobalt were not detected in any of the other wells in the CA groundwater monitoring network. Additionally, the TCE daughter products were not detected in any of the wells comprising the CA groundwater monitoring network.

This event also served as the annual monitoring event in which the POC wells at HWMU-5 were sampled for the constituents listed in Appendix K to Permit Attachment 2 (Groundwater Corrective Action Annual Monitoring List). Annual monitoring for the constituents listed in Appendix K is required in order to evaluate whether additional hazardous constituents that are not the targets for the current CA (e.g., TCE and its daughter products) are present at concentrations greater than their respective GPSs. No other additional hazardous constituents that are not targets for the current CA for the Unit were detected at concentrations greater than their respective GPS during Second Quarter 2019.

A footnote presented in Appendix K to Permit Attachment 2 indicates that verification is required for constituents detected at concentrations less than the QL if their associated GPSs are 1) based on background values equal to the QL, and 2) are greater than the applicable risk-based concentrations (i.e., ACL or RSL). In these instances, verification must be conducted using an alternate low-level analytical method in order to confirm or refute the observed initial detections if the QL achievable by that method is less than, or equal to, the ACL or RSL for the subject constituent. If a concentration greater than the low-level analytical method QL is observed, then the GPS for that constituent will be updated, if warranted.

During Second Quarter 2019, p-nitroaniline (which has a GPS based on a background value equal to the QL) was initially detected in POC well 5WC23 at a concentration less than the QL of 20 ug/l. Additional sample aliquot for POC well 5WC23 was collected during the original Second Quarter 2019 sampling event and submitted to an alternate laboratory for potential low-level analysis, if needed. The alternate laboratory prepared and held the sample pending the initial analytical result. As a result of the initial detection, the alternate laboratory was requested to performed low-level analysis to confirm or refute the observed initial detection. P-nitroaniline was not detected at a concentration greater than the low-level analytical method QL of 1.8 ug/l in POC well 5WC23; therefore, no further action is warranted.

HWMU-16

For this event, all wells in the Compliance groundwater monitoring network were sampled for the constituents listed in Appendix E to Permit Attachment 3 (Unit 16 Groundwater Compliance Monitoring (Semiannual) Constituent List). The Compliance groundwater monitoring network for HWMU-16 consists of upgradient well 16C1, POC wells 16MW8, 16MW9, 16WC1A, and 16WC1B, and plume monitoring wells 16-2, 16-3, 16-5, 16WC2B, and 16SPRING. In accordance with the Final Hazardous Waste Post-Closure Care Permit, the groundwater data from the POC wells at HWMU-16 were compared to the established GPS for the Unit listed in Appendix G of Permit Attachment 3 (modified to add 1,1-dichloroethene in Class 1 Permit Modification approved September 12, 2014; modified to add tetrahydrofuran in Class 1 Permit Modification approved December 1, 2016). The following constituents were detected in the HWMU-16 POC wells at concentrations greater than their respective GPS:

- Total cobalt was detected in POC wells 16MW9, 16WC1A, and 16WC1B at concentrations of 6.2 ug/l, 13 ug/l, and 18 ug/l, respectively, which are greater than the GPS of 5 ug/l. As directed by the VDEQ in electronic correspondence dated November 14, 2018, RFAAP also compared the total cobalt concentrations detected in POC well 16MW9, 16WC1A, and 16WC1B to the latest (effective January 18, 2019) VDEQ Alternate Concentration Limit (ACL) for cobalt of 6 ug/l.

  In accordance with Permit Condition V.J.2.i.(3) and as directed in VDEQ correspondence dated January 21, 2014, RFAAP submitted an alternate source demonstration (ASD) to evaluate whether a total cobalt concentration greater than the GPS detected in well 16WC1B during Fourth Quarter 2013 was due to 1) a source other than the Unit; 2) errors in sampling, analysis, and evaluation; or 3) natural variation in groundwater. In subsequent correspondence from VDEQ dated May 1, 2015, VDEQ requested "cobalt concentrations in monitoring well 16WC1B be monitored for at least a minimum of one additional year." In correspondence dated December 9, 2015, the VDEQ again requested RFAAP to continue additional semiannual monitoring for total cobalt in well 16WC1B in support of the ASD. During Fourth Quarter 2015 total cobalt was reported above the GPS for the first time in POC well 16WC1A. In early 2016, VDEQ concurred with RFAAP to combine the ongoing ASDs for total cobalt at POC wells 16WC1B and 16WC1A. Total cobalt was subsequently reported above the GPS during Second Quarter 2016 in POC well 16MW9. In correspondence dated July 19, 2016, VDEQ concurred with RFAAP to include POC well 16MW9 with the ongoing ASD for total cobalt at POC wells 16WC1A and 16WC1B. In correspondence dated December 18, 2017, RFAAP requested an extension for completion of the ASD; VDEQ approved the extension request in electronic correspondence dated January 9, 2018. In correspondence dated January 28, 2019, RFAAP requested an extension for completion of the ASD due to inconclusive data; VDEQ approved the extension request in electronic correspondence dated April 11, 2019. Therefore, a verification event will not be conducted for the Second Quarter 2019 total cobalt concentrations detected in POC wells 16MW9, 16WC1A, and 16WC1B.

- For this event, total cobalt was detected in POC well 16MW8 at a concentration of 6.8 ug/l, which is greater than the GPS of 5 ug/l and the latest VDEQ ACL of 6 ug/l. However, it should be noted that the total cobalt concentration detected in POC well 16MW8 is less than the cobalt concentrations detected in POC wells 16WC1A and 16WC1B discussed above. **A verification event will be scheduled in order to confirm or refute the total cobalt concentration reported in POC well 16MW8.**

The following constituents were detected at concentrations at or above their respective background concentrations in plume monitoring wells:

- Total barium was detected in plume monitoring wells 16-2, 16-3, and 16Spring at concentrations of 180 ug/l, 800 ug/l, and 180 ug/l, respectively, which are greater than the site-specific background concentration of 175.4 ug/l. However, these concentrations are less than the USEPA maximum contaminant level (MCL) drinking water standard for barium of 2,000 ug/l. Higher total barium concentrations in downgradient plume monitoring wells relative to background at HWMU-16 may be the result of natural variations in trace element distribution in groundwater. As illustrated in the boring logs for the compliance network monitoring wells (Appendix H of Permit Attachment 3), upgradient well 16C1 is screened in limestone while downgradient plume monitoring wells (16-2, 16-3, and 16-5) and former plume well (now piezometer) 16-1 are screened in shale and fault breccia. Such differing lithologic formations would be expected to contain very different trace element distributions. Therefore, no further action regarding the Second Quarter 2019 total barium concentrations detected in plume monitoring wells 16-2, 16-3, and 16Spring is recommended at this time.

This event also served as the annual monitoring event in which the upgradient and POC wells at HWMU-16 were sampled for the 40 CFR Part 264 Appendix IX constituents listed in Appendix I of Permit Attachment 1. The following Appendix IX constituents were detected at or above their respective DLs at HWMU-16:

Well Location	Constituent	Concentration	DL	Units
16MW8	Silver	2.2	0.3	ug/l
16C1	2-Propanol	46 J	18	ug/l
16MW8	2-Propanol	31 J	18	ug/l
16WC1A	2-Propanol	37 J	18	ug/l
16WC1B	2-Propanol	23 J	18	ug/l
16WC1A	Vinyl Chloride	0.184 J	0.153	ug/l

Note: J denotes analyte detected less than the quantitation limit (QL) and concentration is estimated.

The 2-propanol detections are suspect and additional information regarding the 2-propanol detections will be provided to VDEQ under separate correspondence to determine subsequent actions.

In accordance with the permit, a verification event will be scheduled in order to confirm or refute the detections of the Appendix IX constituents silver and vinyl chloride listed in the table above.

Complete details regarding the Second Quarter 2019 monitoring event (field data, laboratory data, and data validation reports) will be forwarded to the VDEQ in the forthcoming *Semiannual Groundwater Monitoring Report for Hazardous Waste Management Units 5 and 16, Second Quarter 2019*, which is due by August 15, 2019.

If you have any questions or concerns, please contact me at 540/639-7701 (jody.hawks@baesystems.com).

Sincerely,

Jody Hawks, CHMM
Sr. Environmental Engineer
BAE Systems, Ordnance Systems Inc.

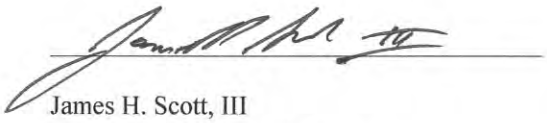
Coordination: J. McKenna
J. McKenna

cc: Brett Fisher, Ashby Scott, VDEQ-CO
Nelson Dail, Deputy Regional Director, VDEQ-BRRO
J. McKenna, Army Staff
J. Hawks, BAE Staff
Mike Lawless, Draper Aden Associates
Janet Frazier, Draper Aden Associates
Env. File – 19-0900-074

Concerning the following:

CY 2019 Second Quarter Semiannual Monitoring Event
Hazardous Waste Management Units 5 – Corrective Action Groundwater Monitoring
Hazardous Waste Management Unit 16 – Compliance Groundwater Monitoring
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

SIGNATURE: 

PRINTED NAME: James H. Scott, III

TITLE: Lieutenant Colonel, US Army
Commanding

SIGNATURE: 

PRINTED NAME: Brian Gathright

TITLE: OSI Vice President/General Manager
BAE Systems

From:	Janet Frazier
To:	Will Mason-Deese; Kathy Olsen; Ross Miller
Subject:	Fw: HWMU 16 Notification Follow-up for 2-Propanol
Date:	Wednesday, June 12, 2019 4:50:10 PM
Attachments:	image001.png image004.png

From: Hawks, Jody (US) <jody.hawks@baesystems.com>
Sent: Wednesday, June 12, 2019 1:51:46 PM
To: Janet Frazier; Mike Lawless; Ross Miller
Subject: FW: HWMU 16 Notification Follow-up for 2-Propanol

> ATTENTION: Email sent from outside DAA.

FYSA

Jody Hawks, CHMM
Sr. Environmental Engineer
BAE Systems, Inc. | OSI

T: +1 540 639 7701 | **M:** +1 540 589 7599 | **E:** jody.hawks@baesystems.com

From: Kurt Kochan [mailto:kurt.kochan@deq.virginia.gov]
Sent: Wednesday, June 12, 2019 1:07 PM
To: Hawks, Jody (US)
Cc: McKenna, Jim; Ashby Scott
Subject: RE: HWMU 16 Notification Follow-up for 2-Propanol

Good afternoon Jody,

The Department is granting your request to continue to use the higher 50 ug/L MDL for 2-propanol with the following stipulation:

- A survey of VELAP certified laboratories should be conducted annually for a period of at least three (3) years to ensure that the lower 18 ug/L MDL reported by RFAAP's current laboratory is not routinely achieved by other VELAP certified laboratories for 2-propanol. This survey should be included as an appendix in the annual report for the unit.

Please let me know if you have any questions or comments.

Best,

Kurt

Kurt W. Kochan
Remedial Project Manager
Virginia Department of Environmental Quality
Office of Remediation Programs
P.O. Box 1105
Richmond, VA 23218
(703) 583-3825

From: Hawks, Jody (US) <jody.hawks@baesystems.com>
Sent: Wednesday, June 5, 2019 8:59 AM
To: 'Kurt Kochan' <kurt.kochan@deq.virginia.gov>
Cc: McKenna, Jim <james.j.mckenna16.civ@mail.mil>
Subject: RE: HWMU 16 Notification Follow-up for 2-Propanol

Kurt – Following our review with DAA, we can see at first glance how you would think there appears to be many labs available to conduct the analysis. However, upon closer evaluation as requested, the same conclusion provided in the earlier email is reached – that there are a limited number of available commercial laboratories to consistently confirm a detection at the lab's 2019 lower MDL. As well, the current lab, with only limited number of analyses performed to date using the 2019 MDL, has not demonstrated their ability to consistently monitor the analyte at the lower MDL. Please note that 2-propanol is a non-standard target analyte and a challenge to analyze (unlike for example, benzene). SW-846 states that the analyte is considered a poor purging compound and high quantitation limits are anticipated (See SW-846 preparation Method 5030). Respectfully, RFAAP would like DEQ to reconsider the request provided in the earlier email to maintain the historical MDL of 50 ug/l. Additional information requested by DEQ is provided below.

Of the list DEQ provided, a variety of laboratories and analytical methods were associated with 2-propanol analysis in water. RFAAP historically and currently uses Method 8260C, an SW-846 analysis which uses gas chromatography with the **critical and definitive** mass spec confirmation feature. Of the list provided, only 6 other labs are VELAP accredited for Method 8260C and one lab no longer performs the analysis. Two of the labs maintain MDLs greater than 18 ug/l (current lab 2019 MDL) further reducing the number of available labs. SW-846 Method 8260D (a more recent update to the Method 8260C) could be considered a comparable method, however, there is only one lab VELAP accredited listed for Method 8260D. The other labs listed in the information provided by DEQ are not SW-846 methods or they do not incorporate the critical and definitive mass spec confirmation feature (i.e., method 8015) – both of which are inconsistent with permit data quality objectives for data comparability and the ability to confirm a detection.

Respectfully, RFAAP would like DEQ to reconsider the request provided in the earlier email to maintain the historical MDL of 50 ug/l for 2-propanol due to:

- the limited number of available commercial laboratories to consistently confirm an observed detection at the lab's current detection limit of 18 ug/l,
- the difficulties to assess if laboratory contamination contributed to the observed detection,
- the elevated risk-based screening limit of 410 ug/l for 2-propanol,
- the use of an MDL of 50 ug/l for the last decade in semiannual groundwater monitoring efforts.

RFAAP requests use of the historical detection limit of 50 ug/l for the second quarter 2019 groundwater monitoring event and to update the MDL listed in Attachment 1, Appendix 1 of the

permit.

As always, should you have any questions, please don't hesitate to contact me.

Regards,

Jody Hawks, CHMM
Sr. Environmental Engineer
BAE Systems, Inc. | OSI

T: +1 540 639 7701 | **M:** +1 540 589 7599 | **E:** jody.hawks@baesystems.com

From: Kurt Kochan [mailto:kurt.kochan@deq.virginia.gov]
Sent: Tuesday, June 04, 2019 11:31 AM
To: Hawks, Jody (US)
Cc: McKenna, Jim
Subject: HWMU 16 Notification Follow-up for 2-Propanol

Hi Jody-

Attached are the labs that are VELAP certified for non-potable water for isopropanol. Please expand your search to determine if a sufficient number of labs can consistently hit the lower MDL and the one DAA did doesn't meet the bar to allow us to sign off on the higher MDL. DEQ is not necessarily against allowing you to do this, but you need better demonstrate that the lower MDL is the outlier. Let me know if you need anything else.

Kurt

Kurt W. Kochan
Remedial Project Manager
Virginia Department of Environmental Quality
Office of Remediation Programs
P.O. Box 1105
Richmond, VA 23218
(703) 583-3825

From: Hawks, Jody (US) <jody.hawks@baesystems.com>
Sent: Tuesday, May 28, 2019 3:10 PM
To: kurt.kochan@deq.virginia.gov
Cc: McKenna, Jim <james.j.mckenna16.civ@mail.mil>
Subject: HWMU 16 Notification Follow-up for 2-Propanol

Kurt – As noted in the notification sent earlier, during Second Quarter 2019, BAE Systems, Ordnance Systems Inc. (BAE) completed semiannual groundwater monitoring for HWMUs 5 and 16 located at the Radford Army Ammunition Plant (RF AAP) in Radford. This event also served as the annual monitoring event in which the upgradient and point of compliance wells at HWMU-16 were sampled for the 40 CFR Part 264 Appendix IX constituents listed in Permit Attachment 1, Appendix I. We received laboratory data for HWMU-16 volatile organics which indicated a new detection of an Appendix IX constituent, 2-propanol (isopropyl alcohol), less than the quantitation limit (QL) of 100 ug/l, but above the lab's new (2019) method detection limit (MDL) of 18 ug/l. For over a decade, the lab MDL was 50 ug/l, however, with the reduction of the lab MDL to 18 ug/l with the recent event, 2-propanol was reported in 4 of the 5 compliance network wells below the historical MDL of 50 ug/l. The 2-propanol detections were at a similar estimated concentration (which is suspect) with the highest estimated concentration in the upgradient well. Due to the technical considerations noted below, we request use of the historical MDL of 50 ug/l and to update Attachment 1, Appendix 1 of the permit.

The historical QL (100 ug/l) and MDL (50 ug/l) has been reported by the lab since 2008. Due to a recent MDL study, the laboratory is now reporting to a lower MDL of 18 ug/l. Since monitoring for this constituent, (i.e., since 2003) there has been no detection of 2-propanol at or above the laboratory QL or MDL. The reported 2-propanol estimated concentrations for the second quarter 2019 groundwater monitoring event at HWMU 16 appear to be similar (and suspect). Discussions with the laboratory do not indicate laboratory contamination issues at the time of analysis, however, the analyte is not routinely monitored. According to the lab, since August 2018, the lab has analyzed only 81 samples. Currently, only 6 other laboratories maintain VELAP accreditation for 2-propanol. DAA contacted 5 of the labs and determined that one lab no longer analyzes the constituent. A sales representative for one lab indicated a 2-propanol QL of 5 ug/l and MDL of 2 ug/l, respectively. However, most labs report a QL of 50 ug/l or higher. The current risk-based regional screening level (RSL-tap water) for 2-propanol is 410 ug/l.

Due to the limited number of available commercial laboratories to confirm an observed detection at the lab's current detection limit of 18 ug/l, the difficulties to assess if laboratory contamination contributed to the observed detection, the elevated risk-based screening limit of 410 ug/l and the use of an MDL of 50 ug/l for the last decade, RFAAP requests use of the historical detection limit of 50 ug/l for the second quarter 2019 groundwater monitoring event and to update the MDL listed in Attachment 1, Appendix 1 of the permit.

Regards,

Jody Hawks, CHMM
Sr. Environmental Engineer
BAE Systems, Inc. | OSI

T: +1 540 639 7701 | **M:** +1 540 589 7599 | **E:** jody.hawks@baesystems.com

ORDNANCE SYSTEMS INC.
Radford Army Ammunition Plant
4050 Pepper's Ferry Road
Radford Virginia 24141

July 16, 2019

Mr. Kurt Kochan
Office of Remediation Programs
Virginia Department of Environmental Quality
1111 East Main Street, Suite 1400
Richmond, Virginia 23218

Subject: June 25, 2019 Verification Event Notification
Annual Corrective Action Groundwater Monitoring Event Notification – HWMU-5
Semiannual Detection Notification – HWMU-16
Post Closure Care Permit HWMUs 5 & 16
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730

Dear Mr. Kochan:

During Second Quarter 2019, BAE Systems, Ordnance Systems Inc. (BAE) completed semiannual groundwater monitoring for HWMUs 5 and 16 located at the Radford Army Ammunition Plant (RFAAP) in Radford, Virginia. This event also served as the annual monitoring event in which the upgradient and POC wells at HWMU-16 were sampled for the 40 CFR Part 264 Appendix IX constituents listed in Appendix I of Permit Attachment 1.

Results of the Second Quarter 2019 groundwater monitoring event at HWMU-16 indicated total cobalt was detected above the groundwater protection standard (GPS) in point of compliance well 16MW8. Additionally, Appendix IX constituents, total silver and vinyl chloride, were detected at or above their respective detection limits (DLs) in 16MW8 and 16WC1A, respectively.

A verification event to confirm or refute the total cobalt, total silver and vinyl chloride results was conducted on June 25, 2019. As summarized below, the verification event result indicates total cobalt was detected less than the GPS and no additional action is required. Additionally, Appendix IX constituents total silver and vinyl chloride were not detected at or above the detection limit and no additional action is required.

Additional required action to the annual monitoring event at HWMU 16 was provided in VDEQ correspondence dated June 12, 2019. VDEQ authorized continued use of the historical detection limit of 50 ug/l for 2-propanol. Additionally, VDEQ requested an annual survey of laboratories maintaining accreditation under the Virginia Environmental Laboratory Accreditation Program (VELAP) for a period of at least three (3) years (i.e., 2020, 2021, 2022) to ensure that the lower 18 ug/L detection for 2-propanol reported by ELLE, Lancaster, Pennsylvania during the Second Quarter 2019 monitoring event is not routinely achieved by other VELAP accredited laboratories. VDEQ also requested including this survey as an appendix in the annual report.

J. Hawks
19-0900-102

Summary of HWMU 16 Verification Event Results
Verification Event June 25, 2019

Well Location	Initial Event Result ug/L (Second Quarter 2019)	Verification Event Results ug/L (June 25, 2019)	Permit Limit (ug/L)	Laboratory
Total Cobalt				
16MW8	6.8	3.1 J	5 (GPS)	Shealy, West Columbia, SC
		3.2 J (blind duplicate)		
Total Silver				
16MW8	2.2	Not detected	0.3 (Detection Limit)	Shealy, West Columbia, SC
		Not detected (blind duplicate)		
Vinyl Chloride				
16WC1A	0.184 J	Not detected	0.153 (Detection Limit)	ELLE, Lancaster PA
		0.157 J (Sample duplicate)		
		Not detected (split sample)		Pace, Mt. Juliet, TN

Note: J denotes analyte detected less than the quantitation limit (QL) and concentration is estimated.

Complete details regarding the Second Quarter 2019 monitoring event (field data, laboratory data, and data validation reports) will be forwarded to the VDEQ in the forthcoming *Semiannual Groundwater Monitoring Report for Hazardous Waste Management Units 5 and 16, Second Quarter 2019*, which is due by August 15, 2019.

If you have any questions or concerns, please contact me at 540/639-7701 (jody.hawks@baesystems.com).

Sincerely,

Jody Hawks, CHMM
Sr. Environmental Engineer
BAE Systems, Ordnance Systems Inc.

Coordination: J. McKenna

cc: Brett Fisher, Ashby Scott, VDEQ-CO
Nelson Dail, Deputy Regional Director, VDEQ-BRRO
J. McKenna, Army Staff
J. Hawks, BAE Staff
Mike Lawless, Draper Aden Associates
Janet Frazier, Draper Aden Associates
Env. File – 19-0900-102

Concerning the following:

CY 2019 Second Quarter Semiannual Monitoring Event
Verification Event Sampling – June 25, 2019
Hazardous Waste Management Units 5 – Corrective Action Groundwater Monitoring
Hazardous Waste Management Unit 16 – Compliance Groundwater Monitoring
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

SIGNATURE: 

PRINTED NAME: Anthony J. Kazor
TITLE: Lieutenant Colonel, US Army
Commanding

SIGNATURE: 

PRINTED NAME: Michael Bocek
TITLE: General Manager
BAE Systems

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Street address: 1111 E. Main Street, Suite 1400, Richmond, Virginia 23219
Mailing address: P.O. Box 1105, Richmond, Virginia 23218
www.deq.virginia.gov

Matthew J. Strickler
Secretary of Natural Resources

David K. Paylor
Director

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

November 12, 2019

Mr. Jim McKenna
Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, Virginia 24143-0100

VIA ELECTRONIC MAIL

Re: Second Quarter 2019 Semi-Annual Groundwater Monitoring Report for HWMUs 5 & 16
Radford Army Ammunitions Plant
Route 114, Radford, Virginia 24141
EPA ID#: VA1210020730

Dear Mr. McKenna:

This letter acknowledges the receipt and review of the Second Quarter 2019 Semi-Annual Groundwater Monitoring Report for Hazardous Waste Management Units (HWMUs) 5 & 16 dated August 1, 2019, submitted to the Virginia Department of Environmental Quality (Department), Office of Remediation Programs by BAE Systems on behalf of the Radford Army Ammunitions Plant (RFAAP).

There reportedly were no new-targeted constituents detected during the groundwater monitoring activities conducted during the second quarter of 2019 for HWMU-5.

Total cobalt was detected in point of compliance wells 16MW9, 16WC1A, and 16WC1B at concentrations greater than the Groundwater Protection Standard (GPS) of 6 microgram per liter during the 2019 second quarter groundwater monitoring activities performed at HWMU-16. RFAAP had previously submitted an Alternate Source Demonstration (ASD) to the Department indicating that the detections of cobalt in this well were due to natural variation. As the report points out, the Department has approved the combination of the ASD for wells 16MW9, 16WC1A and 16WC1B. A revised ASD should be submitted in spring 2020 if data supports an alternate source for cobalt at this unit.

EPA ID#: VA1210020730
Radford Army Ammunitions Plant
Radford, Virginia
November 12, 2019

As previously discussed, the Department acknowledges the presence of barium above the site-specific background concentration. The Department recognizes the variability of the lithology in the area of HWMU-16 that could account for the natural variation of this trace element. No further investigation is required at this time; however, the Department may request further investigation if the barium levels in groundwater fluctuate in the future.

If you have any additional technical questions, you may contact me at 703-583-3825 or by email at Kurt.Kochan@deq.virginia.gov.

Sincerely,

Kurt W. Kochan
Corrective Action Project Manager
Office of Remediation Programs

cc: RFAAP Correspondence File
Tara Mason, Ashby Scott, VDEQ-CO
Nicole Herschler, VDEQ-BRRO
Jody Hawks, BAE
Mike Lawless, DAA

BAE SYSTEMS

ORDNANCE SYSTEMS INC.
Radford Army Ammunition Plant
4050 Pepper's Ferry Road
Radford Virginia 24141

December 4, 2019

Mr. Kurt Kochan
Office of Remediation Programs
Virginia Department of Environmental Quality
1111 East Main Street, Suite 1400
Richmond, Virginia 23218

Subject: **Status Update and Extension Request for ongoing –**
Combined Cobalt Alternate Source Demonstration (ASD) Report and
Proposed Sampling and Evaluation Schedule for Cobalt ASD
Post Closure Care Permit HWMU 16
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730

Dear Mr. Kochan:

During Fourth Quarter 2019, Radford Army Ammunition Plant (RFAAP) completed one additional year of groundwater monitoring at Hazardous Waste Management Unit 16 (HWMU-16) in support of the combined Alternate Source Demonstration (ASD) for total cobalt concentrations detected above the applicable Groundwater Protection Standard (GPS) at the Unit. RFAAP completed this additional year of monitoring for total cobalt in accordance with the schedule presented in correspondence to the Virginia Department of Environmental Quality (VDEQ) dated January 28, 2019, and as approved in electronic correspondence from the VDEQ to RFAAP dated April 11, 2019.

The combined ASD addresses total cobalt concentrations detected above the GPS of 5 ug/l in HWMU-16 point of compliance (POC) wells 16WC1A, 16WC1B, and 16MW9. Total cobalt concentrations detected in the HWMU-16 upgradient well and POC wells are summarized in Table 1 (attached); a graph of total cobalt concentrations detected in POC wells 16WC1A, 16WC1B, and 16MW9 compared with the Permit-specified GPS of 5 ug/l is presented in Figure 1 (attached). The GPS for total cobalt at HWMU-16 was revised from the former VDEQ Alternate Concentration Limit (ACL) of 313 ug/l to the calculated Unit-specific background concentration of 5 ug/l in the VDEQ-approved Class 3 Permit Modification dated September 27, 2011. Additionally, in electronic correspondence dated November 14, 2018, the VDEQ directed RFAAP to compare detected cobalt concentrations to the latest (effective January 18, 2019) ACL of 6 ug/l for cobalt. As shown in Table 1, total cobalt was detected at concentrations greater than the revised GPS of 5 ug/l in POC well 16WC1B beginning in Fourth Quarter 2013, in POC well 16WC1A beginning in Fourth Quarter 2015, and in POC well 16MW9 in Second Quarter 2016. During the recent Fourth Quarter 2019 monitoring event, total cobalt was detected at a concentration greater than the GPS of 5 ug/l and the latest VDEQ ACL of 6 ug/l in POC wells 16WC1A and 16WC1B only; total cobalt was not detected at a concentration greater than the GPS of 5 ug/l or the latest VDEQ ACL of 6 ug/l in POC well 16MW9 during Fourth Quarter 2019.

Based on a review of Table 1 and Figure 1, the total cobalt data collected to-date in support of the combined ASD appear to be inconclusive. Therefore, RFAAP recommends continued monitoring for total cobalt to further evaluate concentration trends. RFAAP requests an extension to the ASD report and proposes an updated sampling and evaluation schedule as detailed below. The updated schedule is consistent with previous correspondence from the VDEQ that approved at least a minimum of one additional year of monitoring total cobalt concentrations before the revised combined ASD report is submitted.

19-0900-167
J. Hawks

Proposed Sampling and Evaluation Schedule for Cobalt Alternate Source Demonstration (ASD) RFAAP – HWMU 16 – 16WC1A, 16WC1B, 16MW9		
Proposed Date	**Quarter**	**Comment**
April 2020	2nd Quarter 2020	Sampling conducted as part of routine semiannual groundwater monitoring.
October 2020	4th Quarter 2020	
November 2020	4th Quarter 2020	Receipt of 4th Quarter 2020 sample results from laboratory (i.e., approximately 30 days from 4th Quarter 2020 sample collection date).
January 2021	1st Quarter 2021	Re-evaluate total cobalt data collected to-date (through 2020) and propose path forward. Path forward may include additional monitoring and evaluation, or preparation and submittal of the ASD report.

If you have any questions or concerns, please contact me at 540/639-7701 (jody.hawks@baesystems.com).

Sincerely,

Jody Hawks, CHMM
Environmental Manager
BAE Systems, Ordnance Systems Inc.

Attachments:
Table 1 – HWMU 16 - SUMMARY OF TOTAL COBALT CONCENTRATIONS IN GROUNDWATER 2010-2019
Figure 1 - HWMU 16 - SUMMARY OF TOTAL COBALT CONCENTRATIONS IN GROUNDWATER 2010-2019

c:
Nichole Herschler, VDEQ-BRRO
Brett Fisher, VDEQ-CO

Coordination: J. McKenna

bc: Env. File
Brett Fisher, Ashby Scott, VDEQ-CO
Chris Evans, VDEQ-CO
Nichole Herschler, VDEQ-BRRO
J. McKenna, Army Staff
Melissa Lincoln, BAE Staff
Mike Lawless, Draper Aden Associates
Janet Frazier, Draper Aden Associates

19-0900-167
J. Hawks

Concerning the following:

CY 2019 Fourth Quarter Semiannual Monitoring Event -
Status Update and Extension Request for Cobalt Alternate Source Demonstration and
Proposed Sampling and Evaluation Schedule for Cobalt ASD
Hazardous Waste Management Unit 16 – Compliance Groundwater Monitoring
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

SIGNATURE: for _____

PRINTED NAME: Anthony J. Kazor
TITLE: Lieutenant Colonel, US Army
Commanding

SIGNATURE: _____

PRINTED NAME: Michael Bocek
TITLE: General Manager
BAE Systems

19-0900-167
J. Hawks

FIGURE 1

HWMU-16: Total Cobalt Concentrations in Groundwater (Fourth Quarter 2011 - Fourth Quarter 2019)

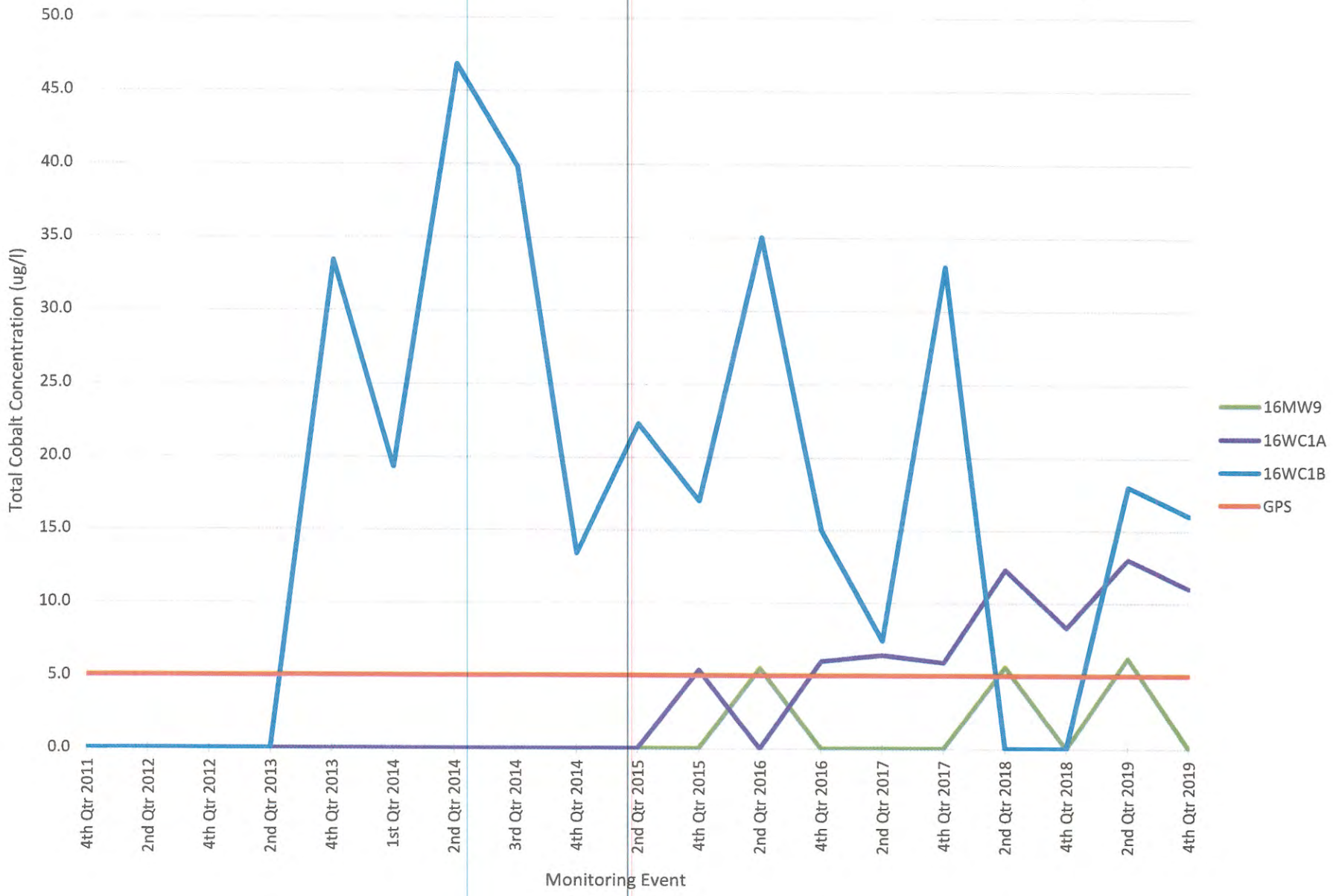


TABLE 1

HAZARDOUS WASTE MANAGEMENT UNIT 16 (HWMU-16)
SUMMARY OF TOTAL COBALT CONCENTRATIONS IN GROUNDWATER 2010-2019
RADFORD ARMY AMMUNITION PLANT, RADFORD, VIRGINIA

Monitoring Event	Total Cobalt Concentrations in Upgradient and Point of Compliance Wells (ug/l)						
	16C1	16MW8	16MW9	16WC1A	16WC1B	GPS	ACL
1st Qtr 2003	~	~	~	~	~	313	na
2nd Qtr 2003	~	~	~	7.9	~	313	na
3rd Qtr 2003	~	~	~	5.2	~	313	na
4th Qtr 2003	~	~	~	7.8	~	313	na
1st Qtr 2004	~	~	~	8.1	7.6	313	na
2nd Qtr 2004	~	~	~	8.5	~	313	na
3rd Qtr 2004	~	~	~	7.7	~	313	na
4th Qtr 2004	~	~	~	8.8	7.1	313	na
1st Qtr 2005	~	~	~	8.8	~	313	na
2nd Qtr 2005	~	~	~	7.7	~	313	na
3rd Qtr 2005	~	~	~	5.2	~	313	na
4th Qtr 2005	~	~	~	6.6	~	313	na
1st Qtr 2006	~	~	~	9.5	~	313	na
2nd Qtr 2006	~	~	~	8.7	~	313	na
3rd Qtr 2006	~	~	~	9.0	~	313	na
4th Qtr 2006	~	~	~	7.6	~	313	na
1st Qtr 2007	~	~	~	5.9	~	313	na
2nd Qtr 2007	~	~	~	7.1	~	313	na
4th Qtr 2007	~	~	~	5.7	~	313	na
2nd Qtr 2008	~	~	~	28.8	~	313	na
4th Qtr 2008	~	~	~	28.1	~	313	na
2nd Qtr 2009	~	~	~	9.6	~	313	na
4th Qtr 2009	~	~	~	8.8	~	313	na
2nd Qtr 2010	~	10.1	~	9.0	~	313	na
4th Qtr 2010	~	~	~	5.6	~	313	na
2nd Qtr 2011	~	~	~	9.2	~	313	na
4th Qtr 2011	~	~	~	~	~	5	na
2nd Qtr 2012	~	~	~	~	~	5	na
4th Qtr 2012	~	~	~	~	~	5	na
2nd Qtr 2013	~	~	~	~	~	5	na
4th Qtr 2013	~	~	~	~	**33.4**	5	na
1st Qtr 2014	ns	ns	ns	ns	**19.3**	5	na
2nd Qtr 2014	~	~	~	~	**46.8**	5	na
3rd Qtr 2014	ns	ns	ns	ns	**39.8**	5	na
4th Qtr 2014	~	~	~	~	**13.4**	5	na
2nd Qtr 2015	~	~	~	~	**22.3**	5	na
4th Qtr 2015	~	~	~	**5.4**	**17.0**	5	na
2nd Qtr 2016	~	~	**5.5**	~	**35.0**	5	na
4th Qtr 2016	~	~	~	**6.0**	**15.0**	5	na
2nd Qtr 2017	~	~	~	**6.4**	**7.4**	5	na
4th Qtr 2017	**5.9**	~	~	**5.9**	**33.0**	5	na
2nd Qtr 2018	~	~	**5.6**	**12.3**	~	5	na
4th Qtr 2018	~	~	~	**8.3**	~	5	6
2nd Qtr 2019	~	~	**6.2**	**13.0**	**18.0**	5	na
4th Qtr 2019	~	~	~	**11.0**	**16.0**	5	6

NOTES:

Well 16C1 is the upgradient monitoring well for HWMU-16.

~: Not detected at or above the Quantitation Limit (QL) of 5 ug/l.

na: Not applicable.

ns: Well was not sampled during this event.

GPS: Permit-specified Groundwater Protection Standard.

Total Cobalt GPS of 313 ug/l (prior to 4th Quarter 2011) based on VDEQ ACL as specified in Final Hazardous Waste Post-Closure Permit for HWMUs 5, 7, 10, and 16 dated October 4, 2002.

Total Cobalt GPS of 5 ug/l (4th Quarter 2011 - present) based on Unit background established in VDEQ-approved Class 3 Permit Modification dated September 27, 2011.

ACL: Latest VDEQ Alternate Concentration Limit. The VDEQ directed RFAAP to compare detected cobalt concentrations to the latest ACL in electronic correspondence dated November 14, 2018.

Bold indicates detected concentration is greater than applicable Permit-specified GPS.

BAE SYSTEMS

ORDNANCE SYSTEMS INC.
Radford Army Ammunition Plant
4050 Pepper's Ferry Road
Radford Virginia 24141

December 10, 2019

Mr. Kurt Kochan
Office of Remediation Programs
Virginia Department of Environmental Quality
1111 East Main Street, Suite 1400
Richmond, Virginia 23218

Subject: Semiannual Corrective Action Groundwater Monitoring Event Notification – HWMU-5
Semiannual Detection Notification – HWMU-16
Post Closure Care Permit HWMUs 5 & 16
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730

Dear Mr. Kochan:

The following information pertains to routine detection notification for the recent semiannual groundwater monitoring event for Hazardous Waste Management Units (HWMUs) 5 and 16.

Groundwater Monitoring Event Notification - HWMU-5 and HWMU-16

During Fourth Quarter 2019, BAE Systems, Ordnance Systems Inc. (BAE) completed semiannual groundwater monitoring for HWMUs 5 and 16 located at the Radford Army Ammunition Plant (RFAAP) in Radford, Virginia. The Fourth Quarter 2019 groundwater monitoring activities were conducted in accordance with the *Final Hazardous Waste Management Post-Closure Care Permit* (Permit) for HWMUs 5 and 16 (reissued August 16, 2014; revised by Class I Permit Modifications dated September 12, 2014 and December 1, 2016). The Fourth Quarter 2019 groundwater monitoring event was conducted using revised detection limits (DLs) and quantitation limits (QLs) for antimony, copper, lead, silver, and vanadium (where applicable) as approved by the Virginia Department of Environmental Quality (VDEQ) in electronic correspondence dated March 29, 2019. The Fourth Quarter 2019 event served as the semiannual Corrective Action (CA) groundwater monitoring event for HWMU-5 conducted in accordance with the Permit. The Fourth Quarter 2019 event also served as semiannual compliance monitoring for HWMU-16. The laboratory analytical data packages for this event were received on December 9, 2019. The following information summarizes the findings of the Fourth Quarter 2019 semiannual activities at each Unit.

HWMU-5

For this event, all wells in the CA groundwater monitoring network were sampled for the constituents listed in Appendix J to Permit Attachment 2 (Groundwater Corrective Action Targeted Constituents - GPS and Semiannual Monitoring List for HWMU-5). The CA groundwater monitoring network for HWMU-5 consists of upgradient well 5W8B, point of compliance (POC) wells 5W5B, 5W7B, 5WC21, 5WC22, and 5WC23, and plume monitoring well 5W12A. During Fourth Quarter 2019, groundwater samples collected from all of the wells in the CA groundwater monitoring network were analyzed for the CA Targeted Constituents: trichloroethene (TCE) and its daughter products 1,1-dichloroethene (1,1-DCE), *cis*-1,2-dichloroethene (*c*DCE), *trans*-1,2-dichloroethene (*t*DCE), and vinyl chloride (VC). Additionally, samples collected from all of the wells in the CA groundwater monitoring network were analyzed for total cobalt, which was added to the list of CA Targeted Constituents as directed by the Virginia Department of Environmental Quality (VDEQ) on May 4, 2011.

TCE was detected in POC wells 5WC21, 5WC22, and 5WC23 at concentrations of 2.0 ug/l, 2.4 ug/l, and 4.0 ug/l respectively, which are less than the GPS of 5 ug/l. TCE was detected in POC well 5W7B at a concentration less than the QL of 1.0 ug/l.

Total cobalt was detected in POC well 5WC21 at a concentration of 22.2 ug/l, which is greater than the GPS of 7 ug/l. Total cobalt was detected in POC wells 5W7B, 5WC22 and 5WC23 at concentrations less than the QL of 5 ug/l.

TCE and total cobalt were not detected in any of the other wells in the CA groundwater monitoring network. Additionally, the TCE daughter products were not detected in any of the wells comprising the CA groundwater monitoring network.

As stated in the Annual Groundwater Monitoring Reports for the Unit for calendar years 2015 through 2018, TCE remedial endpoints have been achieved. During Second and Fourth Quarters 2019, TCE was not detected at concentrations greater than its GPS in any of the wells comprising the CA groundwater monitoring network for HWMU-5. Additionally, no daughter products of TCE were detected in any of the wells comprising the CA groundwater monitoring network for HWMU-5; therefore, TCE remedial objectives continue to be met.

No changes to the continuation of the groundwater CA program are anticipated at this time. An evaluation of the effectiveness of the Corrective Action will be presented in the forthcoming Annual Groundwater Monitoring Report for Units 5 and 16, which is due to the VDEQ on March 1, 2020.

HWMU-16

In accordance with the Final Hazardous Waste Post-Closure Care Permit, the groundwater data from the POC wells at HWMU-16 were compared to the established GPS for the Unit listed in Appendix G of Permit Attachment 3 (modified to add 1,1-dichloroethene in Class 1 Permit Modification approved September 12, 2014; modified to add tetrahydrofuran in Class 1 Permit Modification approved December 1, 2016). The following constituents were detected in the POC wells for HWMU 16 at concentrations greater than their respective GPS:

- Total cobalt was detected in POC wells 16WC1A and 16WC1B at concentrations of 11 ug/l and 16 ug/l, respectively, which are greater than the Permit-specified GPS of 5 ug/l. As directed by the VDEQ in electronic correspondence dated October 26, 2018, RFAAP also compared the total cobalt concentrations in POC wells 16WC1A and 16WC1B to the latest (effective January 18, 2019) VDEQ Alternate Concentration Limit (ACL) for cobalt of 6 ug/l. Total cobalt was not detected at concentrations greater than the Permit-specified GPS or the latest VDEQ ACL in the other POC wells during Fourth Quarter 2019.

  An alternate source demonstration (ASD) is currently ongoing for total cobalt in POC wells 16WC1A, 16WC1B, and 16MW9 as detailed below. Total cobalt was initially detected at a concentration greater than the Permit-specified GPS of 5 ug/l in POC well 16WC1B during Fourth Quarter 2013. In accordance with Permit Condition V.J.2.i.(3) and as directed in VDEQ correspondence dated January 21, 2014, RFAAP submitted an ASD to evaluate whether the total cobalt concentration detected in well 16WC1B during Fourth Quarter 2013 was due to natural variation in groundwater. In subsequent correspondence from VDEQ dated May 1, 2015, VDEQ requested "cobalt concentrations in monitoring well 16WC1B be monitored for at least a minimum of one additional year." In correspondence dated December 9, 2015, the VDEQ again requested RFAAP to continue additional semiannual monitoring for total cobalt in well 16WC1B in support of the ASD. During Fourth Quarter 2015 total cobalt was reported above the GPS for the first time in POC well 16WC1A. In early 2016, VDEQ concurred with RFAAP to combine the ongoing ASDs for total cobalt in POC wells 16WC1B and 16WC1A. Total cobalt was subsequently reported above the GPS during Second Quarter 2016 in POC well 16MW9. In correspondence dated July 19, 2016, VDEQ concurred with RFAAP to include POC well 16MW9 with the ongoing ASD for total cobalt in POC wells 16WC1A and 16WC1B. VDEQ concurred with subsequent recommendations to continue semiannual monitoring for total cobalt in wells 16WC1A, 16WC1B, and 16MW9 in support of the ASD through 2017 and 2018. In correspondence dated January 28, 2019, RFAAP requested an extension for completion of the on-going ASD for total cobalt at point of compliance wells 16MW9, 16WC1A, and 16WC1B due to inconclusive data; VDEQ approved the extension request in electronic correspondence dated April 11, 2019. Therefore, a verification event will not be conducted for the Fourth Quarter 2019 total cobalt concentrations detected in POC wells 16WC1A and 16WC1B. Consistent with the January 28, 2019 extension request, RFAAP will re-evaluate total cobalt data collected to date (through 2019) and propose a path forward; the path forward may include additional monitoring and evaluation, or preparation and

submittal of the ASD report in early 2020.

The following constituents were detected at concentrations at or above their respective background concentrations in plume monitoring wells:

- Total barium was detected in upgradient well 16C1 at a concentration of 190 ug/l and in plume monitoring wells 16-2, 16-3, and 16Spring at concentrations of 200 ug/l, 1,000 ug/l, and 230 ug/l, respectively, which are greater than the site-specific background concentration of 175.4 ug/l. However, these concentrations are less than the USEPA maximum contaminant level (MCL) drinking water standard for barium of 2,000 ug/l. Higher total barium concentrations in downgradient plume monitoring wells relative to background at HWMU-16 may be the result of natural variations in trace element distribution in groundwater. As illustrated in the boring logs for the compliance network monitoring wells (Appendix H of Permit Attachment 3), upgradient well 16C1 is screened in limestone while downgradient plume monitoring wells (16-2, 16-3, and 16-5) and former plume well (now piezometer) 16-1 are screened in shale and fault breccia. Such differing lithologic formations would be expected to contain very different trace element distributions. Therefore, no further action regarding the Fourth Quarter 2019 total barium concentrations detected in plume monitoring wells 16-2, 16-3, and 16Spring is recommended at this time.

Complete details regarding the Fourth Quarter 2019 monitoring event (field data, laboratory data, and data validation reports) will be forwarded to the VDEQ in the forthcoming *Semiannual Groundwater Monitoring Report for Hazardous Waste Management Units 5 and 16, Fourth Quarter 2019*, which will be combined with the 2019 Annual Groundwater Monitoring Report for the Units as directed by the VDEQ on May 4, 2011. The 2019 Annual Groundwater Monitoring Report is due to the VDEQ by March 1, 2020.

If you have any questions or concerns, please contact me at 540/639-7701 (jody.hawks@baesystems.com).

Sincerely,

Jody Hawks, CHMM
Environmental Manager
BAE Systems, Ordnance Systems Inc.

Coordination: J. McKenna
J. McKenna

cc: Env. File
Brett Fisher, Ashby Scott, VDEQ-CO
Chris Evans, VDEQ-CO
Nichole Herschler, VDEQ-BRRO
J. McKenna, Army Staff
Melissa Lincoln, BAE Staff
Mike Lawless, Draper Aden Associates
Janet Frazier, Draper Aden Associates

Concerning the following:

CY 2019 Fourth Quarter Semiannual Monitoring Event
Hazardous Waste Management Unit 5 – Corrective Action Groundwater Monitoring
Hazardous Waste Management Unit 16 – Compliance Groundwater Monitoring
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

SIGNATURE: _____

PRINTED NAME: Anthony J. Kazor

TITLE: Lieutenant Colonel, US Army
Commanding

SIGNATURE: _____

PRINTED NAME: Michael Bocek

TITLE: General Manager
BAE Systems

From:	Hawks, Jody (US)
To:	kurt.kochan@deq.virginia.gov
Cc:	"Brett Fisher"; Ashby.Scott@deq.virginia.gov; "Chris Evans"; "nichole.herschler@deq.virginia.gov"; McKenna, Jim; Lincoln, Melissa (US); Mike Lawless; Janet Frazier
Subject:	RFAAP: HWMU 16 Cobalt ASD Status
Date:	Monday, December 16, 2019 8:34:30 AM
Attachments:	19-0900-167 HWMU 16 Cobalt ASD Status_certified.pdf

ATTENTION: Email sent from outside DAA.

Mr. Kochan – The RFAAP has completed an additional year of groundwater monitoring at HWMU 16 in support of the combined Alternate Source Demonstration for total cobalt concentrations detected above the applicable Groundwater Protection Standards at the aforementioned unit. Based on the information presented in the attachment, RFAAP recommends continued monitoring for total cobalt to further evaluate cobalt trends. Should you have any questions regarding this submission, please don't hesitate to reach out.

Regards,

Jody Hawks, CHMM
Environmental Manager
BAE Systems, Inc. | OSI

T: +1 540 639 7701 | **M:** +1 540 589 7599 | **E:** jody.hawks@baesystems.com

BAE SYSTEMS

ORDNANCE SYSTEMS INC.
Radford Army Ammunition Plant
4050 Pepper's Ferry Road
Radford Virginia 24141

January 29, 2020

VIA ELECTRONIC MAIL
Mr. Ashby Scott
Office of Waste Permitting and Compliance
Virginia Department of Environmental Quality
1111 East Main Street, Suite 1400
Richmond, Virginia 23218

Subject: Class I Permit Modification
Post Closure Care Permit HWMUs 5 & 16
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730

Dear Mr. Scott:

This document presents a Class I Permit Modification associated with the Post-Closure Care Permit for Hazardous Waste Management Units 5 and 16 (HWMUs 5 and 16) located at the Radford Army Ammunition Plant (RFAAP) in Radford, Virginia. RFAAP requests a Class I Permit Modification to revise the following permit conditions:

Revise QLs and DLs for Groundwater Monitoring Constituent Lists

This Class I Permit Modification revises the Permit-specified quantitation limits (QLs) and detection limits (DLs) for select groundwater monitoring constituents for HWMUs 5 and 16. In electronic correspondence dated March 19, 2019, RFAAP notified VDEQ that, due to recent laboratory Method Detection Limit (MDL) studies, QLs and DLs increased for many groundwater monitoring constituents and the respective values were greater than the Permit-specified limits. The revised laboratory QLs and DLs resulted from EPA's recent changes to MDL determination as specified in 40 CFR Part 136 (effective September 27, 2017, and implemented through 2018). In electronic correspondence dated March 29, 2019, the VDEQ granted RFAAP's request to use the updated laboratory QLs and DLs for subsequent groundwater monitoring events, and recommended RFAAP submit a Class I Permit Modification to revise the Permit-specified QLs and DLs to reflect current achievable laboratory values.

Proposed QLs for all constituents analyzed are below the respective Groundwater Protection Standards (GPSs) as specified in the Permit. This request follows the process required by VDEQ in 2016 for similar changes to QLs/DLs. RFAAP requests that the QLs and MDLs specified in the groundwater monitoring constituent lists for HWMUs 5 and 16 be updated to reflect current EPA-mandated MDL studies.

These revisions (where applicable) should be made to the following sections of the Permit (provided as attachments to this correspondence):

- Permit Attachment 1, Appendix H (Groundwater Compliance Monitoring Program – Example of Sampling and Analysis Plan for All Post-Closure Care Units), Appendix H.8 (EPA III Micro-Purging Guidance), BAE Systems Ordnance Systems Inc. Radford Army Ammunition Plant Low-Flow Groundwater Sampling and Analysis Plan
- Permit Attachment 1, Appendix I (Annual Groundwater Sampling Constituent List – Appendix IX 40 CFR Part 264)
- Permit Attachment 2, Appendix E (HWMU-5 Groundwater Compliance Monitoring Semiannual Constituent List)
- Permit Attachment 2, Appendix G (HWMU-5 Groundwater Protection Standards)
- Permit Attachment 2, Appendix J (HWMU-5 CA semiannual monitoring list and GPS)

- Permit Attachment 2, Appendix K (HWMU-5 Groundwater Corrective Action Annual Monitoring List)
- Permit Attachment 3, Appendix E (HWMU-16 Groundwater Compliance Monitoring Semiannual Constituent List)
- Permit Attachment 3, Appendix G (HWMU-16 Groundwater Protection Standards)

This Class I Permit Modification includes revised copies of the above-listed Permit Attachment Appendices with the requested modifications noted in strike-out format.

If you have any questions or concerns, please contact me at 540/639-7701 (jody.hawks@baesystems.com).

Sincerely,

Jody Hawks, CHMM
Environmental Manager
BAE Systems, Ordnance Systems Inc.

Coordination: J. McKenna

Enclosure

c: Env. File
Kurt W. Kochan, VDEQ-CO

Tara Mason, VDEQ-CO
Nichole Herschler, VDEQ-BRRO
J. McKenna, Army Staff
Melissa Lincoln, BAE Staff
Mike Lawless, Draper Aden Associates
Janet Frazier, Draper Aden Associates

Attachments:

- Permit Attachment 1, Appendix H (Groundwater Compliance Monitoring Program – Example of Sampling and Analysis Plan for All Post-Closure Care Units), Appendix H.8 (EPA III Micro-Purging Guidance), BAE Systems Ordnance Systems Inc. Radford Army Ammunition Plant Low-Flow Groundwater Sampling and Analysis Plan – REV 19 1217
- Permit Attachment 1, Appendix I (Annual Groundwater Sampling Constituent List – Appendix IX 40 CFR Part 264) – REV 19 1217
- Permit Attachment 2, Appendix E (HWMU-5 Groundwater Compliance Monitoring Semiannual Constituent List) – REV 19 1217
- Permit Attachment 2, Appendix G (HWMU-5 Groundwater Protection Standards) – REV 19 1217
- Permit Attachment 2, Appendix J (HWMU-5 Groundwater Corrective Action GPS and Semiannual Monitoring List) – REV 19 1217
- Permit Attachment 2, Appendix K (HWMU-5 Groundwater Corrective Action Annual Monitoring List) – REV 19 1217
- Permit Attachment 3, Appendix E (HWMU-16 Groundwater Compliance Monitoring Semiannual Constituent List) – REV 19 1217
- Permit Attachment 3, Appendix G (HWMU-16 Groundwater Protection Standards) – REV 19 1217

Concerning the following:

CY 2019 Class 1 Permit Modification
Post-Closure Care Permit for HWMUs 5 & 16
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations.

SIGNATURE: 

PRINTED NAME: Anthony J. Kazor

TITLE: Lieutenant Colonel, US Army
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SIGNATURE: 

PRINTED NAME: Michael Bocek

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