ANNUAL GROUNDWATER MONITORING REPORT

CALENDAR YEAR 2021
(INCLUDES FOURTH QUARTER 2021 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 2021 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 2021 and Fourth Quarter 2021 for each Unit.

The calendar year 2021 groundwater monitoring events were conducted using revised permit specified method detection limits (MDLS) (a.k.a., detection limits (DLs) and quantitation limits (QLs) as presented in the recent Class 1 Permit Modification approved by the Virginia Department of Environmental Quality (VDEQ) in electronic correspondence dated May 5, 2021. A Unit-specific summary for the Second and Fourth Quarter 2021 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 2021 and Fourth Quarter 2021, trichloroethene (TCE) was detected in point of compliance wells 5WC21, 5WC22, and 5WC23 at concentrations greater than the permit quantitation limit (QL) of 1 ug/l, but less than the Groundwater Protection Standard (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 2021 monitoring events. Additionally, no TCE daughter products were detected in any wells comprising the CA groundwater monitoring network for HWMU-5.

Total cobalt was detected at a concentration greater than the GPS of 7 ug/l in point of compliance well 5WC21 during Second and Fourth Quarters 2021. 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 2021 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.

The current monitoring program is required to continue until the TCE concentrations have remained below the GPS for a period of three consecutive years; upon which the Permittee may request to end corrective action. As stated in Permit Condition I.K.1, the compliance period for HWMU-5 was scheduled to end October 28, 2020. However, although TCE concentrations in groundwater at the Unit have been less than the GPS for over three consecutive years, total cobalt, an Appendix J listed constituent, remains above the GPS in point of compliance well 5WC21 and continued monitoring is required as stated in Permit Condition VI.B.4.c. Semiannual groundwater monitoring will continue at HWMU-5. The next monitoring event is scheduled for Second Quarter 2022.

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 2021) in addition to the Permit-specified GPS of 5 ug/l. During Second Quarter 2021, total cobalt was detected at concentrations greater than the GPS and the VDEQ ACL in point of compliance wells 16MW9, 16WC1A and 16C1B. During Fourth Quarter 2021, total cobalt was detected at a concentration greater than the GPS in point of compliance well 16MW9, and greater than the GPS and the VDEQ ACL in point of compliance well 16WC1A. 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 2021 and Fourth Quarter 2021. Additionally, the total cobalt data were evaluated using the revised ASD for total cobalt in groundwater at HWMU-16 for point of compliance wells 16MW9, 16WC1A, and 16WC1B approved by the VDEQ in electronic correspondence dated September 13, 2021. Based on the conclusions of the VDEQ-approved ASD, calendar year 2021 total cobalt concentrations detected in point of compliance wells 16MW9, 16WC1A and 16WC1B appear to be consistent with natural variation in local groundwater and are not indicative of a release from the Unit. Based on VDEQ correspondence dated September 13, 2021, a separate ASD will not be required. 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 2021 and Fourth Quarter 2021.

Evaluation of the plume monitoring well data indicated that total barium concentrations greater than the site-specific background concentration were detected in

plume monitoring wells 16-2, 16-3 and spring sampling location 16SPRING during Second Quarter and Fourth Quarter 2021. 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 calendar year 2021 total barium concentrations detected in plume monitoring wells 16-2, 16-3 and in spring sampling location 16SPRING is recommended at this time.

The Fourth Quarter 2021 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. The annual event is typically conducted during Second Quarter each year but was conducted in Fourth Quarter 2021 due to the then-pending Class 1 Permit Modification which was subsequently approved on May 5, 2021. No constituents were detected at or above the Permit-specified MDL during Fourth Quarter 2021 and no further action is required.

In correspondence dated June 12, 2019, the VDEQ authorized continued use of the historical laboratory DL of 50 ug/l for 2-propanol during annual monitoring of the constituents listed in Appendix I of Permit Attachment 1. However, VDEQ requested an annual survey of laboratories maintaining 2-propanol 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. A summary of the survey results and additional supporting information collected to-date are included in **Appendix E**. This information does not reflect a final analysis of data reliability of each laboratory for this analyte; such review will occur after the final required survey. The next survey will occur in 2022. During the Fourth Quarter 2021 annual monitoring event, 2-propanol was not detected at or above the Permit specified DL (50 ug/l) or QL (100 ug/l).

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 directed by VDEQ. 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 2022.

1.0 INTRODUCTION

This document presents the Annual Groundwater Monitoring Report for calendar year 2021 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, December 1, 2016, and May 5, 2021). Additionally, the calendar year 2021 groundwater monitoring events were conducted using revised detection limits (DLs) and quantitation limits (QLs) as approved by the Virginia Department of Environmental Quality (VDEQ) in electronic correspondence dated May 5, 2021.

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 2021 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, or until directed by VDEQ. 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 closure certification 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 original effective date of the Permit (October 4, 2002) and continuing until October 4, 2015, or until directed by VDEQ.

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 2021 Monitoring Events:

Second Quarter 2021:	April 29, 2021
Fourth Quarter 2021:	October 7, 2021

HWMU-5 has been in corrective action (CA) since 2010. The calendar year 2021 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 2021 semiannual monitoring events are summarized in **Table 1**. The maximum groundwater elevation fluctuation of approximately 3.87 feet was observed at observation well 5W11A; the minimum groundwater elevation fluctuation of 0 feet was observed at point

of compliance well 5W5B. On average, the groundwater elevation at Unit 5 fluctuated 0.5 foot, 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 2021 groundwater elevations was calculated to be 0.0261 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 2.37 ft/day or 865 ft/year based on the following:

- Average hydraulic conductivity of 5.25×10^{-5} ft/second.
- Average hydraulic gradient of 0.0261 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 2021 and Fourth Quarter 2021, 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 2021 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 2021 groundwater monitoring events were conducted using revised DLs and QLs approved by the VDEQ in electronic correspondence dated May 5, 2021.

The laboratory analytical results for the 2021 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 2021 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 2021 are included in **Appendix E**.

2.4.1 Semiannual Monitoring for Corrective Action Targeted Constituents

During the Second Quarter 2021 and Fourth Quarter 2021 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**. For constituents listed in Appendix J, the laboratory reported QLs and DLs at the respective permit QL or DL presented in the Class 1 Permit Modification and approved May 5, 2021.

During Second Quarter 2021, TCE was detected in point of compliance wells 5WC21, 5WC22 and 5WC23 at concentrations of 1.7 ug/l, 2 ug/l, and 2.9 ug/l, respectively, which are less than the Groundwater Protection Standard (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 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 Fourth Quarter 2021, TCE was detected in point of compliance wells 5WC21, 5WC22 and 5WC23 at concentrations of 1.2 ug/l, 1.6 ug/l, and 3 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 2021, total cobalt was detected in point of compliance well 5WC21 at a concentration of 18 ug/l, which is greater than the Unit-specific GPS of 7 ug/l. Total cobalt was detected in point of compliance well 5W7B at a concentration of 6.4 ug/l, which is less than the GPS but greater than the QL of 5 ug/l. Total cobalt was detected in point of compliance wells 5WC22 and 5WC23 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 2021.

During Fourth Quarter 2021, total cobalt was detected in point of compliance well 5WC21 at a concentration of 19 ug/l, which is greater than the Unit-specific GPS of 7 ug/l. Total cobalt was detected in point of compliance well 5W7B at a concentration of 6.7 ug/l, which is less than the GPS but greater than the QL of 5 ug/l. Total cobalt was detected in point of compliance well 5WC22 at a concentration 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 2021.

2.4.2 Annual Monitoring List – Comparison to Groundwater Protection Standards

During Second Quarter 2021, 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 by VDEQ on May 5, 2021). Appendix K constituents are based on the Compliance Monitoring List, plus those constituents historically detected. 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 their respective 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 2021 (**Appendix A-3**).

The Second Quarter 2021 annual groundwater monitoring event was conducted using QLs and DLs presented in the Class 1 Permit Modification approved by the VDEQ in electronic correspondence dated May 5, 2021. For select constituents listed in Appendix K, the laboratory reported QLs or DLs slightly greater than the respective permit QL or DL. In most cases this resulted from laboratory rounding or sample preparation final volumes. In all instances, the reported QLs were at or below the applicable GPS and no concentrations were detected above the respective GPS.

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). This applies to p-nitroaniline and nitrobenzene only. 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 2021, no constituents with GPS equal to their respective QLs and greater than the applicable risk-based concentrations were detected.

2.4.4 2021 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 2021 groundwater monitoring event, the May 2021 USEPA RSL table reflected the most current RSL values. According to the May 2021 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 a 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 2021 to the current USEPA

RSL (November 2021) 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 2021, diethyl ether was not detected at or above the laboratory QL of 13 ug/l. Additionally, diethyl ether was detected below the QL of 13 ug/l in point of compliance wells 5WC22 and 5WC23 at estimated values of 3.1 ug/l and 7.6 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 and November 2021 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 2021. MNA is the current remedial measure implemented at the Unit to address TCE in groundwater at concentrations greater than the GPS.

As stated in the 2014-2020 Annual Groundwater Monitoring Reports for the Unit (2020 Annual Report approved in VDEQ correspondence dated May 3, 2021; **Appendix E**) TCE remedial endpoints have been achieved. During Second Quarter 2021 and Fourth Quarter 2021, 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.

During Second Quarter 2021 and Fourth Quarter 2021, TCE was detected in point of compliance wells 5W7B, 5WC21, 5WC22, and 5WC23 at concentrations less than the GPS of 5 ug/l. TCE was detected less than the QL (1 ug/l) during Second Quarter 2021 and Fourth Quarter 2021 at point of compliance well 5W7B. TCE was not detected in any other wells comprising the CA monitoring network during the calendar year 2021 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 2021.

Total cobalt was detected at a concentration greater than the GPS of 7 ug/l in point of compliance well 5WC21 during Second Quarter 2021 and Fourth Quarter 2021.

Total cobalt was not detected at concentrations greater than the GPS in the other wells comprising the CA monitoring network.

2.6 Recommendations

TCE concentrations at HWMU-5 remained below the GPS throughout calendar year 2021 indicating achievement of TCE remedial endpoints. The current monitoring program is required to continue until the TCE concentrations have remained below the GPS for a period of three consecutive years; upon which the Permittee may request to end corrective action. However, although TCE concentrations in groundwater at the Unit have been less than the GPS for over three consecutive years, total cobalt, an Appendix J listed constituent, remains above the GPS in point of compliance well 5WC21 and continued monitoring is required as stated in Permit Condition VI.B.4.c. 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 2022.

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 2021 Monitoring Events:

Second Quarter 2021:	April 26-27, 2021, and June 24, 2021 (16-3 plume well resampling event due to laboratory error)
Fourth Quarter 2021:	October 6, 2021 and November 11, 2021 (verification event and also 16C1, 16WC1A, 16WC1B, 16MW8, 16MW9 resampling event due to laboratory error)

The calendar year 2021 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 2021 semiannual monitoring events are summarized in **Table 2**. The maximum groundwater elevation fluctuation of approximately 11.09 feet was observed at observation well 16C3; the

minimum groundwater elevation fluctuation of 0.02 feet was observed at plume monitoring well 16-2. On average, the groundwater elevation at Unit 16 fluctuated 4.44 feet, which is within the range of 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 2021 groundwater elevations was calculated to be 0.0871 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 11.8 ft/day or 4,307 ft/year based on the following:

- Average hydraulic conductivity of 7.87×10^{-5} ft/second.
- Average hydraulic gradient of 0.0871 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 2021 semiannual monitoring events were analyzed for the constituents listed in Permit Attachment 3, Appendix E – *Groundwater Compliance Monitoring (Semiannual) Constituent List*. In addition, during Fourth Quarter 2021 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 2021 groundwater monitoring events were conducted using revised DLs and QLs as presented in the recent Class 1 Permit Modification approved by the VDEQ in electronic correspondence dated May 5, 2021. Additionally, HWMU-16 total cobalt data were evaluated using the revised ASD for total cobalt in groundwater at HWMU-16 approved by the VDEQ in electronic correspondence dated September 13, 2021.

The laboratory analytical results for the 2021 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 2021 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 2021 are included in **Appendix E**.

3.4.1 Annual Monitoring – Permit Attachment 1, Appendix I

Annual monitoring is typically conducted during Second Quarter, however, due to the then-pending Class 1 Permit Modification approval, the Annual monitoring event was conducted in calendar year 2021 during Fourth Quarter 2021.

Four laboratories were utilized to complete the Annual Appendix IX groundwater monitoring event. The *final* laboratory analytical data package for this event was received on December 10, 2021. Other certificates of analysis/analytical data packages were received earlier which allowed for completion of the November 11, 2021 verification and resampling event prior to receipt of the final laboratory data package. The final laboratory data package for this event was associated only with ten Appendix IX semivolatile organic compound (SVOC) constituents analyzed by Pace Analytical Services (Pace) of West Columbia, South Carolina. Additional discussion regarding the November 11, 2021 verification and resampling event is provided below.

As documented in the December 15, 2021, Groundwater Monitoring Event Notification letter (**Appendix E**), the following Appendix IX constituent was initially

detected at an estimated concentration greater than the respective permit DL at HWMU-16 during the Fourth Quarter 2021 groundwater monitoring event:

Well Location	Constituent	Initial Concentration	Lab DL	Permit DL	Units
16MW8	Total Silver	0.32 J	0.3	0.3	ug/l

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

A verification event to confirm or refute the total silver result at 16MW8 was conducted on November 11, 2021, and final results were received on November 19, 2021. The verification event result indicated total silver was not detected at a concentration equal to or greater than the permit DL in point of compliance well 16MW8; therefore, no additional action was required with respect to total silver.

Additionally, all point of compliance wells were resampled on November 11, 2021 for the following Appendix IX constituents, due to the laboratory errors detailed below:

- Cyanide was recollected due to laboratory quality control (QC) issues (i.e., low/no spike recovery in the associated QC samples).
- Trans-1,4-dichloro-2 butene was recollected since the laboratory MDL did not meet the Permit-specified MDL. The laboratory reported an MDL of 1.67 ug/l compared to the Permit-specified MDL of 1.5 ug/l.

Cyanide and trans-1,4 -dichloro-2 butene were not detected at or above the Permit-specified MDLs in the samples collected from the point of compliance wells on November 11, 2021, and no additional action is required. Additional semivolatile aliquot was also collected from point of compliance wells on November 11, 2021. Ten Appendix IX constituents were requested to be analyzed by SVOC Method 8270E for point of compliance groundwater samples collected on October 6, 2021. Due to laboratory scheduling delays, groundwater samples from the October 6, 2021, event were extracted within holding time but were not analyzed within the 40-day holding time requirement, except for bis-2-ethylhexylphalate. Bis-2-ethylhexylphalate was analyzed and reported from the October 6, 2021 groundwater monitoring event. Since analysis for the remaining requested nine constituents to be analyzed by Pace would have been analyzed well beyond the 40-day holding time, SVOC analysis for these nine constituents were performed on point of compliance well samples collected as part of the November 11, 2021, resampling event. The final laboratory analytical data package

for this event was associated with the SVOC analysis discussed above and received from Pace on December 10, 2021.

No additional 40 CFR Part 264 Appendix IX constituents (as listed in Appendix I of Permit Attachment 1) were detected at concentrations greater than their respective permit MDLs in the samples collected from point of compliance wells during Fourth Quarter 2021 or the verification event. VDEQ notification of the verification event result, which included analysis of a sample and sample duplicate, are included in **Appendix E**.

Additional required action with respect to 2-propanol for the annual monitoring event was requested by the VDEQ in 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 2-propanol 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 during Second Quarter 2019 by ELLE of Lancaster, Pennsylvania is not routinely achieved by other VELAP-accredited laboratories. VDEQ also requested including this survey as an appendix in subsequent annual groundwater monitoring reports. A summary of the survey results and additional supporting information collected to-date are included in **Appendix E**. This information does not reflect a final analysis of data reliability of each laboratory for this analyte; such review will occur after the final required survey. It should be noted that 2-propanol was not detected at or above the Permit specified DL (50 ug/l) or QL (100 ug/l) reported by ELLE during Fourth Quarter 2021. The next survey will occur in 2022.

3.4.2 Comparison to Groundwater Protection Standards

As specified in the Final Permit, the calendar year 2021 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; modified to add vinyl chloride in Class 1 Permit Modification approved May 5, 2021). 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**).

During Second Quarter 2021, total cobalt was detected in point of compliance wells 16MW9, 16WC1A and 16WC1B at concentrations of 6.4 ug/l, 16 ug/l and 21 ug/l, respectively, which are greater than the Permit-specified GPS of 5 ug/l. During Fourth Quarter 2021, total cobalt was detected in point of compliance wells 16MW9 and 16WC1A at concentrations of 5.5 ug/l and 14 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 detected total cobalt concentrations to the latest (effective January 18, 2021) VDEQ ACL for cobalt of 6 ug/l. Additionally, the total cobalt data were evaluated using the revised ASD for total cobalt in groundwater at HWMU-16 for point of compliance wells 16MW9, 16WC1A, and 16WC1B approved by the VDEQ in electronic correspondence dated September 13, 2021. Based on the conclusions of the VDEQ-approved ASD, the calendar year 2021 total cobalt concentrations detected in point of compliance wells 16MW9, 16WC1A and 16WC1B appear to be consistent with natural variation in local groundwater and are not indicative of a release from the Unit. A verification event was not conducted for calendar year 2021 total cobalt concentrations detected in point of compliance wells 16MW9, 16WC1A and 16WC1B. As well, based on VDEQ correspondence dated September 13, 2021, a separate ASD will not be required.

Total cobalt was not detected at concentrations greater than the Permit-specified GPS or the latest VDEQ ACL in the other wells comprising the compliance monitoring network during the calendar year 2021 monitoring events.

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 2021 and Fourth Quarter 2021.

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 2021 and Fourth Quarter 2021, no constituents with GPS 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 calendar year 2021 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 was detected at concentrations greater than the site-specific background concentration of 175.4 ug/l in plume monitoring wells 16-2 and 16-3 during Second Quarter 2021, and in plume monitoring wells 16-2 and 16-3 and spring sampling location 16SPRING during Fourth Quarter 2021. All total barium concentrations detected in the plume monitoring locations 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. In correspondence dated May 3, 2021, VDEQ acknowledged the presence of barium above the site-specific background concentration due to lithology. However, VDEQ may request further investigation if barium levels in groundwater increase in the future. No further action regarding calendar year 2021 total barium concentrations detected in plume monitoring wells above the site-specific background concentration is recommended at this time.

No other constituent concentrations detected in the plume monitoring wells were greater than their respective background concentration or applicable Permit-specified QL, as listed in Permit Appendix G to Attachment 3. 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

No further action regarding the 2021 total barium concentrations detected in plume monitoring wells 16-2 and 16-3 and in spring sampling location 16SPRING is recommended at this time.

No further action regarding the 2021 total cobalt concentrations detected in point of compliance wells 16MW9, 16WC1A and 16WC1B is recommended at this time based on the recently approved total cobalt ASD.

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). A summary of the survey results and additional supporting information collected to-date are included in Appendix E. This information does not reflect a final analysis of data reliability of each laboratory for this analyte; such review will occur after the final required survey. The next survey will occur in 2022.

The next semiannual groundwater monitoring event is scheduled for Second Quarter 2022.

SIGNATURE/CERTIFICATION

Prepared by:

Name: Will Mason-Deese; 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 - 2021
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

MONITORING WELL ID	ELEVATION TOP OF WELL	APRIL 29, 2021		OCTOBER 7, 2021	
		DTW	GW ELEV	DTW	GW ELEV
5W8B	1789.58	15.51	1774.07	14.92	1774.66
5W5B	1775.13	9.50	1765.63	9.50	1765.63
5W7B	1774.78	9.91	1764.87	9.68	1765.10
5WC21	1774.43	9.87	1764.56	9.57	1764.86
5WC22	1774.45	9.79	1764.66	9.65	1764.80
5WC23	1773.84	9.14	1764.70	9.05	1764.79
5W12A	1772.46	11.61	1760.85	11.51	1760.95
S5W5	1772.31	9.88	1762.43	8.85	1763.46
S5W7	1776.08	11.88	1764.20	11.66	1764.42
5W9A	1762.20	1.18	1761.02	1.79	1760.41
5W10A	1771.40	12.71	1758.69	13.94	1757.46
5W11A	1766.20	9.95	1756.25	11.92	1754.28
5WC11	1788.92	16.54	1772.38	15.85	1773.07
5WC12	1788.96	16.83	1772.13	16.20	1772.76
5WCA	1779.05	13.12	1765.93	13.13	1765.92
S5W6	1771.43	7.32	1764.11	7.43	1764.00
S5W8	1783.68	12.37	1771.31	11.68	1772.00

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 - 2021
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

MONITORING WELL ID	ELEVATION TOP OF WELL	APRIL 26, 2021		October 6, 2021	
		DTW	GW ELEV	DTW	GW ELEV
16C1	1840.14	44.39	1795.75	48.88	1791.26
16MW8	1815.82	68.90	1746.92	73.50	1742.32
16MW9	1808.88	59.13	1749.75	64.91	1743.97
16WC1A	1812.61	60.34	1752.27	68.01	1744.60
16WC1B	1812.95	60.34	1752.61	68.33	1744.62
16-1	1815.82	40.98	1774.84	47.32	1768.50
16-2	1810.99	55.87	1755.12	55.89	1755.10
16-3	1824.77	53.85	1770.92	56.39	1768.38
16-5	1742.60	3.44	1739.16	4.26	1738.34
16WC2B	1818.71	49.79	1768.92	53.94	1764.77
16WC2A	1820.05	61.25	1758.80	DRY	DRY
16C3	1822.22	56.04	1766.18	67.13	1755.09
16CDH3	1825.60	68.30	1757.30	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.

Table 3: Indicator Parameter Data for Monitoring Wells
Radford Army Ammunition Plant (RFAAP) - Hazardous Waste Management Unit #5
Radford, Virginia

Indicator Parameter	*Unit*	*5W8B*	*5W5B*	*5W7B*	*5WC21*	*5WC22*	*5WC23*	*5W12A*
Second Quarter 2021								
DO	mg/L	7.31	3.47	7.54	0.69	0.26	2.16	2.8
ORP	mV	242.7	287.8	290.8	8.6	59.1	9.6	212.5
pH	s.u.	4.6	5.34	4.2	5.98	6.71	6.88	6.65
Specific Conductivity	uS/cm	60.5	325.2	200.3	747	1005	1122	529.7
Temperature	deg C	14.1	12.6	13	14.6	14.5	13.4	14
Turbidity	NTU	0.98	0.35	1.32	13.8	2.45	0.84	1.12
Fourth Quarter 2021								
DO	mg/L	4.86	3.02	1.31	1.19	0.98	0.19	2.66
ORP	mV	201.8	224.7	225	210.3	226.6	219.7	218
pH	s.u.	4.88	4.88	3.89	5.82	6.56	6.72	6.83
Specific Conductivity	uS/cm	59.4	279	230.2	656	849	1028	463.7
Temperature	deg C	16.1	16.5	16.4	15.5	15.2	15.5	14.8
Turbidity	NTU	1.17	1.03	1.11	3.54	1.07	1.55	1.5

Table 4: Indicator Parameter Data for Monitoring Wells.

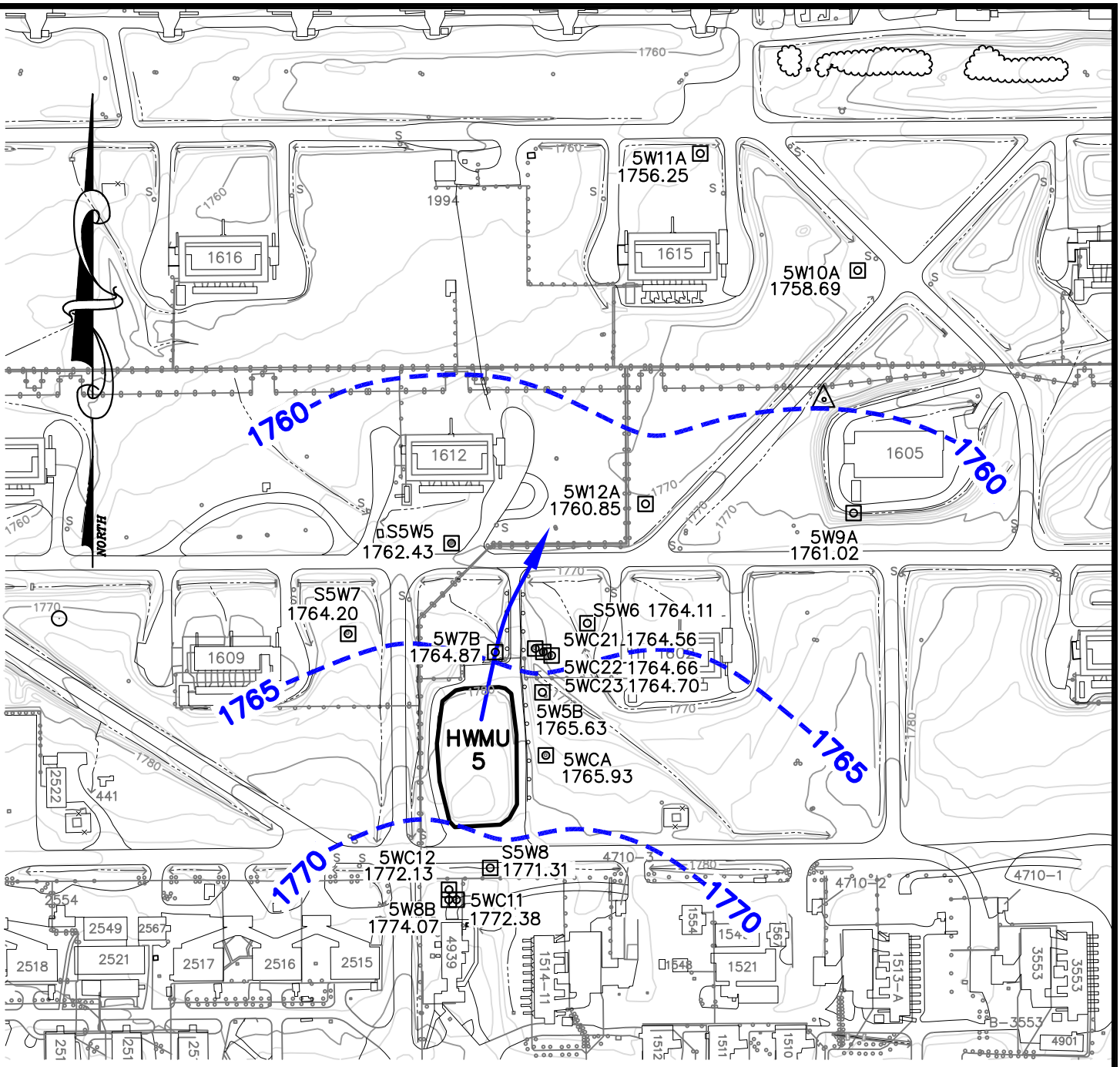
Radford Army Ammunition Plant (RFAAP) - Hazardous Waste Management Unit #16

Radford, Virginia

Indicator Parameter	*Unit*	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*16WC2B*	*16-2*	*16-3*	*16-5*
Fourth Quarter 2021										
Dissolved Oxygen (DO)	mg/L	0.89	0.22	0.29	6.36	2.54	0.67	5.99	5.15	2.16
Oxidation Reduction Potential (ORP)	mV	144.4	186.7	108.7	72.9	177.7	167	179.8	177.8	178.4
pH	s.u.	6.08	4.83	6.28	6.36	5.81	7.67	6.68	7.59	7.71
Specific Conductivity	uS/cm	600.1	152.6	836	703	364.4	293	511	221.4	487.6
Temperature	degs C	15.5	15.3	14.3	15.4	14.9	14.2	14.2	15.9	14
Turbidity	NTU	0.73	7.08	0.78	1.26	4.32	1.11	0.83	1.11	1.28
Second Quarter 2021										
Dissolved Oxygen (DO)	mg/L	1.54	0.33	0.48	0.52	0.48	1.22	6.02	4.59	1.92
Oxidation Reduction Potential (ORP)	mV	53	7.6	7.8	-18.6	34.4	9.1	37.8	15.3	-31.2
pH	s.u.	6.37	5.47	6.4	6.42	6.14	7.69	7.05	7.83	7.29
Specific Conductivity	uS/cm	572.4	177.6	995	753	398.8	309.5	513.5	240.2	511.9
Temperature	degs C	13.9	14.2	13.2	13.1	12.6	13.7	13.6	14.1	12.6
Turbidity	NTU	0.33	1.07	0.38	0.34	3.73	0.32	0.4	2.88	3.53

APPENDIX A

HWMU-5



GRAPHIC SCALE

200 0 100 200 400

(IN FEET)

1 inch = 200 ft.

LEGEND

5W7B
1764.87 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 29, 2021)

RADFORD ARMY AMMUNITION PLANT

RADFORD, VIRGINIA

SCALE: 1"=200'

PLAN NO. 2100706

Draper Aden Associates

Engineering • Surveying • Environmental Services

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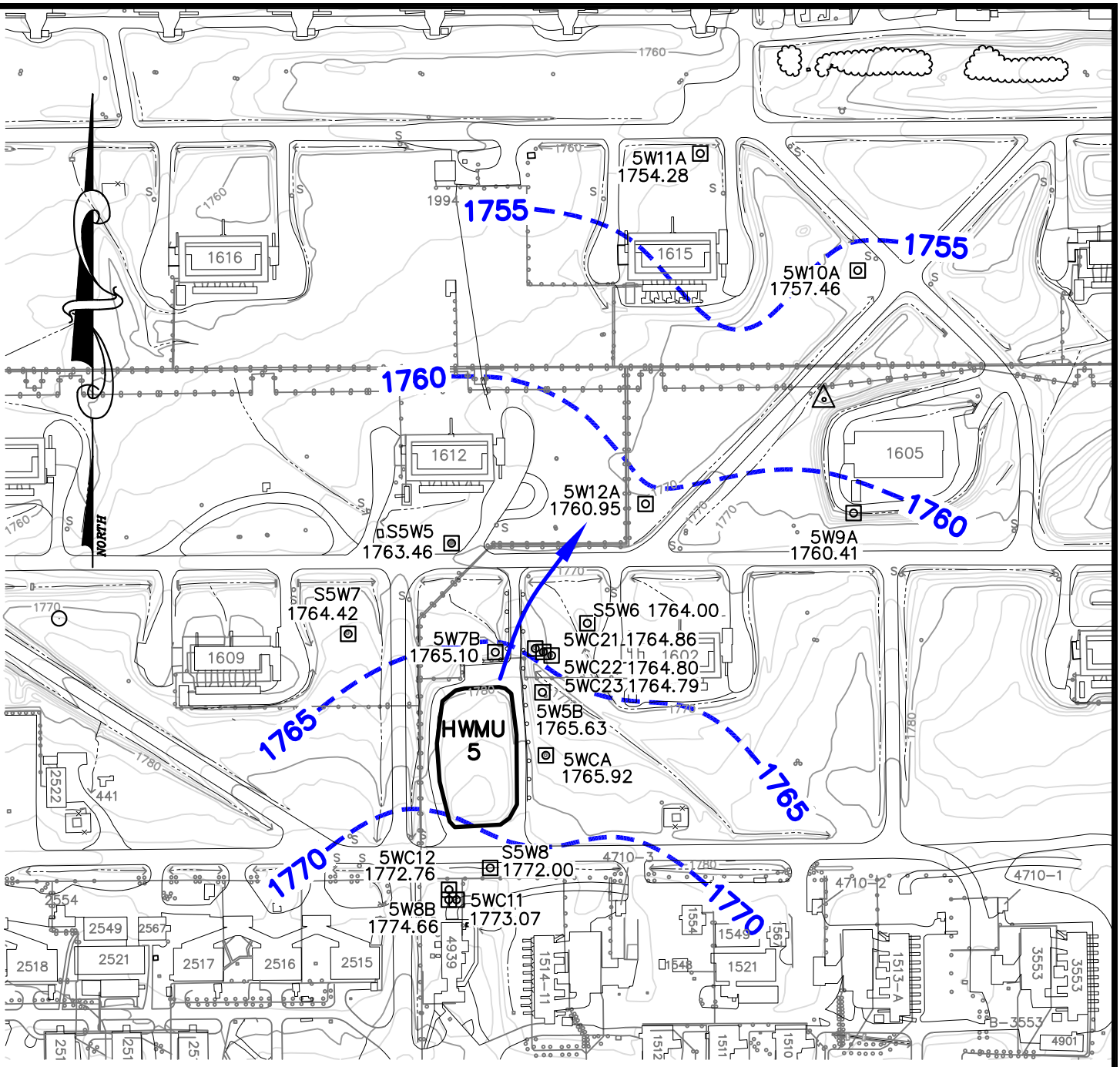
540-552-0444 Fax: 540-552-0291

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

DESIGNED	WMD
DRAWN	DLD
CHECKED	MDL
DATE	07/30/21

FIGURE 1

P:\2021\00700\2100706\01-ENVCAD\2100706_HWMU-5 April 2021.dwg Jul 28, 2021 9:00am



GRAPHIC SCALE

200 0 100 200 400

(IN FEET)

1 inch = 200 ft.

LEGEND

5W7B
1765.10 — 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 (OCTOBER 07, 2021)

RADFORD ARMY AMMUNITION PLANT

RADFORD, VIRGINIA

SCALE: 1"=200'

PLAN NO. 2100706

Draper Aden Associates

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

DESIGNED	WMD
DRAWN	DLD
CHECKED	MDL
DATE	12/15/2021

FIGURE 1

P:\2021\00700\2100706\01-ENVCAD\2100706_HWMU-5 OCTOBER 2021.dwg Dec 15, 2021 3:56pm

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 2021	U	U	6.4	18	4.96 J	1.5 J	U	5	5	7	1	1	ug/L	6020B
Fourth Quarter 2021	U	U	6.7	19	3.3 J	U	U	5	5	7	1	1	ug/L	6020B
1,1-Dichloroethene						*CAS #* 75-35-4								
Second Quarter 2021	U	U	U	U	U	U	U	1	1	7	0.2	0.2	ug/L	8260C LL
Fourth Quarter 2021	U	U	U	U	U	U	U	1	1	7	0.2	0.2	ug/L	8260D
cis-1,2-Dichloroethene						*CAS #* 156-59-2								
Second Quarter 2021	U	U	U	U	U	U	U	1	1	70	0.1	0.1	ug/L	8260C LL
Fourth Quarter 2021	U	U	U	U	U	U	U	1	1	70	0.1	0.1	ug/L	8260D
trans-1,2-Dichloroethene						*CAS #* 156-60-5								
Second Quarter 2021	U	U	U	U	U	U	U	1	1	100	0.8	0.8	ug/L	8260C LL
Fourth Quarter 2021	U	U	U	U	U	U	U	1	1	100	0.8	0.8	ug/L	8260D
Trichloroethene						*CAS #* 79-01-6								
Second Quarter 2021	U	U	0.3 J	1.7	2	2.9	U	1	1	5	0.3	0.3	ug/L	8260C LL
Fourth Quarter 2021	U	U	0.48 J	1.2	1.6	3	U	1	1	5	0.3	0.3	ug/L	8260D
Vinyl chloride						*CAS #* 75-01-4								
Second Quarter 2021	U	U	U	U	U	U	U	1	1	2	0.2	0.2	ug/L	8260C LL
Fourth Quarter 2021	U	U	U	U	U	U	U	1	1	2	0.2	0.2	ug/L	8260D

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. Class 1 Permit Mod approved May 5, 2021

DL Denotes laboratory detection limit.
Permit DL Denotes permit detection limit. Class 1 Permit Mod approved May 5, 2021
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/May 2021 Class I Permit Mods.
The first Corrective Action Monitoring Event occurred Second Quarter 2010.
"–" denotes not sampled.

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 2021	-	U	U	U	U	U	2	2	6	0.5	0.6	ug/L	6020B
Arsenic						*CAS #* 7440-38-2							
Second Quarter 2021	-	U	U	U	U	U	10	10	10	2	2	ug/L	6020B
Barium						*CAS #* 7440-39-3							
Second Quarter 2021	-	21	21	15	27	19	10	10	2,000	1.3	1.3	ug/L	6020B
Beryllium						*CAS #* 7440-41-7							
Second Quarter 2021	-	U	0.31 J	0.21 J	U	U	1	1	4	0.2	0.3	ug/L	6020B
Cadmium						*CAS #* 7440-43-9							
Second Quarter 2021	-	U	U	U	U	U	1	1	5	0.2	0.2	ug/L	6020B
Chromium						*CAS #* 7440-47-3							
Second Quarter 2021	-	U	2.5 J	2.6 J	U	U	5	5	100	1.3	1	ug/L	6020B
Cobalt						*CAS #* 7440-48-4							
Second Quarter 2021	U	U	6.4	18	4.96 J	1.5 J	5	5	7	1	1	ug/L	6020B
Fourth Quarter 2021	U	U	6.7	19	3.3 J	U	5	5	7	1	1	ug/L	6020B
Copper						*CAS #* 7440-50-8							
Second Quarter 2021	-	U	3.7 J	U	U	U	5	5	1,300	2	1.7	ug/L	6020B
Lead						*CAS #* 7439-92-1							
Second Quarter 2021	-	U	U	U	U	U	3	3	15	1	1	ug/L	6020B
Mercury						*CAS #* 7439-97-6							
Second Quarter 2021	-	U	U	U	U	U	2	2	2	0.2	0.2	ug/L	7470A
Nickel						*CAS #* 7440-02-0							
Second Quarter 2021	-	U	6.9 J	11	4 J	2.5 J	10	10	300	2	2	ug/L	6020B
Selenium						*CAS #* 7782-49-2							
Second Quarter 2021	-	U	U	U	U	U	10	10	50	3	3	ug/L	6020B
Silver						*CAS #* 7440-22-4							
Second Quarter 2021	-	U	U	U	U	U	2	2	71	0.3	0.3	ug/L	6020B
Thallium						*CAS #* 7440-28-0							
Second Quarter 2021	-	U	U	U	U	U	1	1	2	0.2	0.2	ug/L	6020B
Vanadium						*CAS #* 7440-62-2							
Second Quarter 2021	-	U	U	U	U	U	10	10	63	2.5	2.5	ug/L	6020B
Zinc						*CAS #* 7440-66-6							
Second Quarter 2021	-	U	19 J	7.5 J	U	U	30	30	4700	7.3	7.3	ug/L	6020B

See last page of this report for definitions.

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*
Acetone						*CAS #* 67-64-1							
Second Quarter 2021	-	U	U	U	U	U	10	10	12000	3	3	ug/L	8260C LL
bis(2-Ethylhexyl)phthalate						*CAS #* 117-81-7							
Second Quarter 2021	-	U	U	U	U	U	6	6	10	2	1.5	ug/L	8270D
2-Butanone						*CAS #* 78-93-3							
Second Quarter 2021	-	U	U	U	U	U	10	10	4900	1.7	1.7	ug/L	8260C LL
Chloroform						*CAS #* 67-66-3							
Second Quarter 2021	-	1.5	0.76 J	1.6	1.5	1.3	1	1	80	0.3	0.3	ug/L	8260C LL
Dichlorodifluoromethane						*CAS #* 75-71-8							
Second Quarter 2021	-	U	U	U	U	U	1	1	190	0.4	0.4	ug/L	8260C LL
1,2-Dichloroethane						*CAS #* 107-06-2							
Second Quarter 2021	-	U	U	U	U	U	1	1	5	0.3	0.3	ug/L	8260C LL
Diethyl ether						*CAS #* 60-29-7							
Second Quarter 2021	-	U	U	U	3.1 J	7.6 J	13	12.5	7,300	1.1	1.11	ug/L	8260C LL
Diethyl phthalate						*CAS #* 84-66-2							
Second Quarter 2021	-	U	U	U	U	U	10	10	11000	2	2	ug/L	8270D
2,4-Dinitrotoluene						*CAS #* 121-14-2							
Second Quarter 2021	-	U	U	U	U	U	10	10	10	1	2.1	ug/L	8270D
2,6-Dinitrotoluene						*CAS #* 606-20-2							
Second Quarter 2021	-	U	U	U	U	U	10	10	10	0.71	2.1	ug/L	8270D
Methylene chloride						*CAS #* 75-09-2							
Second Quarter 2021	-	U	U	U	U	U	1	1	5	0.7	0.7	ug/L	8260C LL
o-Nitroaniline						*CAS #* 88-74-4							
Second Quarter 2021	-	U	U	1.7 J	2 J	2 J	10	10	150	1	1	ug/L	8270D
p-Nitroaniline						*CAS #* 100-01-6							
Second Quarter 2021	-	U	U	U	U	U	20	20	20	1.3	1.5	ug/L	8270D
Nitrobenzene						*CAS #* 98-95-3							
Second Quarter 2021	-	U	U	U	U	U	10	10	10	0.81	0.8	ug/L	8270D
Toluene						*CAS #* 108-88-3							
Second Quarter 2021	-	U	U	U	U	U	1	1	1,000	0.3	0.3	ug/L	8260C LL
Xylenes (Total)						*CAS #* 1330-20-7							
Second Quarter 2021	-	U	U	U	U	U	3	3	10,000	0.4	0.4	ug/L	8260C LL

See last page of this report for definitions.

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*

Definitions:

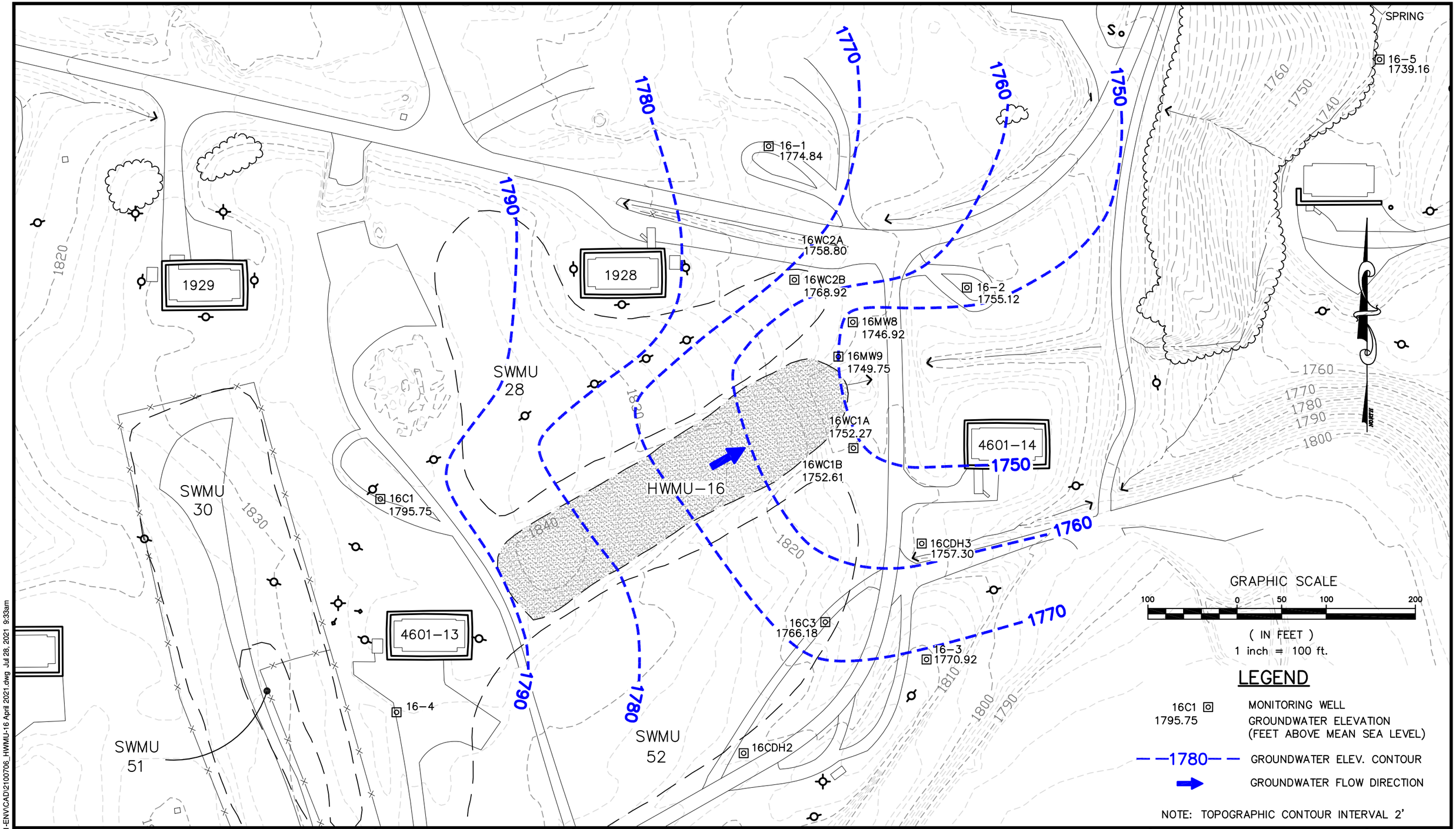
Results are reported to the Permit Detection Limit.
First Corrective Action Monitoring Event Second Quarter 2010:

QL: Denotes laboratory quantitation limit.
Permit QL: Denotes permit quantitation limit. Approved May 5, 2021
Class 1 Permit Modification approved May 5, 2021
DL: Denotes laboratory detection limit.
Permit DL: Denotes permit detection limit.
Class 1 Permit Modification approved May 5, 2021
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 and May 5, 2021 Class I Permit Mods);
"–": Denotes not sampled.

APPENDIX B

HWMU-16



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Northern Virginia
Virginia Beach, VA

DESIGNED	WMD
DRAWN	DLD
CHECKED	MDL
DATE	07/30/2021

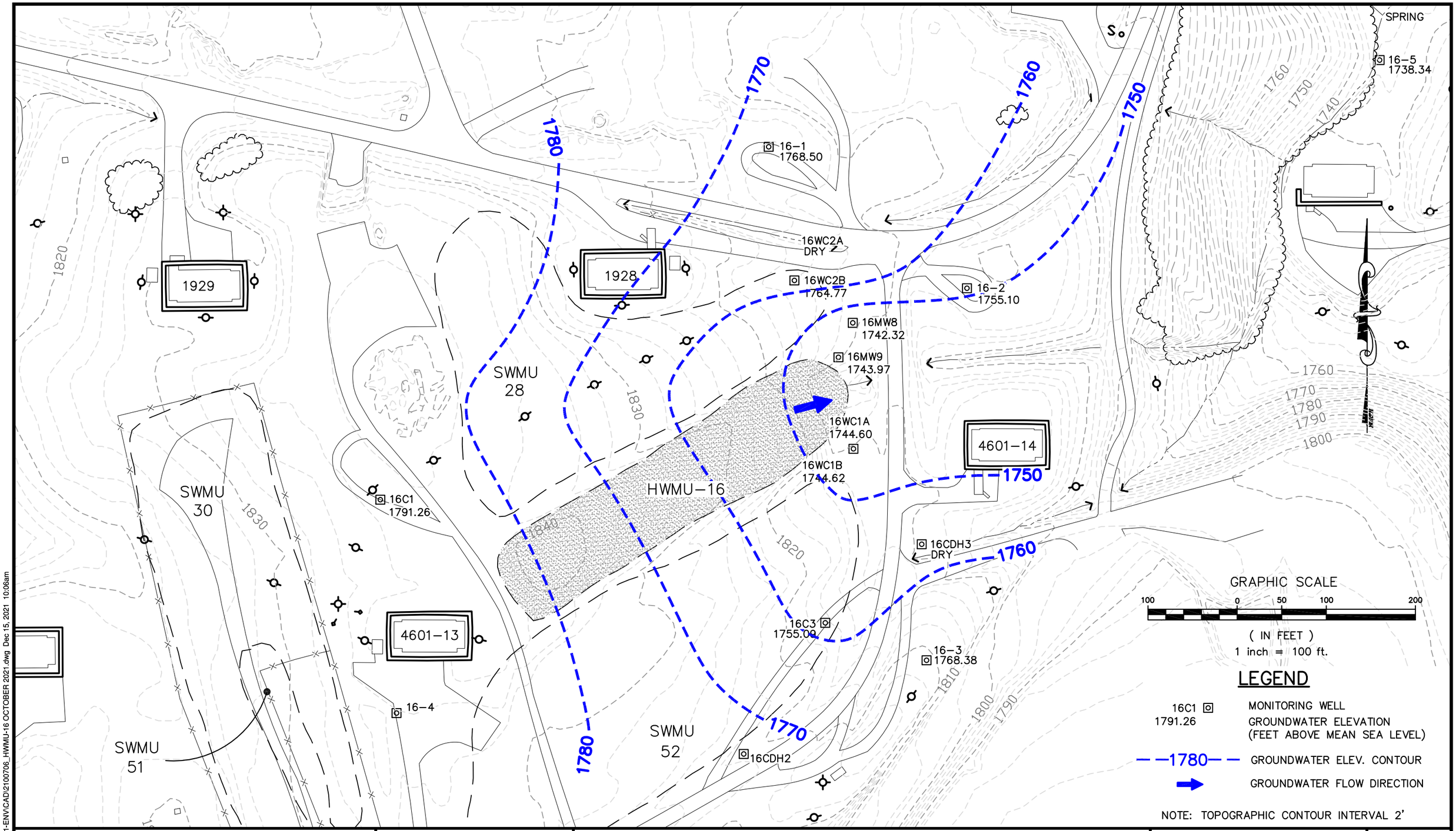
HWMU-16 POTENTIOMETRIC SURFACE MAP - APRIL 26, 2021
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

SCALE: 1"=100'

PLAN NO. 2100706

FIGURE 2

P:\2021\00700\2100706\01-ENV\CAD\2100706_HWMU-16 April 2021.dwg Jul 28, 2021 9:33am



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Fayetteville, NC
Northern Virginia
Virginia Beach, VA

DESIGNED	WMD
DRAWN	DLD
CHECKED	MDL
DATE	12/15/2021

HWMU-16 POTENTIOMETRIC SURFACE MAP - OCTOBER 06, 2021
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

SCALE: 1"=100'

PLAN NO. 2100706

FIGURE 2

P:\2021\00700\2100706\01-ENV\CAD\2100706_HWMU-16 OCTOBER 2021.dwg Dec 15, 2021 10:08am

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

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

Analyte/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*Permit QL*	*DL*	*Permit DL*	*GPS*	*Method*
Antimony					*CAS #*	*7440-36-0*					
Fourth Quarter 2021	U	U	U	U	U	2	2	0.6	0.6	-	6020B
Arsenic					*CAS #*	*7440-38-2*					
Second Quarter 2021	U	U	U	U	U	10	10	1.3	2	10	6020B
Fourth Quarter 2021	U	U	2.1	3.4	U	10	10	2	2	10	6020B
Fourth Quarter 2021	U	U	2.1 J	3.4 J	U	10	10	2	2	10	6020B
Barium					*CAS #*	*7440-39-3*					
Second Quarter 2021	160	130	630	460	110	10	10	1.3	1.3	2000	6020B
Fourth Quarter 2021	200	150	630	470	120	10	10	1.3	1.3	2000	6020B
Beryllium					*CAS #*	*7440-41-7*					
Second Quarter 2021	U	U	U	U	U	1	1	0.15	0.3	4	6020B
Fourth Quarter 2021	U	0.34 J	U	U	U	1	1	0.3	0.3	4	6020B
Cadmium					*CAS #*	*7440-43-9*					
Second Quarter 2021	U	U	U	U	U	1	1	0.13	0.2	5	6020B
Fourth Quarter 2021	U	0.57 J	U	0.21 J	U	1	1	0.2	0.2	5	6020B
Chromium					*CAS #*	*7440-47-3*					
Second Quarter 2021	U	U	U	U	U	5	5	1.3	1	100	6020B
Fourth Quarter 2021	U	U	U	U	U	5	5	1	1	100	6020B
Cobalt					*CAS #*	*7440-48-4*					
Second Quarter 2021	U	U	6.4	16	21	5	5	1.3	1	5	6020B
Fourth Quarter 2021	U	1 J	5.5	14	4.2 J	5	5	1	1	5	6020B
Copper					*CAS #*	*7440-50-8*					
Second Quarter 2021	U	U	U	U	U	5	5	1.3	1.7	1300	6020B
Fourth Quarter 2021	U	28	U	2.1 J	U	5	5	1.7	1.7	1300	6020B
Lead					*CAS #*	*7439-92-1*					
Second Quarter 2021	U	U	U	U	U	3	3	0.25	1	15	6020B
Fourth Quarter 2021	U	1.7 J	U	U	U	3	3	1	1	15	6020B
Mercury					*CAS #*	*7439-97-6*					
Second Quarter 2021	U	U	U	U	U	2	2	0.2	0.2	2	7470A
Fourth Quarter 2021	U	U	U	U	0.22 J	2	2	0.2	0.2	2	7470A
Nickel					*CAS #*	*7440-02-0*					
Second Quarter 2021	U	U	17	14	U	10	10	1.3	2	300	6020B
Fourth Quarter 2021	3.8 J	4.1 J	12	11	U	10	10	2	2	300	6020B
Selenium					*CAS #*	*7782-49-2*					
Fourth Quarter 2021	U	U	U	U	U	10	10	3	3	-	6020B
Silver					*CAS #*	*7440-22-4*					
Fourth Quarter 2021 Verification Event		U	-	-	-	2	2	0.3	0.3	-	6020B
Fourth Quarter 2021	U	0.32 J	U	U	U	2	2	0.3	0.3	-	6020B
Thallium					*CAS #*	*7440-28-0*					
Fourth Quarter 2021	U	U	U	U	U	1	1	0.2	0.2	-	6020B
Vanadium					*CAS #*	*7440-62-2*					
Second Quarter 2021	U	U	U	U	U	10	10	2.5	2.5	151	6020B
Fourth Quarter 2021	U	U	U	U	U	10	10	2.5	2.5	151	6020B
Zinc					*CAS #*	*7440-66-6*					
Second Quarter 2021 Resampling	U	U	U	U	U	30	30	2.5	7.3	4700	6020B
Fourth Quarter 2021	U	56	U	U	U	30	30	7.3	7.3	4700	6020B
Cyanide					*CAS #*	*57-12-5*					
Fourth Quarter 2021	U R	U R	U R	U R	U R	20	20	5	5	-	9012B
Note 1 Fourth Quarter 2021	U	U	U	U	U	20	20	5	5	-	9012B
Acenaphthene					*CAS #*	*83-32-9*					
Fourth Quarter 2021	U	U	U	U	U	10	10	0.35	0.35	-	8270D
Acenaphthylene					*CAS #*	*208-96-8*					
Fourth Quarter 2021	-	U	U	U	U	10	10	0.46	0.48	-	8270D
Fourth Quarter 2021	U	-	-	-	-	10	10	0.47	0.48	-	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.*

Analyte/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*Permit QL*	*DL*	*Permit DL*	*GPS*	*Method*
Acetone					*CAS #*	*67-64-1*					
Fourth Quarter 2021	-	U	U	U	U	10	10	2	2	-	8260D
Fourth Quarter 2021	U	-	-	-	-	13	10	2.3	2	-	8260D
Acetonitrile					*CAS #*	*75-05-8*					
Fourth Quarter 2021	U	-	-	-	-	25	100	13	31.67	-	8260D
Fourth Quarter 2021	-	U	U	U	U	100	100	31	31.67	-	8260D
Acetophenone					*CAS #*	*98-86-2*					
Fourth Quarter 2021	-	U	U	U	U	8.9	10	0.89	1	-	8270E
Fourth Quarter 2021	U	-	-	-	-	9.3	10	0.93	1	-	8270E
2-Acetylaminofluorene					*CAS #*	*53-96-3*					
Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.8	3	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.7	3	-	8270E
Acrolein					*CAS #*	*107-02-8*					
Fourth Quarter 2021	U	U	U	U	U	5	10	1.67	3.4	-	8260D
Acrylonitrile					*CAS #*	*107-13-1*					
Fourth Quarter 2021	-	U	U	U	U	10	10	1.1	1.1	-	8260D
Fourth Quarter 2021	U	-	-	-	-	13	10	1	1.1	-	8260D
Allyl chloride					*CAS #*	*107-05-1*					
Fourth Quarter 2021	U J	-	-	-	-	1.3	10	0.13	1	-	8260D
Fourth Quarter 2021	- J	U	U	U	U	10	10	1	1	-	8260D
4-Aminobiphenyl					*CAS #*	*92-67-1*					
Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.7	3	-	8270E
Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.8	3	-	8270E
Aniline					*CAS #*	*62-53-3*					
Fourth Quarter 2021	-	U	U	U	U	8.9	10	0.98	1.1	-	8270E
Fourth Quarter 2021	U	-	-	-	-	9.3	10	1	1.1	-	8270E
Anthracene					*CAS #*	*120-12-7*					
Fourth Quarter 2021	U	-	-	-	-	10	10	0.51	0.52	-	8270D
Fourth Quarter 2021	-	U	U	U	U	10	10	0.5	0.52	-	8270D
Aramite					*CAS #*	*140-57-8*					
Fourth Quarter 2021	U	-	-	-	-	9.3	10	3.4	3.7	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	3.3	3.7	-	8270E
Benzene					*CAS #*	*71-43-2*					
Second Quarter 2021	U	U	U	U	U	1	1	0.05	0.3	5	8260C LL
Fourth Quarter 2021	- J	U	0.52 J	U	U	1	1	0.3	0.3	5	8260D
Fourth Quarter 2021	0.31 J	-	- J	-	-	1.3	1	0.13	0.3	5	8260D
Benzo[a]anthracene					*CAS #*	*56-55-3*					
Fourth Quarter 2021	-	U	U	U	U	10	10	0.43	0.45	-	8270D
Fourth Quarter 2021	U	-	-	-	-	10	10	0.44	0.45	-	8270D
Benzo[b]fluoranthene					*CAS #*	*205-99-2*					
Fourth Quarter 2021	U	U	U	U	U	10	10	1.2	1.2	-	8270D
Benzo[k]fluoranthene					*CAS #*	*207-08-9*					
Fourth Quarter 2021	U	U	U	U	U	10	10	1.6	1.6	-	8270D
Benzo[ghi]perylene					*CAS #*	*191-24-2*					
Fourth Quarter 2021	U	U	U	U	U	10	10	0.4	0.42	-	8270D
Benzo(a)pyrene					*CAS #*	*50-32-8*					
Fourth Quarter 2021	U	U	U	U	U	10	10	1.5	1.5	-	8270D
1,4-Benzenediamine					*CAS #*	*106-50-3*					
Fourth Quarter 2021	-	U	U	U	U	130	150	24	26.4	-	8270E
Fourth Quarter 2021	U	-	-	-	-	140	150	24	26.4	-	8270E
Benzyl alcohol					*CAS #*	*100-51-6*					
Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.8	3	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.7	3	-	8270E
bis(2-Chloroethoxy)methane					*CAS #*	*111-91-1*					
Fourth Quarter 2021	-	U	U	U	U	0.89	1	0.45	0.5	-	8270E
Fourth Quarter 2021	U	-	-	-	-	0.93	1	0.46	0.5	-	8270E

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.*

Analyte/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*Permit QL*	*DL*	*Permit DL*	*GPS*	*Method*
bis(2-Chloroethyl)ether					*CAS #*	*111-44-4*					
Fourth Quarter 2021	-	U	U	U	U	0.89	1	0.45	0.5	-	8270E
Fourth Quarter 2021	U	-	-	-	-	0.93	1	0.46	0.5	-	8270E
bis(2-Chloro-1-methylethyl)ether					*CAS #*	*108-60-1*					
Fourth Quarter 2021	-	U	U	U	-	2	10	0.6	0.6	-	8270D
Fourth Quarter 2021	U	-	-	-	U	2	10	0.61	0.6	-	8270D
bis(2-Ethylhexyl)phthalate					*CAS #*	*117-81-7*					
Fourth Quarter 2021	U	U	U	U	U	4	10	2	2	-	8270E
Bromodichloromethane					*CAS #*	*75-27-4*					
Fourth Quarter 2021	-	U	U	U	U	1	1	0.3	0.3	-	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.13	0.3	-	8260D
Bromoform					*CAS #*	*75-25-2*					
Fourth Quarter 2021	U	-	-	-	-	2.5	1	0.75	0.4	-	8260D
Fourth Quarter 2021	-	U	U	U	U	1	1	0.4	0.4	-	8260D
4-Bromophenyl phenyl ether					*CAS #*	*101-55-3*					
Fourth Quarter 2021	-	U	U	U	U	10	10	0.54	0.56	-	8270D
Fourth Quarter 2021	U	-	-	-	-	10	10	0.55	0.56	-	8270D
2-Butanone					*CAS #*	*78-93-3*					
Second Quarter 2021	U	U	U	U	U	10	10	0.6	1.7	4900	8260C LL
Fourth Quarter 2021	-	U	U	U	U	10	10	1.7	1.7	4900	8260D
Fourth Quarter 2021	U	-	-	-	-	13	10	1.5	1.7	4900	8260D
Butyl benzyl phthalate					*CAS #*	*85-68-7*					
Fourth Quarter 2021	U	-	-	-	-	9.3	10	0.65	0.7	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	0.63	0.7	-	8270E
Carbon disulfide					*CAS #*	*75-15-0*					
Fourth Quarter 2021	-	U	U	U	U	10	10	0.4	0.4	-	8260D
Fourth Quarter 2021	U	-	-	-	-	2.5	10	0.15	0.4	-	8260D
Carbon tetrachloride					*CAS #*	*56-23-5*					
Second Quarter 2021	U	U	U	U	U	1	1	0.07	0.3	5	8260C LL
Fourth Quarter 2021	-	U	U	U	U	1	1	0.3	0.3	5	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.18	0.3	5	8260D
p-Chloroaniline					*CAS #*	*106-47-8*					
Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.9	3.3	-	8270E
Fourth Quarter 2021	U	-	-	-	-	9.3	10	3.1	3.3	-	8270E
Chlorobenzilate					*CAS #*	*510-15-6*					
Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.7	3	-	8270E
Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.8	3	-	8270E
p-Chloro-m-cresol					*CAS #*	*59-50-7*					
Fourth Quarter 2021	U	U	U	U J	U	10	10	1	1	-	8270D
Chloroethane					*CAS #*	*75-00-3*					
Second Quarter 2021	2.6	U	1.7	1.1	U	1	1	0.07		21000	8260C LL
Fourth Quarter 2021	2.7	-	-	-	-	1.3	1	0.18		21000	8260D
Fourth Quarter 2021	-	-	-	1.5	-	1	1	1		21000	8260D
Fourth Quarter 2021	-	U	2.1	-	U	1	1	0.07		21000	8260D
Chloroform					*CAS #*	*67-66-3*					
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.23	0.3	-	8260D
Fourth Quarter 2021	-	U	U	U	U	1	1	0.3	0.3	-	8260D
2-Chloronaphthalene					*CAS #*	*91-58-7*					
Fourth Quarter 2021	-	U	U	U	U	10	10	0.48	0.5	-	8270D
Fourth Quarter 2021	U	-	-	-	-	10	10	0.49	0.5	-	8270D
2-Chlorophenol					*CAS #*	*95-57-8*					
Fourth Quarter 2021	U	U	U	U J	U	10	10	1	1	-	8270D
4-Chlorophenyl phenyl ether					*CAS #*	*7005-72-3*					
Fourth Quarter 2021	U	-	-	-	U	10	10	0.59	0.6	-	8270D
Fourth Quarter 2021	-	U	U	U	-	10	10	0.58	0.6	-	8270D

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

Analyte/Quarter	16C1	16MW8	16MW9	16WC1A	16WC1B	QL	Permit QL	DL	Permit DL	GPS	Method
Chloroprene					CAS # 126-99-8						
Fourth Quarter 2021	-	U	U	U	U	10	10	0.46	0.46	-	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	10	0.15	0.46	-	8260D
Chrysene					CAS # 218-01-9						
Fourth Quarter 2021	U	U	U	U	U	10	10	0.31	0.31	-	8270D
Diallate					CAS # 2303-16-4						
Fourth Quarter 2021	U	U	U	U	U	10	10	3	3	-	8270D
Dibenz(a,h)anthracene					CAS # 53-70-3						
Fourth Quarter 2021	U	U	U	U	U	10	10	0.36	0.38	-	8270D
Dibenzofuran					CAS # 132-64-9						
Fourth Quarter 2021	U	-	-	-	U	10	10	0.59	0.6	-	8270D
Fourth Quarter 2021	-	U	U	U	-	10	10	0.58	0.6	-	8270D
Dibromochloromethane					CAS # 124-48-1						
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.18	0.4	-	8260D
Fourth Quarter 2021	-	U	U	U	U	1	1	0.4	0.4	-	8260D
1,2-Dibromo-3-chloropropane					CAS # 96-12-8						
Fourth Quarter 2021	-	U	U	U	U	1	1	0.4	0.4	-	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.25	0.4	-	8260D
1,2-Dibromoethane					CAS # 106-93-4						
Fourth Quarter 2021	-	U	U	U	U	1	1	0.3	0.3	-	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.15	0.3	-	8260D
Di-n-butyl phthalate					CAS # 84-74-2						
Fourth Quarter 2021	U	-	-	-	-	9.3	10	1.7	1.8	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	1.6	1.8	-	8270E
1,2-Dichlorobenzene					CAS # 95-50-1						
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.15	0.4	-	8260D
Fourth Quarter 2021	-	U	U	U	U	1	1	0.4	0.4	-	8260D
1,3-Dichlorobenzene					CAS # 541-73-1						
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.15	0.4	-	8260D
Fourth Quarter 2021	-	U	U	U	U	1	1	0.4	0.4	-	8260D
1,4-Dichlorobenzene					CAS # 106-46-7						
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.18	0.4	-	8260D
Fourth Quarter 2021	-	U	U	U	U	1	1	0.4	0.4	-	8260D
3,3'-Dichlorobenzidine					CAS # 91-94-1						
Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.7	3	-	8270E
Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.8	3	-	8270E
trans-1,4-Dichloro-2-butene					CAS # 110-57-6						
Fourth Quarter 2021	U	U	U	U	U	5	10	1.67	1.5	-	8260D
Note 1 Fourth Quarter 2021 Resampling	U J	U J	U J	U J	U J	10	10	1.5	1.5	-	8260D
Dichlorodifluoromethane					CAS # 75-71-8						
Second Quarter 2021	U	U	U	U	U	1	1	0.05	0.4	190	8260C LL
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.13	0.4	190	8260D
Fourth Quarter 2021	-	U	U	U	U	1	1	0.4	0.4	190	8260D
1,1-Dichloroethane					CAS # 75-34-3						
Second Quarter 2021	5.5	U	5.7	3	U	1	1	0.07	0.3	9.5	8260C LL
Fourth Quarter 2021	-	U	6	3.6	U	1	1	0.3	0.3	9.5	8260D
Fourth Quarter 2021	4.8	-	-	-	-	1.3	1	0.18	0.3	9.5	8260D
1,2-Dichloroethane					CAS # 107-06-2						
Fourth Quarter 2021	-	U	U	U	U	1	1	0.3	0.3	-	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.13	0.3	-	8260D
1,1-Dichloroethene					CAS # 75-35-4						
Second Quarter 2021	U	U	U	U	U	1	1	0.06	0.3	7	8260C LL
Fourth Quarter 2021	- J	U	U	U	U	1	1	0.3	0.3	7	8260D
Fourth Quarter 2021	0.17 J	-	-	-	-	1.3	1	0.15	0.3	7	8260D

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

Analyte/Quarter	16C1	16MW8	16MW9	16WC1A	16WC1B	QL	Permit QL	DL	Permit DL	GPS	Method
trans-1,2-Dichloroethene					CAS # 156-60-5						
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.15	0.3	-	8260D
Fourth Quarter 2021	-	U	U	U	U	1	1	0.3	0.3	-	8260D
2,4-Dichlorophenol					CAS # 120-83-2						
Fourth Quarter 2021	U	U	U	U J	U	10	10	1.5	1.59	-	8270D
2,6-Dichlorophenol					CAS # 87-65-0						
Fourth Quarter 2021	U	U	U	U J	U	10	10	1.4	1.4	-	8270D
1,2-Dichloropropane					CAS # 78-87-5						
Fourth Quarter 2021	-	U	U	U	U	1	1	0.4	0.4	-	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.15	0.4	-	8260D
1,3-Dichloropropane					CAS # 142-28-9						
Fourth Quarter 2021	-	U	U	U	U	1	1	0.4	0.4	-	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.18	0.4	-	8260D
trans-1,3-Dichloropropene					CAS # 10061-02-6						
Fourth Quarter 2021	-	U	U	U	U	1	1	0.4	0.4	-	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.15	0.4	-	8260D
Diethyl ether					CAS # 60-29-7						
Second Quarter 2021	30	14	69	U	U	12.5	12.5	0.05	1.11	7300	8260C LL
Fourth Quarter 2021	37	10 J	74	19 J	U	12.5	12.5	1.1	1.11	7300	8260D
Diethyl phthalate					CAS # 84-66-2						
Second Quarter 2021	-	-	-	-	-	10	5	4	2	11000	8270D
Second Quarter 2021	U	U	U	U	U	5	5	2	2	11000	8270D
Fourth Quarter 2021	-	-	-	-	-	5	5	2	2	11000	8270D
Fourth Quarter 2021	U	U	U	U	U	10	5	2	2	11000	8270D
O,O-Diethyl O-2-pyrazinyl					CAS # 297-97-2						
Fourth Quarter 2021	U	U	U	U	U	10	10	2.4	2.4	-	8270D
Dimethoate					CAS # 60-51-5						
Fourth Quarter 2021	U J	U J	U J	U J	U	10	10	3	3	-	8270D
Dimethyl ether					CAS # 115-10-6						
Second Quarter 2021	U J	U J	U J	U J	U J	12.5	12.5	0.04	1.11	17	8260C LL
Fourth Quarter 2021	11 J	U	U	1.4 J	U	12.5	12.5	1.1	1.11	17	8260C
p-(Dimethylamino)azobenzene					CAS # 60-11-7						
Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.8	3	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.7	3	-	8270E
Note 1 **7,12-Dimethylbenz[a]anthracene**					CAS # 57-97-6						
Fourth Quarter 2021	U J	U J	U J	U J	U J	10	10	1.8	1.8	-	8270E
3,3'-Dimethylbenzidine					CAS # 119-93-7						
Fourth Quarter 2021	U	-	-	-	-	9.3	10	3.1	3.3	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.9	3.3	-	8270E
a,a-Dimethylphenethylamine					CAS # 122-09-8						
Fourth Quarter 2021	U J	- J	- J	- J	-	51	50	5	5	-	8270D
Fourth Quarter 2021	- J	U J	U J	U J	U	50	50	4.9	5	-	8270D
2,4-Dimethylphenol					CAS # 105-67-9						
Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.8	3	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.7	3	-	8270E
Dimethyl phthalate					CAS # 131-11-3						
Fourth Quarter 2021	-	-	-	-	U	10.3	10	0.308	0.5	-	8270E
Fourth Quarter 2021	-	U	-	-	-	9.98	10	0.299	0.5	-	8270E
Fourth Quarter 2021	-	-	U	U	-	10	10	0.3	0.5	-	8270E
Fourth Quarter 2021	U	-	-	-	-	9.32	10	0.28	0.5	-	8270E
m-Dinitrobenzene					CAS # 99-65-0						
Fourth Quarter 2021	U	U	U	U	U	10	10	2	2.3	-	8270D
4,6-Dinitro-o-cresol					CAS # 534-52-1						
Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.8	3	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.7	3	-	8270E

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

Analyte/Quarter	16C1	16MW8	16MW9	16WC1A	16WC1B	QL	Permit QL	DL	Permit DL	GPS	Method
2,4-Dinitrophenol					CAS # 51-28-5						
Fourth Quarter 2021	-	U	U	U	U	8.9	10	5.5	6.2	-	8270E
Fourth Quarter 2021	U	-	-	-	-	9.3	10	5.7	6.2	-	8270E
2,4-Dinitrotoluene					CAS # 121-14-2						
Second Quarter 2021	U	U	U	U	U	10	10	1	2.1	10	8270D
Second Quarter 2021	-	-	-	-	-	20	10	2	2.1	10	8270D
Fourth Quarter 2021	U	U	U	U	U	10	10	2.1	2.1	10	8270D
2,6-Dinitrotoluene					CAS # 606-20-2						
Second Quarter 2021	U	U	U	U	U	10	10	0.5	2.1	10	8270D
Second Quarter 2021	-	-	-	-	-	20	10	1	2.1	10	8270D
Fourth Quarter 2021	U	U	U	U	U	10	10	2.1	2.1	10	8270D
Di-n-octyl phthalate					CAS # 117-84-0						
Fourth Quarter 2021	U	-	-	-	-	9.32	10	0.28	0.8	-	8270E
Fourth Quarter 2021	-	U	-	-	-	9.98	10	0.299	0.8	-	8270E
Fourth Quarter 2021	-	-	-	-	U	10.3	10	0.308	0.8	-	8270E
Fourth Quarter 2021	-	-	U	U	-	10	10	0.3	0.8	-	8270E
1,4-Dioxane					CAS # 123-91-1						
Fourth Quarter 2021	-	U J	U J	U J	U J	200	200	45	45.48	-	8260D
Fourth Quarter 2021	U	- J	- J	- J	- J	250	200	50	45.48	-	8260D
Diphenylamine					CAS #						
Fourth Quarter 2021	U	-	-	-	-	9.3	10	0.54	0.58	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	0.52	0.58	-	8270E
Disulfoton					CAS # 298-04-4						
Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.7	3	-	8270E
Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.8	3	-	8270E
Ethylbenzene					CAS # 100-41-4						
Second Quarter 2021	U	U	U	U	U	1	1	0.06	0.3	700	8260C LL
Fourth Quarter 2021	-	U	U	U	U	1	1	0.3	0.3	700	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.15	0.3	700	8260D
Ethyl methacrylate					CAS # 97-63-2						
Fourth Quarter 2021	-	U	U	U	U	10	10	0.81	0.81	-	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	10	0.25	0.81	-	8260D
Ethyl methanesulfonate					CAS # 62-50-0						
Fourth Quarter 2021	U	U	U	U	U	10	10	1.1	1.1	-	8270D
Famphur					CAS # 52-85-7						
Fourth Quarter 2021	U	-	-	-	-	9.3	10	4.6	5	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	4.5	5	-	8270E
Fluoranthene					CAS # 206-44-0						
Fourth Quarter 2021	U	U	U	U	U	10	10	0.4	0.42	-	8270D
Fluorene					CAS # 86-73-7						
Fourth Quarter 2021	U	U	U	U	U	10	10	0.36	0.38	-	8270D
Hexachlorobenzene					CAS # 118-74-1						
Fourth Quarter 2021	U	U	U	-	U	10	10	0.86	0.87	-	8270D
Fourth Quarter 2021	-	-	-	U	-	10	10	0.85	0.87	-	8270D
Hexachlorobutadiene					CAS # 87-68-3						
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.18	0.4	-	8260D
Fourth Quarter 2021	-	U	U	U	U	1	1	0.4	0.4	-	8260D
Hexachlorocyclopentadiene					CAS # 77-47-4						
Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.8	3	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.7	3	-	8270E
Hexachloroethane					CAS # 67-72-1						
Fourth Quarter 2021	U	-	-	-	-	9.3	10	0.37	0.4	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	0.36	0.4	-	8270E

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*	*Permit QL*	*DL*	*Permit DL*	*GPS*	*Method*
	Hexachlorophene					*CAS #*	*70-30-4*					
	Fourth Quarter 2021	- J	- J	- J	- J	U J	514	500	172	185	-	8270E
	Fourth Quarter 2021	U J	- J	- J	- J	- J	466	500	156	185	-	8270E
	Fourth Quarter 2021	- J	U J	- J	- J	- J	499	500	167	185	-	8270E
	Fourth Quarter 2021	- J	- J	U J	U J	- J	500	500	167	185	-	8270E
Note 1	**Hexachloropropene**					*CAS #*	*1888-71-7*					
	Fourth Quarter 2021	U J	U J	U J	U J	U J	10	10	2	2	-	8270E
	2-Hexanone					*CAS #*	*591-78-6*					
	Fourth Quarter 2021	U	-	-	-	-	13	10	1.5	2	-	8260D
	Fourth Quarter 2021	-	U	U	U	U	10	10	2	2	-	8260D
	Indeno[1,2,3-cd]pyrene					*CAS #*	*193-39-5*					
	Fourth Quarter 2021	U	U	U	U	U	10	10	0.15	0.15	-	8270D
	Isobutyl alcohol					*CAS #*	*78-83-1*					
	Fourth Quarter 2021	U	-	-	-	-	63	200	9	11.6	-	8260D
	Fourth Quarter 2021	-	U	U	U	U	200	200	11	11.6	-	8260D
	Isodrin					*CAS #*	*465-73-6*					
	Fourth Quarter 2021	U	U	U	U	U	10	10	1.1	1.1	-	8270D
	Isophorone					*CAS #*	*78-59-1*					
	Fourth Quarter 2021	U	-	-	-	-	9.3	10	0.46	0.5	-	8270E
	Fourth Quarter 2021	-	U	U	U	U	8.9	10	0.45	0.5	-	8270E
	Isosafrole					*CAS #*	*120-58-1*					
	Fourth Quarter 2021	U	U	U	U	U	10	10	1.6	1.6	-	8270D
Note 1	**Kepone**					*CAS #*	*143-50-0*					
	Fourth Quarter 2021	U J	U J	U J	U J	U J	50	50	25	25	-	8270E
	Methacrylonitrile					*CAS #*	*126-98-7*					
	Fourth Quarter 2021	-	U	U	U	U	100	100	9.7	9.75	-	8260D
	Fourth Quarter 2021	U	-	-	-	-	13	100	1.8	9.75	-	8260D
	Methapyrilene					*CAS #*	*91-80-5*					
	Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.7	3	-	8270E
	Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.8	3	-	8270E
	Bromomethane					*CAS #*	*74-83-9*					
	Fourth Quarter 2021	-	U	U	U	U	1	1	0.54	0.542	-	8260D
	Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.18	0.542	-	8260D
	Chloromethane					*CAS #*	*74-87-3*					
	Second Quarter 2021	U	U	U	U	U	1	1	0.06		190	8260C LL
	Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.15		190	8260D
	Fourth Quarter 2021	-	U	U	U	U	1	1	0.06		190	8260D
	3-Methylcholanthrene					*CAS #*	*56-49-5*					
	Fourth Quarter 2021	-	U	U	U	U	8.9	10	0.89	1	-	8270E
	Fourth Quarter 2021	U	-	-	-	-	9.3	10	0.93	1	-	8270E
	Iodomethane					*CAS #*	*74-88-4*					
	Fourth Quarter 2021	U	-	-	-	-	1.3	10	0.15	0.58	-	8260D
	Fourth Quarter 2021	-	U	U	U	U	10	10	0.58	0.58	-	8260D
	Methyl methacrylate					*CAS #*	*80-62-6*					
	Fourth Quarter 2021	U	- J	- J	- J	- J	1.3	10	0.15	3.58	-	8260D
	Fourth Quarter 2021	-	U J	U J	U J	U J	10	10	3.5	3.58	-	8260D
Note1	**Methyl methane sulfonate**					*CAS #*	*66-27-3*					
	Fourth Quarter 2021	U J	U J	U J	U J	U J	10	10	1	1	-	8270E
	2-Methylnaphthalene					*CAS #*	*91-57-6*					
	Fourth Quarter 2021	U	U	U	U	U	10	10	0.29	0.29	-	8270D
	Methyl parathion					*CAS #*	*298-00-0*					
	Fourth Quarter 2021	U	-	-	-	-	9.3	10	3	3.2	-	8270E
	Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.9	3.2	-	8270E
	4-Methyl-2-pentanone					*CAS #*	*108-10-1*					
	Fourth Quarter 2021	U	-	-	-	-	13	10	1.8	2	-	8260D
	Fourth Quarter 2021	-	U	U	U	U	10	10	2	2	-	8260D

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.*

Analyte/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*Permit QL*	*DL*	*Permit DL*	*GPS*	*Method*
2-Methylphenol					*CAS #* 95-48-7						
Fourth Quarter 2021	U	U	U	- J	U	10	10	0.95	0.96	-	8270D
Fourth Quarter 2021	-	-	-	U J	-	10	10	0.94	0.96	-	8270D
3 & 4-Methylphenol					*CAS #*						
Fourth Quarter 2021	U	U	U	U J	U	20	20	2.4	2.47	-	8270D
Dibromomethane					*CAS #* 74-95-3						
Fourth Quarter 2021	-	U	U	U	U	1	1	0.3	0.3	-	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.15	0.3	-	8260D
Methylene chloride					*CAS #* 75-09-2						
Second Quarter 2021	U	U	U	U	U	1	1	0.07	0.7	13.95	8260C LL
Fourth Quarter 2021	- J	U	U	U	U	1	1	0.7	0.7	13.95	8260D
Fourth Quarter 2021	0.85 J	-	-	-	-	1.3	1	0.18	0.7	13.95	8260D
Naphthalene					*CAS #* 91-20-3						
Fourth Quarter 2021	-	U	U	U	U	1	1	0.4	0.4	-	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.13	0.4	-	8260D
1,4-Naphthoquinone					*CAS #* 130-15-4						
Fourth Quarter 2021	- J	- J	U J	U J	- J	10	10	3	3	-	8270E
Fourth Quarter 2021	- J	U J	- J	- J	- J	9.98	10	2.99	3	-	8270E
Fourth Quarter 2021	U J	- J	- J	- J	- J	9.32	10	2.8	3	-	8270E
Fourth Quarter 2021	- J	- J	- J	- J	U J	10.3	10	3.08	3	-	8270E
1-Naphthylamine					*CAS #* 134-32-7						
Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.7	3	-	8270E
Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.8	3	-	8270E
2-Naphthylamine					*CAS #* 91-59-8						
Fourth Quarter 2021	U	-	-	-	-	9.3	10	6.5	7	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	6.3	7	-	8270E
o-Nitroaniline					*CAS #* 88-74-4						
Fourth Quarter 2021	U	U	U	U	U	10	10	1	1	-	8270D
m-Nitroaniline					*CAS #* 99-09-2						
Fourth Quarter 2021	U	-	-	-	-	9.3	10	1.9	2	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	1.8	2	-	8270E
p-Nitroaniline					*CAS #* 100-01-6						
Fourth Quarter 2021	U	U	U	U	U	10	10	1.5	1.5	-	8270D
Nitrobenzene					*CAS #* 98-95-3						
Fourth Quarter 2021	U	-	-	-	U	10	10	0.59	0.6	-	8270D
Fourth Quarter 2021	-	U	U	U	-	10	10	0.58	0.6	-	8270D
o-Nitrophenol					*CAS #* 88-75-5						
Fourth Quarter 2021	U	U	U	U J	U	10	10	1.2	1.27	-	8270D
p-Nitrophenol					*CAS #* 100-02-7						
Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.8	3	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.7	3	-	8270E
4-Nitroquinoline-1-oxide					*CAS #* 56-57-5						
Fourth Quarter 2021	U	-	-	-	-	46	50	4.6	5	-	8270E
Fourth Quarter 2021	-	U	U	U	U	45	50	4.5	5	-	8270E
N-Nitrosodi-n-butylamine					*CAS #* 924-16-3						
Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.8	3	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.7	3	-	8270E
N-Nitrosodiethylamine					*CAS #* 55-18-5						
Fourth Quarter 2021	U	U	U	U	U	10	10	3	3	-	8270D
N-Nitrosodimethylamine					*CAS #* 62-75-9						
Fourth Quarter 2021	U	U	U	U	U	10	10	2	2	-	8270D
N-Nitrosodiphenylamine					*CAS #* 86-30-6						
Fourth Quarter 2021	-	U	U	U	U	10	10	0.56	0.58	-	8270D
Fourth Quarter 2021	U	-	-	-	-	10	10	0.57	0.58	-	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.*

	Analyte/Quarter	16C1	16MW8	16MW9	16WC1A	16WC1B	QL	Permit QL	DL	Permit DL	GPS	Method
	N-Nitrosodipropylamine					CAS # 621-64-7						
	Fourth Quarter 2021	-	U	U	U	U	8.9	10	0.45	0.5	-	8270E
	Fourth Quarter 2021	U	-	-	-	-	9.3	10	0.46	0.5	-	8270E
Note 1	**N-Nitrosomethylethylamine**					CAS # 10595-95-6						
	Fourth Quarter 2021	U J	U J	U J	U J	U J	10	10	1	1	-	8270E
	N-Nitrosomorpholine					CAS # 59-89-2						
	Fourth Quarter 2021	U	U	U	U	U	10	10	3	3	-	8270D
	N-Nitrosopiperidine					CAS # 100-75-4						
	Fourth Quarter 2021	U	U	U	U	U	10	10	1.1	1.1	-	8270D
Note 1	**N-Nitrosopyrrolidine**					CAS # 930-55-2						
	Fourth Quarter 2021	U J	U J	U J	U J	U J	10	10	0.5	0.5	-	8270E
	5-Nitroso-o-toluidine					CAS # 99-55-8						
	Fourth Quarter 2021	U	U	U	U	U	10	10	2	2	-	8270D
	Parathion					CAS # 56-38-2						
	Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.7	3	-	8270E
	Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.8	3	-	8270E
	Pentachlorobenzene					CAS # 608-93-5						
	Fourth Quarter 2021	U	U	U	U	U	10	10	1.6	1.6	-	8270D
	Pentachloroethane					CAS # 76-01-7						
	Fourth Quarter 2021	U	-	-	-	-	1.3	10	0.15	1.7	-	8260D
	Fourth Quarter 2021	-	U	U	U	U	10	10	1.7	1.7	-	8260D
Note 1	**Pentachloronitrobenzene**					CAS # 82-68-8						
	Fourth Quarter 2021	U J	U J	U J	U J	U J	10	10	1	1	-	8270E
	Pentachlorophenol					CAS # 87-86-5						
	Fourth Quarter 2021	U	U	U	U J	U	10	10	3	3	-	8270D
	Phenacetin					CAS # 62-44-2						
	Fourth Quarter 2021	U	U	U	U	U	10	10	1.4	1.4	-	8270D
	Phenanthrene					CAS # 85-01-8						
	Fourth Quarter 2021	-	U	U	U	U	10	10	0.5	0.52	-	8270D
	Fourth Quarter 2021	U	-	-	-	-	10	10	0.51	0.52	-	8270D
	Phenol					CAS # 108-95-2						
	Fourth Quarter 2021	U	U	U	- J	U	10	10	0.76	0.77	-	8270D
	Fourth Quarter 2021	-	-	-	U J	-	10	10	0.75	0.77	-	8270D
	Phorate					CAS # 298-02-2						
	Fourth Quarter 2021	U	U	U	U	U	10	10	2.5	2.5	-	8270D
Note 1	**2-Picoline**					CAS # 931-19-1						
	Fourth Quarter 2021	U J	U J	U J	U J	U J	10	10	1	1	-	8270E
Note 1	**Pronamide**					CAS # 23950-58-5						
	Fourth Quarter 2021	U J	U J	U J	U J	U J	10	10	1.5	1.5	-	8270E
	2-Propanol					CAS # 67-63-0						
	Fourth Quarter 2021	U	U	U	U	U	100	100	50	50	-	8260D
	Propionitrile					CAS # 107-12-0						
	Fourth Quarter 2021	-	U	U	U	U	100	100	10	10.22	-	8260D
	Fourth Quarter 2021	U	-	-	-	-	25	100	3.5	10.22	-	8260D
	Pyrene					CAS # 129-00-0						
	Fourth Quarter 2021	U	U	U	U	U	10	10	0.39	0.41	-	8270D
	Pyridine					CAS # 110-86-1						
	Fourth Quarter 2021	-	U	U	U	U	8.9	10	1.8	2	-	8270E
	Fourth Quarter 2021	U	-	-	-	-	9.3	10	1.9	2	-	8270E
	Safrole					CAS # 94-59-7						
	Fourth Quarter 2021	U	U	U	U	U	10	10	2.2	2.2	-	8270D
	Styrene					CAS # 100-42-5						
	Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.13	0.3	-	8260D
	Fourth Quarter 2021	-	U	U	U	U	1	1	0.3	0.3	-	8260D
	Sulfotep					CAS # 3689-24-5						
	Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.2	2.4	-	8270E
	Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.3	2.4	-	8270E

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.*

Analyte/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*Permit QL*	*DL*	*Permit DL*	*GPS*	*Method*
1,2,4,5-Tetrachlorobenzene					*CAS #* *95-94-3*						
Fourth Quarter 2021	U	U	U	U	U	10	10	2	2	-	8270D
1,1,1,2-Tetrachloroethane					*CAS #* *630-20-6*						
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.18	0.3	-	8260D
Fourth Quarter 2021	-	U	U	U	U	1	1	0.3	0.3	-	8260D
1,1,2,2-Tetrachloroethane					*CAS #* *79-34-5*						
Fourth Quarter 2021	-	U	U	U	U	1	1	0.3	0.3	-	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.18	0.3	-	8260D
Tetrachloroethene					*CAS #* *127-18-4*						
Second Quarter 2021	U	U	U	U	U	1	1	0.06	0.3	5	8260C LL
Fourth Quarter 2021	- J	U	U	U	U	1	1	0.3	0.3	5	8260D
Fourth Quarter 2021	0.16 J	-	-	-	-	1.3	1	0.15	0.3	5	8260D
Tetrahydrofuran					*CAS #* *109-99-9*						
Second Quarter 2021	U	U	U	U	U	25	25	0.8	2	3400	8260C LL
Fourth Quarter 2021	17 J	2.2 J	U	U	U	25	25	2	2	3400	8260D
2,3,4,6-Tetrachlorophenol					*CAS #* *58-90-2*						
Fourth Quarter 2021	U	U	U	U J	U	10	10	1.8	1.8	-	8270D
Toluene					*CAS #* *108-88-3*						
Second Quarter 2021	U	U	U	U	U	1	1	0.07	0.3	1000	8260C LL
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.18	0.3	1000	8260D
Fourth Quarter 2021	-	U	U	U	U	1	1	0.3	0.3	1000	8260D
o-Toluidine					*CAS #* *95-53-4*						
Fourth Quarter 2021	U	-	-	-	-	9.3	10	3.7	4	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	3.6	4	-	8270E
1,2,4-Trichlorobenzene					*CAS #* *120-82-1*						
Fourth Quarter 2021	-	U	U	U	U	1	1	0.6	0.6	-	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.15	0.6	-	8260D
1,1,1-Trichloroethane					*CAS #* *71-55-6*						
Second Quarter 2021	U	U	U	U	U	1	1	0.06	0.3	200	8260C LL
Fourth Quarter 2021	0.31 J	-	-	-	-	1.3	1	0.15	0.3	200	8260D
Fourth Quarter 2021	- J	U	U	U	U	1	1	0.3	0.3	200	8260D
1,1,2-Trichloroethane					*CAS #* *79-00-5*						
Fourth Quarter 2021	-	U	U	U	U	1	1	0.3	0.3	-	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.15	0.3	-	8260D
Trichloroethene					*CAS #* *79-01-6*						
Second Quarter 2021	U	U	U	U	U	1	1	0.06	0.3	5	8260C LL
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.15	0.3	5	8260D
Fourth Quarter 2021	-	U	U	U	U	1	1	0.3	0.3	5	8260D
Trichlorofluoromethane					*CAS #* *75-69-4*						
Second Quarter 2021	U	U	U	U	U	1	1	0.05	0.4	1000	8260C LL
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.13	0.4	1000	8260D
Fourth Quarter 2021	-	U	U	U	U	1	1	0.4	0.4	1000	8260D
2,4,5-Trichlorophenol					*CAS #* *95-95-4*						
Fourth Quarter 2021	U	U	U	U J	U	10	10	2	2	-	8270D
2,4,6-Trichlorophenol					*CAS #* *88-06-2*						
Fourth Quarter 2021	U	U	U	U J	U	10	10	1.8	1.8	-	8270D
1,2,3-Trichloropropane					*CAS #* *96-18-4*						
Fourth Quarter 2021	-	U	U	U	U	1	1	0.3	0.3	-	8260D
Fourth Quarter 2021	U	-	-	-	-	2.5	1	0.25	0.3	-	8260D
1,1,2-Trichloro-1,2,2-Trifluoroethane					*CAS #* *76-13-1*						
Second Quarter 2021	U	U	U	U	U	1	1	0.06	0.4	59000	8260C LL
Fourth Quarter 2021	-	U	U	U	U	1	1	0.4	0.4	59000	8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.15	0.4	59000	8260D
O,O,O-Triethyl phosphorothioate					*CAS #* *126-68-1*						
Fourth Quarter 2021	U	U	U	U	U	10	10	2.6	2.6	-	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*	*Permit QL*	*DL*	*Permit DL*	*GPS*	*Method*
sym-Trinitrobenzene					*CAS #* *99-35-4*						
Fourth Quarter 2021	U	-	-	-	-	9.3	10	2.8	3	-	8270E
Fourth Quarter 2021	-	U	U	U	U	8.9	10	2.7	3	-	8270E
Vinyl acetate					*CAS #* *108-05-4*						
Fourth Quarter 2021	U	- J	- J	- J	- J	1.3	10	0.1	3.29	-	8260D
Fourth Quarter 2021	-	U J	U J	U J	U J	10	10	3.2	3.29	-	8260D
Vinyl chloride					*CAS #* *75-01-4*						
Second Quarter 2021	U	U	U	U	U	1	1	0.1	0.2	2	8260C LL
Fourth Quarter 2021	- J	U	U	0.21 J	U	1	1	0.2	0.2	2	8260D
Fourth Quarter 2021	U J	-	-	- J	-	1.3	1	0.25	0.2	2	8260D
Xylenes (Total)					*CAS #* *1330-20-7*						
Second Quarter 2021	U	U	U	U	U	3	3	0.15	0.4	10000	8260C LL
Fourth Quarter 2021	U	U	U	U	U	3	3	0.4	0.4	10000	8260D
m,p-Xylene					*CAS #* *179601-23-1*						
Fourth Quarter 2021	-	U	U	U	U	2	2	0.4	0.4		8260D
Fourth Quarter 2021	U	-	-	-	-	1.3	2	0.25	0.4		8260D
o-Xylene					*CAS #* *95-47-6*						
Fourth Quarter 2021	U	-	-	-	-	1.3	1	0.13	0.4		8260D
Fourth Quarter 2021	-	U	U	U	U	1	1	0.4	0.4		8260D

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*	*Permit QL*	*DL*	*Permit DL*	*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, 2Q2020, 4Q2021

QL Denotes permit required quantitation limit. Class 1 Permit Mod 5/5/21
U denotes not detected at or above the permit required detection limit. Class 1 permit mod 5/5/21.
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, 2021), 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, 2021).
NS denotes not sampled. **NA** denotes not analyzed.
"–" denotes not detected (pre-2nd Quarter 2003) or not available / not sampled (beginnin g 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. Class 1 Permit Modification 5/5/21.
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, 2016,2021), 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, 2016,2021).

Note 1 - All point of compliance wells were resampled on November 11, 2021 for the following Appendix IX constituents, due to the laboratory errors (1) Cyanide was recollected due to laboratory quality control (QC) issues (i.e., low/no spike recovery in the associated QC samples).
(2) Trans-1,4-dichloro-2 butene was recollected since the laboratory MDL did not meet the Permit-specified MDL. The laboratory reported an MDL of 1.67 ug/l compared to the Permit-specified MDL of 1.5 ug/l. Additional semivolatile aliquot was also collected from point of compliance wells on November 11, 2021. Ten Appendix IX constituents were requested to be analyzed by SVOC Method 8270E for point of compliance groundwater samples collected on October 6, 2021. Due to laboratory scheduling delays, groundwater samples from the October 6, 2021, event were extracted within holding time but were not analyzed within the 40-day holding time requirement, except for bis-2-ethylhexylphalate. Bis-2-ethylhexylphalate was analyzed and reported from the October 6, 2021 groundwater monitoring event. Since analysis for the remaining requested nine constituents to be analyzed by Pace would have been analyzed well beyond the 40-day holding time, SVOC analysis for these nine constituents were performed on point of compliance well samples collected as part of the November 11, 2021, resampling event.

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*	*Permit QL*	*Background*	*Method*
Arsenic						*CAS #7440-38-2*				
Second Quarter 2021	U	U	U	U	U	U	10	10	1	6020B
Fourth Quarter 2021	U	U	U	U	U	U	10	10	1	6020B
Barium						*CAS #7440-39-3*				
Second Quarter 2021	160	200	800	170	120	190	10	10	175.4	6020B
Fourth Quarter 2021	200	230	770	170	120	230	10	10	175.4	6020B
Beryllium						*CAS #7440-41-7*				
Second Quarter 2021	U	U	U	U	U	U	1	1	0.7	6020B
Fourth Quarter 2021	U	U	U	U	U	U	1	1	0.7	6020B
Cadmium						*CAS #7440-43-9*				
Second Quarter 2021	U	U	U	U	U	U	1	1	0.2	6020B
Fourth Quarter 2021	U	U	U	U	U	U	1	1	0.2	6020B
Chromium						*CAS #7440-47-3*				
Second Quarter 2021	U	U	U	U	U	U	5	5	6.2	6020B
Fourth Quarter 2021	U	U	U	U	U	U	5	5	6.2	6020B
Cobalt						*CAS #7440-48-4*				
Second Quarter 2021	U	U	U	U	U	U	5	5	5	6020B
Fourth Quarter 2021	U	U	U	U	U	U	5	5	5	6020B
Copper						*CAS #7440-50-8*				
Second Quarter 2021	U	U	U	U	U	U	5	5	13	6020B
Fourth Quarter 2021	U	U	U	U	U	U	5	5	13	6020B
Lead						*CAS #7439-92-1*				
Second Quarter 2021	U	U	U	U	U	U	3	3	10	6020B
Fourth Quarter 2021	U	U	U	U	U	U	3	3	10	6020B
Mercury						*CAS #7439-97-6*				
Second Quarter 2021	U	U	U	U	U	U	2	2	0.2	7470A
Fourth Quarter 2021	U	U	U	U	U	U	2	2	0.2	7470A
Nickel						*CAS #7440-02-0*				
Second Quarter 2021	U	U	U	U	U	U	10	10	16	6020B
Fourth Quarter 2021	3.8 J	U	U	U	U	U	10	10	16	6020B
Vanadium						*CAS #7440-62-2*				
Second Quarter 2021	U	U	U	U	U	U	10	10	151	6020B
Fourth Quarter 2021	U	U	U	U	U	U	10	10	151	6020B
Zinc						*CAS #7440-66-6*				
Second Quarter 2021	U	U	U	U	U	U	30	30	51	6020B
Fourth Quarter 2021	U	U	U	U	U	U	30	30	51	6020B
Benzene						*CAS #71-43-2*				
Second Quarter 2021	U	U	U	U	U	U	1	1	1	8260C LL
Fourth Quarter 2021	- J	U	U	U	U	U	1	1	1	8260D
Fourth Quarter 2021	0.31 J	-	-	-	-	-	1.3	1	1	8260D
2-Butanone						*CAS #78-93-3*				
Second Quarter 2021	U	U	U	U	U	U	10	10	1.1	8260C LL
Fourth Quarter 2021	-	U J	U J	U J	U J	U J	10	10	1.1	8260D
Fourth Quarter 2021	U	- J	- J	- J	- J	- J	13	10	1.1	8260D

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***

Analyte/Quarter	*16C1 Q*	*16-2 Q*	*16-3 Q*	*16-5 Q*	*16WC2B Q*	*16SPRING Q*	*QL*	*Permit QL*	*Background*	*Method*	
Carbon tetrachloride						*CAS #56-23-5*					
Second Quarter 2021	U	U	U	U	U	U	1	1	0.2	8260C LL	
Fourth Quarter 2021	U	-	-	-	-	-	1.3	1	0.2	8260D	
Fourth Quarter 2021	-	U	U	U	U	U	1	1	0.2	8260D	
Chloroethane						*CAS #75-00-3*					
Second Quarter 2021	2.6	U	U	U	U	U	1	1	20.7	8260C LL	
Fourth Quarter 2021	2.7	-	-	-	-	-	1.3	1	20.7	8260D	
Fourth Quarter 2021	-	U	U	U	U	U	1	1	20.7	8260D	
Fourth Quarter 2021	-	-	-	-	-	-	1	1	20.7	8260D	
Dichlorodifluoromethane						*CAS #75-71-8*					
Second Quarter 2021	U	U	U	U	U	U	1	1	46.5	8260C LL	
Fourth Quarter 2021	U	-	-	-	-	-	1.3	1	46.5	8260D	
Fourth Quarter 2021	-	U	U	U	U	U	1	1	46.5	8260D	
1,1-Dichloroethane						*CAS #75-34-3*					
Second Quarter 2021	5.5	U	U	U	U	U	1	1	9.5	8260C LL	
Fourth Quarter 2021	4.8	-	-	-	-	-	1.3	1	9.5	8260D	
Fourth Quarter 2021	-	U	U	U	U	U	1	1	9.5	8260D	
1,1-Dichloroethene						*CAS #75-35-4*					
Second Quarter 2021	U	U	U	U	U	U	1	1	1	8260C LL	
Fourth Quarter 2021	- J	U	U	U	U	U	1	1	1	8260D	
Fourth Quarter 2021	0.17 J	-	-	-	-	-	1.3	1	1	8260D	
Diethyl ether						*CAS #60-29-7*					
Second Quarter 2021	30	U	U	U	U	U	12.5	12.5	75.5	8260C LL	
Fourth Quarter 2021	37	U	U	U	U	U	12.5	12.5	75.5	8260D	
Diethyl phthalate						*CAS #84-66-2*					
Second Quarter 2021	U	U	U	U	U	U	5	5	5	8270D	
Second Quarter 2021	-	-	U	-	-	-	5	5	5	8270D	6/24/2021 resampling
Fourth Quarter 2021	U	-	-	-	-	-	10	5	5	8270D	
Fourth Quarter 2021	-	U	U	U	U	U	5	5	5	8270D	
Dimethyl ether						*CAS #115-10-6*					
Second Quarter 2021	U J	U J	U J	U J	U J	U J	12.5	12.5	17.0	8260C LL	
Fourth Quarter 2021	11 J	U	U	U	U	U	12.5	12.5	17.0	8260C	
2,4-Dinitrotoluene						*CAS #121-14-2*					
Second Quarter 2021	-	-	U	-	-	-	10	10	10	8270D	6/24/2021 Resampling
Second Quarter 2021	U	U	U	U	U	U	10	10	10	8270D	
Fourth Quarter 2021	U	U	U	U	U	U	10	10	10	8270D	
2,6-Dinitrotoluene						*CAS #606-20-2*					
Second Quarter 2021	-	-	U	-	-	-	10	10	10	8270D	6/24/2021 resampling
Second Quarter 2021	U	U	U	U	U	U	10	10	10	8270D	
Fourth Quarter 2021	U	U	U	U	U	U	10	10	10	8270D	
Ethylbenzene						*CAS #100-41-4*					
Second Quarter 2021	U	U	U	U	U	U	1	1	0.1	8260C LL	
Fourth Quarter 2021	-	U	U	U	U	U	1	1	0.1	8260D	
Fourth Quarter 2021	U	-	-	-	-	-	1.3	1	0.1	8260D	

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*	*Permit QL*	*Background*	*Method*
Chloromethane						*CAS #74-87-3*				
Second Quarter 2021	U	U	U	U	U	U	1	1	0.3	8260C LL
Fourth Quarter 2021	-	U	U	U	U	U	1	1	0.3	8260D
Fourth Quarter 2021	U	-	-	-	-	-	1.3	1	0.3	8260D
Methylene chloride						*CAS #75-09-2*				
Second Quarter 2021	U	U	U	U	U	U	1	1	13.95	8260C LL
Fourth Quarter 2021	0.85 J	-	-	-	-	-	1.3	1	13.95	8260D
Fourth Quarter 2021	- J	U	U	U	U	U	1	1	13.95	8260D
Tetrachloroethene						*CAS #127-18-4*				
Second Quarter 2021	U	U	U	U	U	U	1	1	0.7	8260C LL
Fourth Quarter 2021	0.16 J	-	-	-	-	-	1.3	1	0.7	8260D
Fourth Quarter 2021	- J	U	U	U	U	U	1	1	0.7	8260D
Tetrahydrofuran						*CAS #109-99-9*				
Second Quarter 2021	U	U	U	U	U	U	25	25	25	8260C LL
Fourth Quarter 2021	17 J	U J	U J	U J	U J	U J	25	25	25	8260D
Toluene						*CAS #108-88-3*				
Second Quarter 2021	U	U	U	U	U	U	1	1	0.1	8260C LL
Fourth Quarter 2021	U	-	-	-	-	-	1.3	1	0.1	8260D
Fourth Quarter 2021	-	U	U	U	U	U	1	1	0.1	8260D
1,1,1-Trichloroethane						*CAS #71-55-6*				
Second Quarter 2021	U	U	U	U	U	U	1	1	9.2	8260C LL
Fourth Quarter 2021	- J	U	U	U	U	U	1	1	9.2	8260D
Fourth Quarter 2021	0.31 J	-	-	-	-	-	1.3	1	9.2	8260D
Trichloroethene						*CAS #79-01-6*				
Second Quarter 2021	U	U	U	U	U	U	1	1	0.1	8260C LL
Fourth Quarter 2021	U	-	-	-	-	-	1.3	1	0.1	8260D
Fourth Quarter 2021	-	U	U	U	U	U	1	1	0.1	8260D
Trichlorofluoromethane						*CAS #75-69-4*				
Second Quarter 2021	U	U	U	U	U	U	1	1	11.3	8260C LL
Fourth Quarter 2021	-	U	U	U	U	U	1	1	11.3	8260D
Fourth Quarter 2021	U	-	-	-	-	-	1.3	1	11.3	8260D
1,1,2-Trichloro-1,2,2-Trifluoroethane						*CAS #76-13-1*				
Second Quarter 2021	U	U	U	U	U	U	1	1	1.2	8260C LL
Fourth Quarter 2021	U	-	-	-	-	-	1.3	1	1.2	8260D
Fourth Quarter 2021	-	U	U	U	U	U	1	1	1.2	8260D
Vinyl chloride						*CAS #75-01-4*				
Second Quarter 2021	U	U	U	U	U	U	1	1	1	8260C LL
Fourth Quarter 2021	- J	U	U	U	U	U	1	1	1	8260D
Fourth Quarter 2021	U J	-	-	-	-	-	1.3	1	1	8260D
Xylenes (Total)						*CAS #1330-20-7*				
Second Quarter 2021	U	U	U	U	U	U	3	3	0.2	8260C LL
Fourth Quarter 2021	U	U	U	U	U	U	3	3	0.2	8260D

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*	*Permit QL*	*Background*	*Method*

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 lab quantitation limit. Permit QL denotes Pemit QL (2021)
U Denotes analyte not detected at or above QL. 5/5/2021 Class 1 Permit Mod
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, May 5, 2021), 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, 2016,2021).

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

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
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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
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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

COMMONWEALTH of VIRGINIA

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Matthew J. Strickler
Secretary of Natural Resources

David K. Paylor
Director

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

May 3, 2021

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

VIA ELECTRONIC MAIL

Re: 2020 Annual Groundwater Monitoring Report for
Hazardous Waste Management Units 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 2020 Annual Groundwater Monitoring Report for Hazardous Waste Management Units (HWMU) 5 & 16 dated February 2021, submitted to the Virginia Department of Environmental Quality (Department or DEQ), Office of Remediation Programs (ORP) by BAE Systems on behalf of the Radford Army Ammunitions Plant (RFAAP).

There were reportedly no new-targeted constituents detected during the groundwater monitoring activities conducted during the second or fourth quarters of 2020 for HWMU-5. However, total cobalt, a potentially newly detected constituent, continues to be detected at concentrations greater than the groundwater protection standard (GPS) and alternate concentration limit (ACL) in several monitoring wells at HWMU-16. The Department requested a revised Alternate Source Demonstration (ASD) for cobalt in December 2020. The revised ASD should be submitted as soon as practicable.

Further, the presence of vinyl chloride was verified in 16WC1A at HWMU-16. The Department concurs with the recommendations to utilize a background value of 1 ug/L based on permit specified QL as the constituent has not previously been detected at the unit and a GPS of 2 ug/L based on the USEPA MCL for vinyl chloride.

As previously noted, the Department acknowledges the presence of barium above the site-specific background concentration. The Department recognizes that the variability of the lithology in the area of HWMU-16 could potentially explain the variation of this 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.

The Department accepts the report as complete. However, the Department does want to acknowledge that several constituents were reported above the permit specified detection limits. The Department does not require any action at this time as this issue is being addressed by a Class 1 permit modification that is currently under review by DEQ.

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

Sincerely,

Kurt W. Kochan
Project Manager

cc: RFAAP Correspondence File
Tara Mason, Ashby Scott, DEQ-CO
Nikki Herschler, DEQ-BRRO
Melissa Lincoln, Jody Hawks, BAE
Mike Lawless, DAA

APPENDIX C
LABORATORY ANALYTICAL RESULTS – YEAR 2021
(CD-ROM)

APPENDIX D

FIELD NOTES (CD-ROM)

4/29/21 RFAAP (UNIT-5) / 2100706 / KFC · KLV

General Notes

- Weather - Mostly cloudy & 60°-70°s
- PPE - Nitrile gloves, eye protection, safety boots & facemasks
- Calibrations - YSI Pro Plus / D.O. % = 98.5 %
  pH: 4.00 - 4.00, 7.00 - 7.00, 10.00 - 10.00
  Conductivity reads 1413 mS/cm in a 1413 mS/cm 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 and disposed of at dedicated, on-site location.
- All samples collected, transported & stored on ice in coolers.
- Sample collection order: 8260C, 8270D & TM
- All wells purged & sampled at 0.25 L/min.
- All DTW's collected in feet.

SAMPLE ANALYSIS	Preservative	Sample Analysis	Preservative
8260C	HCL	TOTAL METALS	HNO3
8270D	N/A		

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

Confidence Solution Value Range

BATCH # - 20m1C Date Opened: 4/29/21

	Temp (°C)		Sp Cond mS/cm		ORP (mV)		pH	
	Actual	Range	Actual	Range	Actual	Range	Actual	Range
PRE -	23.6	21-25	7768	7630 - 8010	220.8	212-242	7.01	6.8-7.2
POST -	25.0	21-25	7829	7630 - 8010	220.7	212-242	6.97	6.8-7.2

STATIC WATER LEVEL TABLE (measured in feet)

WELL	DTW	P/P DTW	NOTES	WELL	DTW	P/P DTW	NOTES
SW8B	15.51	16.12		SW5B	9.50	9.76	
SW12A	11.61	11.61		SWC21	9.87	9.88	
SW7B	9.91	9.91		SWC22	9.79	9.76	

* CONT'D ON FOLLOWING PAGE

STATIC WATER LEVEL TABLE (Measured in feet)

WELL	DTW	P/P DTW	NOTES	WELL	DTW	P/P DTW	NOTES
5WC23	9.14	9.15		5WC12	16.83	N/A	
• SWL's ONLY •				S5W5	9.88	↓	
5W9A	1.18	N/A		S5W6	7.32		
5WCA	13.12			S5W7	11.88		
5W10A	12.71			S5W8	12.37		
5WC11	16.54	↓		5W11A	9.95	↓	

5W8B

DTW: 15.51

CB: 17

Begin Purge (0644)

POST PURGE DTW: 16.12

Initial Purge - CLEAR

TIME	Temp (°C)	SpCond mS/cm	DO mg/L	pH	ORP (mV)	TURB (NTU)	DTW	Desc.
(0645)	14.3	63.9	7.97	5.13	204.9	1.14	16.22	clr.
(0650)	14.1	61.1	9.40	4.49	208.2	0.66	16.16	clr.
(0655)	14.2	60.9	7.07	4.59	217.0	1.08	16.14	clr.
(0700)	14.1	60.7	7.13	4.57	229.0	0.53	15.88	clr.
(0705)	14.1	60.5	7.46	4.59	235.9	1.06	16.12	clr.
(0710)	~~14.1~~	~~60.5~~ ~~readings stable~~	7.31	4.60	242.7	0.98	16.14	clr.

Post-purge readings: (KFC 4-29-21)

TIME	Temp (°C)	SpCond mS/cm	DO mg/L	pH	ORP (mV)	TURB (NTU)	DTW	Desc.
(0720)	14.2	60.6	7.26	4.61	249.3	1.18	16.12	clr.

Sample Time (0715) / Samples collected: (3) 8260C + (1) TM

5W12A

DTW: 11.61

CB: 17

Begin Purge (0733)

P/P DTW: 11.61

Initial Purge - CLEAR

TIME	TEMP (°C)	Cond mS/cm	DO mg/L	pH	ORP (mV)	TURB (NTU)	DTW	Desc.
(0735)	13.8	528.8	5.03	6.50	239.9	0.55	11.61	clr.
(0740)	13.9	530.5	4.56	6.61	231.8	1.31	11.61	clr.
(0745)	13.9	531.2	4.06	6.62	228.1	1.08	11.61	clr.
(0750)	14.0	531.4	3.56	6.63	225.1	0.77	11.61	clr.
(0755)	14.0	531.5	2.97	6.63	221.9	0.74	11.61	clr.
(0800)	14.0	530.7	2.81	6.64	219.0	0.72	11.61	clr.
(0805)	14.0	530.0	2.79	6.64	216.2	0.81	11.61	clr.
(0815)	14.0	529.1	2.80	6.65	212.5	1.12	11.61	clr.

(136)

4/28/21 RFAAP (UNIT-5) / 2100706 / KFC·KLV

(SWI24 Cont'd.)

(0805) Readings Stable

Post Purge ~~Readings~~ Readings (see page 136 @ 0815)

	Temp(°C)	Cond mS/cm	DO mg/L	pH	ORP(mV)	Turb(NTU)	DTW	Desc.	
(0815)	14.0	529.7	3.80	6.65	272.5	1.12	11.61	clear	KW

Sample Time (0810) / Samples Collected: (3) 8260C, (1) TM

SWTB

DTW: 9.91

CB Setting: 14

Begin Purge (0823)

Initial Purge: clear

Post Purge DTW: 9.94

Time	Temp(°C)	Cond mS/cm	DO mg/L	pH	ORP(mV)	Turb(NTU)	DTW	Desc.
(0825)	13.0	198.4	9.07	4.24	249.3	0.51	9.92	clear
(0830)	13.0	201.0	7.91	4.18	263.2	0.56	9.90	clear
(0835)	13.0	199.5	6.99	4.20	276.1	0.97	9.92	clear
(0840)	12.9	196.7	7.13	4.21	282.2	0.92	9.90	clear
(0845)	12.8	198.1	~~5.42~~ 7.52	4.20	287.9	1.07	9.90	clear
(0850)	13.0	200.3	7.54	4.20	290.8	1.32	9.92	clear

(0850) Readings Stable

Post Purge Readings:

(0915)	13.8	215.4	7.75	4.17	305.0	1.39	9.91	clear

Sample Time (0855) Samples Collected: (9) 8260C, (12) 8270D, (3) TM

SWSB

DTW: 9.50

Control Box Setting: 14

Begin Purge (0923)

Initial Purge: clear

Post Purge DTW: 9.76

Time	Temp(°C)	Cond mS/cm	DO mg/L	pH	ORP(mV)	Turb(NTU)	DTW	Desc.
(0930)	13.4	315.7	8.47	5.21	306.2	0.87	9.89	clear
(0935)	12.9	323.7	4.41	5.30	300.3	0.30	9.73	clear
(0940)	12.9	324.8	3.87	5.31	295.9	0.35	9.72	clear
(0945)	12.7	325.0	3.57	5.33	293.1	0.68	9.72	clear
(0950)	12.5	325.3	3.57	5.33	291.1	0.25	9.73	clear
(0955)	12.6	325.2	3.47	5.34	287.8	0.35	9.73	clear

(0955) Readings Stable

Post-Purge Readings

(1005)	12.6	326.4	3.61	5.33	282.4	0.82	9.76	clear

SWSB Cont'd

Sample Time(1000)/Samples Collected: (3)8260C, (4)8270D, (1)TM

5WC22 -JCF/DAA - 7-26-2021

5WC2-2

DTW: 9.73

CB Setting
30

Begin Purge (1018)

Post Purge DTW: 9.76

Initial Purge: clear

Time	Temp(°C)	Cond mS/cm	DO mg/L	pH	ORP(mV)	Turb (NTU)	DTW	Desc
(1020)	13.5	967	3.10	7.4	282.5	4.24	9.80	clear
(1025)	13.9	982	0.51	6.61	278.0	26.9	9.75	clear
(1030)	14.5	993	0.35	6.62	269.2	51.4	9.75	clear
(1035)	14.3	995	0.31	6.62	262.4	43.6	9.76	clear
(1040)	14.4	997	0.28	6.65	230.0	26.4	9.75	clear
(1045)	14.4	1001	0.36	6.69	152.4	8.77	9.76	clear
(1050)	14.2	1003	0.30	6.71	105.0	4.36	9.76	clear
(1051)	14.2	1002	0.30	6.70	94.8	3.48	9.76	clear
(1054)	14.4	1004	0.28	6.70	66.2	2.60	9.76	clear
(1057)	14.5	1005	0.26	6.70	63.0	2.80	9.75	clear
(1100)	14.5	1005	0.26	6.71	59.1	2.45	9.76	clear

(1100) Readings Stable

Post-Purge Readings:

(1110)	14.9	1010	0.62	6.76	27.1	4.74	9.75	clear

Sample Time (1105)/Samples Collected: (3)8260C, (4)8270D, (1)TM

5WC23 JCF 7-26-2021

5WC2-3

DTW: 9.14

CB Setting
30

Begin Purge (1111)

Post Purge DTW: 9.15

Initial Purge: clear

Time	Temp(°C)	Cond mS/cm	DO mg/L	pH	ORP(mV)	Turb (NTU)	DTW	Desc
(1115)	13.5	1163	2.51	6.92	22.5	0.71	9.14	clear
(1120)	13.3	1044	2.41	6.91	14.1	0.83	9.14	clear
(1125)	13.3	1135	2.21	6.88	10.7	0.84	9.15	clear
(1130)	13.4	1131	2.20	6.24	9.6	0.85	9.14	clear
(1135)	13.5	1126	2.17	6.73	10.3	0.77	9.14	clear
(1140)	13.4	1122	2.16	6.88	9.6	0.84	9.15	clear

(1140) Readings Stable

5WC2-3 Cont'd

Time	Temp(c)	Cond mS/cm	DO mg/L	pH	ORP(mV)	Turb (NTU's)	DTW	Desc.
Post-Purge Readings:								
(1150)	13.8	1121	2.22	6.88	5.3	0.74	9.15	clear

Sample Time (1145)/Samples Collected: (3)8260C, (4)8270D, (1)TM

5WC21 JCF/DAA 7-26-2021

5WC2-1

DTW: 9.87

CB Setting
21

Begin Purge (1154)

Post Purge DTW: 9.88

Initial Purge: clear

Time	Temp(c)	Cond mS/cm	DO mg/L	pH	ORP(mV)	Turb(NTU)	DTW	Desc.
(1155)	14.8	832	2.11	6.27	28.7	4.75	9.88	clear
(1200)	14.7	802	1.86	6.21	28.8	4.92	9.97	clear
(1205)	14.7	780	1.10	6.16	24.1	9.95	9.99	clear
(1210)	14.8	769	0.77	6.14	16.7	13.7	9.89	clear
(1215)	14.4	762	0.85	6.09	14.1	16.4	9.88	clear
(1220)	14.4	755	0.64	6.02	11.1	15.6	9.89	clear
(1225)	14.5	749	0.66	6.01	9.3	15.6	9.89	clear
(1230)	14.6	747	0.69	5.98	8.6	13.8	9.89	clear
(1230) Readings Stable								
Post-Purge Readings:								
(1240)	15.1	742	2.19	5.95	23.1	18.6	9.88	clear

Sample Time (1235)/Samples Collected: (3)8260C, (4)8270D, (1)TM

SW-DUP

Sample Time (1245)/Samples Collected: (3)8260C, (2)8270D, (1)TM

blind field duplicate 5WDUP collected at 5WC21. JCF/DAA 5-28-2021

General Notes: Unit-5

- Weather - Overcast, misty & 60°-70°s
- PPE - Nitrile gloves, eye protection, safety boots & face masks
- Calibrations - YSI ProPlus / D.O.% = 95.4
  pH: 4.00 - 4.00, 7.00 - 7.00, 10.00 - 10.00
  Conductivity reads 1413 $\frac{\mu S}{cm}$ in a 1413 $\frac{\mu S}{cm}$ std.
  HACH 2100Q Turbidimeter: 0.02-1000 NTU
- Dedicated well skirts & tubing used at each well.
- All equipment decanned before & after event and between use at each sample location.
- All purge water collected and disposed of at a dedicated, on-site location.
- All samples collected, transported & stored on ice in coolers.
- Sample collection order:
- All wells purged and sampled at 0.25L/min.
- All DTW's collected in feet.
- Sample Analysis — Preservative
  8260D — HCL
  TM — HNO_3
- VOA's collected from one pulse from Bladder Pump.
- Bladder pump settings @ 4 cycles/min. 5 sec discharge, 10 sec recharge

Confidence Solution Value Range

BATCH #: 21B1C Date Opened: 9/21/21

(WL)	Temp (°C)		Cond $\frac{\mu S}{cm}$		ORP (mV)		pH	
	Actual	Range	Actual	Range	Actual	Range	Actual	Range
PRE	20.4	16-20	7764	7630-7970	248	222-252	6.97	6.8-7.2
POST	17.1	16-20	7674	7630-7970	244.5	222-252	7.03	6.8-7.2

F.B#4

10/07/21 RFAAP (Unit-5) / 210706 / KFC-1SM F.B#4

STATIC WATER LEVEL TABLE (Measured in Feet)

WELL	DTW	P/P DTW	NOTES
SW8B-	14.92	15.53	
SW12A-	11.51	11.60	
SW7B-	9.68	9.81	No sign attached
SW5B-	9.50	9.86	Sign not attached
SWC21-	9.57	9.79	
SWC22-	9.65	9.68	
SWC23-	9.05	9.09	
• SWL's ONLY •			
SW9A-	1.79	N/A	

WELL	DTW	P/P DTW	NOTES
SWCA-	13.13	N/A	SIGN PRESENT
SW10A-	13.94		
SWC11-	15.85		NO CAP
SWC12-	16.20		SHRUBS AND GRASS GROWN OVER
SSW5-	8.55		
SSW6-	7.43		
SSW7-	11.66		
SSW8-	11.68		NO CAP
SW11A-	11.92		

SW8B [EB: 24]

DTW: 14.92 POST PURGE DTW: 15.53 / BEGIN PURGE (0734) INITIAL PURGE: Clear

TIME	TEMP(C)	Cond mS/cm	DO mg/L	pH	ORP (mV)	TURB (NTU)	DTW	Desc.
(0735)	16.2	64.3	5.11	5.89	190.2	1.37	15.47	CLR
(0740)	16.1	62.8	4.89	5.44	193.9	1.32	15.44	CLR
(0745)	16.1	61.2	4.72	5.24	195.9	1.57	15.44	CLR
(0750)	16.0	60.4	4.75	5.07	198.4	0.88	15.49	CLR
(0755)	16.1	59.8	4.71	4.97	200.8	0.75	15.50	CLR
(0800)	16.1	59.4	4.86	4.88	201.8	1.17	15.49	CLR
(0800)	Readings stable			Sample Time (0805)			~~15.53~~	
Samples Collected: (3) 8260D, (1) TPH								
(0809)	16.1	58.9	4.75	4.86	206.5	1.43	15.53	CLR

SW12A CB: 20

DTW: 11.51 Post Purge DTW: 11.60 / Begin Purge (0814) Initial Purge - Clear

Time	Temp(°C)	Cond ms/cm	DO mg/L	pH	ORP (mV)	Turb (NTU)	DTW	Desc.
(0815)	14.8	464.2	3.25	6.71	223.3	1.20	11.60	clear
(0820)	14.7	465.2	2.79	6.77	223.8	1.21	11.65	Clear
(0825)	14.7	465.6	2.74	6.84	222.4	0.92	11.60	clear
(0830)	14.7	465.0	2.62	6.82	221.2	1.05	11.60	Clear
(0835)	14.7	464.6	2.63	6.84	219.6	0.86	11.60	Clear
(0840)	14.8	463.7	2.66	6.83	218.0	1.50	11.60	Clear

(0840) Readings stable Sample Time (0845)

( ) samples Collected: (3)8260D, (4)TM

(0848) 14.8 464.0 2.69 6.82 217.0 0.81 11.60 Clear

SW7B CB: [15]

DTW: 9.68 Post Purge DTW: 9.81 / Begin Purge (0849) Initial purge: Clear

Time	Temp°C	Cond ms/cm	DO mg/L	PH	ORP (mV)	Turb (NTU)	DTW	DesC
(0850)	17.3	223.7	4.58	4.20	219.9	0.73	9.92	Clear
(0855)	16.7	212.9	1.63	4.16	218.6	0.91	9.86	"
(0900)	16.6	228.9	1.36	3.93	222.1	1.07	9.82	"
(0905)	16.5	231.4	1.31	3.90	223.3	1.04	9.84	"
(0910)	16.4	230.5	1.28	3.91	224.0	0.87	9.86	"
(0915)	16.4	230.2	1.31	3.89	225.0	1.11	9.84	"

(0915) Readings Stable Sample Time (0920)

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

(0925) 16.4 232.2 1.41 3.88 226.4 0.70 9.81 "

F-B#14

10/07/21 RFAAP(UNIT-5)/2100706/RFC-ISM F-B#14

5WSB CB:15

DTW: 9.50 Post Purge DTW: 9.86 Begin Purge (0929) Initial Purge: Clear

Time	Temp °C	Cond ms/cm	DO mg/L	PH	ORP (mV)	Turb (NTU)	DTW	Desc
(0930)	16.0	287.0	2.76	4.83	226.8	0.52	9.92	Clear
(0935)	16.2	285.5	2.48	4.84	226.5	0.92	9.94	"
(0940)	16.4	279.1	2.57	4.37	227.4	1.21	9.86	"
(0945)	16.5	278.8	2.67	4.69	226.6	1.18	9.86	"
(0950)	16.5	278.5	2.97	4.85	226.3	1.45	9.86	"
(0955)	16.5	279.1	2.99	4.88	225.5	1.23	9.86	"
(1000)	16.5	279.0	3.02	4.88	224.7	1.03	9.86	"

(1000) Readings stable Sample Time (1005)

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

(1007)	16.6	279.1	3.08	4.98	223.8	0.95	9.86	"

5WC22 - RGM/DAA - 12-22-2021

~~FB~~ SWC2-2 CB:18

DTW: 9.65 Post Purge DTW: 9.68 Begin Purge (1012) Initial Purge: CLR.

Time	Temp °C	Cond ms/cm	DO mg/L	PH	ORP (mV)	Turb (NTU)	DTW	Desc
(1015)	15.3	857	2.70	5.79	232.0	2.16	9.66	CLR
(1020)	15.3	644	1.08	5.88	232.0	1.20	9.72	CLR
(1025)	15.3	846	1.25	6.59	230.9	1.33	9.68	CLR
(1030)	15.4	847	1.18	6.73	230.0	1.10	9.67	CLR
(1035)	15.2	848	1.08	6.63	227.9	1.18	9.66	CLR
(1040)	15.2	849	0.98	6.56	226.6	1.07	9.68	CLR

(1040) Readings Stable Sample Time (1045)

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

(1047)	15.4	852	0.27	6.53	225.3	1.10	9.68	CLR

10-7-21 RFAAP (Unit 05) / 2100706 / ISM - KFC FB#14

5WC23 - RGM/DAA - 12-22-2021

5WC2-3 CB: 50

DTW: 9.05 Post Purge DTW: 9.09 Begin Purge (1044) Initial Purge - Clear

Time	Temp (C)	Cond mS/cm	DO mg/L	pH	ORP (mV)	Turb (NTU)	DTW	Desc.
(1045)	17.7	1019	1.79	6.39	225.5	1.24	9.10	Clear
(1050)	16.0	1019	0.98	6.40	226.0	1.09	9.11	Clear
(1055)	15.7	1024	0.63	6.87	225.3	1.12	9.09	Clear
(1100)	15.~~9~~7	1029	0.19	6.87	222.6	1.51	9.09	Clear
(1105)	15.6	1029	0.16	6.79	221.0	1.21	9.09	Clear
(1110)	15.5	1028	0.19	6.72	219.7	1.55	9.12	Clear
(1110)	Readings Stable Sample Time (1115)							
Samples Collected: (3)8260D, (1)TM								
(1117)	15.6	1032	0.24	6.71	218.8	1.61	9.09	Clear

5WC21 - RGM/DAA 12-22-2021

5WC2-1

DTW: 9.57 Post Purge DTW: 9.79 Begin Purge (1118) Initial Purge: Clear

Time	Temp °C	Cond mS/cm	DO mg/L	pH	ORP (mV)	Turb (NTU)	DTW	Desc
(1120)	15.1	714	3.06	5.45	217.6	6.08	9.77	clear
(1125)	15.4	694	1.54	5.94	216.0	6.30	9.79	"
(1130)	15.4	677	1.36	5.90	214.3	5.72	9.76	"
(1135)	15.4	665	1.23	5.82	212.8	4.84	~~9.85~~ 9.75	"
(1140)	15.3	659	1.21	5.79	211.6	4.58	9.76	"
(1145)	15.5	656	1.19	5.82	210.3	3.54	9.78	"
(1145)	Readings stable Sample Time (1150)							
Samples Collected: (3)8260D, (1)TM								
(1157)	15.5	631	0.75	5.40	209.9	3.36	9.79	Clear

5W DUP Sampled from 5WC2-1

Sample Time (1155)

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

General Notes: (UNIT-16)

- Weather- Sunny, clear 40°-60°s
- PPE- Nitrile gloves, eye protection, safety boots & face masks
- Calibrations- YSI Pro Plus / D.O.% = 96.7 %
  pH: 4.00 - 4.00, 7.00 - 7.00, 10.00 - 10.00
  Conductivity reads 1413 $\frac{ms}{cm}$ in a 1413 $\frac{ms}{cm}$ stnd.
  HACH 2100Q Turbidiment- 0.02-1000 ntu
- Dedicated well skirts & tubing used at each well.
- All equipment decomed before & after event and between use at each sample location.
- All purge water collected & disposed of 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	Sample Analysis	Preservative
8260C	HCL	Total Metals	HNO_3
8270D	—		

- VOAs collected from one pulse from bladder pump.
- Bladder pump setting: 4 cycles/MIN. 5 sec. discharge/10 sec. recharge

Confidence Solution Value Range

BATCH #: 20M1C Date Opened: 4/20/21

	Temp (°C)		SpCond $\frac{ms}{cm}$		ORP (mV)		pH	
	Actual	Range	Actual	Range	Actual	Range	Actual	Range
PRE -	8.7	5-10	7702	7600-7950	247.1	238-268	7.02	6.8-7.2
POST -	18.5	16-20	7829	7630-7970	234.7	223-252	7.03	6.8-7.2

STATIC WATER LEVEL TABLE (measured in feet)

WELL	DTW	P/D DTW	NOTES	WELL	DTW	P/D DTW	NOTES	WELL	DTW	P/D DTW	NOTES
16-2	55.81	55.87		16MW9	59.13	60.41					
16-3	53.85	61.12		16C1	44.39						
16-5	3.44	14.97		SWL's ONLY							
16WC2B	49.79	51.92		16C3	56.04						
16WC1B	60.34	60.86		16CDH3	68.36						
16WC1A	60.34	61.68		16WC2A	61.25						
16MW8	68.20	70.23		16-1	40.28						

F.B.#121

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3/6.8-7.2
Feet)
NOTES

4/26/21 RFAAP (UNIT-16)/2100706/KFC·KLV F.B.#14

16-S:

DTW: 3.44

PID SETTING 35

Begin Purge (0849)

Post Purge DTW: 14.97

Initial Purge - clear

TIME	Temp (°C)	Cond (ms/cm)	DO (mg/L)	pH	ORP (mV)	Turb (NTU)	DTW	Desc.
(0850)	11.4	507.4	4.43	7.10	180.5	1.31	4.79	clear
(0855)	12.0	508.8	3.22	7.13	172.8	1.54	5.88	clear
(0900)	12.0	510.1	2.83	7.16	168.6	1.32	7.19	clear
(0905)	12.1	510.4	2.64	7.16	164.8	0.89	8.56	clear
(0910)	12.2	510.8	2.51	7.16	161.2	0.79	9.59	clear
(0915)	12.3	510.8	2.42	7.20	110.0	0.48	10.53	clear
(0920)	12.3	511.3	2.51	7.18	59.7	1.22	11.23	clear
(0925)	12.3	511.5	2.26	7.18	-2.5	1.09	11.67	clear
(0930)	12.4	511.9	2.09	7.21	-23.6	1.43	12.31	clear
(0933)	12.5	512.1	1.98	7.23	-0.1	1.24	12.81	clear
(0936)	12.5	512.4	1.93	7.24	-0.4	1.90	13.19	clear
(0939)	12.5	512.7	1.80	7.27	-38.4	2.89	13.71	clear
(0942)	12.5	511.9	1.93	7.28	-28.8	3.53	13.98	clear
(0945)	12.6	511.9	1.92	7.29	-31.2	3.53	14.22	clear
(0945)	Readings Stable							
(0955)	12.6	513.7	1.48	7.28	2.3	6.55	14.97	clear

Sample Time (0950) Samples collected: (3) 8260C, (2) 8270D, (1) TM

Post Purge Readings

16 Spring:

Temp (°C)	Cond (ms/cm)	DO mg/L	pH	ORP (mV)	Turb (NTU)
13.1	537.7	6.85	7.26	-13.1	3.77

Sample Time (1005)

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

16WC2B:

CB Setting: 54

DTW: 49.79

Begin Purge: 1017

Post Purge DTW: 51.92

Initial Purge: clear

Time	Temp(C)	Cond mS/cm	DO mg/L	pH	ORP(mV)	Turb NTU	DTW	Desc
(1020)	13.6	311.0	7.06	7.61	-1.3	0.34	50.83	clear
(1025)	13.6	309.2	2.60	7.73	18.8	0.55	54.33	clear
(1030)	14.3	309.4	1.61	7.71	22.1	0.44	55.08	clear
(1035)	14.0	309.4	1.40	7.66	27.1	0.48	55.46	clear
(1040)	13.8	309.2	0.1	7.66	-0.5	0.23	56.99	clear
(1045)	13.7	309.4	0.96	7.69	8.0	0.24	58.89	clear
(1050)	13.7	309.5	1.22	7.69	9.1	0.32	60.08	clear
(1050) Readings Stable								
(1100)	13.9	309.9	1.05	7.67	12.4	0.30	51.92	clear

Post Purge Readings

Sample Time (1055) / Samples collected: (3) 8260C, (2) 8270D, (1) TM

16-2:

CB Setting: 55

DTW: 55.81

Begin Purge: 1112

Post Purge DTW: 55.87

Initial Purge: clear

Time	Temp(C)	Cond mS/cm	DO mg/L	pH	ORP(mV)	Turb (NTU)	DTW	Desc.
(1115)	13.2	530.4	6.16	6.99	23.0	0.50	54.82	clear
(1120)	13.7	526.9	5.65	7.00	46.1	0.40	55.81	clear
(1125)	13.5	520.7	5.93	7.00	31.9	0.56	55.84	clear
(1130)	13.5	518.5	5.97	6.99	41.1	0.33	55.84	clear
(1135)	13.4	516.2	6.03	7.04	33.7	0.33	55.85	clear
(1140)	13.6	513.5	6.02	7.05	37.8	0.40	55.87	clear
(1140) Readings Stable								

~~Post Purge Readings~~ (1150) KLV 4/26/2021

Sample Time (1145) / Samples collected: (3) 8260C, (2) 8270D, (1) TM

Post-Purge Readings:

(1150)	13.5	503.3	6.13	7.00	-5.1	0.66	55.87	clear

16MW8 JCF /DAA 7-27-2021

16MW-8:

CB setting 52

Begin Purge (1208)

DTW: 68.90

Initial Purge: clear

Post Purge DTW: 70.53

Time	Temp(C)	Cond(ms/cm)	DO %	pH	ORP(mV)	Turb (NTU)	DTW	Desc
(1210)	14.1	183.1	5.40	5.14	76.2	1.55	69.15	clear
(1215)	14.4	183.5	1.32	5.55	49.9	1.67	69.39	clear
(1220)	14.3	181.2	—	5.49	28.2	1.19	69.76	clear
(1225)	14.0	176.9	0.75	5.49	34.3	1.16	69.82	clear
(1230)	14.0	177.3	0.44	5.44	3.5	1.10	70.09	clear
(1235)	14.2	177.9	0.33	5.49	3.9	1.41	70.17	clear
(1240)	14.2	177.6	0.33	5.47	7.6	1.07	70.33	clear

(1240) Readings Stable

Post-Purge Readings:

(1250)	14.0	178.2	0.28	5.36	23.9	0.82	70.53	clear

Sample Time (1245) / Samples Collected: (3) 8260C, (2) 8270D, (1) TM

16-3:

CB setting 50

Begin Purge (1259)

DTW: 53.85

Initial Purge: clear

Post-Purge DTW: 61.12

Time	Temp(C)	Cond(ms/cm)	DO %	pH	ORP(mV)	Turb (NTU)	DTW	Desc
(1300)	13.5	232.4	8.50	6.81	12.9	1.38	54.54	clear
(1305)	14.3	240.5	4.29	7.65	1.2	1.42	56.12	clear
(1310)	14.4	241.8	4.46	7.77	-5.3	2.30	57.18	clear
(1315)	14.4	240.9	4.94	7.81	-2.8	3.69	58.45	clear
(1320)	14.3	241.4	4.52	7.84	5.3	3.11	59.02	clear
(1325)	14.1	240.2	4.59	7.83	15.3	2.85	59.72	clear

(1325) Readings Stable

Post-Purge Readings:

(1335)	13.9	239.8	4.85	7.79	25.1	2.34	61.12	clear

Sample Time (1330) / Samples Collected: (3) 8260C, (2) 8270D, (1) TM

General Notes

- Weather - Clear, sunny & 40° - 60°'s
- PPE - Nitrile gloves, eye protection, safety boots & face masks
- Calibrations - YSI ProPlus / D.O.% = 94.7 %

See page 128 for event specifics

- Dedicated well skirts & tubing used at each well.
- All equipment decomed before & after event and between use at each sample location.
- All purge water collected & disposed of a 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 0.25L/MIN
- All DTW's measured in feet.

SAMPLE ANALYSIS	Preservative	Sample Analysis	Preservative
8260C	HCL	Total Metals	HNO_3
8270D	-		

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

CONFIDENCE SOLUTION VALUE RANGE

BATCH # - 20 M1C Date Opened: 4/20/21

	Temp (°C)		SpCond mS/cm		ORP (mV)		pH	
	Actual	Range	Actual	Range	Actual	Range	A	R
Pre -	12.9	11-15	7677	7600-7970	236.6	229-261	7.05	6.8-7.2
Post -	23.5	21-25	7678	7630-8010	226.8	212-242	6.98	6.8-7.2

16WC1B

DTW - 60.34

CB setting 52

Begin Purge (0733)

POST PURGE DTW - 60.88

Initial Purge - CLEAR

TIME	Temp (°C)	SpCond mS/cm	DO mg/L	pH	ORP (mV)	TURB (NTU)	DTW	Desc.
(0735)	12.4	405.5	5.00	5.99	67.2	8.45	60.82	CW.
(0740)	12.5	395.8	1.10	6.05	55.7	2.65	60.86	CW.
(0745)	12.4	394.0	0.67	6.08	52.4	2.79	60.87	CW.
(0750)	12.3	395.4	0.60	6.11	44.9	3.29	60.83	CW.
(0755)	12.5	397.2	0.53	6.12	38.6	4.60	60.83	CW.

F.B.#14

7/27/21 RFAAP (UNIT-16) / 2100706 / JCFC · KLV

F.B.#14

16WC1B (Cont'd.)

TIME	Temp (°C)	SpCond mS/cm	DO mg/L	pH	ORP (mV)	Turb (NTU)	DTW	Desc.
(0800)	12.6	398.8	0.48	6.14	34.4	3.73	60.89	clr.

(0800) Readings stable

Post-purge readings

(0809) 12.5 399.3 0.68 6.16 28.1 6.44 60.88 clr.

Sample Time (0805) / Samples collected: (3) 8260, (2) 82700 + (1) TM

16WC1A

DTW: 60.34

EB Setting 58

Begin Purge (0817)

Post-Purge DTW: 61.68

Initial Purge: clear

Time	Temp (°C)	SpCond mS/cm	DO mg/L	pH	ORP (mV)	Turb (NTU)	DTW	Desc.
(0820)	12.3	635.0	4.83	6.98	29.0	2.56	61.12	clear
(0825)	12.9	736	0.79	6.74	22.8	1.04	61.89	clear
(0830)	13.0	740	0.62	6.58	1.4	0.37	61.99	clear
(0835)	13.0	750	0.54	6.47	-14.1	0.25	61.83	clear
(0840)	13.4	749	0.52	6.48	-17.5	0.32	61.74	clear
(0845)	13.1	753	0.52	6.42	-18.6	0.34	61.67	clear

(0845) Readings stable

Post-Purge Readings:

(0910) 13.0 756 0.47 6.41 -21.5 0.55 61.68 clear

Sample Time (0850) / Samples collected: (6) 8260, (6) 8270D, (3) TM

16MWDUP

Sample Time (0900)

Samples Collected: (3) 8260C, (2) 82700, (1) TM

Blind field duplicate 16MWDUP collected at 16WC1A. JCF/DAA 7-27-2021

16MW-9

DTW: ~~60.02~~ 59.13 kw

CB Setting 52

Begin Purge (0914)

Post Purge DTW: 60.41

Initial Purge: clear

Time	Temp(°C)	Cond mS/cm	DO mg/L %	pH	ORP(mV)	Turb (NTU)	DTW	Desc
(0915)	12.8	795	6.29	6.63	10.0	1.37	60.18	clear
(0920)	13.0	992	0.87	6.59	7.0	0.42	60.27	clear
(0925)	13.1	993	0.59	6.39	5.4	0.36	60.41	clear
(0930)	13.2	984	0.51	6.40	7.5	0.37	60.49	clear
(0935)	13.6	981	0.51	6.40	8.1	0.31	60.05	clear
(0940)	13.2	995	0.48	6.40	7.8	0.38	60.21	clear

(0940) Readings Stable

Post-Purge Readings:

(0950)	13.3	985	0.43	6.40	7.0	0.61	60.41	clear

Sample Time (0945) / Samples collected: (3) 8260C, (2) 8270D, (1) TM

16C1 - jcf 7-27-2021

16C-1

DTW: 44.39

CB Setting 52

Begin Purge (0958)

Post-Purge DTW:

Initial Purge: clear

Time	Temp(°C)	Cond mS/cm	DO mg/L %	pH	ORP(mV)	Turb (NTU)	DTW	Desc.
(1000)	13.5	885	3.63	6.56	-0.6	0.40	44.43	clear
(1005)	13.6	909	2.57	6.50	5.3	0.41	44.43	clear
(1010)	14.2	894	1.66	6.60	12.9	0.43	~~44.43~~ 44.43 kw	clear
(1015)	14.1	789	1.63	6.59	22.5	0.79	44.43	clear
(1020)	13.9	683	1.44	6.42	36.8	0.27	44.43	clear
(1025)	13.9	613.0	1.58	6.39	~~46.0~~ 46.6 kw	0.37	~~44.43~~ 44.43 kw	clear
(1030)	13.9	572.4	1.54	6.37	53.0	0.33	44.43	clear

(1030) Readings Stable

Post-Purge Readings:

~~(1035)~~ (1040) kw	13.9	547.4	1.73	6.33	-10.8	0.35	44.43	clear

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

6/24/21 RFAAP (UNIT-16) / 2100706 / KFC · TAW F.B. #14

General Notes (UNIT-16)

- Weather - Overcast & 60's
- PPE - Nitrile gloves, eye protection, safety boots
- Calibrations - YSI Pro Plus / D.O. % = 96.4 %
  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: 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 of at dedicated on-site location.
- All samples collected, transported & stored on ice in coolers.
- Sample collection order: 8270D
- All wells purged & sampled at 0.25 L/min.
- All DTW's measured in feet.

SAMPLE ANALYSIS	PRESERVATIVE
8270D	—

- Bladder pump setting: 4 cycles/min. 5 sec discharge 10 sec recharge

Confidence Solution Value Range

BATCH # - 21BIC Date Opened: 6/22/21

	Temp (°C)		Cond mS/cm		ORP (mV)		pH	
	Actual	Range	Actual	Range	Actual	Range	Actual	Range
PRE-	17.6	16-20	7737	7630-7970	230.7	222-252	6.96	6.8-7.2
POST -	18.3	16-20	7777	7630-7970	227.9	222-252	7.01	6.8-7.2

16-3 DTW: 54.98 PP DTW: 64.42 CB: 55 BEGIN PURGE (0904) INITIAL PURGE - clear

TIME	TEMP (°C)	SP COND (mS/cm)	DO (mg/L)	pH	ORP (mV)	TURB (NTU)	DTW	DESC.
(0905)	15.9	242.9	9.23	7.43	-72.2	0.85	56.75	clear
(0910)	13.9	235.4	5.80	7.91	-123.8	1.72	58.95	clear
(0915)	14.0	234.9	6.27	7.93	-127.8	1.40	60.14	clear
(0920)	14.0	234.7	5.57	7.89	-129.1	1.37	61.49	clear
(0925)	14.0	233.6	5.27	7.85	-127.5	0.94	62.47	clear

6/24/21 RFAAP(UNIT-16)/2100706/KLFC • TAW

TIME	TEMP(°C)	COND(µS/cm)	DO(mg/L)	pH	ORP(mV)	TURB (NTU)	DTW	DESC.
(0930)	14.0	233.0	5.28	7.04	-123.9	0.68	63.33	clear

(0930) READINGS STABLE / SAMPLES COLLECTED: (2) 8270D

POST PURGE READINGS / SAMPLE TIME (0935)

(0940)	14.1	233.3	5.71	7.85	-122.4	1.19	64.42	clear

DUP

SAMPLE TIME (0940)

SAMPLES COLLECTED: (2) 8270D

General Notes - (Unit-16)

- Weather: Overcast, misty & 60's
- PPE - Nitrile gloves, eye protection, safety boots & face masks.
- Calibrations - YSI Pro Plus / D.O. % = 99.6 %
  pH: 4.00 - 4.00, 7.00 - 7.00, 10.00 - 10.00
  Conductivity reads 1413 $\frac{\mu S}{cm}$ in a 1413 $\frac{mS}{cm}$ stnd.
  HACH 2100Q Turbidity Meter: 0.02 - 1000 NTU
- Dedicated well skirts & tubing used at each well.
- All equipment decon'ed before & after event and btwn. use at each sample location.
- All purge water collected & disposed of at dedicated on-site location.
- All samples collected, transported & stored on ice in coolers.
- Sample collection order: 8260D, 8270, TM & CN
- All ~~samples~~ wells purged & sampled at 0.25 L/MIN
- All DTW's measured in feet.

SAMPLE ANALYSIS	Preservative	Sample Analysis	Preservative
8260D	HCL	TOTAL Metals	HNO_3
8270	—	CYANIDE	NaOH

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

Confidence Solution Value Range

Batch # - 21BIC Date Opened - 9/21/21

	Temp (°C)		Cond $\frac{mS}{cm}$		ORP (mV)		pH	
	Actual	Range	Actual	Range	Actual	Range	Actual	Range
PRE -	22.3	21-25	7665	7630-8010	246.5	212-242	6.94	6.8-7.2
POST -	22.4	21-25	7693	7630-8010	212.8	212-242		6.8-7.2

10/06/21 RFAAP (UNIT-16) / 2100706 / KFC-15M

F.B.#14

STATIC WATER LEVEL TABLE (Measured in feet)

Well	DTW	P/PDTW	Notes	Well	DTW	P/PDTW	Notes
16-2	55.89	55.95		16MW9	64.91	66.40	
16-3	56.39	61.52		16C1	48.88	49.01	
16-5	4.26	12.18		SWLs ONLY			
16WC2B	53.94	65.14		16C3	67.13	–	–
16WC1B	68.33	68.90		16CDH3	Dry	–	DRY
16WC1A	68.01	69.81		16WC2A	DRY	–	DRY
16MW8	73.50	Top of pump		16-1	47.32	–	–

CB: 30

16-5: DTW 4.26 / POST PURGE DTW / BEGIN PURGE (0749) / INITIAL PURGE - Clear

Time	Temp(C)	Cond mS/cm	DO mg/L	pH	ORP (mV)	Turb (NTU)	DTW	Desc.
(0750)	14.2	507.4	3.41	8.60	201.2	1.92	5.54	CLR
(0755)	14.2	501.7	2.32	8.20	193.1	1.22	6.77	CLR
(0800)	14.2	498.8	2.38	8.28	189.1	0.99	7.73	CLR
(0805)	14.1	494.6	2.22	7.93	184.6	0.99	9.07	CLR
(0810)	14.1	491.0	2.20	7.78	181.2	0.93	10.04	CLR
(0815)	14.0	487.6	2.16	7.71	178.4	1.28	11.13	CLR
(0815)	Readings Stable				SAMPLE TIME (0820)			
Post Purge Readings / SAMPLES COLLECTED: (3) 8260D, (2) 8270D & (1) TIM								
(0825)	14.1	484.2	2.25	7.62	175.1	1.46	12.18	CLR

16SPRING

Temp(C)	Cond mS/cm	DO mg/L	pH	ORP (mV)	Turb (NTU)
14.6	522.0	3.05	6.41	93.7	3.68
					Clear

Sample Time (0830)

Samples collected: (3) 8260D, (2) 8270D & (1) TIM

CB: 50

16WC2B: DTW 53.94 / Post Purge DTW 65.14 / Begin Purge (0840) / Initial Purge - CLR

Time	Temp(°C)	Cond ms/cm	DO mg/L	pH	ORP (mV)	Turb (NTU)	DTW	Desc.
(0845)	15.2	299.6	0.81	6.99	172.8	1.04	55.18	CLR
(0850)	14.3	296.2	0.79	7.45	168.3	0.92	57.28	Clr
(0855)	14.2	295.8	0.63	7.63	169.4	0.81	59.04	Clr
(0900)	14.1	294.7	0.51	7.66	168.5	0.71	60.36	Clr
(0905)	14.2	293.6	0.58	7.71	167.7	0.83	62.16	Clr
(0910)	14.2	293.0	0.67	7.67	167.0	1.11	63.22	Clr
(0910)	Readings stable					Sample Time (0915)		
Samples collected: (3)18260D, (2)18270D, (1)TM								
(0916)	14.2	291.0	0.81	7.60	166.6	1.03	65.14	Clr

16-2 CB: 40

DTW: 55.89 / Post Purge DTW: 55.95 / Begin Purge (0923) / Initial Purge: Clear

Time	Temp°C	Cond ms/cm	DO mg/L	pH	ORP (mV)	Turb (NTU)	DTW	Desc
(0925)	14.2	470.7	6.68	6.47	179.0	0.74	55.91	Clear
(0930)	14.1	514.5	5.72	6.80	180.0	0.84	55.92	"
(0935)	14.4	511.5	4.82	6.38	179.9	1.24	55.93	"
(0940)	14.2	519.7	5.83	6.64	178.8	0.98	55.93	"
(0945)	14.2	513.7	5.87	6.75	179.2	0.65	55.94	"
(0950)	14.2	511.0	5.99	6.68	179.8	0.83	55.95	"
(0950)	Readings stable					Sample Time (0955)		
Samples Collected: (3)18260D, (2)18270D, (1)TM								
(0954)	14.4	507.9	6.06	6.64	180.3	0.85	55.95	Clear

10/06/21 RFAAP(UNIT-16)/2100706/KFC.ISM

16MW8 - RGM/DAA - 12-22-2021

16MW-8 CB: [42]

DTW: 73.50 Post Purge DTW: Top of pump Begin Purge (1004) Initial Purge: Clear

Time	Temp°C	Cond ms/cm	DO mg/L	pH	ORP (mV)	Turb (NTU)	DTW	Desc
(1005)	15.4	1066.2	1.45	5.56	188.9	1.09	73.88	Clear
(1010)	14.5	148.8	0.23	5.16	197.4	2.46	74.65	"
(1915)	15.2	145.2	0.24	4.98	187.8	1.58	74.89	"
(1020)	15.3	149.5	0.25	4.90	188.3	3.27	75.36	"
(1025)	15.3	152.5	0.23	4.87	187.0	4.53	75.57	"
(1030)	15.3	152.6	0.22	4.83	186.7	7.08	75.77	"

(1030) Readings stable Sample Time (1035)

Samples Collected: (9)8260D, (5)8270E, (1)TM, (1)CN,

(1056)	16.9	156.1	0.31	4.98	185.9	10.0	Top of pump	Clr

16-3

DTW: 56.39 Post Purge DTW: 61.52 Begin Purge (1104) Initial Purge: Clear

Time	Temp°C	Cond ms/cm	DO mg/L	pH	ORP (mV)	Turb (NTU)	DTW	Desc
(1105)	15.9	220.1	6.97	7.67	175.6	1.20	57.38	Clear
(1110)	16.1	221.4	5.87	6.75	180.4	1.30	57.76	"
(1115)	15.9	222.0	5.54	7.34	179.7	1.05	58.54	"
(1120)	16.0	221.8	5.52	7.44	179.8	0.93	59.16	"
(1125)	15.9	222.2	5.18	7.54	178.3	1.08	59.73	"
(1130)	15.9	221.4	5.15	7.59	177.8	1.11	60.19	"

(1139) Readings stable Sample Time (1135)

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

(1136)	15.5	222.6	5.38	7.67	176.9	1.05	61.52	"

16WC1B

DTW: 68.33 post purge DTW: 68.90 Begin Purge (1144) Initial purge: Clear

Time	Temp°C	Cond mS/cm	DO mg/L	PH	ORP (mV)	Turb (NTU)	DTW	Desc
(1145)	15.1	311.1	6.25	6.52	185.9	4.72	68.81	Clear
(1150)	14.8	352.1	3.18	5.68	155.8	6.48	68.83	"
(1155)	14.8	358.8	2.81	5.57	168.2	3.98	68.83	"
(1200)	14.8	362.2	2.73	5.75	175.1	5.09	68.84	"
(1205)	14.9	364.1	2.58	5.80	176.6	4.46	68.84	"
(1210)	14.9	364.4	2.54	5.81	177.7	4.32	68.89	"

(1210) Readings Stable Sample Time (1215)

Samples Collected: (9) 8260D, (6) 8270, (1) TM, (1) CN

(1226) 15.2 368.6 1.68 6.01 175.4 4.62 68.90 Clear

16WC1A

DTW: 68.01 post purge DTW: 69.81 Begin Purge (1233) Initial purge: Clear

Time	Temp°C	Cond mS/cm	DO mg/L	PH	ORP (mV)	Turb (NTU)	DTW	Desc
(1235)	15.0	508.0	5.45	6.78	144.5	1.04	68.84	Clear
(1240)	15.2	619.0	0.89	6.53	135.2	0.72	69.11	Clear
(1245)	15.1	615.9	0.49	6.52	133.3	0.44	69.18	Clear
(1250)	15.2	632	0.34	6.55	96.5	0.71	69.19	Clear
(1255)	15.3	689	0.32	6.45	78.0	0.91	69.11	Clear
(1300)	15.3	698	0.30	6.39	74.3	0.77	69.08	Clear
(1305)	15.4	703	0.29	6.36	72.9	1.26	69.11	Clear

(1305) Readings Stable Sample Time (1310)

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

(1345) 14.2 700 0.13 6.63 27.3 ~~0.84~~ 0.86 69.81 Clear

16MW Dup sampled from 16WC1A

Sample Time (1330)

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

10/6/21 RFAAP (unit-16) 2100706 / ISM - KFC

FB#14

16MW9 - RGM/DAA - 12-22-2021

16MW-9

DTW: 64.91 Past Purge DTW: 66.40 Begin Purge (1359) Initial Purge: Clear

Time	Temp °C	Cond ms/cm	DO mg/L	PH	ORP (mV)	Turb (NTU)	DTW	Desc
(1400)	15.1	829	1.33	6.37	106.0	1.67	65.89	Clear
(1405)	16.4	853	0.73	6.29	100.3	1.04	65.58	"
(1410)	14.6	842	0.43	6.24	103.4	0.89	66.05	"
(1415)	14.5	838	0.34	6.23	106.8	0.68	66.15	"
(1420)	14.4	840	0.32	6.32	107.3	0.73	66.18	"
(1425)	14.3	836	0.29	6.28	108.7	0.78	66.20	"

(1425) Readings Stable Sample Time (1430)

Samples Collected: (14)8260D, (6)8270E, (1)TM, (1)CN

(1442) 15.0 833 0.25 6.49 106.1 2.00 66.40 "

16C1 - RGM/DAA - 12-22-2021

16C-1

DTW: 48.88 Past Purge DTW: 49.01 Begin Purge (1449) Initial Purge: Clear

Time	Temp °C	Cond ms/cm	DO mg/L	PH	ORP (mV)	Turb (NTU)	DTW	Desc
(1450)	16.4	493.5	4.82	6.54	129.3	0.99	48.89	Clear
(1455)	16.0	701	1.91	6.37	131.5	0.73	48.90	"
(1500)	15.7	701	1.34	6.29	133.3	0.70	48.91	"
(1505)	15.6	643	1.03	6.25	132.1	1.60	48.91	"
(1510)	15.5	609.6	0.98	5.96	140.0	0.88	48.91	"
(1515)	15.5	599.8	0.88	6.05	143.2	0.88	48.91	"
(1520)	15.5	600.1	0.89	6.08	144.4	0.73	48.91	"

(1520) Readings Stable Sample Time (1525)

Samples Collected: (14)8260D, (6)8270E (1)TM, (1)CN

(1531) 14.1 578.1 0.85 5.99 152.1 1.37 49.01 Clear

General Notes

- Weather - Cloudy, calm & 50°-60°'s
- PPE - Nitrile gloves, eye protection, safety boots & face masks
- Calibrations - YSI Pro Plus / D.O.% = 100.0 %
  pH: 4.00 - 4.00, 7.00 - 7.00, 10.00 - 10.00
  Conductivity reads 1413 $\frac{mS}{cm}$ in a 1413 $\frac{mS}{cm}$ 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 of at dedicated on-site location.
- All samples collected, transported & stored on ice in coolers.
- Sample collection order:
- All wells purged & sampled at 0.25L/MIN
- All DTW's measured in feet.

SAMPLE ANALYSIS	PRESERVATIVE	Sample Analysis	Preservative
8260D	HCL	TOTAL metals	HNO_3
SVOC's	—	Cyanide	NaOH

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

Confidence Solution Value Range

BATCH # - 21B1C Date Opened - 10/29/21

	Temp (°C)		Cond $\frac{mS}{cm}$		ORP (mV)		pH	
EVENT:	Actual	Range	Actual	Range	Actual	Range	Actual	Range
PRE-	17.8	16-20	7735	7630-7970	225	220-252	7.07	6.8-7.2
POST-	14.6	11-15	7645	7600-7970	229.7	229-261	6.95	6.8-7.2

11/11/21 RFAAP (UNIT-16)/210706/RFC-15M. F.B. #15

16MW8 - RGM/DAA - 12-22-2021

- 16MW-8- DTW: 73.81 Begin Purge (0734)

CB: 49 | Post Purge DTW: T.O.P* Initial Purge - CLEAR

TIME	Temp(C)	Cond ms/cm	DO mg/L	pH	ORP (mV)	Turbs (NTU)	DTW	Desc.
(0735)	12.9	163.2	0.79	5.06	129.9	3.33	74.31	clr
(0740)	12.8	157.6	0.20	5.49	131.3	3.66	74.72	clr
(0745)	12.8	148.4	0.16	5.28	132.9	2.53	75.12	clr
(0750)	12.6	149.6	0.15	5.23	134.0	2.56	75.31	clr
(0755)	12.5	150.3	0.14	5.15	134.7	3.13	75.35	clr
~~(0760)~~	12.5	150.6	0.14	5.12	136.0	2.41	75.41	clr
~~(0765)~~								
(0800)	Readings stable							

/Sample Time (0800)

Samples collected: (4) 8260D, (2) TM, (1) COC, (4) SVOC's

(0815)	11.0	152.1	0.78	5.24	149.8	6.35	T.O.P*	clr

- 16MWDUP2 - Sample Time (0810)

Sample collected: (1) ~~COC~~ TM

*Top of Pump

- 16WC1B - DTW: 69.05 Begin Purge (0824)

CB: 45 | Post Purge DTW: 69.58 Initial Purge - CLEAR

TIME	Temp(C)	Cond ms/cm	DO mg/L	pH	ORP (mV)	Turbs (NTU)	DTW	Desc.
(0825)	12.7	384.3	3.01	5.90	107.8	39.2	69.47	clear w/ black specs
(0830)	12.9	387.7	2.72	6.24	101.4	47.5	69.45	clear w/ blk. specks
(0835)	12.8	392.6	2.09	6.25	93.0	23.6	69.50	clear w/ black specks
(0840)	12.8	395.9	1.58	6.25	78.1	17.7	69.51	clear w/ blk. specks
(0845)	12.8	399.5	1.34	6.26	68.4	15.3	69.50	clear w/ black specs
(0850)	12.8	398.5	1.29	6.26	66.5	15.2	69.52	clear w/ blk. specs
(0850)	Readings stable							

/Sample Time (0855)

Samples collected: (4) 8260D, (4) SVOC's + (1) CN

(0905)	12.9	400.2	0.79	6.26	53.0	20.0	69.58	clear w/ black spec

11/11/21 RFAAP (UNIT-16) / 2100706 / RFC-1SM F.B #15

•16WC1A DTW-68.72 BEGIN PURGE-(0911)

CB: 46 [POST PURGE] DTW-69.73 INITIAL PURGE- CLEAR

TIME	Temp(C)	Cond ms/cm	DO mg/L	pH	ORP (mV)	TURB (NTU)	DTW	DESC
(0915)	12.8	777	1.75	6.92	9.3	0.96	69.60	Clear
(0920)	12.9	744	1.02	6.94	18.9	0.56	69.71	Clear
(0925)	13.0	733	0.78	6.92	2.0	0.33	69.74	clear
(0930)	13.0	761	0.66	6.80	-25.1	0.45	69.74	Clear
(0935)	13.0	769	0.58	6.76	-30.6	0.38	69.75	clear
(0940)	13.1	773	0.48	6.74	-36.2	0.22	69.75	clear

(0940) Readings stable / SAMPLE TIME (0945)

Samples collected: (12) 8260D, (12) SVOCs & (3) CN

(1032)	13.5	776	0.25	6.79	-34.2	1.81	69.73	Clear

Blind field duplicate 16WDUP collected at 16WC1A. RGM/DAA - 12-22-2021

•16WDUP: Sample Time (1000)

Samples collected: (4) 8260D, (4) SVOCs & (1) CN

11/11/21 RFAAP (UNIT-16) / 2100706 / KFC-ISM

16MW9 - RGM/DAA - 12-22-2021

•16MW-9: DTW - 65.49 Begin Purge (1039)

CB: 40 Post Purge DTW - 66.81 Initial Purge - Clear

Time	Temp (C)	Cond mS/cm	DO mg/L	pH	ORP (mV)	Turb (NTU)	DTW	Desc.
(1040)	13.8	976	0.70	6.68	-3.6	0.64	66.79	Clear
(1045)	13.8	973	0.34	6.67	-4.6	0.32	66.74	Clear
(1050)	13.9	964	0.32	6.66	-2.8	0.30	66.70	Clear
(1055)	13.9	953	0.29	6.65	-3.0	0.20	66.68	Clear
(1100)	14.0	948	0.27	6.65	-3.3	0.22	66.63	Clear
(1105)	14.0	946	0.25	6.64	-3.3	0.89	66.41	Clear

(1105) Readings stable / Sample Time (1110)

( ) Samples Collected: (4) 8260D, (4) SVOC's, (1) CN

(1118)	14.2	950	0.39	6.65	-2.8	3.69	66.81	Clear

•16C1: DTW - 49.12 Begin Purge (1129)

CB: 40 Post Purge DTW - 49.12 Initial Purge - Clear

Time	Temp (C)	Cond mS/cm	DO mg/L	pH	ORP (mV)	Turb (NTU)	DTW	Desc.
(1130)	14.8	731	3.83	6.66	38.8	0.52	49.12	Clear
(1135)	14.3	815	1.15	6.59	38.7	0.22	49.12	Clear
(1140)	14.3	755	0.88	6.51	42.7	0.24	49.12	Clear
(1145)	14.6	726	0.76	6.47	44.6	0.33	49.12	Clear
(1150)	14.3	723	0.60	6.45	46.2	0.47	49.12	Clear
(1155)	14.2	721	0.48	6.39	48.6	0.32	49.12	Clear

(1155) Readings stable / Sample Time (1200)

Samples collected: (4) 8260D, (4) SVOC's, (1) CN

(1209)	14.3	731	0.52	6.44	46.7	1.69	49.12	Clear

APPENDIX E

CORRESPONDENCE (CD-ROM)

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
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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

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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
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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)

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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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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

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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
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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
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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
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(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,

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Sr. Environmental Engineer
BAE Systems, Inc. | OSI

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BAE SYSTEMS

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

April 13, 2021

Ashby Scott
Hazardous Waste Permit Writer
Virginia Department of Environmental Quality (VDEQ)
1111 East Main Street, Suite 1400
Richmond, Virginia 23218

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

Dear Mr. Scott:

In electronic correspondence dated February 12, 2020, RFAAP submitted to VDEQ a Class 1 Permit Modification to reflect changes to Permit-specified groundwater monitoring detection limits (DLs) and quantitation limits (QLs) and other similar modifications for the above referenced Permit. In electronic correspondence dated April 23, 2020, VDEQ requested RFAAP revise the pending Class 1 Permit Modification information to include DLs and QLs based on information obtained from four commercial laboratories. RFAAP submitted this information to you in electronic correspondence on March 26, 2021 and upon preliminary review of the proposed limits, you directed RFAAP on March 26, 2021 in electronic correspondence to formally submit the information to VDEQ. This Class 1 Permit Modification presents these changes. Additionally, we are taking the opportunity under this Class 1 Permit Modification to address other minor edits as detailed below that are needed to keep the permit updated and reflect current permit conditions.

This Class 1 Permit Modification request presents the following update:

- Update the proposed Permit-specified QLs and DLs for specific constituents to reflect current achievable laboratory limits. The proposed limits were generated by reviewing limits from four separate laboratories and removing the highest outlier for each analyte. In most cases, the third highest value was used to accommodate minor fluctuations in DLs from quarter to quarter.

  This update was made all permit attachments listed below. Additionally, for your convenience, please see below for special consideration information provided for the HWMU 16 Appendix IX Annual groundwater monitoring constituent 2-propanol.

Additionally, this Class 1 Permit Modification request presents the following administrative updates to reflect current permit conditions:

- Update Attachment 2 Appendix J- Corrective Action monitoring list and GPS (Unit 5) to remove the analytical method suffix (e.g., 8260B) and include the comment that the current method used must be accredited under the Virginia Environmental Laboratory Accreditation Program (VELAP). This update was inadvertently omitted on this attachment only and not submitted with the 2017 Class 1 permit modification for the same update.
- Update Unit 5 Compliance Monitoring List presented in Attachment 1 Appendix H8-3 SAP to include trichloroethene and reflect constituents currently monitored annually under Corrective Action.
- Update the semiannual compliance groundwater monitoring list for HWMU-16 to include vinyl chloride. Vinyl chloride was detected in Second Quarter 2020 and as reported to VDEQ on July 14, 2020. This modification was made to Attachment 3 Appendix E, Attachment 3 Appendix G and Attachment 1 SAP.

Special Consideration for 2-Propanol Revised QL and DL

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 Permit Attachment 1, Appendix I (Annual Groundwater Sampling Constituent List – Appendix IX 40 CFR Part 264). 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 Virginia Environmental Laboratory Accreditation Program (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 cannot be routinely achieved by other VELAP-accredited laboratories. This Class 1 Permit Modification proposes a DL of 50 ug/l and a QL of 100 ug/l for 2-propanol as currently authorized by VDEQ; however, RFAAP recognizes that the DL and QL for 2-propanol may need to be revised in a future Class 1 Permit Modification following the completion of the annual survey of laboratories in 2022.

The requested 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 (Groundwater Corrective Action Targeted Contaminants – GPSs and Semiannual Monitoring List for Unit 5)
- 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 1 Permit Modification includes revised copies of the above-listed Permit Attachment Appendices with the requested modifications noted in red-line/strike-out format.

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

Sincerely,

Users, Hawks, Jody Digitally signed by Users, Hawks, Jody
Date: 2021.04.13 16:23:46 -04'00'

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

Enclosure

Cc: Nikki Herschler, VDEQ, BRRO w/attachments
Tara Mason, Ashby Scott, VDEQ-Central w/attachments
J. McKenna, Army Staff
Melissa Lincoln, BAE Staff
Mike Lawless, Draper Aden Associates
Janet Frazier, Draper Aden Associates
Env. File 21-0900-058

Coordination: J. McKenna

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 21 0406
- Permit Attachment 1, Appendix I (Annual Groundwater Sampling Constituent List – Appendix IX 40 CFR Part 264) – REV 21 0406
- Permit Attachment 2, Appendix E (HWMU-5 Groundwater Compliance Monitoring Semiannual Constituent List) – REV 21 0406
- Permit Attachment 2, Appendix G (HWMU-5 Groundwater Protection Standards) – REV 21 0406
- Permit Attachment 2, Appendix J (Groundwater Corrective Action Targeted Contaminants – GPSs and Semiannual Monitoring List for Unit 5) – REV 21 0406
- Permit Attachment 2, Appendix K (HWMU-5 Groundwater Corrective Action Annual Monitoring List) – REV 21 0406
- Permit Attachment 3, Appendix E (HWMU-16 Groundwater Compliance Monitoring Semiannual Constituent List) – REV 21 0406
- Permit Attachment 3, Appendix G (HWMU-16 Groundwater Protection Standards) – REV 21 0406

Concerning the following:

CY 2021 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: FOR ROBERT N DAVIE III DCO
PRINTED NAME: Anthony Kazor
TITLE: Lieutenant Colonel, US Army
Commanding

SIGNATURE:
PRINTED NAME: Kirk Johnson
TITLE: General Manager
BAE Systems

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

May 3, 2021

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

VIA ELECTRONIC MAIL

Re: 2020 Annual Groundwater Monitoring Report for
Hazardous Waste Management Units 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 2020 Annual Groundwater Monitoring Report for Hazardous Waste Management Units (HWMU) 5 & 16 dated February 2021, submitted to the Virginia Department of Environmental Quality (Department or DEQ), Office of Remediation Programs (ORP) by BAE Systems on behalf of the Radford Army Ammunitions Plant (RFAAP).

There were reportedly no new-targeted constituents detected during the groundwater monitoring activities conducted during the second or fourth quarters of 2020 for HWMU-5. However, total cobalt, a potentially newly detected constituent, continues to be detected at concentrations greater than the groundwater protection standard (GPS) and alternate concentration limit (ACL) in several monitoring wells at HWMU-16. The Department requested a revised Alternate Source Demonstration (ASD) for cobalt in December 2020. The revised ASD should be submitted as soon as practicable.

Further, the presence of vinyl chloride was verified in 16WC1A at HWMU-16. The Department concurs with the recommendations to utilize a background value of 1 ug/L based on permit specified QL as the constituent has not previously been detected at the unit and a GPS of 2 ug/L based on the USEPA MCL for vinyl chloride.

As previously noted, the Department acknowledges the presence of barium above the site-specific background concentration. The Department recognizes that the variability of the lithology in the area of HWMU-16 could potentially explain the variation of this 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.

The Department accepts the report as complete. However, the Department does want to acknowledge that several constituents were reported above the permit specified detection limits. The Department does not require any action at this time as this issue is being addressed by a Class 1 permit modification that is currently under review by DEQ.

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

Sincerely,

Kurt W. Kochan
Project Manager

cc: RFAAP Correspondence File
Tara Mason, Ashby Scott, DEQ-CO
Nikki Herschler, DEQ-BRRO
Melissa Lincoln, Jody Hawks, BAE
Mike Lawless, DAA

BAE SYSTEMS

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

May 19, 2021

Mr. Kurt Kochan
Office of Remediation Programs
Virginia Department of Environmental Quality (VDEQ)
1111 East Main Street, Suite 1400
Richmond, Virginia 23219

Subject: Revised Cobalt ASD – HWMU 16
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730

Dear Mr. Kochan:

The Revised Alternate Source Demonstration for total cobalt in groundwater at Hazardous Waste Management Unit (HWMU) 16 at RFAAP can be accessed at the link below. The links below are now password protected and require use of the following password noted below.

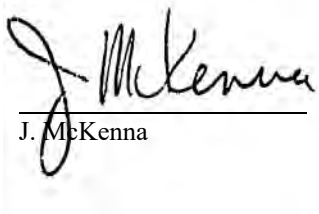
Revised Cobalt ASD – HWMU-16
https://share.daa.com/index.php/s/HR8Y3kXZf4DHmqE
Password: Draperaden2021

If you have any questions or concerns, please contact me at 540/639-7087 (melissa.lincoln@baesystems.com).

Sincerely,

Melissa Lincoln
Environmental Specialist
BAE Systems, Ordnance Systems Inc.

Cc: Nikki Herschler, VDEQ, BRRO w/attachments
Tara Mason, Ashby Scott, VDEQ-Central w/attachments
J. McKenna, Army Staff
Jody Hawks, BAE Staff
Mike Lawless, Draper Aden Associates
Janet Frazier, Draper Aden Associates
Env. File 21-0900-079

Coordination: 
J. McKenna

Concerning the following:

Revised Cobalt ASD for HWMU 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 Kazor
TITLE: Lieutenant Colonel, US Army
Commanding

SIGNATURE: _____
PRINTED NAME: Kirk Johnson
TITLE: General Manager
BAE Systems

June 8, 2021

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 2021, 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 2021 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 2021 groundwater monitoring event also served as the semiannual Compliance monitoring event for HWMU-16. The Second Quarter 2021 groundwater monitoring event was conducted using revised detection limits (DLs) and quantitation limits (QLs), where applicable, as specified in the Class 1 Permit Modification approved by the Virginia Department of Environmental Quality (VDEQ) in electronic correspondence dated May 5, 2021. The following information summarizes the findings of the Second Quarter 2021 semiannual monitoring 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 Second Quarter 2021, 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 1.7 ug/l, 2 ug/l, and 2.9 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 ug/l.

Total cobalt was detected in POC well 5WC21 at a concentration of 18 ug/l, which is greater than the GPS of 7 ug/l. Total cobalt was detected in POC wells 5W7B and 5WC22 at concentrations of 6.4 ug/l and 5 ug/l, respectively, which are less than the GPS. Total cobalt was detected in POC well 5WC23 at a concentration 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 2021.

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 2021, no constituents with GPS equal to their respective QLs and greater than the applicable risk-based concentrations were detected.

HWMU-16

In accordance with the 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; modified to add vinyl chloride in Class 1 Permit Modification approved May 5, 2021). 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 16MW9, 16WC1A and 16WC1B at concentrations of 6.4 ug/l, 16 ug/l and 21 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 16MW9, 16WC1A and 16WC1B to the latest (effective January 18, 2021) 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 Second Quarter 2021.

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 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. RFAAP submitted the requested information to the VDEQ in correspondence dated July 2, 2020 and in December 2020, VDEQ requested RFAAP submit a revised ASD for total cobalt in groundwater at HWMU-16 for POC wells 16MW9, 16WC1A, and 16WC1B. RFAAP submitted the revised cobalt ASD to VDEQ on May 19, 2021; VDEQ review of

the ASD is pending. Therefore, a verification event will not be conducted for the Second Quarter 2021 total cobalt concentrations detected in POC wells 16MW9, 16WC1A, and 16WC1B.

No other constituents were detected in the upgradient well or in the POC wells at concentrations greater than their respective GPS during Second Quarter 2021.

The following constituents were detected at concentrations greater than 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 200 ug/l, 800 ug/l, and 190 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 2021 total barium concentrations detected in plume monitoring wells 16-2, 16-3, and 16Spring is recommended at this time.

Total barium was detected in plume monitoring wells 16-5 and 16WC2B at concentrations of 170 ug/l and 120 ug/l, respectively, which are less than the site-specific background concentration of 175.4 ug/l. No other constituents were detected in the plume monitoring wells at concentrations greater than their respective Permit-specified QLs. However, subsequent data validation for plume monitoring well 16-3 requires rejection of the semivolatile results due to laboratory quality control error (i.e., no sample surrogate recovery during initial analysis and holding time exceedance on subsequent sample re-extraction). As such, a sampling event will be scheduled on or before June 30 for recollection of plume monitoring well 16-3 for semivolatile analysis.

Complete details regarding the Second Quarter 2021 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 2021*, which is due by August 15, 2021.

If you have any questions or concerns, please contact me at 540/639-7087 (Melissa.lincoln@baesystems.com).

Sincerely,

Melissa Lincoln
Environmental Specialist
BAE Systems, Ordnance Systems Inc.

Coordination: J. McKenna

cc: Nikki Herschler, VDEQ-BRRO
Tara Mason, Ashby Scott, VDEQ-CO
J. McKenna, Army Staff
Jody Hawks, BAE Staff
Mike Lawless, Draper Aden Associates
Janet Frazier, Draper Aden Associates
Env. File

Concerning the following:

CY 2021 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: Russell A. Jones
TITLE: Lieutenant Colonel, US Army
Commanding

SIGNATURE: _____

PRINTED NAME: Kirk Johnson
TITLE: General Manager
BAE Systems

Lincoln
21-0900-085

ORDNANCE SYSTEMS INC.
Radford Army Ammunition Plant
114 Pepper's Ferry Road
Radford, VA 24141
Telephone: 540-639-7785

July 8, 2021

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

Subject: HWMU 16 - Plume Well 16-3 Resampling Due to Laboratory Error
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 2021, BAE Systems, Ordnance Systems Inc. (BAE) completed semiannual groundwater monitoring for Hazardous Waste Management Units (HWMUs) 5 and 16 located at the Radford Army Ammunition Plant (RFAAP) in Radford, Virginia.

Second Quarter 2021 groundwater monitoring results for HWMU-16 indicated that resampling of plume monitoring well 16-3 for semivolatile analysis was needed due to laboratory quality control error (i.e., no sample surrogate recovery during initial analysis and holding time exceedance on subsequent sample re-extraction). As such, plume monitoring well 16-3 was sampled for semivolatile analysis on June 24, 2021. Plume monitoring well 16-3 resampling results indicated that no semivolatile organic compounds were detected at or above the associated background concentration. No additional action is required.

Complete details regarding the Second Quarter 2021 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 2021*, which is due by August 15, 2021.

If you have any questions or concerns, please contact me at 540/639-7087 (Melissa.lincoln@baesystems.com).

Sincerely,

Users, Lincoln, Melissa

Digitally signed by Users, Lincoln, Melissa
DN: dc=com, dc=radford-aap, dc=ad, cn=Users, cn=Lincoln, Melissa, email=Melissa.Lincoln@baesystems.com
Date: 2021.07.08 15:43:56 -04'00'

Melissa Lincoln
Environmental Specialist
BAE Systems, Ordnance Systems Inc.

Coordination:

J. McKenna

cc: Nikki Herschler, VDEQ-BRRO
Tara Mason, Ashby Scott, VDEQ-CO
J. McKenna, Army Staff
Jody Hawks, BAE Staff
Mike Lawless, Draper Aden Associates
Janet Frazier, Draper Aden Associates
Env. File

Lincoln
21-0900-103

Concerning the following:

CY 2021 Second Quarter Semiannual Monitoring Event
HWMU 16 - 16-3 Plume Well Resampling
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: Russell A. Jones
TITLE: Lieutenant Colonel, US Army
Commanding

SIGNATURE: _____

PRINTED NAME: Kirk Johnson
TITLE: General Manager
BAE Systems

Lincoln
21-0900-103

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

August 4, 2021

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

Subject: **Semiannual Groundwater Monitoring Report –**
HWMU-5 and HWMU-16
Post Closure Care Permit HWMUs 5 & 16
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730

Dear Mr. Kochan:

The Hazardous Waste Management Units (HWMUs) 5 & 16 Semiannual Groundwater Monitoring Report for Second Quarter 2021 can be accessed at:

File 1 of 3 - RPT - 21 0730 - 2Qtr 2021 SA GW Monitoring Rpt Units 5-16 -Final.pdf
https://share.daa.com/index.php/s/j827Wc9bkKkQtzD

File 2 of 3 - App B - HWMU5 2Q 2021 Validation Report and Lab data.pdf
https://share.daa.com/index.php/s/L76LALnSEtLx2Nm

File 3 of 3 - App B - HWMU16 2Q 2021 Validation Report and Lab data.pdf
https://share.daa.com/index.php/s/G7Jk46aJzZeTAw3

Password for all link : Draper2021

This report meets the requirements of the Semiannual Groundwater Monitoring Report for Second Quarter 2021 for the Post-Closure Care Permit for HWMU 5 and 16 at RFAAP.

If you have any questions or concerns, please contact me at 540/639-7087 (Melissa.lincoln@baesystems.com).

Sincerely,

Melissa Lincoln
Environmental Specialist
BAE Systems, Ordnance Systems Inc.

Coordination: J. McKenna

cc: Nikki Herschler, VDEQ- BRRO
Tara Mason, Ashby Scott, VDEQ-CO
J. McKenna, Army Staff
Jody Hawks, BAE Staff
Mike Lawless, Draper Aden Associates
Janet Frazier, Draper Aden Associates
Env. File

Concerning the following:

CY 2021 Second Quarter Semiannual Groundwater Monitoring Event
Hazardous Waste Management Units 5 – Correction 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: Russell A. Jones
TITLE: Lieutenant Colonel, US Army
Commanding

SIGNATURE: _____

PRINTED NAME: Kirk Johnson
TITLE: General Manager
BAE Systems

Commonwealth of Virginia

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

1111 E. Main Street, Suite 1400, Richmond, Virginia 23219
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(800) 592-5482 FAX (804) 698-4178
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Matthew J. Strickler
Secretary of Natural and Historic Resources

David K. Paylor
Director
(804) 698-4000

September 13, 2021

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

VIA ELECTRONIC MAIL

Re: Alternate Source Demonstration for Cobalt in monitoring wells 16MW9, 16WC1A, and 16WC1B, HWMU #16
Radford Army Ammunitions Plant
Route 114, Radford, Virginia 24141
EPA ID#: VA1210020730

Dear Mr. McKenna:

The above-noted Alternate Source Demonstration (ASD) investigation, submitted on behalf of Radford Army Ammunition Plant, by Alliant Techsystems Inc., dated April 2021, has been reviewed for technical content and consistency with the requirements of 40 CFR 264.99.(i). The need to submit an ASD was triggered by an exceedance of the Cobalt Groundwater Protection standard reported to the Department for monitoring wells 16MW9, 16WC1A, and 16WC1B.

As defined under 40 CFR 264.99.(i), the Alternate Source Demonstration (ASD) report must show one of the following in order to obtain approval:

1) The contamination was caused by natural variation in groundwater.
2) The contamination was a result of an error in field sampling.
3) The contamination was the result of an error in lab analysis.
4) The SSI contamination was result of an error in statistical analysis.

The ASD report focused on proving the applicability of item #1 by presenting a statistical trend analysis that shows no trend or a decreasing trend of total cobalt concentrations in groundwater in 16MW9 and 16WC1B, respectively. Although an increasing trend in observed in

16WC1A, based on the historical data from the well, current concentrations are less than historical values detected (including non-detects), therefore the observed values appear to be caused by a natural variation in local groundwater. Therefore, presenting data shows that cobalt is widely observed at significant concentrations in non-waste derived materials and ASD concentrations observed in groundwater monitoring wells 16MW9, 16WC1A, and 16WC1B are derived from ambient, naturally-occurring and naturally variable trace elements in the aquifer matrix, and not from a temporally- varying source such as a release from the closed hazardous waste management unit (HWMU-16).

Based on the above discussion and the body of evidence presented to the Department, the content of the ASD is determined to be sufficient to meet the Regulatory criteria for approval and as a result, the facility does not have to remediate the cobalt GPS exceedances observed in wells 16MW9, 16WC1A, and 16WC1B. Please note that future exceedances of the GPS for Cobalt noted in 16MW9, 16WC1A, and 16WC1B will not require the submittal of a separate ASD unless the monitoring results reveal a change in site conditions that may indicate a release from HWMU-16. Please make sure that this approval is reflected in future correspondence.

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

Sincerely,

Kurt W. Kochan
Office of Remediation Programs

cc: RFAAP Correspondence File
Tara Mason, Ashby Scott, VDEQ-CO
Nichole Herschler, VDEQ- BRO
Jody Hawks, BAE

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

December 15, 2021

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 Compliance Monitoring and Annual 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 groundwater monitoring event for Hazardous Waste Management Units (HWMUs) 5 and 16 located at the Radford Army Ammunition Plant (RFAAP) in Radford, Virginia.

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

During Fourth Quarter 2021, BAE Systems, Ordnance Systems Inc. (BAE) completed groundwater monitoring for HWMUs 5 and 16 in accordance with the *Final Hazardous Waste Post-Closure Care Permit for HWMUs 5 and 16* (reissued August 16, 2014). The Fourth Quarter 2021 event served as the semiannual Corrective Action (CA) groundwater monitoring event for HWMU-5 and the semiannual compliance monitoring event for HWMU-16. The Fourth Quarter 2021 groundwater monitoring event also served as the annual monitoring event under 40 CFR 264 Appendix IX for HWMU-16. The laboratory analytical data packages for this event were received on December 10, 2021. The Fourth Quarter 2021 groundwater monitoring event was conducted using revised detection limits (DLs) and quantitation limits (QLs), where applicable, as specified in the Class 1 Permit Modification approved by the Virginia Department of Environmental Quality (VDEQ) in electronic correspondence dated May 5, 2021. Additionally, HWMU-16 total cobalt data were evaluated using the revised alternate source demonstration (ASD) for total cobalt in groundwater at HWMU-16 approved by the VDEQ in electronic correspondence dated September 13, 2021. The following information summarizes the findings of the Fourth Quarter 2021 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 2021, 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 1.2 ug/l, 1.6 ug/l, and 3 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 ug/l.

Total cobalt was detected in POC well 5WC21 at a concentration of 19 ug/l, which is greater than the GPS of 7 ug/l. Total cobalt was detected in POC well 5W7B at concentration of 6.7 ug/l which is less than the GPS. Total cobalt was detected in POC well 5WC22 at a concentration 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 2020, TCE remedial endpoints have been achieved. During Second and Fourth Quarters 2021, 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. However, total cobalt continued to be detected at concentrations greater than its GPS during Second and Fourth Quarters 2021.

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, 2022.

HWMU-16

In accordance with the 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, tetrahydrofuran, and vinyl chloride in Class 1 Permit Modifications approved September 12, 2014, December 1, 2016, and May 5, 2021, respectively). 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 16MW9 and 16WC1A at concentrations of 5.5 ug/l and 14 ug/l, respectively, which are greater than the GPS of 5 ug/l. As directed by the VDEQ in electronic correspondence dated October 26, 2018, RFAAP also compared the total cobalt concentrations detected in POC well 16MW9 and 16WC1A to the latest (effective January 18, 2021) VDEQ Alternate Concentration Limit (ACL) for cobalt of 6 ug/l. Additionally, the total cobalt data were evaluated using the revised ASD for total cobalt in groundwater at HWMU-16 for POC wells 16MW9, 16WC1A, and 16WC1B approved by the VDEQ in electronic correspondence dated September 13, 2021. Based on the conclusions of the VDEQ-approved ASD, the Fourth Quarter 2021 total cobalt concentrations detected in POC wells 16MW9 and 16WC1A appear to be consistent with natural variation in local groundwater and are not indicative of a release from the Unit. Therefore, a verification event will not be conducted for the Fourth Quarter 2021 total cobalt concentrations detected in POC wells 16MW9 and 16WC1A. As well, based on VDEQ correspondence dated September 13, 2021, a separate ASD will not be required.

No other constituents were detected in the upgradient well or in the POC wells at concentrations greater than their respective GPS during Fourth Quarter 2021.

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 230 ug/l, 770 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 2021 total barium concentrations detected in plume monitoring wells 16-2, 16-3 and 16Spring is recommended at this time.

Total barium was detected in plume monitoring wells 16-5, 16WC2B at concentrations of 170 ug/l and 120 ug/l, respectively, which are less than the site-specific background concentration of 175.4 ug/l. No other constituents were detected in the plume monitoring wells at concentrations greater than their respective Permit-specified QLs.

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 annual event is typically conducted during Second Quarter each year but was conducted in Fourth Quarter 2021 due to the then-pending Class 1 Permit Modification which was subsequently approved on May 5, 2021. During the Fourth Quarter 2021 event, one Appendix IX constituent (silver) was initially detected in POC well 16MW8 at or above the Permit-specified MDL. **A verification event was conducted on November 11, 2021**, to confirm or refute the initial detection of total silver at POC well 16MW8; total silver was not detected at or above the Permit-specified MDL in the verification sample, and no additional action is required.

Well Location	October 6, 2021 Initial Result (ug/l)	November 11, 2021 Verification Result (ug/l)	Lab QL (ug/l)	Lab MDL (ug/l)	Permit QL (ug/l)	Permit MDL (ug/l)
Silver						
16MW8	0.32 J	U	2.0	0.3	2.0	0.3

Note: MDL denotes method detection limit.
J denotes analyte detected less than the quantitation limit (QL) and concentration is estimated.
U denotes not detected at or above the MDL.

Additionally, all POC wells were resampled on November 11, 2021, due to the following laboratory errors:

- Cyanide was recollected due to laboratory quality control (QC) issues (i.e., low/no spike recovery in the associated QC samples).
- Trans-1,4-dichloro-2 butene was recollected since the laboratory MDL did not meet the Permit-specified MDL. The laboratory reported an MDL of 1.67 ug/l compared to the Permit-specified MDL of 1.5 ug/l.

Cyanide and trans-1,4 -dichloro-2 butene were not detected at or above the Permit-specified MDLs in the samples collected from the POC wells on November 11, 2021, and no additional action is required. Additional semivolatile aliquot was also collected from POCs wells on November 11, 2021. Ten constituents were requested to be analyzed by semivolatile (SVOC) Method 8270E for POC groundwater samples collected on October 6, 2021. Due to laboratory scheduling delays, groundwater samples from the October 6, 2021 event were extracted within holding time but were not analyzed within the 40 day holding time requirement, except for bis-2-ethylhexylphalate. Bis-2-ethylhexylphalate was analyzed and reported from the October 6, 2021 groundwater monitoring event. Since analysis for the remaining requested nine constituents to be analyzed by Pace Analytical Services of West Columbia, South Carolina, would have been analyzed well beyond the 40 day holding time, SVOC analysis for these nine constituents were performed on POC samples collected as part of the November 11, 2021 resampling event.

In correspondence dated June 12, 2019, the VDEQ authorized continued use of the historical laboratory DL of 50 ug/l for 2-propanol during annual monitoring of the constituents listed in Appendix I of Permit Attachment 1. However, VDEQ requested an annual survey of laboratories maintaining 2-propanol 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. During the Fourth Quarter 2021 annual monitoring event, 2-propanol was not detected in the POC wells at concentrations greater than the Permit-specified DL of 50 ug/l.

To summarize, **a verification event sample was collected from POC well 16MW8** on November 11, 2021 and refuted the initial reported total silver detection discussed above; therefore, no further action is required. Additionally, due to laboratory error, all POC wells were resampled for cyanide, trans 1,4 -dichloro-2 butene and

nine other SVOC constituents on November 11, 2021; these constituents were not detected at or above the Permit-specified MDLs and no further action is required.

Complete details regarding the Fourth Quarter 2021 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 2021*, which is due by March 1, 2022.

If you have any questions or concerns, please contact me at 540/639-7087 (Melissa.lincoln@baesystems.com).

Sincerely,

Melissa Lincoln
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BAE Systems, Ordnance Systems Inc.

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Concerning the following:

CY 2021 Fourth 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: _____

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TITLE: Lieutenant Colonel, US Army
Commanding

SIGNATURE: _____

PRINTED NAME: Kirk Johnson
TITLE: General Manager
BAE Systems

VELAP Laboratories' 2-Propanol Analysis Capabiliites

2021

Laboratory	Date of Last MDL Study	MDL Study Under New Rule?	# 2-propanol samples/year	MDL Check Available?	MDL Blank Verification Available?	5ml or 25ml purge used?	Current MDL	Current PQL
AEL - Jacksonville, FL	performed over last 8 quarters (8015C)	yes	>50/year	yes	--	Uses 8015C	0.9 mg/L	8 mg/L
Alpha Lab - Westborough, MA	June 2015	no (NELAC-TNI)	220 in 2021	yes	yes	5 ml	3.52 ug/L	100 ug/L
ALS - Middletown, PA	Currently in progress	yes	Not many	yes	yes	5 ml	7 ug/L	25 ug/L
Enthalpy Analytical - Richmond, VA	Capable of analyzing for 2-propanol, but not currently part of standard analyses							
ELLE - Lancaster, PA	June 2021	yes	209 in last year	yes	yes	5 ml	18 ug/L	100 ug/L
Eurofins TA - Pittsburgh, PA	August 2019	yes	50 in 2021	yes	yes	5 ml	8.98 ug/L	25 ug/L
GEL - Charleston, SC	March 2021	no (EPA MDL Procedure, Rev 2)	10 in 2021 (by 8260)	yes	yes	5 ml	16.7 ug/L	50 ug/L
GEO-CES - Somerset, PA	February 2021	no (2016)	80 (by either 624.1 or 8260D)	yes	yes	5 ml	50 ug/L	100 ug/L
JR Reed - Newport News, VA	Annually (only analyze for wastewater, not groundwater)	yes	0	yes	yes	Dependent upon instrument	10.9 ug/L	20 ug/L
PACE-Gulf Coast - Baton Rouge, LA	July 2011 (8015C)	no	--	yes	yes	na	231 ug/L	1000 ug/L
SGS - Orlando, FL	Did not provide information in time for this report							

-- = Information not provided by laboratory