2016 ANNUAL GROUNDWATER MONITORING REPORT

(INCLUDES FOURTH QUARTER 2016 SEMIANNUAL GROUNDWATER MONITORING REPORT)

HAZARDOUS WASTE MANAGEMENT UNITS
5 AND 16
CALENDAR YEAR 2016

RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

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Hardcopy Version:
Certain appendices/attachments associated with this report are presented only in PDF. The specific information that is not presented in hard copy is identified in the Table of Contents (where applicable) and on the Appendix/Attachment cover(s) in the hard copy report, and is included only in the PDF.

EXECUTIVE SUMMARY

This document presents the Annual Groundwater Monitoring Report for calendar year 2016 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). This Annual Groundwater Monitoring Report evaluates the analytical data from Second Quarter 2016 and Fourth Quarter 2016 for each Unit.

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 2016 and Fourth Quarter 2016, trichloroethene (TCE) was detected in point of compliance wells 5WC21, 5WC22, and 5WC23 at concentrations less than the Groundwater Protection Standard (GPS) of 5 µg/l. TCE was not detected at concentrations greater than the quantitation limit (QL) in any other wells comprising the CA monitoring network during the calendar year 2016 monitoring events. Additionally, no daughter products of TCE were detected in any wells comprising the CA groundwater monitoring network for HWMU-5.

Total cobalt was detected at concentrations greater than the GPS of 7 µg/l in point of compliance wells 5WC21 and 5WC22 during Second Quarter 2016, and in point of compliance well 5WC21 during Fourth Quarter 2016. 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 2016 data for the CA Targeted Constituents and comparison with historical data indicates effective progress of groundwater CA through natural attenuation. TCE remedial endpoints have been achieved. No changes to the continuation of the groundwater CA program are anticipated at this time. Semiannual groundwater monitoring will continue at HWMU-5. The next monitoring event is scheduled for Second Quarter 2017.

HWMU-16

Semiannual Compliance groundwater monitoring for HWMU-16 is conducted during the second and fourth quarter of each year. Total cobalt was detected at concentrations greater than the GPS of 5 µg/l in point of compliance wells 16WC1B and 16MW9 during Second Quarter 2016, and in point of compliance wells 16WC1A and 16WC1B during Fourth Quarter 2016. Total cobalt was not detected at concentrations greater than the GPS in the other wells comprising the compliance monitoring network.

In September 2016, VDEQ concurred with RFAAP to extend the on-going Alternative Source Demonstration (ASD) for total cobalt at point of compliance wells 16WC1B, 16WC1A,

and 16MW9 for a period of one year. As part of the ASD extension, all three wells are scheduled to be monitored semiannually for total cobalt through 2017.

Evaluation of the plume monitoring well data indicated that the concentrations of total barium in upgradient well 16C1 (Fourth Quarter 2016 only) and in plume monitoring wells 16-2 and 16-3, and spring sampling location 16SPRING were greater than the site-specific background concentration. 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 2016 total barium concentrations detected in plume monitoring wells 16-2 and 16-3 and in spring sampling location 16SPRING is recommended at this time.

One additional 40 CFR Part 264 Appendix IX constituent (as presented in Permit Attachment 1, Appendix I), tetrahydrofuran, was initially detected at concentrations greater than the detection limit in samples collected from point of compliance wells 16MW8 and 16WC1A. Tetrahydrofuran was subsequently confirmed in a verification sample collected from well 16WC1A. Therefore, RFAAP submitted a Class 1 Permit Modification to add tetrahydrofuran to the Groundwater Compliance Monitoring List for HWMU-16. VDEQ approved the Class 1 Permit Modification in correspondence dated December 1, 2016.

It should be noted that as stated in Permit Condition I.K.2, the Compliance Period during which the GPS applies to HWMU-16 is 13 years, beginning on the effective date of the Final Permit and continuing until October 4, 2015, or until the Director approves clean closure of the unit. No changes to the continuation of the groundwater program are anticipated at this time. Semiannual groundwater monitoring will continue at HWMU-16. The next monitoring event is scheduled for Second Quarter 2017.

1.0 INTRODUCTION

This document presents the Annual Groundwater Monitoring Report for calendar year 2016 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).

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 2016 semiannual monitoring events were evaluated in accordance with the reissued Final Permit dated August 16, 2014.

1.1 HWMU-5

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

1.2 HWMU-16

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

2.0 HWMU-5 ANNUAL GROUNDWATER MONITORING REPORT

2.1 Waste Management Unit Information

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

Unit Location: RFAAP Main Plant Area, Radford, Virginia

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

2.2 Groundwater Monitoring Plan

Monitoring Network:

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

Monitoring Status: Corrective Action Monitoring Program

CY 2016 Monitoring Events:

Second Quarter 2016:	April 25-26, 2016
Fourth Quarter 2016:	October 19-20, 2016

HWMU-5 has been in corrective action (CA) since 2010. The calendar year 2016 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 2016 semiannual monitoring events are summarized in **Table 1**. The maximum groundwater elevation fluctuation of one foot was observed at well 5W9A; the minimum groundwater elevation fluctuation of 0.03 feet was observed at well 5W11A. On average, the groundwater elevation at Unit 5 fluctuated 0.09 feet, which is less than the expected annual fluctuation (2 to 5 feet) discussed in the permit. As shown on the HWMU-5 Potentiometric Surface Maps (**Appendix A-1**), groundwater movement beneath the site is generally to the 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 2016 groundwater elevations was calculated to be 0.0243 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 0.276 ft/day or 101 ft/year based on the following:

- Average hydraulic conductivity of 5.25×10^{-5} ft/second.
- Average hydraulic gradient of 0.0243 ft/ft.
- Assumed effective porosity of 0.40, 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

For Second Quarter 2016 and Fourth Quarter 2016, 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 2016 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).

The laboratory analytical results for the 2016 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 laboratory analytical results for the 2016 monitoring events are included 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 are included in **Appendix C**. Copies of field notes recorded during sample collection are included in **Appendix D**.

2.4.1 Semiannual Monitoring for Corrective Action Targeted Constituents

During the Second Quarter 2016 and Fourth Quarter 2016 monitoring events, groundwater samples collected from all of the wells in the CA groundwater monitoring network were analyzed for the CA Targeted Constituents listed in Appendix J to Permit Attachment 2. The CA Targeted Constituents consist of TCE and its daughter products: 1,1-dichloroethene (1,1-DCE), *cis*-1,2-dichloroethene (*c*DCE), *trans*-1,2-dichloroethene (*t*DCE), and vinyl chloride (VC). In addition, the VDEQ added total cobalt to the list of CA Targeted Constituents during a meeting with RFAAP on May 4, 2011. The laboratory analytical results for the CA Targeted Constituents are summarized in **Appendix A-2**.

During Second Quarter 2016, TCE was detected in point of compliance wells 5WC21, 5WC22 and 5WC23 at concentrations of 3.5 µg/l, 3.8 µg/l, and 3.9 µg/l, respectively, which are less than the GPS of 5 µg/l (**Appendix A-2**). TCE was not detected in any of the other wells in the CA groundwater monitoring network. Additionally, the TCE daughter products were not detected in any of the wells comprising the CA groundwater monitoring network.

During Fourth Quarter 2016, TCE was detected in point of compliance wells 5WC21, 5WC22 and 5WC23 at concentrations of 2.6 µg/l, 2.9 µg/l, and 3.1 µg/l, respectively, which are less than the GPS of 5 µg/l (**Appendix A-2**). TCE was detected at a concentration less than the QL of 1 µg/l but greater than the detection limit (DL) in 5W5B, which is less than the GPS. 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 2016, total cobalt was detected in point of compliance wells 5WC21 and 5WC22 at concentrations of 61.6 µg/l and 11.4 µg/l, respectively, which are greater than the GPS of 7 µg/l. Total cobalt was detected in point of compliance wells 5W7B and 5WC23 at concentrations less than the QL of 5 µg/l but greater than the (DL) of 1 µg/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 2016.

During Fourth Quarter 2016, total cobalt was detected in point of compliance well 5WC21 at a concentration of 71.6 µg/l, which is greater than the GPS of 7 µg/l. Total cobalt was detected at point of compliance well 5WC22 at 6.9 µg/l, which is greater than the QL of 5 µg/l but less than the GPS. Total cobalt was detected in point of compliance wells 5W7B and 5WC23 at concentrations less than the QL of 5 µg/l but greater than the DL of 1 µg/l (**Appendix A-2**). Total cobalt was not detected at concentrations greater than the DL or QL in any other wells comprising the CA monitoring network during Fourth Quarter 2016.

2.4.2 Annual Monitoring List - Comparison to Groundwater Protection Standards

During Second Quarter 2016, 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). Annual monitoring for the constituents listed in Appendix K is required in order to evaluate whether additional hazardous

constituents that are not the targets for the current Corrective Action (e.g., TCE and its daughter products, total cobalt) are present at concentrations greater than the Groundwater Protection Standards (GPS) for the Unit. No additional hazardous constituents that are not targets for the current Corrective Action for the Unit were detected at concentrations greater than their respective GPS during Second Quarter 2016 (**Appendix A-3**).

2.4.3 2016 USEPA Region 3 Regional Screening Levels (RSLs)

The USEPA periodically updates the Region 3 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 2016 groundwater monitoring event, the January/May 2016 USEPA Region 3 RSL table reflected the most current values. The USEPA RSL for one constituent, diethyl ether, listed in Appendix K to Permit Attachment 2 was updated from 7,300 µg/l to 3,900 µg/l; therefore, the GPS comparison value for diethyl ether listed in Appendix A-3 of this report is 3,900 µg/l. Diethyl ether is the only constituent listed in Appendix K to Permit Attachment 2 whose GPS is based on an EPA RSL that was updated subsequent to the October 4, 2014 Permit reissuance date.

Diethyl ether was detected below the quantitation limit of 12 µg/l in point of compliance wells 5WC21, 5WC22, and 5WC23 at estimated concentrations of 1.6 µg/l, 3.6 µg/l, and 4.8 µg/l, respectively. These estimated concentrations are below the GPS for diethyl ether listed in Appendix K to Permit Attachment 2 (7,300 µg/l) as well as the January/May 2016 USEPA Region 3 RSL of 3,900 µg/l. Diethyl ether was not detected in any other wells comprising the CA groundwater monitoring network.

2.4.4 Annual Monitoring List – Verification of Estimated Values

A footnote presented in Appendix K to Permit Attachment 2 indicates that verification is required for constituents detected at concentrations less than the QL if their associated GPSs are 1) based on background values equal to the QL, and 2) are greater than the applicable risk-based concentrations (i.e., ACL or RSL). In these instances, verification must be conducted using an alternate low-level analytical method in order to confirm or refute the observed initial detections if the QL achievable by that method is less than, or equal to, the ACL or RSL for the subject constituent. If a concentration greater than the low-level analytical method QL is observed, then the GPS for that constituent will be updated, if warranted. During Second Quarter 2016, no constituents with GPSs based on background values 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.

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 2016. MNA is the current remedial measure implemented at the Unit to address TCE in groundwater at concentrations greater than the GPS.

During Second Quarter 2016 and Fourth Quarter 2016, TCE was detected in point of compliance wells 5WC21, 5WC22, and 5WC23 at concentrations less than the GPS of 5 µg/l. TCE was not detected at concentrations greater than the QL in any other wells comprising the CA monitoring network during the calendar year 2016 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 2016.

2.6 Recommendations

Concentrations of TCE at HWMU-5 remained below the GPS throughout calendar year 2016 indicating achievement of remedial endpoints. The current monitoring program is required to continue until the concentrations of TCE have remained below the GPS for a period of three consecutive years; upon which the Permittee may request to end corrective action and return to compliance monitoring which is currently scheduled to end October 28, 2020.

Please note that the last time TCE was detected at a concentration greater than the GPS at HWMU-5 was during Fourth Quarter 2014; therefore, TCE concentrations in groundwater at the Unit have been below the GPS for two consecutive years. If TCE concentrations remain below the GPS during calendar year 2017, RFAAP may submit a request to end corrective action in early 2018.

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 2016 Monitoring Events:

Second Quarter 2016:	April 26-27, 2016
Verification Event	June 16, 2016
Fourth Quarter 2016:	October 24-25, 2016

The calendar year 2016 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 2016 semiannual monitoring events are summarized in **Table 2**. The maximum groundwater elevation fluctuation of 7.42 feet was observed at well 16C3; the minimum groundwater elevation fluctuation of 0.03 feet was observed at well 16-2. On average, the groundwater elevation at Unit 16 fluctuated 3.73 feet, which is consistent with the expected annual fluctuation (2 to 4 feet) discussed in the permit. As shown on the HWMU-16 Potentiometric Surface Maps (**Appendix B-1**), groundwater movement beneath the site is generally to the northeast.

Darcian flow conditions were assumed for the weathered residuum and carbonate bedrock beneath HWMU-16. As a result, the groundwater velocities were calculated by multiplying the hydraulic conductivity (determined from previously conducted slug tests) by the average hydraulic

gradient across the site and dividing by an assumed effective porosity for the aquifer materials. The average hydraulic gradient was determined by superimposing three evenly spaced flow line vectors over the potentiometric surface map, measuring their lengths, calculating the head differential over the distances measured, and dividing the head differential by the length of the flow line vectors. The three calculated gradients were then averaged to a single value. Using this method, the average groundwater hydraulic gradient across the site based on Fourth Quarter 2016 groundwater elevations was calculated to be 0.086 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 1.46 ft/day or 533 ft/year based on the following:

- Average hydraulic conductivity of 7.87×10^{-5} ft/second.
- Average hydraulic gradient of 0.086 ft/ft.
- Assumed effective porosity of 0.40, 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 2016 semiannual monitoring events were analyzed for the constituents listed in Appendix E to Attachment 3 in the August 16, 2014 reissuance of the Final Permit. In addition, during Second Quarter 2016 groundwater samples were collected from the upgradient well and the point of compliance wells for annual monitoring for the 40 CFR Part 264 Appendix IX constituents listed in Permit Attachment 1, Appendix I. The laboratory analytical results for the 2016 monitoring events are included in **Appendix B-2** (point of compliance wells) and in **Appendix B-3** (plume monitoring wells). The laboratory analytical results for the 2016 monitoring events also are included 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 are included in **Appendix C**. Copies of field notes recorded during sample collection are included on in **Appendix D**.

3.4.1 Annual Monitoring – Permit Attachment 1, Appendix I

Upon receipt of the Second Quarter 2016 analytical data, RFAAP notified the VDEQ of the initial detection of three additional 40 CFR Part 264 Appendix IX constituents (tetrahydrofuran, cyanide, vinyl chloride) that are not listed in Permit Attachment 3, Appendix E – *Groundwater Compliance Monitoring (Semiannual) Constituent List*.

As documented in the June 14, 2016 Groundwater Monitoring Even Notification letter **(Appendix E)**, the following 40 CFR Part 264 Appendix IX constituents were initially detected at concentrations equal to or greater than their respective DLs but less than their respective QLs at HWMU-16 during the Second Quarter 2016 groundwater monitoring event:

Well Location	Constituent	Concentration	DL	Units
16C1 (*)	Tetrahydrofuran	13 J	2	µg/l
16MW8	Tetrahydrofuran	2.2 J	2	µg/l
16WC1A	Tetrahydrofuran	4.6 J	2	µg/l
16MW8	Cyanide	13 J	5	µg/l
16MW9	Cyanide	8.5 J	5	µg/l
16WC1A	Cyanide	19 J	5	µg/l
16MW9	Vinyl Chloride	0.2 J	0.2	µg/l
16WC1A	Vinyl Chloride	0.2 J	0.2	µg/l

Note: J denotes analyte detected concentration less than the quantitation limit (QL) but equal to or greater than the detection limit (DL) and concentration is estimated. (*) Denotes upgradient monitoring well.

On June 16, 2016, RFAAP collected verification samples from point of compliance wells 16WC1A, 16MW8, and 16MW9 to confirm or refute the initial detections of the respective additional 40 CFR Part 264 Appendix IX constituents detected in those wells. Cyanide and vinyl chloride were not detected at concentrations greater than the DLs in the verification samples from their respective wells; therefore, no further action is required regarding cyanide and vinyl chloride. Tetrahydrofuran was not detected at a concentration greater than the DL in the verification sample from well 16MW8. However, tetrahydrofuran was detected in the verification sample from well 16WC1A at an estimated concentration of 2.2 µg/l, which is greater than the detection limit of 2.0 µg/l; therefore, the original estimated tetrahydrofuran concentration of 4.6 µg/l was confirmed. In accordance with Permit Condition V.J.2.e.(2), tetrahydrofuran was added to the Compliance Monitoring List for HWMU-16 and analyzed in all groundwater samples collected from the Compliance monitoring well network beginning in Fourth Quarter 2016.

In correspondence dated November 9, 2016, RFAAP submitted a request for a Class I Permit Modification, which included the formal request to add tetrahydrofuran to the Groundwater Compliance Monitoring List for HWMU-16 and to establish the background concentration (25 µg/l and GPS for the constituent. VDEQ approved the Class 1 Permit Modification in correspondence dated December 1, 2016.

Other than tetrahydrofuran, 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 DLs in the samples collected from the point of compliance wells during Second Quarter 2016 or the June 16, 2016 verification event.

3.4.2 Comparison to Groundwater Protection Standards

As specified in the Final Permit, the calendar year 2016 groundwater analytical data for the upgradient well and the point of compliance wells were compared to GPS for HWMU-16 listed in Appendix G of Permit Attachment 3 (modified to add 1,1-dichloroethene in Class 1 Permit

Modification approved September 12, 2014; modified to add tetrahydrofuran in Class 1 Permit Modification approved December 1, 2016). In accordance with Permit Condition V.I.2, RFAAP performed a simple empirical comparison of the upgradient well and the point of compliance well data to the GPS (**Appendix B-2**).

During Second Quarter 2016 and Fourth Quarter 2016, total cobalt was detected in point of compliance well 16WC1B at concentrations of 35 µg/l and 15 µg/l, respectively, which are greater than the GPS of 5 µg/l. During Fourth Quarter 2016, total cobalt was detected in point of compliance well 16CW1A at a concentration of 6 µg/l, which is greater than the GPS of 5 µg/l (total cobalt was detected in well 16WC1A at a concentration less than the GPS during Second Quarter 2016). Total cobalt was detected previously in well 16WC1B at concentrations greater than the GPS beginning in Fourth Quarter 2013, and detected previously in well 16WC1A at concentrations greater than the GPS beginning in Fourth Quarter 2015.

During Second Quarter 2016, total cobalt was initially detected in point of compliance well 16MW9 at a concentration of 5.5 µg/l, which is greater than the GPS of 5 µg/l. On June 16, 2016, RFAAP collected verification samples to confirm or refute the initial cobalt concentration detected in point of compliance well 16MW9; the analytical results confirmed the initial concentration detected in well 16MW9. During Fourth Quarter 2016, total cobalt was not detected at a concentration greater than the QL and GPS of 5 µg/l.

In accordance with Permit Condition V.J.2.i.(3) and as directed in VDEQ correspondence dated January 21, 2014, RFAAP submitted an alternate source demonstration (ASD) to evaluate whether the Fourth Quarter 2013 total cobalt concentration detected in point of compliance well 16WC1B was due to 1) source other than the Unit; 2) errors in sampling, analysis, and evaluation; or 3) natural variation in groundwater quality. 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 requested RFAAP to continue additional semiannual monitoring for total cobalt in point of compliance well 16WC1B in support of the ASD. During Fourth Quarter 2015 total cobalt was reported above the GPS for the first time in point of compliance well 16WC1A. In early 2016, VDEQ concurred with RFAAP to combine the ongoing ASDs for total cobalt at wells 16WC1B and 16WC1A. Total cobalt was subsequently reported above the GPS during Second Quarter 2016 in point of compliance well 16MW9. In correspondence dated July 19, 2016, VDEQ concurred with RFAAP to include point of compliance well 16MW9 with the ongoing ASD for total cobalt at point of compliance wells 16WC1A and 16WC1B. The revised combined ASD report for total cobalt for point of compliance wells 16WC1A, 16WC1B, and 16MW9 will be due to VDEQ in first Quarter 2018, as detailed in the August 30, 2016 correspondence (**Appendix E**). Copies of correspondence relating to groundwater monitoring activities conducted at HWMU-16 during calendar year 2016 are included in **Appendix E**.

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 GPSs 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 Fourth Quarter 2016, no constituents with GPSs equal to their respective QLs and greater than the applicable risk-based concentrations were detected at concentrations less than their respective QLs; therefore, no further action was warranted.

3.4.3 Comparison to Background Concentrations

As specified in Permit Condition V.O, the 2016 groundwater analytical data for the plume monitoring wells were compared to the background concentrations for HWMU-16 listed in Appendix F of Permit Attachment 3. In accordance with Permit Condition V.I.2, RFAAP performed a simple empirical comparison of the plume monitoring well data to the background concentrations (**Appendix B-3**).

As shown in **Appendix B-3**, total barium concentrations detected during Second Quarter 2016 in plume monitoring wells 16-2 and 16-3, and in spring sampling location 16SPRING were greater than the background concentration of 175.4 µg/l. Total barium concentrations detected during Fourth Quarter 2016 in upgradient well 16C1, in plume monitoring wells 16-2 and 16-3, and in spring sampling location 16SPRING were greater than the background concentration of 175.4 µg/l. All of the total barium concentrations detected in the plume monitoring wells were well below the USEPA MCL for barium of 2,000 µg/l. Higher barium concentrations in downgradient plume monitoring wells relative to background may be the result of natural variations in trace element distribution in groundwater. As illustrated in the boring logs for the compliance network monitoring wells (Appendix H of Permit Attachment 5), upgradient well 16C1 is screened in limestone while downgradient plume monitoring wells 16-2, 16-3, and 16-5 are screened in shale and fault breccia. Such differing lithologic formations would be expected to contain different trace element distributions.

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

3.5 Recommendations

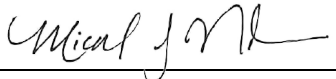
As part of the on-going ASD, total cobalt will be monitored at point of compliance wells 16WC1B, 16WC1A, and 16MW9 on a semiannual basis for a minimum of one year. Per VDEQ's request, the combined ASD report for 16WC1B, 16WC1A, and 16MW9 will be submitted within 90 days following completion of the Fourth Quarter 2017 semiannual groundwater monitoring event.

No further action regarding the 2016 total barium concentrations detected in plume monitoring wells 16-2 and 16-3 and in spring sampling location 16SPRING is recommended at this time.

SIGNATURE/CERTIFICATION

Prepared by:

Name: Michael J. Nelson, P.E.; Senior Project Engineer

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 - 2016
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

MONITORING WELL ID	ELEVATION TOP OF WELL	APRIL 25, 2016		OCTOBER 19, 2016	
		DTW	GW ELEV	DTW	GW ELEV
5W8B	1789.58	15.43	1774.15	15.17	1774.41
5W5B	1775.13	9.96	1765.17	9.75	1765.38
5W7B	1774.78	9.89	1764.89	9.78	1765.00
5WC21	1774.43	10.11	1764.32	9.96	1764.47
5WC22	1774.45	10.07	1764.38	9.91	1764.54
5WC23	1773.84	9.50	1764.34	9.33	1764.51
5W12A	1772.46	13.07	1759.39	12.94	1759.52
S5W5	1772.31	9.65	1762.66	9.38	1762.93
S5W7	1776.08	12.90	1763.18	12.56	1763.52
5W9A	1762.20	2.93	1759.27	2.90	1759.30
5W10A	1771.40	14.22	1757.18	14.86	1756.54
5W11A	1766.20	11.83	1754.37	12.83	1753.37
5WC11	1788.92	16.49	1772.43	16.11	1772.81
5WC12	1788.96	16.74	1772.22	16.42	1772.54
5WCA	1779.05	13.88	1765.17	13.40	1765.65
S5W6	1771.43	7.89	1763.54	7.77	1763.66
S5W8	1783.68	12.59	1771.09	12.29	1771.39

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 - 2016
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

MONITORING WELL ID	ELEVATION TOP OF WELL	APRIL 26, 2016		OCTOBER 24, 2016	
		DTW	GW ELEV	DTW	GW ELEV
16C1	1840.14	46.06	1794.08	49.51	1790.63
16MW8	1815.82	70.67	1745.15	73.49	1742.33
16MW9	1808.88	62.23	1746.65	65.29	1743.59
16WC1A	1812.61	62.43	1750.18	68.12	1744.49
16WC1B	1812.95	63.41	1749.54	68.33	1744.62
16-1	1815.82	41.43	1774.39	48.24	1767.58
16-2	1810.99	55.87	1755.12	55.90	1755.09
16-3	1824.77	54.73	1770.04	56.38	1768.39
16-5	1742.60	3.63	1738.97	4.39	1738.21
16WC2B	1818.71	50.53	1768.18	54.95	1763.76
16WC2A	1820.05	DRY	DRY	DRY	DRY
16C3	1822.22	60.61	1761.61	68.03	1754.19
16CDH3	1825.60	DRY	DRY	DRY	DRY
SPRING	na	na	na	na	na

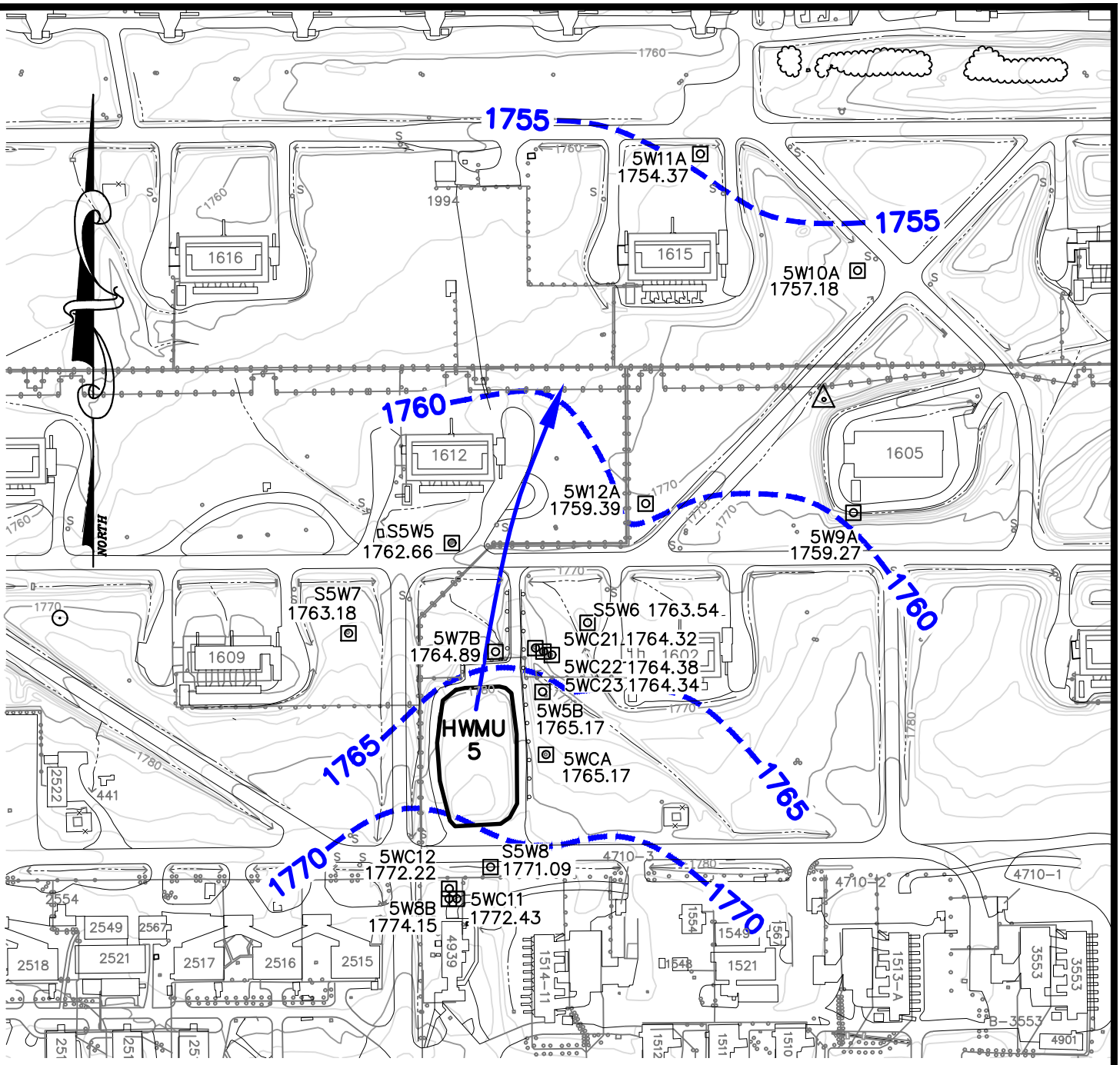
NOTES:
DTW: Depth to water from top of casing.
GW ELEV: Groundwater elevation.
All elevations in feet above mean sea level.
na: Not applicable.

APPENDIX A

HWMU-5

APPENDIX A-1

HWMU-5 POTENTIOMETRIC SURFACE MAPS
SECOND QUARTER 2016
FOURTH QUARTER 2016



GRAPHIC SCALE

200 0 100 200 400

(IN FEET)

1 inch = 200 ft.

LEGEND

5W7B
1764.89 — 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 25, 2016)

RADFORD ARMY AMMUNITION PLANT

RADFORD, VIRGINIA

SCALE: 1"=200'

PLAN NO. B03204-16

Draper Aden Associates

Engineering • Surveying • Environmental Services

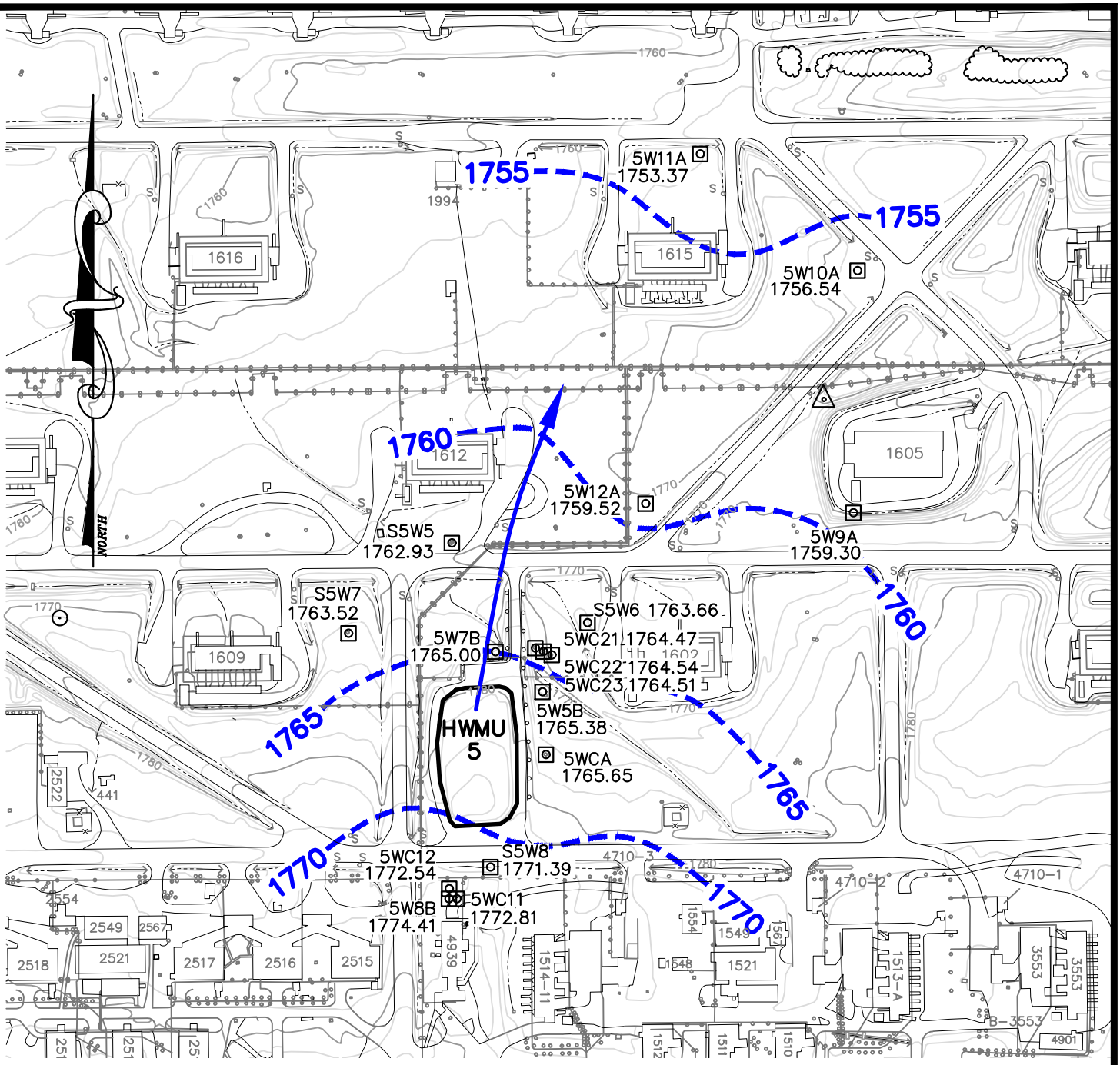
2206 South Main Street
Blacksburg, VA 24060
540-552-0444 Fax: 540-552-0291

Richmond, VA Coats, NC
Charlottesville, VA Fayetteville, NC
Hampton Roads, VA Northern Virginia

DESIGNED	WMD
DRAWN	DLD
CHECKED	MDL
DATE	07/19/16

FIGURE 1

P:\B03\200\B03204\B03204-16\CAD\B03204-16_HWMU-5 April 2016.dwg Jul 22, 2016 8:46am



GRAPHIC SCALE

200 0 100 200 400

(IN FEET)

1 inch = 200 ft.

LEGEND

5W7B ⊙ MONITORING WELL
1765.00 GROUNDWATER ELEVATION (feet above mean sea level)

--1770-- GROUNDWATER CONTOUR

GROUNDWATER FLOW DIRECTION

NOTE: TOPOGRAPHIC CONTOUR INTERVAL 2'

HWMU-5 POTENTIOMETRIC SURFACE MAP (OCTOBER 19, 2016)

RADFORD ARMY AMMUNITION PLANT

RADFORD, VIRGINIA

SCALE: 1"=200'

PLAN NO. B03204-16

Draper Aden Associates

Engineering • Surveying • Environmental Services

2206 South Main Street
Blacksburg, VA 24060
540-552-0444 Fax: 540-552-0291

Richmond, VA Coats, NC
Charlottesville, VA Fayetteville, NC
Hampton Roads, VA Northern Virginia

DESIGNED	WMD
DRAWN	DLD
CHECKED	MDL
DATE	01/04/17

FIGURE 1

P:\B03\200\B03204\B03204-16\CAD\B03204-16_HWMU-5 October 2016.dwg Jan 10, 2017 1:59pm

APPENDIX A-2

HWMU-5 2016 LABORATORY ANALYTICAL RESULTS
GROUNDWATER CORRECTIVE ACTION TARGETED CONSTITUENTS
GPS AND SEMIANNUAL MONITORING LIST

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

Upgradient well = 5W8B

Analyte/Quarter	*5W8B Q*	*5W5B Q*	*5W7B Q*	*5WC21 Q*	*5WC22 Q*	*5WC23 Q*	*5W12A Q*	*QL*	*Permit QL*	*GPS*	*DL*	*Permit DL*	*UNIT*	*Method*
Cobalt						*CAS #* 7440-48-4								
Second Quarter 2016	U	U	1.4 J	61.6	11.4	3.1 J	U	5	5	7	1	1	ug/l	6020A
Fourth Quarter 2016	U	U	1.5 J	71.6	6.9	2.2 J	U	5	5	7	1	1	ug/l	6020A
1,1-Dichloroethene						*CAS #* 75-35-4								
Second Quarter 2016	U	U	U	U	U	U	U	1	1	7	0.4	0.44	ug/l	8260C
Fourth Quarter 2016	U	U	U	U	U	U	U	1	1	7	0.4	0.44	ug/l	8260C
cis-1,2-Dichloroethene						*CAS #* 156-59-2								
Second Quarter 2016	U	U	U	U	U	U	U	1	1	70	0.1	0.1	ug/l	8260C
Fourth Quarter 2016	U	U	U	U	U	U	U	1	1	70	0.1	0.1	ug/l	8260C
trans-1,2-Dichloroethene						*CAS #* 156-60-5								
Second Quarter 2016	U	U	U	U	U	U	U	1	1	100	0.8	0.8	ug/l	8260C
Fourth Quarter 2016	U	U	U	U	U	U	U	1	1	100	0.8	0.8	ug/l	8260C
Trichloroethene						*CAS #* 79-01-6								
Second Quarter 2016	U	U	U	3.5 J	3.8 J	3.9 J	U	1	1	5	0.2	0.177	ug/l	8260C
Fourth Quarter 2016	U	0.3 J	U	2.6	2.9	3.1	U	1	1	5	0.2	0.177	ug/l	8260C
Vinyl chloride						*CAS #* 75-01-4								
Second Quarter 2016	U J	U J	U J	U J	U J	U J	U J	1	1	2	0.1	0.1	ug/l	8260C
Fourth Quarter 2016	U J	U J	U J	U J	U J	U J	U J	1	1	2	0.1	0.1	ug/l	8260C

See last page of this report for definitions.

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

Upgradient well = 5W8B

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

Definitions:

Results are reported to the permit detection limit.

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

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

Note:

APPENDIX A-3

HWMU-5 2016 LABORATORY ANALYTICAL RESULTS
GROUNDWATER CORRECTIVE ACTION ANNUAL MONITORING LIST

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

Upgradient well = 5W8B

Analyte/Quarter	*5W8B Q*	*5W5B Q*	*5W7B Q*	*5WC21 Q*	*5WC22 Q*	*5WC23 Q*	*QL*	*Permit QL*	*GPS*	*DL*	*Permit DL*	*UNIT*	*Method*
Antimony						*CAS #* 7440-36-0							
Second Quarter 2016	-	U	U	U	U	U	2	2	6	0.4	0.4	ug/l	6020A
Arsenic						*CAS #* 7440-38-2							
Second Quarter 2016	-	U	U	U	U	U	4	10	10	2	2	ug/l	6020A
Barium						*CAS #* 7440-39-3							
Second Quarter 2016	-	32.3	44.8	13.8	33.6	22.9	4	10	2,000	1	1	ug/l	6020A
Beryllium						*CAS #* 7440-41-7							
Second Quarter 2016	-	U	U	1	U	U	1	1	4	0.2	0.2	ug/l	6020A
Cadmium						*CAS #* 7440-43-9							
Second Quarter 2016	-	U	U	0.43 J	0.25 J	U	1	1	5	0.2	0.2	ug/l	6020A
Chromium						*CAS #* 7440-47-3							
Second Quarter 2016	-	U	U	3.6 J	U	U	4	5	100	1	1	ug/l	6020A
Cobalt						*CAS #* 7440-48-4							
Second Quarter 2016	U	U	1.4 J	61.6	11.4	3.1 J	5	5	7	1	1	ug/l	6020A
Fourth Quarter 2016	U	U	1.5 J	71.6	6.9	2.2 J	5	5	7	1	1	ug/l	6020A
Copper						*CAS #* 7440-50-8							
Second Quarter 2016	-	1.3 J	1.1 J	3.1 J	U	U	4	5	1,300	1	1	ug/l	6020A
Lead						*CAS #* 7439-92-1							
Second Quarter 2016	-	0.53 J	0.76 J	U	U	U	2	2	15	0.2	0.2	ug/l	6020A
Mercury						*CAS #* 7439-97-6							
Second Quarter 2016	-	U	U	U	U	U	2	2	2	0.2	0.2	ug/l	7470A
Nickel						*CAS #* 7440-02-0							
Second Quarter 2016	-	U	U	32.9	5.6	2.9 J	4	10	300	2	2	ug/l	6020A
Selenium						*CAS #* 7782-49-2							
Second Quarter 2016	-	U	U	U	U	U	4	10	50	3	3	ug/l	6020A
Silver						*CAS #* 7440-22-4							
Second Quarter 2016	-	U	U	U	U	U	1	2	71	0.2	0.2	ug/l	6020A
Thallium						*CAS #* 7440-28-0							
Second Quarter 2016	-	U	U	U	U	U	1	1	2	0.2	0.2	ug/l	6020A
Vanadium						*CAS #* 7440-62-2							
Second Quarter 2016	-	U	U	U	U	U	10	10	63	1	1	ug/l	6020A

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*
Zinc						*CAS # 7440-66-6*							
Second Quarter 2016	-	U	6.1 J	27.1 J	U	U	30	30	4700	3	7.3	ug/l	6020A
Acetone						*CAS # 67-64-1*							
Second Quarter 2016	-	U	U	U	U	U	10	10	12000	3	3	ug/l	8260C
bis(2-Ethylhexyl)phthalate						*CAS # 117-81-7*							
Second Quarter 2016	-	U	U	U	U	U	6	6	10	1.5	1.5	ug/l	8270D
2-Butanone						*CAS # 78-93-3*							
Second Quarter 2016	-	U	U	U	U	U	10	10	4900	1	1	ug/l	8260C
Chloroform						*CAS # 67-66-3*							
Second Quarter 2016	-	2.3	34	1.1	0.9 J	0.9 J	1	1	80	0.1	0.1	ug/l	8260C
Dichlorodifluoromethane						*CAS # 75-71-8*							
Second Quarter 2016	-	U	U	U	U	U	1	1	190	0.3	0.28	ug/l	8260C
1,2-Dichloroethane						*CAS # 107-06-2*							
Second Quarter 2016	-	U	U	U	U	U	1	1	5	0.1	0.147	ug/l	8260C
Diethyl ether						*CAS # 60-29-7*							
Second Quarter 2016	-	U	U	1.6 J	3.6 J	4.8 J	12	12	7,300	0.4	0.39	ug/l	8260C
Diethyl phthalate						*CAS # 84-66-2*							
Second Quarter 2016	-	U	U	U	U	U	10	10	11000	0.5	0.5	ug/l	8270D
2,4-Dinitrotoluene						*CAS # 121-14-2*							
Second Quarter 2016	-	U	U	1 J	0.7 J	0.8 J	10	10	10	0.6	0.6	ug/l	8270D
2,6-Dinitrotoluene						*CAS # 606-20-2*							
Second Quarter 2016	-	U	U	U	U	U	10	10	10	0.7	0.7	ug/l	8270D
Methylene chloride						*CAS # 75-09-2*							
Second Quarter 2016	-	U	0.3 J	U	U	U	1	1	5	0.2	0.182	ug/l	8260C
o-Nitroaniline						*CAS # 88-74-4*							
Second Quarter 2016	-	U	U	0.8 J	2 J	2 J	10	10	150	0.7	0.7	ug/l	8270D
p-Nitroaniline						*CAS # 100-01-6*							
Second Quarter 2016	-	U	U	U	U	U	20	20	20	1.3	1.3	ug/l	8270D
Nitrobenzene						*CAS # 98-95-3*							
Second Quarter 2016	-	U	U	1 J	1 J	1 J	10	10	10	0.8	0.8	ug/l	8270D

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

Upgradient well = 5W8B

Analyte/Quarter	*5W8B Q*	*5W5B Q*	*5W7B Q*	*5WC21 Q*	*5WC22 Q*	*5WC23 Q*	*QL*	*Permit QL*	*GPS*	*DL*	*Permit DL*	*UNIT*	*Method*
Toluene						*CAS #* 108-88-3							
Second Quarter 2016	-	U	U	U	U	U	1	1	1,000	0.1	0.1	ug/l	8260C
Xylenes (Total)						*CAS #* 1330-20-7							
Second Quarter 2016	-	U	U	U	U	U	3	3	10,000	0.2	0.208	ug/l	8260C

Definitions:

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

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

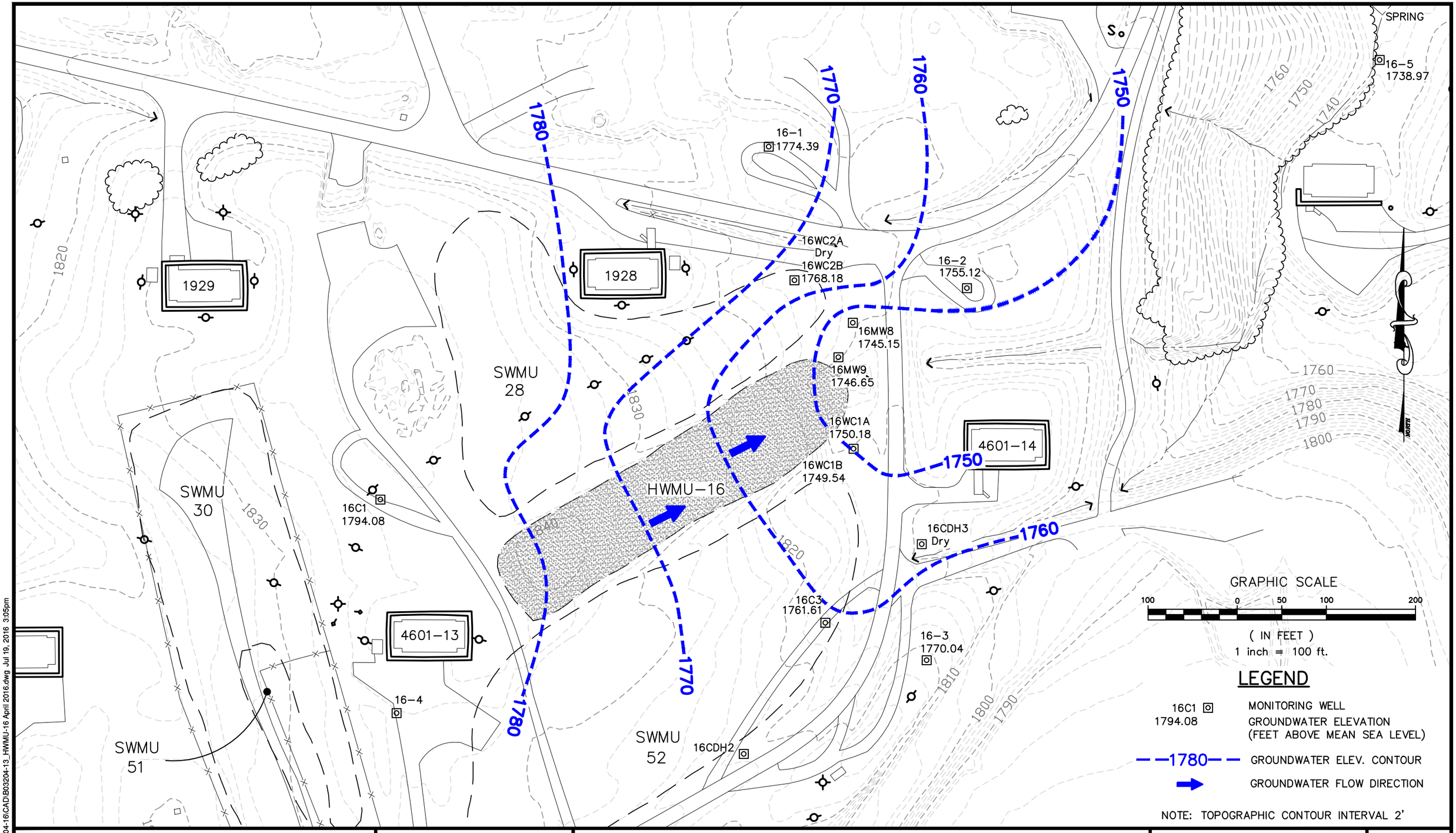
CAS#: Denotes Chemical Abstract Services registration number.
GPS: Denotes Groundwater Protection Standards listed in Appendix K of Module VI-Groundwater Corrective Action & Monitoring Program for Unit 5 (approved by the VDEQ and incorporated into the Final Hazardous Waste Post-Closure Permit for Hazardous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

APPENDIX B

HWMU-16

APPENDIX B-1

HWMU-16 POTENTIOMETRIC SURFACE MAPS
SECOND QUARTER 2016
FOURTH QUARTER 2016



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Richmond, VA Coats, NC
Charlottesville, VA Fayetteville, NC
Hampton Roads, VA Northern Virginia

DESIGNED	WMD
DRAWN	DLD
CHECKED	MDL
DATE	07/19/2016

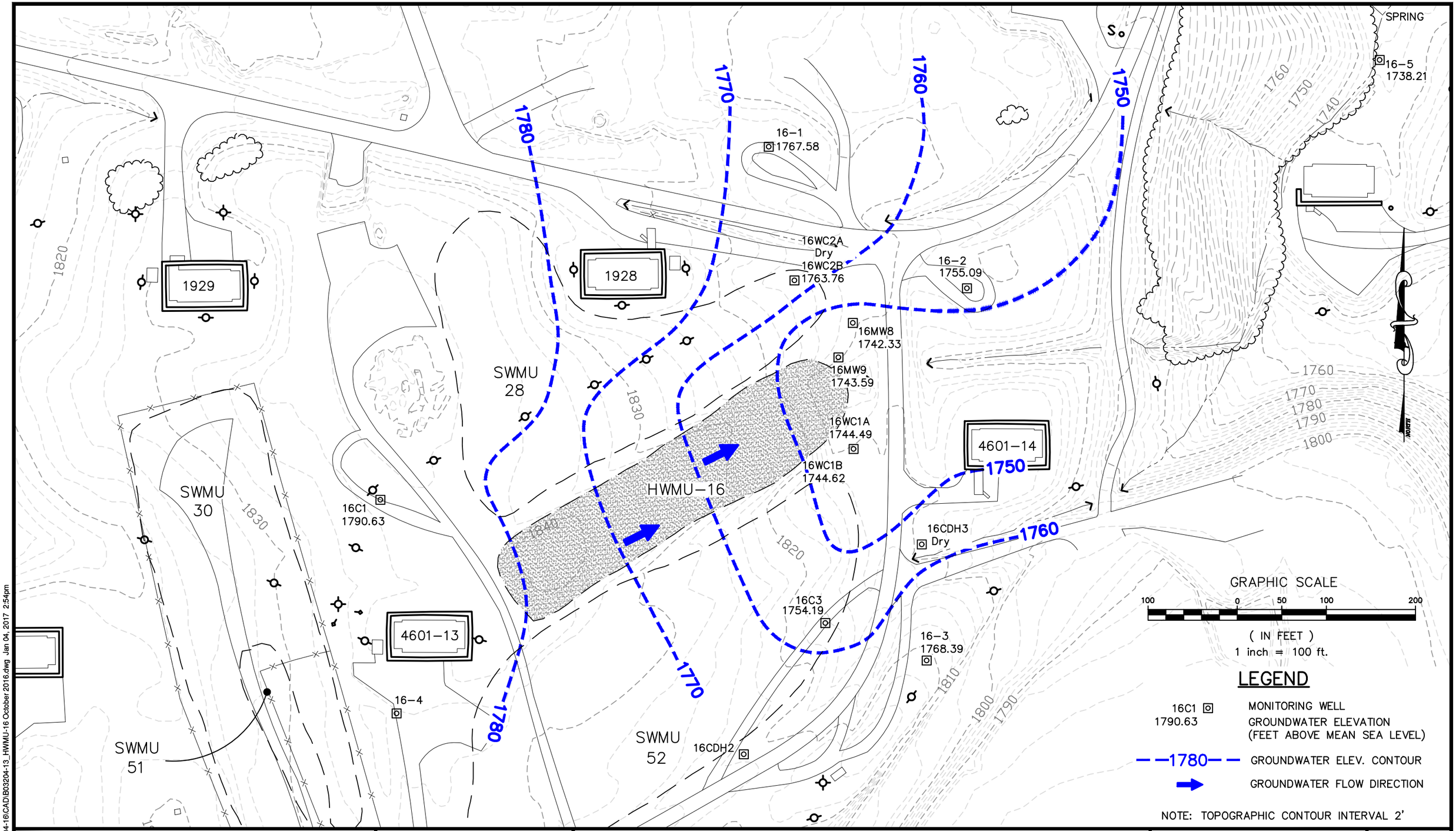
HWMU-16 POTENTIOMETRIC SURFACE MAP - APRIL 26, 2016
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

SCALE: 1"=100'

PLAN NO. B03204-16

FIGURE 2

P:\B03\200\B03204\B03204-16\CAD\B03204-13_HWMU-16 April 2016.dwg Jul 19, 2016 3:05pm



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DESIGNED	WMD
DRAWN	DLD
CHECKED	MDL
DATE	01/04/2017

HWMU-16 POTENTIOMETRIC SURFACE MAP - OCTOBER 24, 2016

RADFORD ARMY AMMUNITION PLANT

RADFORD, VIRGINIA

SCALE: 1"=100'

PLAN NO. B03204-16

FIGURE 2

P:\B03\200\B03204\B03204-16\CAD\B03204-13_HWMU-16 October 2016.dwg Jan 04, 2017 2:54pm

APPENDIX B-2

HWMU-16 2016 LABORATORY ANALYTICAL RESULTS
POINT OF COMPLIANCE WELLS

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

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

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
Antimony					*CAS #* 7440-36-0			
Second Quarter 2016	U	U	U	U	U	2	-	6020A
Arsenic					*CAS #* 7440-38-2			
Second Quarter 2016	U	U	U	U	U	10	10	6020A
Fourth Quarter 2016	U	U	U	U	U	10	10	6020A
Barium					*CAS #* 7440-39-3			
Second Quarter 2016	140	120	590	330	120	10	2000	6020A
Fourth Quarter 2016	200	130	520	310	130	10	2000	6020A
Beryllium					*CAS #* 7440-41-7			
Second Quarter 2016	0.52 J	0.54 J	0.23 J	0.3 J	U	1	4	6020A
Fourth Quarter 2016	U	U	U	U	U	1	4	6020A
Cadmium					*CAS #* 7440-43-9			
Second Quarter 2016	0.42 J	0.4 J	U	0.26 J	0.23 J	1	5	6020A
Fourth Quarter 2016	U	U	U	U	U	1	5	6020A
Chromium					*CAS #* 7440-47-3			
Second Quarter 2016	U	U	U	U	U	5	100	6020A
Fourth Quarter 2016	U	U	U	U	U	5	100	6020A
Cobalt					*CAS #* 7440-48-4			
Second Quarter 2016	U	4 J	5.5	4.9 J	35	5	5	6020A
Fourth Quarter 2016	U	U	U	6	15	5	5	6020A
Copper					*CAS #* 7440-50-8			
Second Quarter 2016	U	6.5	U	U	U	5	1300	6020A
Fourth Quarter 2016	U	31	U	U	U	5	1300	6020A
Lead					*CAS #* 7439-92-1			
Second Quarter 2016	U	0.36 J	U	U	U	1	15	6020A
Fourth Quarter 2016	U	2.7	U	U	U	2	15	6020A
Mercury					*CAS #* 7439-97-6			
Second Quarter 2016	U	U	U	U	U	2	2	7470A
Fourth Quarter 2016	U	U	U	U	U	2	2	7470A
Nickel					*CAS #* 7440-02-0			
Second Quarter 2016	3.9 J	6.1 J	15	7.6 J	7.2 J	10	300	6020A
Fourth Quarter 2016	U	U	14	11	U	10	300	6020A
Selenium					*CAS #* 7782-49-2			
Second Quarter 2016	U	U	U	U	U	5	-	6020A
Silver					*CAS #* 7440-22-4			
Second Quarter 2016	U	U	U	U	U	1	-	6020A
Thallium					*CAS #* 7440-28-0			
Second Quarter 2016	U	U	U	U	U	1	-	6020A
Vanadium					*CAS #* 7440-62-2			
Second Quarter 2016	U	U	U	U	U	10	151	6020A
Fourth Quarter 2016	U N	U N	U N	U N	U N	10	151	6020A
Zinc					*CAS #* 7440-66-6			
Second Quarter 2016	U	27	U	U	U	10	4700	6020A
Fourth Quarter 2016	U	130	U	U	U	30	4700	6020A
Cyanide					*CAS #* 57-12-5			
Second Quarter 2016	U	U	U	U	U	20	-	9012B
Acenaphthene					*CAS #* 83-32-9			
Second Quarter 2016	U	U	U	U	U	0	-	8270D
Acenaphthylene					*CAS #* 208-96-8			
Second Quarter 2016	U	U	U	U	U	0	-	8270D
Acetone					*CAS #* 67-64-1			
Second Quarter 2016	U	U	U	U	U	10	-	8260C
Acetonitrile					*CAS #* 75-05-8			
Second Quarter 2016	U	U	U	U	U	100	-	8260C
Acetophenone					*CAS #* 98-86-2			
Second Quarter 2016	U	U	U	U	U	1	-	8270D

See last page of this report for definitions.

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

All Results in ug/L.

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
2-Acetylaminofluorene					*CAS #* 53-96-3			
Second Quarter 2016	U	U	U	U	U	5	-	8270D
Acrolein					*CAS #* 107-02-8			
Second Quarter 2016	U J	U J	U J	U J	U J	25	-	8260C
Acrylonitrile					*CAS #* 107-13-1			
Second Quarter 2016	U J	U J	U J	U J	U J	10	-	8260C
Allyl chloride					*CAS #* 107-05-1			
Second Quarter 2016	U	U	U	U	U	10	-	8260C
4-Aminobiphenyl					*CAS #* 92-67-1			
Second Quarter 2016	U J	U J	U J	U J	U J	1	-	8270D
Aniline					*CAS #* 62-53-3			
Second Quarter 2016	U	U	U	U	U	1	-	8270D
Anthracene					*CAS #* 120-12-7			
Second Quarter 2016	U	U	U	U	U	0	-	8270D
Aramite					*CAS #* 140-57-8			
Second Quarter 2016	U J	U J	U J	U J	U J	15	-	8270D
Benzene					*CAS #* 71-43-2			
Second Quarter 2016	0.3 J	U	0.4 J	0.4 J	U	1	5	8260C
Fourth Quarter 2016	U	U	U	U	U	1	5	8260C
Benzo[a]anthracene					*CAS #* 56-55-3			
Second Quarter 2016	U	U	U	U	U	0	-	8270D
Benzo[b]fluoranthene					*CAS #* 205-99-2			
Second Quarter 2016	U	U	U	U	U	0	-	8270D
Benzo[k]fluoranthene					*CAS #* 207-08-9			
Second Quarter 2016	U	U	U	U	U	0	-	8270D
Benzo[ghi]perylene					*CAS #* 191-24-2			
Second Quarter 2016	U	U	U	U	U	0	-	8270D
Benzo(a)pyrene					*CAS #* 50-32-8			
Second Quarter 2016	U	U	U	U	U	0	-	8270D
1,4-Benzenediamine					*CAS #* 106-50-3			
Second Quarter 2016	U	U	U	U	U	300	-	8270D
Benzyl alcohol					*CAS #* 100-51-6			
Second Quarter 2016	U	U	U	U	U	15	-	8270D
bis(2-Chloroethoxy)methane					*CAS #* 111-91-1			
Second Quarter 2016	U	U	U	U	U	1	-	8270D
bis(2-Chloroethyl)ether					*CAS #* 111-44-4			
Second Quarter 2016	U	U	U	U	U	1	-	8270D
bis(2-Chloro-1-methylethyl)ether					*CAS #* 108-60-1			
Second Quarter 2016	U	U	U	U	U	1	-	8270D
bis(2-Ethylhexyl)phthalate					*CAS #* 117-81-7			
Second Quarter 2016	U	U	U	U	U	5	-	8270D
Bromodichloromethane					*CAS #* 75-27-4			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
Bromoform					*CAS #* 75-25-2			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
4-Bromophenyl phenyl ether					*CAS #* 101-55-3			
Second Quarter 2016	U	U	U	U	U	1	-	8270D
2-Butanone					*CAS #* 78-93-3			
Second Quarter 2016	U	U	U	U	U	10	4900	8260C
Fourth Quarter 2016	U J	U	U J	U J	U J	10	4900	8260C
Butyl benzyl phthalate					*CAS #* 85-68-7			
Second Quarter 2016	U	U	U	U	U	5	-	8270D
Carbon disulfide					*CAS #* 75-15-0			
Second Quarter 2016	U	U	U	U	U	10	-	8260C
Carbon tetrachloride					*CAS #* 56-23-5			
Second Quarter 2016	U	U	U	U	U	1	5	8260C
Fourth Quarter 2016	U	U	U	U	U	1	5	8260C

See last page of this report for definitions.

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

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
p-Chloroaniline					*CAS #* 106-47-8			
Second Quarter 2016	U	U	U	U	U	4	-	8270D
Chlorobenzilate					*CAS #* 510-15-6			
Second Quarter 2016	U	U	U	U	U	10	-	8270D
p-Chloro-m-cresol					*CAS #* 59-50-7			
Second Quarter 2016	U	U	U	U	U J	1	-	8270D
Chloroethane					*CAS #* 75-00-3			
Second Quarter 2016	4.9	U	3.3	2.4	U	1	21000	8260C
Fourth Quarter 2016	3.9	U	2	1.1	U	1	21000	8260C
Chloroform					*CAS #* 67-66-3			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
2-Chloronaphthalene					*CAS #* 91-58-7			
Second Quarter 2016	U	U	U	U	U	1	-	8270D
2-Chlorophenol					*CAS #* 95-57-8			
Second Quarter 2016	U	U	U	U	U J	1	-	8270D
4-Chlorophenyl phenyl ether					*CAS #* 7005-72-3			
Second Quarter 2016	U	U	U	U	U	1	-	8270D
Chloroprene					*CAS #* 126-99-8			
Second Quarter 2016	U	U	U	U	U	10	-	8260C
Chrysene					*CAS #* 218-01-9			
Second Quarter 2016	U	U	U	U	U	0	-	8270D
Diallate					*CAS #* 2303-16-4			
Second Quarter 2016	U	U	U	U	U	5	-	8270D
Dibenz(a,h)anthracene					*CAS #* 53-70-3			
Second Quarter 2016	U	U	U	U	U	0	-	8270D
Dibenzofuran					*CAS #* 132-64-9			
Second Quarter 2016	U	U	U	U	U	1	-	8270D
Dibromochloromethane					*CAS #* 124-48-1			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
1,2-Dibromo-3-chloropropane					*CAS #* 96-12-8			
Second Quarter 2016	U J	U J	U J	U J	U J	1	-	8260C
1,2-Dibromoethane					*CAS #* 106-93-4			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
Di-n-butyl phthalate					*CAS #* 84-74-2			
Second Quarter 2016	U	U	U	U	U	5	-	8270D
1,2-Dichlorobenzene					*CAS #* 95-50-1			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
1,3-Dichlorobenzene					*CAS #* 541-73-1			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
1,4-Dichlorobenzene					*CAS #* 106-46-7			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
3,3'-Dichlorobenzidine					*CAS #* 91-94-1			
Second Quarter 2016	U	U	U	U	U	5	-	8270D
trans-1,4-Dichloro-2-butene					*CAS #* 110-57-6			
Second Quarter 2016	U J	U J	U J	U J	U J	10	-	8260C
Dichlorodifluoromethane					*CAS #* 75-71-8			
Second Quarter 2016	U	U	U	U	U	1	190	8260C
Fourth Quarter 2016	U J	U	U J	U J	U J	1	190	8260C
1,1-Dichloroethane					*CAS #* 75-34-3			
Second Quarter 2016	6	0.3 J	9.1	6	U	1	9.5	8260C
Fourth Quarter 2016	6.7	U	6.9	3.6	U	1	9.5	8260C
1,2-Dichloroethane					*CAS #* 107-06-2			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
1,1-Dichloroethene					*CAS #* 75-35-4			
Second Quarter 2016	0.3 J	U	0.3 J	U	U	1	7	8260C
Fourth Quarter 2016	U	U	U	U	U	1	7	8260C

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

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
trans-1,2-Dichloroethene					*CAS #* 156-60-5			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
2,4-Dichlorophenol					*CAS #* 120-83-2			
Second Quarter 2016	U	U	U	U	U J	1	-	8270D
2,6-Dichlorophenol					*CAS #* 87-65-0			
Second Quarter 2016	U	U	U	U	U J	1	-	8270D
1,2-Dichloropropane					*CAS #* 78-87-5			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
1,3-Dichloropropane					*CAS #* 142-28-9			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
trans-1,3-Dichloropropene					*CAS #* 10061-02-6			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
Diethyl ether					*CAS #* 60-29-7			
Second Quarter 2016	33	12 J	70	28	U	13	7300	8260C
Fourth Quarter 2016	51	U	54	24	U	13	7300	8260C
Diethyl phthalate					*CAS #* 84-66-2			
Second Quarter 2016	U	U	U	U	U	5	11000	8270D
Fourth Quarter 2016	U	U	U	U	U	5	11000	8270D
O,O-Diethyl O-2-pyrazinyl					*CAS #* 297-97-2			
Second Quarter 2016	U	U	U	U	U	5	-	8270D
Dimethoate					*CAS #* 60-51-5			
Second Quarter 2016	U	U	U	U	U	10	-	8270D
Dimethyl ether					*CAS #* 115-10-6			
Second Quarter 2016	7.8 J	0.6 J	0.8 J	4.9 J	0.3 J	13	17	8260C
Fourth Quarter 2016	U	U	U	U	U	13	17	8260C
p-(Dimethylamino)azobenzene					*CAS #* 60-11-7			
Second Quarter 2016	U	U	U	U	U	1	-	8270D
7,12-Dimethylbenz[a]anthracene					*CAS #* 57-97-6			
Second Quarter 2016	U	U	U	U	U	1	-	8270D
3,3'-Dimethylbenzidine					*CAS #* 119-93-7			
Second Quarter 2016	U	U	U	U	U	75	-	8270D
a,a-Dimethylphenethylamine					*CAS #* 122-09-8			
Second Quarter 2016	U J	U J	U J	U J	U J	50	-	8270D
2,4-Dimethylphenol					*CAS #* 105-67-9			
Second Quarter 2016	U	U	U	U	U J	1	-	8270D
Dimethyl phthalate					*CAS #* 131-11-3			
Second Quarter 2016	U	U	U	U	U	5	-	8270D
m-Dinitrobenzene					*CAS #* 99-65-0			
Second Quarter 2016	U	U	U	U	U	5	-	8270D
4,6-Dinitro-o-cresol					*CAS #* 534-52-1			
Second Quarter 2016	U	U	U	U	U J	15	-	8270D
2,4-Dinitrophenol					*CAS #* 51-28-5			
Second Quarter 2016	U J	U J	U J	U J	U J	30	-	8270D
2,4-Dinitrotoluene					*CAS #* 121-14-2			
Second Quarter 2016	U	U	U	U	U	10	10	8270D
Fourth Quarter 2016	U	U	U	U	U	10	10	8270D
2,6-Dinitrotoluene					*CAS #* 606-20-2			
Second Quarter 2016	U	U	U	U	U	10	10	8270D
Fourth Quarter 2016	U	U	U	U	U	10	10	8270D
Di-n-octyl phthalate					*CAS #* 117-84-0			
Second Quarter 2016	U	U	U	U	U	5	-	8270D
1,4-Dioxane					*CAS #* 123-91-1			
Second Quarter 2016	U	U	U	U	U	200	-	8260C
Disulfoton					*CAS #* 298-04-4			
Second Quarter 2016	U	U	U	U	U	50	-	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.

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
Ethylbenzene					*CAS #*	*100-41-4*		
Second Quarter 2016	U	U	U	U	U	1	700	8260C
Fourth Quarter 2016	U	U	U	U	U	1	700	8260C
Ethyl methacrylate					*CAS #*	*97-63-2*		
Second Quarter 2016	U	U	U	U	U	10	-	8260C
Ethyl methanesulfonate					*CAS #*	*62-50-0*		
Second Quarter 2016	U	U	U	U	U	1	-	8270D
Famphur					*CAS #*	*52-85-7*		
Second Quarter 2016	U	U	U	U	U	50	-	8270D
Fluoranthene					*CAS #*	*206-44-0*		
Second Quarter 2016	U	U	U	U	U	0	-	8270D
Fluorene					*CAS #*	*86-73-7*		
Second Quarter 2016	U	U	U	U	U	0	-	8270D
Hexachlorobenzene					*CAS #*	*118-74-1*		
Second Quarter 2016	U	U	U	U	U	0	-	8270D
Hexachlorobutadiene					*CAS #*	*87-68-3*		
Second Quarter 2016	U	U	U	U	U	1	-	8260C
Hexachlorocyclopentadiene					*CAS #*	*77-47-4*		
Second Quarter 2016	U	U	U	U	U	15	-	8270D
Hexachloroethane					*CAS #*	*67-72-1*		
Second Quarter 2016	U	U	U	U	U	5	-	8270D
Second Quarter 2016	U	U	U	U	U	10	-	8260C
Hexachlorophene					*CAS #*	*70-30-4*		
Second Quarter 2016	U J	U J	U J	U J	U J	8.9	-	8270D
Hexachloropropene					*CAS #*	*1888-71-7*		
Second Quarter 2016	U	U	U	U	U	5	-	8270D
2-Hexanone					*CAS #*	*591-78-6*		
Second Quarter 2016	U	U	U	U	U	10	-	8260C
Indeno[1,2,3-cd]pyrene					*CAS #*	*193-39-5*		
Second Quarter 2016	U	U	U	U	U	0	-	8270D
Isobutyl alcohol					*CAS #*	*78-83-1*		
Second Quarter 2016	U	U	U	U	U	200	-	8260C
Isodrin					*CAS #*	*465-73-6*		
Second Quarter 2016	U	U	U	U	U	1	-	8270D
Isophorone					*CAS #*	*78-59-1*		
Second Quarter 2016	U	U	U	U	U	1	-	8270D
Isosafrole					*CAS #*	*120-58-1*		
Second Quarter 2016	U	U	U	U	U	5	-	8270D
Kepone					*CAS #*	*143-50-0*		
Second Quarter 2016	U	U	U	U	U	50	-	8270D
Methacrylonitrile					*CAS #*	*126-98-7*		
Second Quarter 2016	U J	U J	U J	U J	U J	100	-	8260C
Methapyrilene					*CAS #*	*91-80-5*		
Second Quarter 2016	U	U	U	U	U	50	-	8270D
Bromomethane					*CAS #*	*74-83-9*		
Second Quarter 2016	U	U	U	U	U	1	-	8260C
Chloromethane					*CAS #*	*74-87-3*		
Second Quarter 2016	U	U	U	U	U	1	190	8260C
Fourth Quarter 2016	U J	U	U J	U J	U J	1	190	8260C
3-Methylcholanthrene					*CAS #*	*56-49-5*		
Second Quarter 2016	U	U	U	U	U	1	-	8270D
Iodomethane					*CAS #*	*74-88-4*		
Second Quarter 2016	U	U	U	U	U	10	-	8260C
Methyl methacrylate					*CAS #*	*80-62-6*		
Second Quarter 2016	U J	U J	U J	U J	U J	10	-	8260C
Methyl methane sulfonate					*CAS #*	*66-27-3*		
Second Quarter 2016	U	U	U	U	U	5	-	8270D

See last page of this report for definitions.

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

All Results in ug/L.

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
2-Methylnaphthalene					*CAS #*	*91-57-6*		
Second Quarter 2016	U	U	U	U	U	0	-	8270D
Methyl parathion					*CAS #*	*298-00-0*		
Second Quarter 2016	U	U	U	U	U	5	-	8270D
4-Methyl-2-pentanone					*CAS #*	*108-10-1*		
Second Quarter 2016	U J	U J	U J	U J	U J	10	-	8260C
2-Methylphenol					*CAS #*	*95-48-7*		
Second Quarter 2016	U	U	U	U	U J	1	-	8270D
3 & 4-Methylphenol					*CAS #*	*m 108-39-4 p 106-44-5*		
Second Quarter 2016	U	U	U	U	U J	1	-	8270D
Dibromomethane					*CAS #*	*74-95-3*		
Second Quarter 2016	U	U	U	U	U	1	-	8260C
Methylene chloride					*CAS #*	*75-09-2*		
Second Quarter 2016	1.8	U	U	0.4 J	U	1	13.95	8260C
Fourth Quarter 2016	1.7	U	U	U	U	1	13.95	8260C
Naphthalene					*CAS #*	*91-20-3*		
Second Quarter 2016	U J	U J	U J	U J	U J	1	-	8260C
1,4-Naphthoquinone					*CAS #*	*130-15-4*		
Second Quarter 2016	U J	U J	U J	U J	U J	60	-	8270D
1-Naphthylamine					*CAS #*	*134-32-7*		
Second Quarter 2016	U	U	U	U	U	15	-	8270D
2-Naphthylamine					*CAS #*	*91-59-8*		
Second Quarter 2016	U	U	U	U	U	15	-	8270D
o-Nitroaniline					*CAS #*	*88-74-4*		
Second Quarter 2016	U	U	U	U	U	1	-	8270D
m-Nitroaniline					*CAS #*	*99-09-2*		
Second Quarter 2016	U	U	U	U	U	1	-	8270D
p-Nitroaniline					*CAS #*	*100-01-6*		
Second Quarter 2016	U	U	U	U	U	1	-	8270D
Nitrobenzene					*CAS #*	*98-95-3*		
Second Quarter 2016	U	U	U	U	U	1	-	8270D
o-Nitrophenol					*CAS #*	*88-75-5*		
Second Quarter 2016	U	U	U	U	U J	1	-	8270D
p-Nitrophenol					*CAS #*	*100-02-7*		
Second Quarter 2016	U	U	U	U	U J	30	-	8270D
4-Nitroquinoline-1-oxide					*CAS #*	*56-57-5*		
Second Quarter 2016	U J	U J	U J	U J	U J	60	-	8270D
N-Nitrosodi-n-butylamine					*CAS #*	*924-16-3*		
Second Quarter 2016	U	U	U	U	U	5	-	8270D
N-Nitrosodiethylamine					*CAS #*	*55-18-5*		
Second Quarter 2016	U	U	U	U	U	1	-	8270D
N-Nitrosodimethylamine					*CAS #*	*62-75-9*		
Second Quarter 2016	U	U	U	U	U	5	-	8270D
N-Nitrosodiphenylamine					*CAS #*	*86-30-6*		
Second Quarter 2016	U	U	U	U	U	1	-	8270D
N-Nitrosodipropylamine					*CAS #*	*621-64-7*		
Second Quarter 2016	U	U	U	U	U	1	-	8270D
N-Nitrosomethylethylamine					*CAS #*	*10595-95-6*		
Second Quarter 2016	U	U	U	U	U	5	-	8270D
N-Nitrosomorpholine					*CAS #*	*59-89-2*		
Second Quarter 2016	U	U	U	U	U	5	-	8270D
N-Nitrosopiperidine					*CAS #*	*100-75-4*		
Second Quarter 2016	U	U	U	U	U	1	-	8270D
N-Nitrosopyrrolidine					*CAS #*	*930-55-2*		
Second Quarter 2016	U	U	U	U	U	1	-	8270D
5-Nitroso-o-toluidine					*CAS #*	*99-55-8*		
Second Quarter 2016	U	U	U	U	U	1	-	8270D

See last page of this report for definitions.

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

All Results in ug/L.

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
Parathion					*CAS #* 56-38-2			
Second Quarter 2016	U	U	U	U	U	5	-	8270D
Pentachlorobenzene					*CAS #* 608-93-5			
Second Quarter 2016	U	U	U	U	U	1	-	8270D
Pentachloroethane					*CAS #* 76-01-7			
Second Quarter 2016	U	U	U	U	U	10	-	8260C
Pentachloronitrobenzene					*CAS #* 82-68-8			
Second Quarter 2016	U	U	U	U	U	5	-	8270D
Pentachlorophenol					*CAS #* 87-86-5			
Second Quarter 2016	U	U	U	U	U J	5	-	8270D
Phenacetin					*CAS #* 62-44-2			
Second Quarter 2016	U	U	U	U	U	1	-	8270D
Phenanthrene					*CAS #* 85-01-8			
Second Quarter 2016	U	U	U	U	U	0	-	8270D
Phenol					*CAS #* 108-95-2			
Second Quarter 2016	U	U	U	U	U J	1	-	8270D
Phorate					*CAS #* 298-02-2			
Second Quarter 2016	U	U	U	U	U	1	-	8270D
2-Picoline					*CAS #* 931-19-1			
Second Quarter 2016	U	U	U	U	U	5	-	8270D
Pronamide					*CAS #* 23950-58-5			
Second Quarter 2016	U	U	U	U	U	1	-	8270D
2-Propanol					*CAS #* 67-63-0			
Second Quarter 2016	U	U	U	U	U	100	-	8260C
Propionitrile					*CAS #* 107-12-0			
Second Quarter 2016	U	U	U	U	U	100	-	8260C
Pyrene					*CAS #* 129-00-0			
Second Quarter 2016	U	U	U	U	U	0	-	8270D
Pyridine					*CAS #* 110-86-1			
Second Quarter 2016	U	U	U	U	U	5	-	8270D
Safrole					*CAS #* 94-59-7			
Second Quarter 2016	U	U	U	U	U	5	-	8270D
Styrene					*CAS #* 100-42-5			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
Sulfotep					*CAS #* 3689-24-5			
Second Quarter 2016	U	U	U	U	U	8.9	-	8270D
1,2,4,5-Tetrachlorobenzene					*CAS #* 95-94-3			
Second Quarter 2016	U	U	U	U	U	1	-	8270D
1,1,1,2-Tetrachloroethane					*CAS #* 630-20-6			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
1,1,2,2-Tetrachloroethane					*CAS #* 79-34-5			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
Tetrachloroethene					*CAS #* 127-18-4			
Second Quarter 2016	0.3 J	U	U	0.3 J	U	1	5	8260C
Fourth Quarter 2016	U	U	U	U	U	1	5	8260C
Tetrahydrofuran					*CAS #* 109-99-9			
Second Quarter 2016	13 J	U	U J	4.6 J	U J	25	3400	8260C
Fourth Quarter 2016	U J	U	U J	U J	U J	25	3400	8260C
2,3,4,6-Tetrachlorophenol					*CAS #* 58-90-2			
Second Quarter 2016	U	U	U	U	U J	1	-	8270D
Toluene					*CAS #* 108-88-3			
Second Quarter 2016	U	U	U	U	U	1	1000	8260C
Fourth Quarter 2016	U	U	U	U	U	1	1000	8260C
o-Toluidine					*CAS #* 95-53-4			
Second Quarter 2016	U	U	U	U	U	1	-	8270D
1,2,4-Trichlorobenzene					*CAS #* 120-82-1			
Second Quarter 2016	U	U	U	U	U	1	-	8260C

See last page of this report for definitions.

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

Analtye/Quarter	*16C1*	*16MW8*	*16MW9*	*16WC1A*	*16WC1B*	*QL*	*GPS*	*Method*
1,1,1-Trichloroethane					*CAS #* 71-55-6			
Second Quarter 2016	0.2 J	U	U	U	U	1	200	8260C
Fourth Quarter 2016	U	U	U	U	U	1	200	8260C
1,1,2-Trichloroethane					*CAS #* 79-00-5			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
Trichloroethene					*CAS #* 79-01-6			
Second Quarter 2016	0.3 J	U	U	0.2 J	U	1	5	8260C
Fourth Quarter 2016	U	U	U	U	U	1	5	8260C
Trichlorofluoromethane					*CAS #* 75-69-4			
Second Quarter 2016	U	U	U	U	U	1	1000	8260C
Fourth Quarter 2016	U	U	U	U	U	1	1000	8260C
2,4,5-Trichlorophenol					*CAS #* 95-95-4			
Second Quarter 2016	U	U	U	U	U J	1	-	8270D
2,4,6-Trichlorophenol					*CAS #* 88-06-2			
Second Quarter 2016	U	U	U	U	U J	1	-	8270D
1,2,3-Trichloropropane					*CAS #* 96-18-4			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
1,1,2-Trichloro-1,2,2-Trifluoroethane					*CAS #* 76-13-1			
Second Quarter 2016	U	U	U	U	U	1	59000	8260C
Fourth Quarter 2016	U	U	U	U	U	1	59000	8260C
O,O,O-Triethyl phosphorothioate					*CAS #* 126-68-1			
Second Quarter 2016	U	U	U	U	U	5	-	8270D
sym-Trinitrobenzene					*CAS #* 99-35-4			
Second Quarter 2016	U	U	U	U	U	15	-	8270D
Vinyl acetate					*CAS #* 108-05-4			
Second Quarter 2016	U	U	U	U	U	10	-	8260C
Vinyl chloride					*CAS #* 75-01-4			
Second Quarter 2016	U	U	U	U	U	1	-	8260C
Xylenes (Total)					*CAS #* 1330-20-7			
Second Quarter 2016	U	U	U	U	U	3	10000	8260C
Fourth Quarter 2016	U	U	U	U	U	3	10000	8260C

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

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

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

Definitions:

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

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

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

Notes:

Verification event performed June 16, 2016 for:
Cyanide, cobalt, tetrahydrofuran and vinyl chloride – see validation report for details

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

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

APPENDIX B-3

HWMU-16 2016 LABORATORY ANALYTICAL RESULTS
PLUME MONITORING WELLS

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

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

Analtye/Quarter	*16C1 Q*	*16-2 Q*	*16-3 Q*	*16-5 Q*	*16WC2B Q*	*16SPRING Q*	*QL*	*Background*	*Method*
Arsenic						*CAS # 7440-38-2*			
Second Quarter 2016	U	U	U	U	U	U	10	1	6020A
Fourth Quarter 2016	U	U	U	U	U	U	10	1	6020A
Barium						*CAS # 7440-39-3*			
Second Quarter 2016	140	180	750	160	110	180	10	175.4	6020A
Fourth Quarter 2016	200	240	770	170	110	210	10	175.4	6020A
Beryllium						*CAS # 7440-41-7*			
Second Quarter 2016	0.52 J	U	U	U	U	U	1	0.7	6020A
Fourth Quarter 2016	U	U	U	U	U	U	1	0.7	6020A
Cadmium						*CAS # 7440-43-9*			
Second Quarter 2016	0.42 J	U	U	U	U	U	1	0.2	6020A
Fourth Quarter 2016	U	U	U	U	U	U	1	0.2	6020A
Chromium						*CAS # 7440-47-3*			
Second Quarter 2016	U	U	U	U	U	U	5	6.2	6020A
Fourth Quarter 2016	U	U	U	U	U	U	5	6.2	6020A
Cobalt						*CAS # 7440-48-4*			
Second Quarter 2016	U	U	U	U	U	U	5	5	6020A
Fourth Quarter 2016	U	U	U	U	U	U	5	5	6020A
Copper						*CAS # 7440-50-8*			
Second Quarter 2016	U	U	U	U	U	U	5	13	6020A
Fourth Quarter 2016	U	U	U	U	U	U	5	13	6020A
Lead						*CAS # 7439-92-1*			
Second Quarter 2016	U	U	U	U	U	U	1	10	6020A
Fourth Quarter 2016	U	U	U	U	U	U	2	10	6020A
Mercury						*CAS # 7439-97-6*			
Second Quarter 2016	U	U	U	U	U	U	2	0.2	7470A
Fourth Quarter 2016	U	U	U	U	U	U	2	0.2	7470A
Nickel						*CAS # 7440-02-0*			
Second Quarter 2016	3.9 J	U	U	U	U	U	10	16	6020A
Fourth Quarter 2016	U	U	U	U	U	U	10	16	6020A
Vanadium						*CAS # 7440-62-2*			
Second Quarter 2016	U	U	U	U	U	U	10	151	6020A
Fourth Quarter 2016	U N	U N	U N	U N	U N	U N	10	151	6020A
Zinc						*CAS # 7440-66-6*			
Second Quarter 2016	U	U	U	U	U	U	10	51	6020A
Fourth Quarter 2016	U	U	U	U	U	U	30	51	6020A
Benzene						*CAS # 71-43-2*			
Second Quarter 2016	0.3 J	U	U	U	U	U	1	1	8260C
Fourth Quarter 2016	U	U	U	U	U	U	1	1	8260C
2-Butanone						*CAS # 78-93-3*			
Second Quarter 2016	U	U	U	U	U	U	10	1.1	8260C
Fourth Quarter 2016	U J	U J	U J	U J	U J	U J	10	1.1	8260C
Carbon tetrachloride						*CAS # 56-23-5*			
Second Quarter 2016	U	U	U	U	U	U	1	0.2	8260C
Fourth Quarter 2016	U	U	U	U	U	U	1	0.2	8260C
Chloroethane						*CAS # 75-00-3*			
Second Quarter 2016	4.9	U	U	U	U	U	1	20.7	8260C
Fourth Quarter 2016	3.9	U	U	U	U	U	1	20.7	8260C

See last page of this report for definitions.

Target Analyte Monitoring Results At Or Above Permit Quantitation Limit
HWMU-16 Plume Monitoring Wells
Radford Army Ammunition Plant, Radford, Virginia
All Results in ug/L. ***Upgradient well = 16C1***

Analtye/Quarter	*16C1 Q*	*16-2 Q*	*16-3 Q*	*16-5 Q*	*16WC2B Q*	*16SPRING Q*	*QL*	*Background*	*Method*
Dichlorodifluoromethane						*CAS #75-71-8*			
Second Quarter 2016	U	U	U	U	U	U	1	46.5	8260C
Fourth Quarter 2016	U J	U J	U J	U J	U J	U J	1	46.5	8260C
1,1-Dichloroethane						*CAS #75-34-3*			
Second Quarter 2016	6	U	U	U	U	U	1	9.5	8260C
Fourth Quarter 2016	6.7	U	U	U	U	U	1	9.5	8260C
1,1-Dichloroethene						*CAS #75-35-4*			
Second Quarter 2016	0.3 J	U	U	U	U	U	1	1	8260C
Fourth Quarter 2016	U	U	U	U	U	U	1	1	8260C
Diethyl ether						*CAS #60-29-7*			
Second Quarter 2016	33	U	U	U	U	U	13	75.5	8260C
Fourth Quarter 2016	51	U	U	U	U	U	13	75.5	8260C
Diethyl phthalate						*CAS #84-66-2*			
Second Quarter 2016	U	U	U	U	U	U	5	5	8270D
Fourth Quarter 2016	U	U	U	U	U	U	5	5	8270D
Dimethyl ether						*CAS #115-10-6*			
Second Quarter 2016	7.8 J	U	U	U	U	U	13	17.0	8260C
Fourth Quarter 2016	U	U	U	U	U	U	13	17.0	8260C
2,4-Dinitrotoluene						*CAS #121-14-2*			
Second Quarter 2016	U	U	U	U	U	U	10	10	8270D
Fourth Quarter 2016	U	U	U	U	U	U	10	10	8270D
2,6-Dinitrotoluene						*CAS #606-20-2*			
Second Quarter 2016	U	U	U	U	U	U	10	10	8270D
Fourth Quarter 2016	U	U	U	U	U	U	10	10	8270D
Ethylbenzene						*CAS #100-41-4*			
Second Quarter 2016	U	U	U	U	U	U	1	0.1	8260C
Fourth Quarter 2016	U	U	U	U	U	U	1	0.1	8260C
Chloromethane						*CAS #74-87-3*			
Second Quarter 2016	U	U	U	U	U	U	1	0.3	8260C
Fourth Quarter 2016	U J	U J	U J	U J	U J	U J	1	0.3	8260C
Methylene chloride						*CAS #75-09-2*			
Second Quarter 2016	1.8	U	U	U	U	U	1	13.95	8260C
Fourth Quarter 2016	1.7	U	U	U	U	U	1	13.95	8260C
Tetrachloroethene						*CAS #127-18-4*			
Second Quarter 2016	0.3 J	U	U	U	U	U	1	0.7	8260C
Fourth Quarter 2016	U	U	U	U	U	U	1	0.7	8260C
Tetrahydrofuran						*CAS #109-99-9*			
Second Quarter 2016	13 J	-	-	-	-	-	25	25	8260C
Fourth Quarter 2016	U J	U J	U J	U J	U J	U J	25	25	8260C
Toluene						*CAS #108-88-3*			
Second Quarter 2016	U	U	U	U	U	U	1	0.1	8260C
Fourth Quarter 2016	U	U	U	U	U	U	1	0.1	8260C
1,1,1-Trichloroethane						*CAS #71-55-6*			
Second Quarter 2016	0.2 J	U	U	U	U	U	1	9.2	8260C
Fourth Quarter 2016	U	U	U	U	U	U	1	9.2	8260C
Trichloroethene						*CAS #79-01-6*			
Second Quarter 2016	0.3 J	U	U	U	U	U	1	0.1	8260C
Fourth Quarter 2016	U	U	U	U	U	U	1	0.1	8260C

See last page of this report for definitions.

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

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

Analtye/Quarter	*16C1 Q*	*16-2 Q*	*16-3 Q*	*16-5 Q*	*16WC2B Q*	*16SPRING Q*	*QL*	*Background*	*Method*
Trichlorofluoromethane						*CAS #75-69-4*			
Second Quarter 2016	U	U	U	U	U	U	1	11.3	8260C
Fourth Quarter 2016	U	U	U	U	U	U	1	11.3	8260C
1,1,2-Trichloro-1,2,2-Trifluoroethane						*CAS #76-13-1*			
Second Quarter 2016	U	U	U	U	U	U	1	1.2	8260C
Fourth Quarter 2016	U	U	U	U	U	U	1	1.2	8260C
Xylenes (Total)						*CAS #1330-20-7*			
Second Quarter 2016	U	U	U	U	U	U	3	0.2	8260C
Fourth Quarter 2016	U	U	U	U	U	U	3	0.2	8260C

Definitions:

All plume monitoring well results reported to at or above the permit quantitation limit except for the upgradient well during the Appendix IX monitoring Event. During the Appendix IX monitoring event, results for the upgradient well are reported to the c

Q Denotes data validation qualifier.
QL Denotes permit required quantitation limit.
U Denotes analyte not detected at or above QL.
UA Denotes analyte not detected at or above adjusted sample QL.
J Denotes result is estimated. When used with "U" (i.e., "**UJ**"), denotes analyte not detected at or above QL and QL is estimated. When used with "UA" (i.e., "**UAJ**"), denotes analyte not detected at or above adjusted QL and adjusted QL is estimated.
UN Denotes analyte concentration is less than five times the blank concentration. Not reliably detected due to blank contamination.
R Denotes result rejected.
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 July 17, 2014, rev December 1, 2016).
CAS# Denotes Chemical Abstract Services registration number.
GPS Denotes groundwater protection standard. (2016)

NS denotes not sampled. **NA** denotes not analyzed. "–"denotes not detected (pre-2nd Quarter 2003) or not available / not sampled (beginning 2nd Quarter 2003).

Notes:
4Q2004. No data for 16-1 8270C-semivolatiles. Well dry-insufficient sample volume.
4Q2006 - No data for 16-1; well dry.
4Q2008- No data for 16-1; well dry.
2Q2009- No data for 16-1; well dry.

NOTE:
Fourth Quarter 2008
Due to laboratory error all HWMU 16 samples were analyzed using Method 8260B 5 ml purge instead of a 25 ml purge which resulted in a higher QL. For these samples, all results were evaluated to the detection limit, which is comparable to the permit QL. Results below the laboratory QL but at or above the permit QL are reported and qualified as estimated.

APPENDIX B-4

ESTABLISHED BACKGROUND VALUES AND COMPUTATIONS FOR HWMU-16

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

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

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

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

3.3 HWMU-16 GROUNDWATER MONITORING ANALYTE LIST

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

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

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

3.4 HWMU-16 GROUNDWATER BACKGROUND CONCENTRATIONS

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

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

3.5 HWMU-16 STATISTICAL ANALYSIS

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

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

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

3.5.1 Background Data and Statistical Comparisons

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3.5.2 Results of Statistical Comparisons

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

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

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

3.6 HWMU-16 PLUME DELINEATIONS

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

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

TABLE 2
HWMU-16
Calculated Background Values

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

TABLE 2
HWMU-16
Calculated Background Values

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

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

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

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

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

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

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

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

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

Discussion of Tests for Normality

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

Discussion of Prediction Interval Tests

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

Summary of UPL

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

Statistical Computations – RAAP HWMU-16

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

Discussion of Tests for Normality

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

Discussion of Prediction Interval Tests

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

Summary of UPLs

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

RAAP-HWMU-16 - Statistical Analysis - Notes

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

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

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

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

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

Normality Tests

Report Printed: 02-02-2005 13:49

Facility:RAAPHWMU16 Haz. Waste Unit 16 - RAAP

Address:

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

Contact:
Phone:( ) -

Permit Type:Detection

Constituent:ClEthane Chloroethane

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

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

Normality Test on Observations for wells listed below:

Well:16C1 Position:Upgradient Observations:5

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

Pooled Statistics
Observations: 5

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

Shapiro-Wilk Statistics

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

Log:	0.7615*	0.7620	0.6860

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

Parametric Prediction Interval
Report Printed February 2,2005

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

ONE-TAILED UPPER PARAMETRIC PREDICTION INTERVAL

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

Report Produced by GRITS/STAT 5.01

Normality Tests

Report Printed: 02-02-2005 13:49

Facility:RAAPHWMU16 Haz. Waste Unit 16 - RAAP

Address:

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

Contact:
Phone:( ) -

Permit Type:Detection

Constituent:DEthEth Diethyl ether

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

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

Normality Test on Observations for wells listed below:

Well:16C1 Position:Upgradient Observations:5

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

Pooled Statistics
Observations: 5

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

Shapiro-Wilk Statistics

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

Log:	0.9507	0.7620	0.6860

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

Parametric Prediction Interval
Report Printed February 2,2005

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

ONE-TAILED UPPER PARAMETRIC PREDICTION INTERVAL

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

Report Produced by GRITS/STAT 5.01

Normality Tests

Report Printed: 02-02-2005 13:53

Facility:RAAPHWMU16 Haz. Waste Unit 16 - RAAP

Address:

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

Contact:
Phone:( ) -

Permit Type:Detection

Constituent:DMethEth Dimethyl ether

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

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

Normality Test on Observations for wells listed below:

Well:16C1 Position:Upgradient Observations:5

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

Pooled Statistics
Observations: 5

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

Shapiro-Wilk Statistics

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

Log:	0.5521*	0.7620	0.6860

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

Nonparametric Prediction Interval
Report Printed February 2,2005

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

ONE-TAILED UPPER PARAMETRIC PREDICTION INTERVAL

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

UL: 17.000 ppb
LL: 0.000

Report Produced by GRITS/STAT 5.01

Normality Tests

Report Printed: 02-02-2005 13:54

Facility:RAAPHWMU16 Haz. Waste Unit 16 - RAAP

Address:

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

Contact:
Phone:( ) -

Permit Type:Detection

Constituent:MeCl Dichloromethane (Methylene chloride)

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

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

Normality Test on Observations for wells listed below:

Well:16C1 Position:Upgradient Observations:5

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

Pooled Statistics
Observations: 5

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

Shapiro-Wilk Statistics

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

Log:	0.8519	0.7620	0.6860

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

Parametric Prediction Interval
Report Printed February 2,2005

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

ONE-TAILED UPPER PARAMETRIC PREDICTION INTERVAL

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

Report Produced by GRITS/STAT 5.01

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

All Results in ug/L.

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

See last page of this report for definitions.

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

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

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

See last page of this report for definitions.

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

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

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

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

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

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

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

Ross Miller

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

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

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

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

Jeremy:

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

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

COMMONWEALTH of VIRGINIA

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

Molly Joseph Ward
Secretary of Natural Resources

David K. Paylor
Director

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

Office of Waste Permitting and Compliance

Land Protection and Remediation Division

September 12, 2014

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

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

Dear Mr. Stewart:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Sincerely,

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

Enclosures: Facility Mailing List, Modified Permit Pages

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

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

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Molly Joseph Ward
Secretary of Natural Resources

David K. Paylor
Director

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1-800-592-5482

July 19, 2016

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

VIA ELECTRONIC MAIL

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

Dear Mr. Stewart:

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

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

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

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

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

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

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

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

Sincerely,

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

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

APPENDIX C
LABORATORY ANALYTICAL RESULTS – YEAR 2016
(PDF ONLY)

APPENDIX D

FIELD NOTES (PDF ONLY)

4/25/16 REAAP/UNIT-5 F.B.#12
60320Y-16
KEC/JWMD

General Notes -
- Weather - Mostly sunny - 50°-80°s
- PPE - Nitrile gloves, eye protection, steel toe boots.
- Calibrations: YSI 556-MDS
  pH: 4.00 = 4.00, 7.00 = 7.01, 10.00 = 9.97
  Conductivity reads 1413 µs in a 1413 µs standard
  DO% = 100 %
  HACH 2100P Turbidimeter range: 0.02-1000 NTU
- Dedicated well skirts and tubing used at each well.
- All equipment decon'ed before and after each event and between use at each sampling location.
- All purge water collected and disposed of at dedicated on-site location.
- All samples collected, stored & transported on ice & in coolers.
- Sample collection order & preservatives
  1. 8260 HCL
  2. 8270 NONE
  3. Total Metals HNO_3
- All wells purged and sampled at 0.25 L/min.
- VOA's collected from one pulse from bladder pump.
- Bladder pump setting: 4 cycles/min. - 5 sec. discharge, 10 sec. recharge

STATIC WATER LEVEL TABLE (UNIT 5)

WELL	DTW	Post purge DTW
5W8B	15.43	15.91
5W12A	13.07	13.08
5W7B	9.89	9.96
5W5B	9.96	10.45
5WC22	10.07	10.11
5WC23	9.50	9.57
5WC21	10.11	10.21

WELL	DTW (ONLY)
5W9A	2.93
5W10A	14.22
5W11A	11.83
5WC1A	13.88
5WC11	16.49
5WC12	16.74
S5W5	9.65
S5W6	7.89
S5W7	12.90
S5W8	12.59

4/25/16 RFAAP-UNIT5 F.B. #12
BO3204-16
KFe/mmo

SW8B

Control Box Setting: 22 PSI
Begin Purge (0901)
Initial Purge: clear

DTW: 15.43
Postpurge DTW: 15.91

TIME	Temp(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mv)	Turb(NTU)	DTW	Desc
(0905)	13.99	112	7.30	4.82	177.0	2.17	15.98	clear
(0910)	14.04	111	6.98	4.42	190.8	2.09	15.86	clear
(0915)	14.14	110	6.93	4.40	193.0	2.00	15.81	clear
(0920)	14.25	109	6.92	4.43	191.9	2.43	15.83	clear
(0925)	14.28	108	6.89	4.44	192.3	2.03	15.85	clear
(0930)	14.29	108	6.88	4.43	191.9	1.91	15.88	clear
(0930)	Readings Stable					~~1.96~~ 2 MWS 4-25-16		
(0940)	14.50	107	6.98	4.50	188.0	1.96	15.91	clear

Sample Time (0935)
Samples Collected: (3) 8260C, (1) TIM

SW12A

Control Box: 24 PSI
Begin Purge (0956)
Initial Purge: clear

DTW: 13.07
Post Purge DTW: 13.08

TIME	TEMP(c)	Cond(µs)	DO(mg/L)	pH	ORP(mv)	Turb(NTU)	DTW	Desc
(1000)	14.89	585	2.81	6.18	99.5	4.43	13.10	clear
(1005)	14.89	585	2.27	6.25	90.5	3.18	13.08	clear
(1010)	14.93	583	1.91	6.33	80.8	2.97	13.08	clear
(1015)	15.00	587	1.88	6.36	73.4	2.54	13.07	clear
(1020)	14.95	587	1.77	6.38	69.6	1.99	13.08	clear
(1025)	15.13	585	1.70	6.40	65.9	1.76	13.08	clear
(1030)	15.09	586	1.67	6.42	61.9	2.03	13.08	clear
(1030)	Readings Stable							
(1040)	15.33	586	2.28	6.43	60.2	2.44	13.08	

Sample Time (1035)
Samples Collected: (3) 8260C, (1) TIM

4/25/16 RFAAP UNIT 5 F.B.#12
B03204-16
LFC/MMD

5WTB

Control Box: 24 PSI
Begin Purge (1045)
Initial Purge: clear

DTW: 9.89
Post Purge DTW: 9.96

TIME	TEMP(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mV)	Turb(NTU)	DTW	Desc
(1050)	12.92	187	8.64	5.02	162.1	1.51	9.91	clear
(1055)	13.00	181	8.87	4.73	164.4	1.51	9.92	clear
(1100)	12.90	179	8.95	4.75	161.9	1.51	9.92	clear
(1105)	12.80	178	9.47	5.01	145.3	1.43	9.93	clear
(1110)	12.81	177	8.97	4.76	154.8	2.07	9.93	clear
(1115)	12.77	178	9.07	4.77	154.1	1.54	9.94	clear
(1120)	12.91	178	9.08	4.79	151.6	1.39	9.95	clear
(1120) Readings Stable								
(1140)	14.96	182	9.15	4.80	146.0	1.35	9.96	clear

Sample Time (1125)
Samples Collected: (9) 8260C, (12) 8270D, (3) TM

5WSB

Control Box: 24 PSI
Begin Purge (1155)
Initial Purge: clear

DTW: 9.96
Post Purge DTW: 10.45

TIME	TEMP(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mV)	Turb(NTU)	DTW	Desc
(1200)	13.19	468	2.54	5.36	115.0	1.91	10.41	clear
(1205)	12.95	466	2.14	5.32	114.8	1.96	10.47	clear
(1210)	13.09	465	1.96	5.31	114.2	1.60	10.50	clear
(1215)	13.08	465	1.93	5.33	112.3	1.82	10.47	clear
(1220)	13.23	464	1.95	5.36	110.0	1.61	10.43	clear
(1225)	13.26	465	2.04	5.36	108.9	1.64	10.45	clear
(1225) Readings Stable								
(1240)	13.27	468	2.92	5.47	101.7	1.76	10.45	clear

Sample Time (1230)
Samples Collected: (3) 8260C, (4) 8270D, (1) TM

4/25/16 RFAAP/Units 5 B032604-16 KFC/WWO FB. #12

SWC22

Control Box: 25 PSI

DTW: 10.07

Begin Purge (1250)

Post Purge DTW: 10.11

Initial Purge: clear

TIME	TEMP(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mV)	Turb(ntu)	DTW	Desc
(1255)	14.64	1007	0.53	6.20	70.3	25.4	10.09	clear
(1300)	14.57	1021	0.32	6.27	63.8	50.1	10.10	clear
(1305)	14.62	1025	0.28	6.33	57.8	26.5	10.11	clear
(1310)	14.72	1024	0.26	6.35	55.3	15.9	10.14	clear
(1315)	14.76	1024	0.24	6.37	52.4	10.0	10.10	clear
(1320)	14.76	1024	0.23	6.38	51.2	5.49	10.11	clear
(1320)	Readings Stable							
(1332)	15.21	1028	0.46	6.43	54.2	10.5	10.11	clear

Sample Time (1325)

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

SWC23

Control Box: 32 PSI

DTW: 9.50

Begin Purge (1340)

Post Purge DTW: 9.57

Initial Purge: clear

TIME	TEMP(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mV)	Turb(ntu)	DTW	Desc
(1345)	13.82	1107	3.26	6.52	56.8	14.8	9.55	clear
(1350)	13.83	1092	2.22	6.46	59.4	12.4	9.48	clear
(1355)	13.84	1091	2.24	6.47	54.8	10.6	9.55	clear
(1400)	14.12	1091	2.21	6.47	52.9	7.93	9.51	clear
(1405)	13.96	1092	2.11	6.49	50.7	6.44	9.59	clear
(1410)	14.07	1093	2.03	6.46	52.2	6.70	9.55	clear
(1410)	Readings Stable							
(1422)	14.52	1100	2.18	6.48	51.9	7.32	9.57	clear

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

Sample Time (1415)

4/26/16 RFAAP/UNIT-5 F.B.#12
503204-16
KEC/vmw

General Notes -
- Weather -
- PPE - Nitrile gloves, eye protection, steel toe boots
- Calibrations - YSI 556 - MDS
  pH: 4.00 = 4.00, 7.00 = 7.01, 10.00 = 9.97
  Conductivity reads 1413 µs in a 1413 µs standard
  DO% = 100 %
  HACH 2100P Turbidimeter: 0.02 - 1000 NTU
- Dedicated well skirts & tubing used at each well.
- All equipment decon'ed between wells & after each event.
- All purge water collected & disposed of at dedicated on-site location.
- All samples collected, stored & transported on ice in coolers.
- Sample collection order & preservatives:
  1. 8260 — HCl
  2. 8270 — None
  3. T.M. — HNO_3
- All wells purged and sampled at .25 L/min.
- VOAs collected from one pulse from bladder pump.
- Bladder pump setting = 4/cycles/min: 5 sec. discharge, 10 sec. recharge

SWC21
Control Box: 22 PSI
DTW: 10.13
Begin Purge: (0845)
Post Purge DTW: 10.21
Initial Purge: clear

TIME	Temp (°C)	Cond (µs)	DO (mg/L)	pH	ORP (mV)	TURB (NTU)	DTW	DESC.
(0850)	14.12	703	4.75	4.68	153.6	7.08	10.22	clear
(0855)	14.24	712	1.60	4.67	151.6	8.81	10.12	clear
(0900)	14.26	707	1.16	4.68	151.0	11.1	10.15	clear
(0905)	14.34	702	0.92	4.74	145.7	12.1	10.16	clear
(0910)	14.48	698	0.85	4.78	141.8	10.7	10.16	clear
(0915)	14.50	695	0.77	4.80	138.1	10.1	10.14	clear
(0920)	14.55	695	0.75	4.82	135.2	10.2	10.15	clear
(0920)	Readings Stable							
(0940)	14.74	693	0.80	4.86	128.5	9.93	10.21	clear

SWC21 (continued)

Sample Time (0925)

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

SWDUP (Taken from SWC21)

Sample Time (0935)

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

APPROVED BY AT

DATE 6/21/2016

STATIC WATER LEVEL TABLE - HWMU 16

WELL	DTW	Post Purge DTW	Notes
~~16-1~~ (1 per 4-27-16)	DO NOT SAMPLE THIS EVENT		
16-2	55.87	55.97	
16-3	54.73	64.27	
16-5	3.63	12.13	
16WC2B	50.53	63.58	
16MW8	70.67	72.85	
16WC1B	63.41	63.81	
16WC1A	62.48	64.91	
16MW9	62.23	63.69	
16C1	46.06	46.08	
SWL ONLY			
16C3	60.61		
16CDH3	DRY @ 68.57		Sign not Attached
16WC2A	~~60~~ 61.88		
16-1	41.43		

4/26/16 RFAA/UNIT 503204-16 12FC/UMD F-B.#12

5WC21 (continued)

Sample Time (0925)

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

5WDUP (Taken from 5WC21)

Sample Time (0935)

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

APPROVED BY AT

DATE 6/21/2016

STATIC WATER LEVEL TABLE - HWMU 16

WELL	DTW	Post Purge DTW	Notes
~~16-1~~	DO NOT SAMPLE THIS EVENT		
16-2	55.87	55.97	
16-3	54.73	64.27	
16-5	3.63	12.13	
16WC2B	50.53	63.58	
16MW8	70.67	72.85	
16WC1B	63.41	63.81	
16WC1A	62.48	64.91	
16MW9	62.23	63.69	
16C1	46.06	46.08	
SWL ONLY			
16C3	60.61		
16CDH3	DRY @ 68.57		Sign not Attached
16WC2A	~~16.~~ 61.58		
16-1	41.43		

4/26/16 RFAAP/UNIT-16 EB#12
BG3204-16
12°C/WMD

GENERAL NOTES

Weather: Mostly sunny 70-80°s + breezy

PPE: nitrile gloves, eye protection, steel toed boots

Calibrations: YSI 556-MDS

pH: 4.00 = 4.00, 7.00 = 7.01, 10.00 = 9.97

Conductivity Reads 1413 µs in a 1413 µs standard

DO% = 100%

HACH 2100 P Turbidimeter: 0.02 - 1000 NTU

- Dedicated well skirts and tubing used at each well
- All equipment decanned between wells + after each event.
- All purge water collected and disposed of at dedicated location on site.
- Samples collected stored and transported on ice in coolers
- Sample Collection order and preservatives

① 8260C	HCL
② 8270D	none
③ cyanide	NaOH
④ T.M.	HNO_3

- All wells purged and sampled at 0.25 mL/min
- VOAs collected from one pulse from bladder pump
- Bladder pump setting = 4 cycle/minute 5 second discharge 10 second Recharge

35 WMD 4-26-16

16-5

Control Box: ~~22~~ PSI

DTW: 3.63

Begin Purge (1005)

Post Purge DTW: 12.13

Initial Purge: clear

TIME	TEMP(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mV)	Turb(NTU)	DTW	Desc
(1010)	13.44	558	2.89	6.84	47.9	3.36	6.38	clear
(1015)	13.51	559	2.53	6.85	48.3	2.79	7.18	clear
(1020)	13.46	559	2.38	6.87	46.9	2.81	8.12	clear
(1025)	13.81	560	2.32	6.88	44.5	2.19	8.53	clear
(1030)	13.72	561	2.24	6.89	43.0	1.89	9.03	clear
(1035)	13.44	561	2.12	6.89	41.2	1.96	9.81	clear

16-5 (continued)

TIME	TEMP(C)	Cond(ms)	pH	DO(mg)	ORP(mv)	Turb(ntu)	DTW	Desc
(1040)	13.38	561	6.89	2.03	40.1	2.27	10.74	clear
(1040)	Readings Stable							
(1050)	13.76	564	6.92	2.25	35.7	2.67	12.13	clear

Sample Time (1045)
Samples Collected: (3)8260, (1)TM, (2)8270D

16 Spring

TEMP(C)	Cond(ms)	DO(mg)	pH	ORP(mv)	Turb(ntu)
13.74	590	8.53	6.92	46.5	4.67

Sample Time (1100)
Samples Collected: (3)8260C, (2)8270D, (1)TM

16WC2B

Control Box: 47 psi
DTW: 50.53
Begin Purge (1120)
Post Purge DTW: 63.58
Initial Purge: clear

TIME	TEMP(C)	Cond(ms)	DO(mg)	pH	ORP(mv)	Turb(ntu)	DTW	Desc
(1125)	14.75	368	3.07	7.41	24.3	1.83	52.72	clear
(1130)	14.39	364	0.83	7.38	11.4	1.59	55.46	clear
(1135)	14.55	365	0.92	7.38	14.8	1.78	56.78	clear
(1140)	14.47	364	0.88	7.39	12.6	1.57	58.10	clear
(1145)	14.40	363	0.87	7.39	10.0	1.63	59.91	clear
(1150)	14.67	362	0.85	7.39	10.5	1.90	60.89	clear
(1150)	Readings Stable							
(1205)	14.77	365	1.08	7.40	9.5	1.98	63.58	clear

Sample Time (1155)
Samples Collected: (3)8260, (2)8270D, (1)TM

4/26/16 RFAAP/UNIT-16 F.B.#12
Bo320-16
K.FC/WMS

16-2 Control Box: 25 PSI
DTW: 55.87 Begin Purge (1215)
Post Purge DTW: 55.97 Initial Purge: clear

TIME	TEMP(°C)	Cond(mS/cm)	DO(mg/L)	pH	ORP(mV)	Turb(NTU)	DTW	Desc
(1220)	13.79	583	7.63	6.90	41.2	1.77	55.91	clear
(1225)	14.09	572	7.96	7.06	25.8	1.55	55.91	clear
(1230)	13.99	567	8.00	6.91	35.1	1.58	55.91	clear
(1235)	14.30	560	8.16	6.87	37.3	1.52	55.91	clear
(1240)	14.09	556	8.35	6.84	40.2	1.58	55.93	clear
(1245)	14.14	550	8.44	6.83	39.7	1.72	55.95	clear
(1245)	Readings Stable				~~45.7~~ error 4-26-16			
(1255)	14.55	544	8.61	6.80	45.7	1.98	55.97	clear

Sample Time (1250)
Samples Collected: (3) 8260C, (2) 8270D, (1) TM

16MW8 Control Box: 49 PSI
DTW: 70.67 Begin Purge (1305)
Post Purge DTW: 72.85 Initial Purge: clear

TIME	TEMP(°C)	Cond(mS/cm)	DO(mg/L)	pH	ORP(mV)	Turb(NTU)	DTW	Desc
(1310)	14.65	208	1.65	5.82	43.5	2.16	71.24	clear
(1315)	14.21	192	0.57	5.68	29.6	2.13	71.68	clear
(1320)	14.57	194	0.43	5.70	15.3	2.76	71.98	clear
(1325)	14.72	198	0.37	5.75	21.5	2.62	72.08	clear
(1330)	14.59	195	0.36	5.59	41.3	2.81	72.16	clear
(1335)	14.76	191	0.33	5.55	54.2	2.98	72.27	clear
(1340)	14.79	190	0.32	5.51	65.4	3.22	72.38	clear
(1345)	14.86	190	0.31	5.53	71.1	2.85	72.43	clear
(1350)	14.59	191	0.30	5.48	76.5	2.61	72.53	clear
(1350)	Readings Stable							
(1410)	14.80	193	0.42	5.62	80.1	3.08	72.85	

Sample Time (1355)
Samples Collected: (6) 8260C, (4) 8270D, (1) cyanide
(1) TM

4/26/16 RFAAP/UNIT-16 F.B.#12
B032204-16
KFC/WMN

16-3 Control Box: 48 PSI
DTW: 54.73 Begin Purge (1415)
Post Purge DTW: 64.27 Initial Purge: clear

TIME	TEMP(C)	Cond(ms)	DO(mg/L)	pH	ORP(mV)	Turb(ntu)	DTW	Desc
(1420)	14.86	284	9.21	6.54	10.3	2.10	57.78	clear
(1425)	14.70	286	8.87	6.78	22.2	2.43	59.83	clear
(1430)	14.79	285	8.87	6.87	26.2	2.53	61.03	clear
(1435)	14.85	286	9.01	6.96	33.5	1.81	61.89	clear
(1440)	14.61	285	9.13	7.00	35.6	1.76	62.71	clear
(1445)	15.03	284	9.07	7.08	32.5	2.18	63.17	clear
(1445)	Readings Stable @							
(1500)	14.89	286	9.25	7.16	37.0	1.95	64.27	clear

Sample Time (1450)
Samples Collected: (3) 8260C, (2) 8270D, (1) TM

16

(110)

4/27/16 RFAAP/UNIT-16 F.B.# 12
803204-16
KFC/MMD

General Notes -
- Weather - Mostly cloudy & 60°-70°s w/ some sprinkles
- PPE - Nitrile gloves, eye protection & steel toe boots
- Calibrations - YSI 556-MDS
  pH: 4.00 = 4.00, 7.00 = 7.01, 10.00 = 9.97
  Conductivity reads 1413 µs in a 1413 µs standard.
  DO% = 100.0 %
  HACH 2100P Turbidimeter: 0.02 - 1000 NTU
- Dedicated well skirts & tubing used at each well.
- All equipment decon'ed between wells & after each event.
- All purge water collected & disposed at at dedicated location on-site.
- Samples collected, stored & transported on ice in coolers.
- Sample collection order & preservatives:

①	8260	HCL
②	8270D	NONE
③	Cyanide	NaOH
④	T.M.	HNO_3

- All wells purged and sampled at 0.25 mL/min
- Bladder pump setting: 4 cycles/min. -5 second discharge -10 second recharge

16WC1B
DTW: 63.41
Post Purge DTW: 63.81

Control Box: 49 psi
Begin Purge (0902)
Initial Purge: cloudy w/ specks

TIME	TEMP(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mV)	Turb(ntu)	DTW	Desc
(0905)	13.33	403	1.55	5.73	30.5	91.1	63.70	cloudy brwn specks
(0910)	13.41	408	1.93	5.82	-15.3	12.4	63.76	clear
(0915)	13.30	417	0.86	5.83	-23.2	8.08	63.83	clear
(0920)	13.24	424	0.54	5.87	-33.3	5.54	63.82	clear
(0925)	13.37	428	0.47	5.92	-40.2	5.04	63.82	clear
(0930)	13.35	431	0.45	5.95	-43.1	3.62	63.81	clear
(0935)	13.36	434	0.39	6.00	-49.3	3.16	63.85	clear
(0940)	13.32	434	0.37	5.99	-49.5	2.93	63.87	clear

16WC1B (cont'd.)

Time	Temp(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mv)	Turb(NTU)	DTW	Desc.
(0945)	13.33	434	0.35	6.01	-50.1	3.17	63.89	clear
(0945)	Readings Stable		~~0.01~~					mmd 4-27-16
(1000)	13.72	437	0.55	6.04	-52.2	4.39	63.81	clear

Sample Time (0950)
Samples Collected: (6) 8260C, (4) 8270D
(1) Cyanide, (1) TM

16WC1A

DTW: 62.48
Post Purge DTW: 64.91

Control Box: 48PSI
Begin Purge (1005)
Initial Purge: clear

TIME	TEMP(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mv)	Turb(NTU)	DTW	Desc
(1010)	13.30	760	1.22	6.70	-26.5	1.83	64.78	clear
(1015)	13.30	773	0.73	6.63	-50.2	1.66	64.91	clear
(1020)	13.33	786	0.64	6.57	-53.4	1.62	64.77	clear
(1025)	13.37	817	0.51	6.45	-45.8	1.24	64.76	clear
(1030)	13.95	835	0.47	6.44	-38.2	1.31	64.81	Clear
(1035)	14.01	839	0.39	6.46	-28.7	1.38	64.88	Clear
(1040)	14.15	840	0.36	6.50	-24.9	1.42	64.90	Clear
(1045)	14.20	844	0.35	6.52	-22.7	1.69	64.87	clear
(1045)	Readings Stable							
(1130)	14.91	862	0.65	6.63	-23.5	1.82	64.91	clear

Sample Time (1050)
Samples Collected: (18) 8260C, (12) 8270D
(3) Cyanide, (3) TM

16WDUP (Taken from 16WC1A)

Sample Time (1110)
Samples Collected: (6) 8260C, (4) 8270D
(1) Cyanide, (1) TM

4/27/16 RFAAP/MNIT-16 B03204-16 KFC/WMW F.B#12

16MW9

Control Box: 45 PSI

DTW: 62.23

Begin Purge (1140)

Post Purge DTW: 63.69

Initial Purge: clear

TIME	TEMP(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mV)	Turb(ntu)	DTW	Desc
(1145)	13.83	995	1.59	6.48	-55.5	1.37	63.47	clear
(1150)	13.65	1005	0.68	6.47	-51.6	1.37	63.64	clear
(1155)	13.72	1006	0.59	6.46	-51.9	1.38	63.68	clear
(1200)	13.90	1008	0.51	6.47	-53.2	1.41	63.68	clear
(1205)	13.89	1009	0.47	6.48	-53.3	1.46	63.55	clear
(1210)	13.83	1007	0.44	6.47	-52.7	1.40	63.57	clear
(1210)	Readings Stable				~~-46.1~~		4-27-16	
(1225)	14.33	1011	0.54	6.55	-46.4	1.40	63.69	clear

Sample Time (1215)

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

APPROVED BY [signature]

DATE 6/21/2016

16CI

Control Box: 40 PSI

DTW: 46.06

Begin Purge (1240)

Post Purge DTW: 46.08

Initial Purge: clear

TIME	TEMP(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mV)	Turb(ntu)	DTW	Desc
(1245)	14.52	764	7.54	6.97	3.6	3.26	46.07	clear
(1250)	13.93	901	1.30	6.62	24.4	1.91	46.05	clear
(1255)	13.84	857	0.82	6.56	33.7	1.31	46.07	clear
(1300)	13.85	666	0.61	6.44	44.8	1.63	46.04	clear
(1305)	13.93	605	0.52	6.38	48.4	1.58	46.08	clear
(1310)	13.96	585	0.49	6.35	49.8	1.87	46.08	clear
(1315)	13.93	576	0.44	6.33	51.5	1.63	46.07	clear
(1320)	14.05	570	0.41	6.34	50.8	1.58	46.08	clear
(1320)	Readings Stable							
(1335)	14.20	573	0.63	6.39	48.5	1.80	46.08	clear

Sample Time (1325)

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

10/19/16 RFAAP-UNIT-5 F.B#12
B03204-16A
KFC/LUMO

General Notes:

- Weather- Foggy - 50's - 70's
- PPE - Nitrile gloves, eye protection & safety shoes
- Calibrations: YSI-556 MDS
  pH: 4.00 = 4.00, 7.00 = 7.00, 10.00 = 10.00
  Conductivity reads 1413 µs in a 1413 µs standard
  DO% = 100% %
  HACH 2100P Turbidimeter range: 0.02-1000 NTU
- Dedicated well skirts and tubing used at each well.
- All equipment decon'ed before and after each event and between use at each sample location.
- All purge water collected and disposed of at dedicated on-site location.
- All samples collected, transported & stored on ice in coolers
- Sample collection order: 8260C & TM
- All wells purged and sampled at 0.25 L/min.

Sample Analysis	Preservative
8260C	HCl
TOTAL METALS	HNO_3

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

STATIC WATER LEVEL - UNIT-5 (1st)

WELL	DTW	Post-Purge DTW
SWBB	15.17	15.75
SW12A	12.94	12.96
SW7B	9.78	9.81
SW5B	9.75	10.52
SWC22	9.91	9.96
SWC23	9.33	9.38
SWC21	9.96	10.00

Well	DTW	Post-purge DTW
SW9A	2.90	N/A
SW10A	14.66	
SW11A	12.83	
SWC14	13.40	
SWC11	16.11	
SWC12	16.42	
S5W5	9.38	
S5W6	7.77	
S5W7	12.56	
S5W8	12.29	

10/19/16 RFAAP-UNIT-5 FB#2
303204-16A
K=C/mmD

SW8B

DTW: 15.17 CONTROL BOX SETTING: 20 PSI BEGIN PURGE (0857)
POST PURGE DTW: 15.75 INITIAL PURGE-clear

Time	Temp(°C)	Cond(ms)	DO mg/L	pH	ORP(mv)	Turb(NTU)	DTW	Desc.
(0900)	15.47	89	6.13	4.70	132.2	3.30	15.74	clear
(0905)	15.48	89	5.56	4.62	136.2	2.02	15.76	clear
(0910)	15.48	88	5.42	4.59	136.6	1.84	15.81	clear
(0915)	15.51	87	5.37	4.56	136.4	1.45	15.81	clear
(0920)	15.54	87	5.33	4.56	135.8	1.96	15.71	clear
(0925)	15.55	87	5.31	4.56	134.5	1.45	15.75	clear
(0925)	Readings Stable							
(0935)	15.58	87	5.42	4.55	134.1	1.92	15.75	clear

Sample Time (0930)
Samples Collected: (3) 8260C, (1) TM

SW12A

DTW: 12.94 Control Box: 20 psi Begin Purge (0948)
Post Purge DTW: 12.96 Initial Purge: clear

Time	Temp(°C)	Cond(ms)	DO mg/L	pH	ORP(mv)	Turb(NTU)	DTW	Desc.
(0950)	15.04	580	2.38	6.06	76.2	2.06	12.94	clear
(0955)	14.76	591	1.41	6.20	65.2	2.87	12.94	clear
(1000)	14.83	595	1.21	6.29	56.7	2.50	12.95	clear
(1005)	14.81	598	1.10	6.38	46.8	1.67	12.98	clear
(1010)	14.75	598	1.05	6.45	37.9	0.98	12.98	clear
(1015)	14.75	598	1.05	6.50	34.2	1.04	12.96	clear
(1020)	14.77	599	1.03	6.54	31.7	1.01	12.96	clear
(1020)	Readings Stable							
(1030)	14.77	600	0.99	6.60	29.4	0.97	12.96	clear

Sample Time (1025)
Samples Collected: (3) 8260C, (1) TM

10/19/16 RFAAP-UNIT-5 F.B #12
B03204-16A
KFC/MMA

SW7B

DTW: 9.78 Control Box: 15 PSI Begin Purge (1043)
Post Purge DTW: 9.81 Initial Purge: clear

TIME	TEMP(°C)	Cond(ms)	DO(mg/L)	pH	ORP(mV)	Turb(NTU)	DTW	Desc.
(1045)	21.52	167	2.86	4.93	106.1	0.86	9.86	clear
(1050)	21.62	167	2.66	4.75	104.3	0.82	9.78	clear
(1055)	21.65	168	2.67	4.69	103.8	0.94	9.79	clear
(1100)	21.65	168	2.77	4.68	100.8	1.00	9.81	clear
(1105)	21.70	169	2.80	4.71	97.3	1.09	9.79	clear
(1110)	21.66	168	2.86	4.78	89.9	0.91	9.81	clear
(1110)	Readings Stable							
(1120)	21.91	167	2.98	4.72	90.3	0.93	9.81	clear

Sample Time (1115)
Samples Collected: (9) 8260C, (3) TM

SW5B

DTW: 9.75 Control Box: 15 PSI Begin Purge (1131)
Post Purge DTW: 10.52 Initial Purge: clear

TIME	TEMP(°C)	Cond(ms)	DO(mg/L)	pH	ORP(mV)	Turb(NTU)	DTW	Desc.
(1135)	17.03	442	2.75	5.16	83.1	0.84	10.17	clear
(1140)	17.07	432	2.77	5.21	74.9	0.99	10.15	clear
(1145)	17.08	430	2.82	5.23	68.8	0.83	10.22	clear
(1150)	17.07	432	2.76	5.25	66.6	0.79	10.25	clear
(1155)	17.02	434	2.86	5.26	63.2	0.78	10.32	clear
(1200)	16.98	435	2.99	5.28	62.0	0.76	10.38	clear
(1200)	Readings Stable							
(1210)	17.05	436	3.19	5.31	59.5	0.75	10.52	clear

Sample Time (1205)
Samples Collected: (3) 8260C, (1) TM

10/20/16 RFAAP-UNIT-5 F.B.#:
B03294-16A
KFC/WMD

SWC22

DTW: 9.91 Control Box: 23 PSI Begin Purge (0913)
Post Purge DTW: 9.96 Initial Purge: clear

TIME	TEMP(C)	Cond(us)	DO(mg/L)	pH	ORP(mv)	Turb(NTU)	DTW	Desc
(0915)	15.17	988	2.98	6.62	53.8	1.90	9.92	clear
(0920)	14.76	957	2.33	6.53	48.2	1.83	9.95	clear
(0925)	14.67	949	2.06	6.53	43.0	1.80	9.97	clear
(0930)	14.63	948	1.83	6.53	37.3	1.56	9.94	clear
(0935)	14.62	948	1.64	6.54	32.6	1.35	9.92	clear
(0940)	14.61	948	1.48	6.55	28.7	1.43	9.97	clear
(0945)	14.60	948	1.29	6.56	24.8	1.61	9.96	clear
(0950)	14.62	948	0.40	6.56	20.4	1.34	9.97	clear
(0955)	14.69	948	0.31	6.57	15.6	1.24	9.96	clear
(1000)	14.78	948	0.27	6.58	11.4	1.39	9.96	clear
(1005)	14.93	948	0.26	6.60	5.2	1.31	9.96	clear
(1010)	14.93	949	0.27	6.59	1.5	1.26	9.96	clear
(1010)	Readings Stable							
(1020)	14.95	949	0.32	6.61	-1.9	1.78	9.96	clear

Sample Time (1015)
Samples Collected: (3) 8260C, (1) TM

GENERAL NOTES:
Weather: Foggy / Sunny 50's - 70's
PPE: Nitrile gloves, eye protection, safety shoes
Calibrations: YSI - 556 MDS
pH: 4.00 = 4.00, 7.00 = 7.00, 10.00 = 10.00
Conductivity Reads 1413 us in a 1413 us standard
DO% = 100%
HACH 2100P Turbidimeter range 0.02 - 1000 NTU
* See page 143 for additional notes.

10/20/16 RFAAP-UNIT-5 F.B.#12
130204-16A
KFC/JWM

5WC23

DTW: 9.33 Control Box: 28 PSI Begin Purge (1027)
Post Purge DTW: 9.38 Initial Purge: clear

TIME	TEMP(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mv)	Turb(NTU)	DTW	Desc.
(1030)	16.30	1009	2.41	6.69	1.0	5.98	9.38	clear
(1035)	16.25	984	2.22	6.70	2.5	4.03	9.35	clear
(1040)	16.18	978	2.08	6.70	2.2	1.99	9.35	clear
(1045)	16.23	980	2.10	6.70	1.3	1.71	9.36	clear
(1050)	15.93	983	2.09	6.70	1.5	1.85	9.34	clear
(1055)	15.80	984	2.03	6.69	0.6	2.23	9.35	clear

(1055) Readings Stable
Sample Time (1100)
Samples Collected: (3) 8260C, (1) TM

(1105)	16.20	984	2.09	6.71	-1.6	3.55	9.38	clear

5WC21

DTW: 9.96 Control Box: 20 PSI Begin Purge (1108)
Post Purge DTW: 10.00 Initial Purge: clear

TIME	TEMP(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mv)	Turb(NTU)	DTW	Desc
(1110)	15.57	686	2.93	5.45	66.4	6.17	9.98	clear
(1115)	15.49	669	0.89	5.28	71.9	6.28	9.98	clear
(1120)	15.45	663	0.62	5.22	75.3	6.32	9.99	clear
(1125)	15.41	659	0.49	5.21	75.8	5.80	9.99	clear
(1130)	15.44	652	0.43	5.20	75.5	5.60	9.99	clear
(1135)	15.45	647	0.42	5.23	73.5	5.77	9.98	clear
(1140)	15.42	643	0.40	5.28	69.1	5.65	10.00	clear

(1140) Readings Stable

(1155)	15.52	644	0.66	5.30	63.1	6.42	10.00	clear

Sample Time (1145)
Samples Collected: (3) 8260C, (1) TM

10/20/16 RFAAP - Unit 5 F.B.#12
B03204-16A
WMD/KFC

5WDUP (taken from SWC21)
Sample Time (1150)
Samples Collected: (3) 8260C, (1) TM

APPROVED BY AT

DATE 11/2/2016

10/24/16 RFAAP-UNIT-16 FB.#12
B03204-16
KFC/WMD

General Notes

- Weather - Sunny & 50's
- PPE - Nitrile gloves, eye protection & safety shoes
- Calibrations: YSI-556 MDS
  pH: 4.00 = 4.00, 7.00 = 7.00, 10.00 = 10.00
  Conductivity reads 1413 µs in a 1413 µs standard
  DO% = 100.0 %
  HACH 2100P Turbidimeter range: 0.02 - 1000 NTU
- Dedicated well skirts & tubing used at each well
- All equipment decon'ed before and after each event and between use at each sample location.
- All purge water collected and disposed of at dedicated, on-site location.
- All samples collected, transported and stored on ice in coolers.
- Sample collection order: 8260C, 8270D & TAL
- All wells purged and sampled at 0.25 L/min.

Sample Analysis	Preservative
8260C	HCl
8270D	UNPRESERVED
TOTAL METALS	HNO_3

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

STATIC WATER LEVEL - UNIT-16

WELL	DTW	Postpurge DTW
16-2	55.90	55.99
16-3	56.38	66.38
16-5	4.39	12.78
16WC2B	54.95	62.71
16MW8	73.49	TOP
16WC1B	68.33	68.75
16WC1A	68.12	69.14
16MW9	65.29	66.81
16C1	49.51	49.54

SWL's ONLY

16C3	68.03
16CDH3	Dry @ 68.50 SIGN NOT ATTACHED
16WC2A	Dry @ 68.95
16-1	48.24

10/24/16 RFAAP-UNIT-H F.B.#12
BOS204-16
KFC-WMD

16-5

DTW: 9.39 Control Box Begin Purge (0907)
Post purge DTW: 12.78 Setting: 30 PSI Initial Purge: clear

TIME	Temp(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mv)	Turb(NTU)	DTW	Desc
(0910)	14.09	546	2.46	6.65	40.4	2.48	6.86	clear
(0915)	13.94	551	2.09	6.82	30.8	1.66	8.28	clear
(0920)	14.07	551	2.02	6.93	28.1	1.20	9.57	clear
(0925)	14.08	550	1.97	7.00	26.4	1.02	10.73	clear
(0930)	14.17	549	1.90	7.05	25.1	0.83	11.88	clear
(0935)	14.56	548	1.85	7.07	22.8	0.97	12.58	clear
(0935)	Readings Stable					~~1.86~~ WMD 10-24-16		
(0945)	14.66	548	1.99	7.11	19.2	1.80	12.78	clear

Sample Time (0940)
Samples Collected: (3)8260(c), (2)8270D, (1)TM

16Spring

TEMP(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mv)	Turb (NTU)
13.83	591	8.10	7.17	-5.8	1.95

Sample Time (1000)
Samples Collected: (3)8260, (2)8270D, (1)TM

16WC2B

DTW: 54.35 Control Box: 51 PSI Begin Purge (1015)
Post Purge DTW: 62.71 Initial Purge: clear

TIME	TEMP(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mv)	Turb(NTU)	DTW	Desc
(1020)	14.35	353	2.76	7.44	18.3	0.71	56.64	clear
(1025)	14.35	354	1.17	7.53	4.2	0.86	58.0	clear
(1030)	14.28	354	1.00	7.59	-1.8	0.71	58.97	clear
(1035)	14.19	354	0.97	7.61	-4.2	0.74	60.48	clear
(1040)	14.69	352	0.98	7.62	-5.6	0.77	61.54	clear
(1045)	15.43	352	1.04	7.67	-7.7	0.76	61.26	clear
(1045)	Readings Stable							
(1057)	15.34	355	1.40	~~7.68~~ 7.50	-7.9	0.83	62.71	clear

10/24/16 RFAAP-UNIT-16 F.B.#12
BO3204-16
KFC/mmD

16WC2B (continued)

Sample Time (1050)
Samples Collected: (3)8260C, (2)8270D, (1)TM

16-2

DTW: 55.90 Control Box: 42 PSI Begin Purge (1121)
Post Purge DTW: 55.99 Initial Purge: clear

TIME	TEMP(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mv)	Turb(NTU)	DTW	Desc
(1125)	14.45	610	6.16	7.08	32.8	0.74	55.92	clear
(1130)	14.49	636	5.73	7.03	29.6	0.77	55.93	clear
(1135)	14.46	648	5.94	7.03	27.5	0.77	55.95	clear
(1140)	14.47	648	6.13	7.02	26.8	0.81	55.95	clear
(1145)	14.40	645	6.36	7.01	27.1	0.79	55.96	clear
(1150)	14.39	643	6.51	7.00	27.5	0.77	55.98	clear
(1150)	Readings Stable							
(1200)	14.83	637	6.93	7.02	25.1	1.03	55.99	clear

Sample Time (1155)
Samples Collected: (3)8260C, (2)8270D, (1)TM

16MW8

DTW: 73.49 Control Box: 45 PSI Begin Purge (1211)
Post Purge DTW: TOP Initial Purge: clear

TIME	TEMP(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mv)	Turb(NTU)	DTW	Desc.
(1215)	14.58	168	0.80	5.71	69.4	4.03	74.59	clear
(1220)	14.57	160	0.58	5.52	88.6	2.21	75.62	clear
(1225)	14.80	162	0.50	5.46	95.4	2.06	75.76	clear
(1230)	15.91	162	0.48	5.51	91.8	1.93	75.56	clear
(1235)	14.77	165	0.45	5.39	97.3	1.27	75.88	clear
(1240)	15.33	167	0.43	5.39	94.5	1.57	TOP	clear
(1245)	15.85	171	0.45	5.42	90.6	2.71	TOP	clear
(1245)	Readings Stable							
(1305)	17.96	174	0.53	5.36	84.4	2.54	TOP	clear

10/24/16 RFAAP UNIT-12 B03204-16 KFC/mmD F.B#

16-5 PW&D 10-24-16

~~DTW~~

16MW8 (continued)

Sample Time (1250)

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

16-3

DTW: 56.68 Control Box: 40 PSI Begin Purge (1315)

Post Purge DTW: 66.38 Initial Purge: clear

TIME	TEMP(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mv)	Turb(NTU)	DTW	Desc
(1320)	15.00	271	7.84	6.60	27.9	1.53	59.49	clear
(1325)	14.86	271	7.75	6.89	22.2	1.05	61.07	clear
(1330)	14.82	271	7.53	7.06	21.3	1.15	62.01	clear
(1335)	14.98	271	7.60	7.21	22.8	0.96	62.81	clear
(1340)	14.93	271	7.64	7.31	22.5	1.06	63.46	clear
(1345)	14.94	269	7.69	7.38	21.4	0.95	64.29	clear
(1350)	14.92	269	7.70	7.42	20.7	0.96	65.14	clear
(1350)	Readings Stable							
(1400)	15.24	269	7.56	7.49	19.4	0.99	66.38	clear

Sample Time (1355)

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

#12 10/25/16 REMAP UNIT-16 FB#12
B03294-16
KFC/MMD

General Notes-

- Weather- clear-sunny 40's-60's
- PPE- Nitrile gloves, eye protection & safety shoes
- Calibrations- YSI-556 MDS
  pH: 4.00= 4.00, 7.00= 7.00, 10.00= 10.00
  Conductivity reads 1413 µs in a 1413 µs stnd.
  DO% = 100.0 %
  HACH 2100P Turbidimeter range: 0.02-1000 NTU
- Dedicated well skirts & tubing used at each well.
- All equipment decon'ed before and after each event and between use at each sample location.
- All purge water collected and disposed of at dedicated on-site location.
- All samples collected, transported and stored on ice in coolers.
- Sample collection order: 8260C, 8270D & TM
- All wells purged and sampled at 0.25 L/min.

Sample Analysis	Preservative
8260C	HCl
8270D	UNPRESERVED
TOTAL METALS	HNO_3

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

10/25/16 RFAAP UNIT-16 BG3204-16A KFC/mmd F.B#12

16WC1B

DTW: 68.33 Control Box: 47psi Begin Purge (0931)

Post Purge DTW: 68.75 Initial Purge: clear

TIME	TEMP(c)	Cond(mS)	DO(mg/L)	pH	ORP(mv)	Turb(NTU)	DTW	Desc.
(0935)	13.03	419	4.47	6.35	65.1	29.8	68.68	clear
(0940)	13.05	430	4.45	6.36	66.6	10.3	68.74	clear
(0945)	13.10	431	4.28	6.35	69.2	6.20	68.75	clear
(0950)	13.17	431	4.13	6.34	70.5	3.76	68.72	clear
(0955)	13.18	431	3.79	6.34	72.1	2.55	68.72	clear
(1000)	13.27	428	3.47	6.33	73.6	1.85	68.73	clear
(1005)	13.27	426	2.96	6.31	75.2	1.82	68.73	clear
(1010)	13.40	424	2.70	6.32	74.2	1.75	68.74	clear
(1015)	13.43	423	2.34	6.30	72.3	1.95	68.72	clear
(1020)	13.41	422	2.08	6.29	69.1	1.57	68.72	clear
(1025)	13.40	421	1.85	6.28	63.2	2.21	68.73	clear
(1030)	13.37	420	1.65	6.27	56.3	1.80	68.73	clear
(1035)	13.50	420	1.49	6.28	46.1	2.07	68.74	clear
(1040)	13.58	419	1.40	6.29	36.4	2.08	68.73	clear
(1045)	13.62	418	1.33	6.28	28.1	2.50	68.74	clear
(1050)	13.68	418	1.24	6.28	19.5	2.42	68.73	clear
(1050)	Readings Stable							
(1100)	13.63	419	1.31	6.30	10.4	2.39	68.75	clear

Sample Time (1055)

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

F.B.#12 | 10/25/16 | RFAAP UNIT-16 303204-164 KFC/MMD | F.B.#12

16WC1A

DTW: 68.12 Control Box: 50 PSI Begin Purge (1107)
Post Purge DTW: 69.14 Initial Purge: clear

TIME	TEMP(°C)	Cond(us/cm)	DO(mg/L)	pH	ORP(mv)	Turb(NTU)	DTW	Desc
(1110)	13.47	773	1.50	6.85	-1.5	0.81	69.26	clear
(1115)	13.40	774	0.96	6.87	-7.5	0.69	69.38	clear
(1120)	13.40	788	0.70	6.79	-69.2	0.72	69.74	clear
(1125)	13.44	799	0.65	6.74	-82.3	0.70	69.38	clear
(1130)	13.43	801	0.56	6.72	-82.5	0.67	69.31	clear
(1135)	13.50	802	0.51	6.72	-84.8	0.70	69.30	clear
(1140)	13.47	803	0.48	6.72	-86.2	0.73	69.30	clear
(1140) Readings Stable								
(1206)	13.91	804	0.77	6.73	-82.5	0.91	69.14	clear

Sample Time (1145)
Samples Collected: (9) 8260C, (6) 8270D, (3) TM

16MWDUP (collected from 16WC1A)

Sample Time (1200)
Samples Collected: (3) 8260C, (2) 8270D, (1) TM

16MW9

DTW: 65.29 Control Box: 45 PSI Begin Purge (1218)
Post Purge DTW: 66.81 Initial Purge: clear

TIME	TEMP(c)	Cond(us/cm)	DO(mg/L)	pH	ORP(mv)	Turb(NTU)	DTW	Desc
(1220)	14.02	944	3.87	6.85	-47.5	1.50	66.48	clear
(1225)	13.59	985	1.04	6.70	-61.0	0.76	66.65	clear
(1230)	13.62	974	1.02	6.72	-62.9	0.79	66.70	clear
(1235)	13.59	948	0.66	6.72	-58.2	0.78	66.75	clear
(1240)	13.65	942	0.59	6.72	-58.4	0.72	66.75	clear
(1245)	13.57	933	0.52	6.72	-58.1	0.70	66.81	clear
(1250)	13.66	929	0.49	6.72	-57.2	0.76	66.75	clear
(1255)	13.69	929	0.47	6.73	-57.2	0.71	66.76	clear
(1255) Readings Stable								

10/25/16 RFAAP Unit-16 F.B. #12
B03204-16A
WMD/KFC

TIME	Temp(°C)	Cond(µs)	DO(mg/L)	pH	ORP(mV)	Turb(NTU)	DTW	Desc
16MW9 (continued)								
(1305)	13.62	925	0.45	6.73	-58.5	0.76	66.81	clear

Sample Time (1300)
Samples Collected: (3)82600, (2)82700, (1)TM

16C1
DTW: 49.51 Control Box: 40 PSI Begin Purge (1327)
Post Purge DTW: 49.54 Initial Purge: clear

TIME	TEMP(°C)	cond(µs)	DO(mg/L)	pH	ORP(mV)	Turb(NTU)	DTW	Desc
(1330)	13.98	739	3.74	6.69	10.4	0.62	49.51	clear
(1335)	13.64	776	2.69	6.61	10.5	0.72	49.51	clear
(1340)	13.58	786	2.05	6.57	12.0	0.73	49.52	clear
(1345)	13.50	787	1.66	6.57	11.1	0.66	49.52	clear
(1350)	13.50	785	1.31	6.54	7.5	0.66	49.52	clear
(1355)	13.56	783	1.11	6.54	5.9	0.66	49.53	clear
(1400)	13.55	782	0.93	6.53	1.9	0.65	49.54	clear
(1405)	13.62	781	0.79	6.54	-0.7	0.64	49.53	clear
(1410)	13.54	781	0.68	6.54	-2.0	0.68	49.52	clear
(1415)	13.57	781	0.58	6.55	-3.1	0.70	4952	clear
(1420)	13.89	781	0.53	6.56	-3.9	0.70	49.54	clear
(1425)	13.86	781	0.52	6.57	-4.5	0.72	49.53	clear
(1425)	Readings Stable							
(1435)	13.66	782	1.19	6.55	-1.4	0.87	49.54	clear

Sample Time (1430)
Samples Collected: (3)82600, (2)82700, (1)TM

APPROVED BY [signature]
DATE 11/2/2016

6/16/2016 REAAP / Unit 16 F.B. #12
B03204-16
WMD / MJV

GENERAL NOTES:
- Weather: 70's - 80's partly cloudy
- PPE: nitrile gloves, eye protection, steel toed boots

Calibrations: YSI
pH 4.00 = 4.00, 7.00 = 7.00, 10.00 = 10.00
Conductivity reads 1413 µs in a 1413 µs standard
DO = 100 %
HACH 2100P Turbidimeter: 0.02 - 1000 NTU Range
- Dedicated well skirts and tubing used at each well
- All equipment decon'ed between wells and after event
- All purge water collected and disposed of at dedicated location onsite.
- Samples stored and transported on ice in coolers
- Sample collection order and preservatives:

① 8260c	HCl
② Cyanide	NaOH
③ T.M.	HNO_3

- All wells purged and sampled at 0.25 L/min
- Bladder Pump Settings: 4 cycles/min 5 second Discharge 10 second Recharge

16MW8
DTW: 72.72
Post purge DTW: 75.94
Control Box: 50 PSI
Begin Purge (1012)
Initial Purge: clear

TIME	TEMP(c)	Cond(µs)	DO(mg/L)	pH	ORP(mv)	TURB (NTU)	DTW	Desc
(1015)	15.0	94.2	0.42	5.05	165.9	3.40	73.59	clear
(1020)	15.0	96.8	0.30	5.05	169.7	2.16	74.00	clear
(1025)	15.1	99.1	0.18	5.11	165.6	1.86	74.42	clear
(1030)	15.6	106.2	0.17	5.30	171.9	0.86	74.55	clear
(1035)	15.6	110.2	0.13	5.19	188.0	0.80	74.75	clear
(1040)	15.6	113.5	0.12	5.16	200.2	0.72	75.06	clear
(1045)	15.5	119.2	0.12	5.18	204.4	0.69	75.32	clear
(1050)	15.3	116.6	0.12	5.22	199.9	0.67	75.54	clear
(1055)	15.4	115.0	0.11	5.23	196.8	0.59	75.78	clear

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6/16/2016 RFAAP Unit K6 F.B. #12
B03204-16
WMD/MSV

Post Purge

	Temp	Cond	DO (mg/L)	pH	ORP (mV)	Turb	DTW	Desc
(1118)	15.5	130.9	0.23	5.17	202.6	0.56	75.94	clear

16MW01A
DTW: 66.73
Post Purge DTW: 68.32

Control Box: 50 PSI
Begin Purge (1141)
Initial Purge: clear

Time	Temp (°C)	Cond (us)	DO (mg/L)	pH	ORP (mV)	Turb (NTU)	DTW	Desc
(1145)	14.3	682	2.86	7.17	148.6	2.62	68.15	clear
(1150)	14.6	641	1.16	6.91	134.2	0.90	68.32	clear
(1155)	14.2	655	1.02	6.74	25.0	0.68	68.50	clear
(1200)	14.2	647	0.64	6.71	16.6	0.67	68.49	clear
(1205)	15.4	687	0.37	6.71	11.1	0.69	68.15	clear
(1210)	14.4	680	0.44	6.69	11.1	0.61	68.33	clear
(1215)	14.4	678	0.42	6.69	10.4	0.58	68.35	clear
(1220)	14.4	678	0.39	6.69	10.1	0.55	68.46	clear
Post Purge Reading								
(1240)	14.8	692	1.47	6.90	16.3	0.59	68.32	clear

16MW09
DTW: 64.51
Post Purge DTW:

Control Box: 45 PSI
Begin Purge (1257)
Initial Purge: ~~1257~~ clear

Time	Temp (°C)	Cond (us)	DO (mg/L)	pH	ORP (mV)	Turb (NTU)	DTW	Desc
(1300)	15.3	858	1.48	6.71	7.7	0.43	65.55	clear
(1305)	15.4	854	0.68	6.65	-2.4	0.29	65.59	clear
(1310)	15.6	844	0.55	6.66	-7.3	0.27	65.50	clear
(1315)	15.7	846	0.46	6.66	-3.5	0.29	65.73	clear
(1320)	15.3	840	0.39	6.66	-5.2	0.25	65.80	clear
(1325)	15.1	834	0.34	6.66	-6.6	0.28	65.63	clear
(1330)	15.2	838	0.39	6.66	-8.7	0.22	65.67	clear
(1335)	15.2	841	0.38	6.66	-11.1	0.25	65.71	clear
Post Purge (1430)	16.2	881	0.46	6.71	-17.1	0.23	65.35	clear

6/16/16 RFAAP/Unit 16 FOB #12
303204-16
WWD/MTJN

16MW8

Sample Time (1100)
Samples collected: (6) 8260C, (2) cyanide

16WC1A

Sample Time (1225)
Samples Collected: (6) 8260C, (2) cyanide

16WDUP1 (collected from 16WC1A)
Sample Time (1235)
Samples Collected: (6) 8260C

16MW9

Sample Time (1340)
Samples Collected: (12) 8260C, (2) cyanide, (2) TM

16MW DUP2 (Taken from 16MW9)
Sample Time (1350)
Samples collected: (2) cyanide, (2) TM

APPENDIX E

CORRESPONDENCE (PDF ONLY)

BAE SYSTEMS

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

July 11, 2016

Mr. Kurt Kochan
Office of Remediation Programs
Virginia Department of Environmental Quality
629 East Main Street
Richmond, Virginia 23219

Subject: Notification of Groundwater Verification Sample Results and Additional Appendix IX Groundwater Monitoring Results
Post Closure Care Permit HWMUs 5 & 16
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730

Dear Mr. Kochan:

During Second Quarter 2016, BAE Systems, Ordnance Systems Inc., completed semiannual groundwater monitoring for Hazardous Waste Management Units (HWMUs) 5 and 16 located at the Radford Army Ammunition Plant (RFAAP) in Radford, Virginia. The Second Quarter 2016 groundwater monitoring event also served as annual monitoring for the constituents listed in Appendix IX to 40 CFR Part 264 as presented in Appendix I of Permit Attachment 1 for HWMU-16. A verification event was conducted on June 16, 2016, in order to confirm or refute detections observed during the Second Quarter 2016 groundwater monitoring event at HWMU-16. The following information summarizes the results from the verification sampling event.

On June 16, 2016, RFAAP collected a verification sample from HWMU-16 point of compliance (POC) well 16MW8 to confirm or refute initial detections of tetrahydrofuran and cyanide. Neither tetrahydrofuran nor cyanide were detected at concentrations greater than the detection limits in the verification sample from well 16MW8; therefore, no further action is required.

A verification sample was collected on June 16, 2016 from HWMU-16 POC well 16WC1A to confirm or refute initial detections of tetrahydrofuran, vinyl chloride, and cyanide. Neither vinyl chloride nor cyanide were detected at concentrations greater than the detection limits in the verification sample from well 16WC1A; therefore, no further action is required regarding vinyl chloride and cyanide in well 16WC1A. However, the additional Appendix IX constituent, 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/l; therefore, the original estimated tetrahydrofuran concentration of 4.6 ug/l is confirmed. No other Appendix IX constituents were detected in the verification samples collected at HWMU-16. **RFAAP will submit a Class 1 Permit Modification to add tetrahyrofuran to the Groundwater Compliance Monitoring List for the Unit.**

The permit requires collection of four quarters of monitoring data from a Unit's upgradient well(s) to establish background values for newly detected Appendix IX constituents. However, RFAAP has collected tetrahydrofuran data from HWMW-16 upgradient monitoring well 16C1 during the previous 14 annual Appendix IX groundwater monitoring events (2003-2016). Tetrahydrofuran has never been detected at or above the permit specified Quantitation Limit (QL) in upgradient well 16C1; therefore, in lieu of quarterly background monitoring, we propose to use these data to define the background value for tetrahydrofuran as the permit specified QL of 25 ug/l.

Additionally, there is no USEPA Maximum Contaminant Level (MCL) or VDEQ Alternate Concentration Limit (ACL) for tetrahydrofuran; therefore, we propose to use the May 2016 USEPA Regional Screening Level (RSL) of 3,400 ug/l as the Groundwater Protection Standard (GPS).

A verification sample was collected on June 16, 2016 from HWMU-16 POC well 16MW9 to confirm or refute initial detections vinyl chloride and cyanide. Neither vinyl chloride nor cyanide were detected at concentrations greater than the detection limits in the verification sample from well 16MW9; therefore, no further action is required regarding vinyl chloride and cyanide in well 16MW9.

Verification samples were also collected on June 16, 2016 from POC well 16MW9 to confirm or refute the initial detection of total cobalt at a concentration of 5.5 ug/l which is greater than the GPS of 5 ug/l. A verification sample and sample duplicate were collected from 16MW9 and sent for analysis to Test America, North Canton, Ohio (Test America) as Test America was the laboratory used for the initial cobalt analysis during the Second Quarter 2016 groundwater monitoring event at HWMU-16. For confirmation, a split sample and split sample duplicate were also collected from well 16MW9 and sent to Eurofins Lancaster Laboratories Environmental, Lancaster, Pennsylvania (Eurofins). The sample and sample duplicate result concentrations from Test America are 4.7 ug/l and 4.8 ug/l, respectively, which are less than the GPS of 5 ug/l. The split sample and split sample duplicate result concentrations from Eurofins are 5.6 ug/l and 6.0 ug/l, respectively, which are greater than the GPS of 5 ug/l.

It is our professional opinion that these results do not represent an exceedance of cobalt above the GPS of 5 ug/l because both the sample and sample duplicate result concentrations from Test America, the primary laboratory used for the initial cobalt analysis during the Second Quarter 2016 groundwater monitoring event at HWMU-16, are below the GPS of 5 ug/l; therefore, no further action is required.

Complete details regarding the Second Quarter 2016 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 2016* which is due to the VDEQ by August 15, 2016.

If you have any questions or concerns, please contact me at (540) 639-7785 or at *jay.stewart@baesystems.com*.

Sincerely,

Jay Stewart
Environmental Manager
BAE Systems, Ordnance Systems Inc.

Attachments:
VDEQ Correspondence - June 14, 2016

c: w/attachments
Aziz Farahmand, VDEQ-BRRO
Brett Fisher, VDEQ-CO

Coordination: J. McKenna

bc: BAE Administrative File
J. McKenna, Army Staff
Allen Patton, BAE Staff
Jody Hawks, BAE Staff
Mike Lawless, Draper Aden Associates
Env. File

Concerning the following:

CY 2016 Second Quarter Semiannual Monitoring Event- Verification Event Results
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: Alicia M. Masson
TITLE: LTC, CM
Commanding

SIGNATURE: _____

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BAE Systems

ORDNANCE SYSTEMS INC.
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June 14, 2016

Mr. Kurt Kochan
Office of Remediation Programs
Virginia Department of Environmental Quality
629 East Main Street
Richmond, Virginia 23219

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 2016, 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 2016 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 2016 groundwater monitoring event also served as annual monitoring under 40 CFR 264 Appendix IX for HWMU-16. The laboratory analytical data packages for this event were received on June 8, 2016. The following information summarizes the findings of the Second Quarter 2016 semiannual activities at each Unit. A verification groundwater monitoring event will be conducted for HWMU-16 as discussed below.

HWMU-5

For this event, all wells in the CA groundwater monitoring network were sampled for the constituents listed in Appendix J to Permit Attachment 2 (Groundwater Corrective Action Targeted Constituents - GPS and Semiannual Monitoring List for HWMU-5). The CA groundwater monitoring network for HWMU-5 consists of upgradient well 5W8B, point of compliance (POC) wells 5W5B, 5W7B, 5WC21, 5WC22, and 5WC23, and plume monitoring well 5W12A. During Second Quarter 2016, 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 estimated concentrations of 3.5 ug/l, 3.8 ug/l, and 3.9 ug/l respectively, which are less than the GPS of 5 ug/l.

Total cobalt was detected in POC wells 5WC21 and 5WC22 at concentrations of 61.6 ug/l and 11.4 ug/l respectively, which are greater than the GPS of 7 ug/l. Total cobalt was detected in POC wells 5WC23 and 5W7B at concentrations less than the QL of 5 ug/l. TCE and total cobalt were not detected in any of the other wells in the CA groundwater monitoring network. Additionally, the TCE daughter products were not detected in any of the wells comprising the CA groundwater monitoring network.

This event also served as the annual monitoring event in which the POC wells at HWMU-5 were sampled for the constituents listed in Appendix K to Permit Attachment 2 (Groundwater Corrective Action Annual Monitoring List) since corrective action annual monitoring began in Second Quarter 2010. 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 2016.

HWMU-16

In accordance with the Final Hazardous Waste Post-Closure Care Permit, the groundwater data from the POC wells at HWMU 16 were compared to the established GPS for the Unit as revised in the VDEQ-approved *Final Hazardous Waste Post-Closure Care Permit for HWMUs 5 and 16* (reissued August 16, 2014). 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 well 16WC1B at a concentration of 35 ug/l, which is greater than the GPS of 5 ug/l. In accordance with Permit Condition V.J.4.i.(3)(c) and as directed in VDEQ correspondence dated January 21, 2014, RFAAP submitted an alternate source demonstration (ASD) to evaluate whether the total cobalt concentration detected in well 16WC1B 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 this well in support of the ASD. Additionally, it should be noted that total cobalt was previously reported above the GPS during Fourth Quarter 2015 at POC well 16WC1A. In early 2016, VDEQ concurred with RFAAP to combine the ongoing ASDs for total cobalt at POC wells 16WC1A and 16WC1B. A revised ASD incorporating these results will be submitted to the VDEQ within 90 days following collection of the last semiannual sampling event in 2016. Due to the pending VDEQ combined ASD review, a verification event will not be conducted at POC well 16WC1B for total cobalt. Total cobalt was not detected above the GPS at 16WC1A during Second Quarter 2016.

- Total cobalt was detected in POC well 16MW9 at a concentration of 5.5 ug/l which is greater than the GPS of 5 ug/l. However, it should be noted that the cobalt concentration in 16MW9 is below the cobalt concentration in POC well 16WC1B discussed above, and below the recently revised VDEQ alternate concentration limit (ACL) for cobalt (6 ug/l), effective February 15, 2016. **A verification event will be scheduled on or before June 30, 2016**, in order to confirm or refute the concentration reported in POC well 16MW9.

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

- Total barium was detected in plume monitoring wells 16-2, 16-3, and 16Spring at concentrations of 180 ug/l, 750 ug/l, and 180 ug/l, respectively, which are greater than the site-specific background concentration of 175.4 ug/l. However, these concentrations are less than the USEPA MCL for barium of 2,000 ug/l. Higher 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 2016 total barium concentrations detected in plume monitoring wells 16-2, 16-3, and 16Spring is recommended at this time.

The following Appendix IX constituents were detected at or above the detection limit (DL) at HWMU-16:

Well Location	Constituent	Concentration	DL	Units
16C1	Tetrahydrofuran	13 J	2	ug/l
16MW8	Tetrahydrofuran	2.2 J	2	ug/l
16WC1A	Tetrahydrofuran	4.6 J	2	ug/l
16MW8	Cyanide	13 J	5	ug/l
16MW9	Cyanide	8.5 J	5	ug/l
16WC1A	Cyanide	19 J	5	ug/l
16MW9	Vinyl Chloride	0.2 J	0.2	ug/l
16WC1A	Vinyl Chloride	0.2 J	0.2	ug/l

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

A verification event will be scheduled on or before June 30, 2016, in order to confirm or refute the detections of the Appendix IX constituents listed in the table above, with the exception of tetrahydrofuran in upgradient well 16C1. Tetrahydrofuran detected in upgradient well 16C1 will not be verified, as upgradient well 16C1 is the background well rather than a POC well. Furthermore, sampling of well 16C1 for Appendix IX constituents is not required per the Post-Closure Care Permit for the Unit; therefore, tetrahydrofuran will be added to the groundwater compliance monitoring list for HWMU-16 **only** if verified in POC well 16MW8 and 16WC1A, respectively.

To summarize, **samples will be collected from the following wells on or before June 30, 2016**, in order to verify or refute the initial reported detection discussed above:

Well Location	Constituent(s)
HWMU-16	
16MW9	Cobalt, Cyanide, Vinyl Chloride
16MW8	Tetrahydrofuran, Cyanide
16WC1A	Tetrahydrofuran, Cyanide, Vinyl Chloride

Complete details regarding the Second Quarter 2016 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 2016*, which is due to the VDEQ by August 15, 2016.

If you have any questions or concerns, please contact Mr. Allen Patton at 540/639-8504 (mark.patton@baesystems.com).

Sincerely,

Jay Stewart
Environmental Manager
BAE Systems, Ordnance Systems Inc.

c: w/attachments
Aziz Farahmand, VDEQ-BRRO
Brett Fisher, VDEQ-CO

Coordination: J. McKenna
J. McKenna

bc: BAE Administrative File
J. McKenna, Army Staff
Allen Patton, BAE Staff
Mike Lawless, Draper Aden Associates
Env. File

Concerning the following:

CY 2016 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: ALICIA M. MASSON
TITLE: LTC, CM
Commanding

SIGNATURE: _____

PRINTED NAME: William M. Barnett
TITLE: General Manager
BAE Systems

BAE Systems, Ordnance Systems Inc. is contracted by the Army to conduct semiannual compliance groundwater monitoring at HWMU-16 and corrective action groundwater monitoring at HWMU-5. This letter summarizes groundwater monitoring results for HWMUs 5 and 16 during Second Quarter 2016. A verification event at HWMU 16 will be conducted at select monitoring wells on or before June 30, 2016.

BAE SYSTEMS

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

August 5, 2016

Mr. Kurt Kochan
Office of Remediation Programs
Virginia Department of Environmental Quality
629 East Main Street
Richmond, Virginia 23219

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 2016 can be accessed at:

16 0803 - 2Q 2016 SA GW Monitoring Rpt - HWMU 516 - RFAAP
https://files.daa.com/fl/qg2bhvNGYc/16%200803%20-%202Q%202016%20SA%20GW%20Monitoring%20Rpt%20-%20HWMU%20516%20-%20RFAAP_

This report meets the requirements of the Semiannual Groundwater Monitoring Report for Second Quarter 2016 for the Post-Closure Care Permit for HWMU 5 and 16 at RFAAP.

If you have any questions or concerns, please contact me at 540/639-7785 (jay.stewart@baesystems.com).

Sincerely,

Jay Stewart
Environmental Manager
BAE Systems, Ordnance Systems Inc.

Enclosure

c: Aziz Farahmand, VDEQ-BRRO (w/ enclosure)
Kurt W. Kochan, VDEQ-Central (w/ enclosure)

Coordination: J. McKenna
J. McKenna

bc: Administrative File
J. Stewart
J. McKenna, Army Staff
Mark Allen Patton
Jody Hawks
Mike Lawless, Draper Aden Associates

Concerning the following:

CY 2016 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

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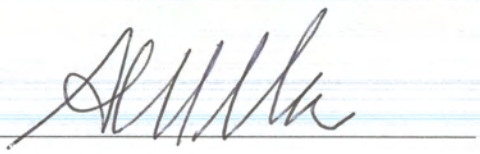
SIGNATURE: 

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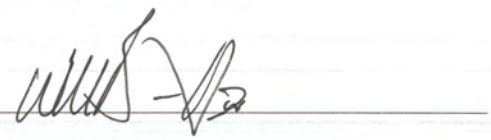
SIGNATURE: 

PRINTED NAME: William M. Barnett
TITLE: General Manager
BAE Systems

BAE SYSTEMS

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

August 30, 2016

Mr. Kurt Kochan
Office of Remediation Programs
Virginia Department of Environmental Quality
629 East Main Street
Richmond, Virginia 23219

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

Dear Mr. Kochan:

As requested in your July 19, 2016 letter and in regards to the ongoing combined Alternate Source Demonstration (ASD) for total cobalt concentrations detected above the applicable Groundwater Protection Standard (GPS) at Hazardous Waste Management Unit (HWMU) 16 at the Radford Army Ammunition Plant (RFAAP), RFAAP plans to include point of compliance well 16MW9 in the pending combined ASD for total cobalt. Due to the recent addition of 16MW9 to the ongoing combined ASD, RFAAP requests an extension to the ASD report which is currently due First Quarter of 2017 and proposes an updated sampling and reporting schedule as detailed below.

The July 19, 2016 letter from the Virginia Department of Environmental Quality (VDEQ) stated that RFAAP should continue to collect data for the ongoing combined ASD for total cobalt in point of compliance wells 16WC1B, 16WC1A, and now 16MW9 at HWMU 16. Below is an updated proposed schedule for sampling and reporting. The updated schedule is consistent with the December 9 and May 1, 2015 correspondence from VDEQ that requested a minimum of one additional year of monitoring total cobalt concentrations before the revised combined ASD report is submitted to DEQ. The updated schedule is also consistent with the schedule previously approved by DEQ (see email from K. Kochan, DEQ to M. Alberts, BAE, on February 4, 2016).

Proposed Sampling and Reporting Schedule for Cobalt Alternate Source Demonstration (ASD) RFAAP – HWMU 16 – 16WC1A, 16WC1B, 16MW9		
Proposed Date	**Quarter**	**Comment**
October, 2016	4th Quarter 2016	Sampling conducted as part of routine semiannual groundwater monitoring.
April, 2017	2nd Quarter 2017	
October, 2017	4th Quarter 2017	
November, 2017	4th Quarter 2017	Receipt of 4th Quarter 2017 sample results from laboratory (i.e., approximately 30 days from 4th Quarter 2017 sample collection date).
February, 2018	1st Quarter 2018	Combined ASD Report for total cobalt to DEQ – within 90 days from 4th Quarter 2017 semiannual groundwater

If you have any questions or concerns, please contact me at (540) 639-7785 (jay.stewart@baesystems.com).

Sincerely,

Jay Stewart
Environmental Manager
BAE Systems, Ordnance Systems Inc.

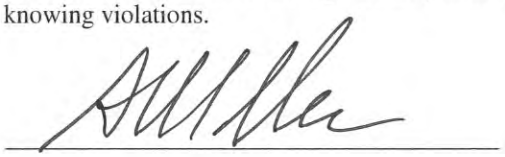
Coordination: J. McKenna
J. McKenna

cc:
Aziz Farahmand, VDEQ-BRRO
Brett Fisher, VDEQ-CO

bc: BAE Administrative File
J. McKenna, Army Staff
Allen Patton, BAE Staff
Jody Hawks, BAE Staff
Mike Lawless, Draper Aden Associates
Environmental File

CY 2016 Second Quarter Semiannual Monitoring Event -
Extension Request to Cobalt Alternate Source Demonstration and
Proposed Sampling and Reporting Schedule for Cobalt ASD
Hazardous Waste Management Unit 16 – Compliance Groundwater Monitoring
Radford Army Ammunition Plant, Radford, Virginia
EPA ID#: VA1210020730

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

SIGNATURE: 

PRINTED NAME: ALICIA M. MASSON
TITLE: LTC, CM
Commanding

SIGNATURE: 

PRINTED NAME: William M. Barnett
TITLE: General Manager
BAE Systems

BAE SYSTEMS

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

August 5, 2016

Mr. Kurt Kochan
Office of Remediation Programs
Virginia Department of Environmental Quality
629 East Main Street
Richmond, Virginia 23219

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 2016 can be accessed at:

16 0803 - 2Q 2016 SA GW Monitoring Rpt - HWMU 516 - RFAAP
https://files.daa.com/fl/qg2bhvNGYc/16%200803%20-%202Q%202016%20SA%20GW%20Monitoring%20Rpt%20-%20HWMU%20516%20-%20RFAAP_

This report meets the requirements of the Semiannual Groundwater Monitoring Report for Second Quarter 2016 for the Post-Closure Care Permit for HWMU 5 and 16 at RFAAP.

If you have any questions or concerns, please contact me at 540/639-7785 (jay.stewart@baesystems.com).

Sincerely,

Jay Stewart
Environmental Manager
BAE Systems, Ordnance Systems Inc.

Enclosure

c: Aziz Farahmand, VDEQ-BRRO (w/ enclosure)
Kurt W. Kochan, VDEQ-Central (w/ enclosure)

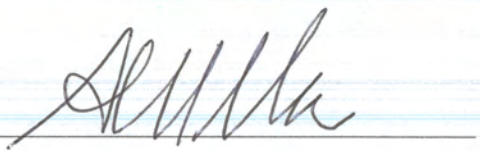
Coordination: J. McKenna
J. McKenna

bc: Administrative File
J. Stewart
J. McKenna, Army Staff
Mark Allen Patton
Jody Hawks
Mike Lawless, Draper Aden Associates

Concerning the following:

CY 2016 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: 

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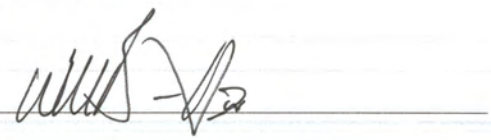
SIGNATURE: 

PRINTED NAME: William M. Barnett
TITLE: General Manager
BAE Systems

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

June 14, 2016

Mr. Kurt Kochan
Office of Remediation Programs
Virginia Department of Environmental Quality
629 East Main Street
Richmond, Virginia 23219

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 2016, 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 2016 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 2016 groundwater monitoring event also served as annual monitoring under 40 CFR 264 Appendix IX for HWMU-16. The laboratory analytical data packages for this event were received on June 8, 2016. The following information summarizes the findings of the Second Quarter 2016 semiannual activities at each Unit. A verification groundwater monitoring event will be conducted for HWMU-16 as discussed below.

HWMU-5

For this event, all wells in the CA groundwater monitoring network were sampled for the constituents listed in Appendix J to Permit Attachment 2 (Groundwater Corrective Action Targeted Constituents - GPS and Semiannual Monitoring List for HWMU-5). The CA groundwater monitoring network for HWMU-5 consists of upgradient well 5W8B, point of compliance (POC) wells 5W5B, 5W7B, 5WC21, 5WC22, and 5WC23, and plume monitoring well 5W12A. During Second Quarter 2016, 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 estimated concentrations of 3.5 ug/l, 3.8 ug/l, and 3.9 ug/l respectively, which are less than the GPS of 5 ug/l.

Total cobalt was detected in POC wells 5WC21 and 5WC22 at concentrations of 61.6 ug/l and 11.4 ug/l respectively, which are greater than the GPS of 7 ug/l. Total cobalt was detected in POC wells 5WC23 and 5W7B at concentrations less than the QL of 5 ug/l. TCE and total cobalt were not detected in any of the other wells in the CA groundwater monitoring network. Additionally, the TCE daughter products were not detected in any of the wells comprising the CA groundwater monitoring network.

This event also served as the annual monitoring event in which the POC wells at HWMU-5 were sampled for the constituents listed in Appendix K to Permit Attachment 2 (Groundwater Corrective Action Annual Monitoring List) since corrective action annual monitoring began in Second Quarter 2010. 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 2016.

HWMU-16

In accordance with the Final Hazardous Waste Post-Closure Care Permit, the groundwater data from the POC wells at HWMU 16 were compared to the established GPS for the Unit as revised in the VDEQ-approved *Final Hazardous Waste Post-Closure Care Permit for HWMUs 5 and 16* (reissued August 16, 2014). 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 well 16WC1B at a concentration of 35 ug/l, which is greater than the GPS of 5 ug/l. In accordance with Permit Condition V.J.4.i.(3)(c) and as directed in VDEQ correspondence dated January 21, 2014, RFAAP submitted an alternate source demonstration (ASD) to evaluate whether the total cobalt concentration detected in well 16WC1B 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 this well in support of the ASD. Additionally, it should be noted that total cobalt was previously reported above the GPS during Fourth Quarter 2015 at POC well 16WC1A. In early 2016, VDEQ concurred with RFAAP to combine the ongoing ASDs for total cobalt at POC wells 16WC1A and 16WC1B. A revised ASD incorporating these results will be submitted to the VDEQ within 90 days following collection of the last semiannual sampling event in 2016. Due to the pending VDEQ combined ASD review, a verification event will not be conducted at POC well 16WC1B for total cobalt. Total cobalt was not detected above the GPS at 16WC1A during Second Quarter 2016.

- Total cobalt was detected in POC well 16MW9 at a concentration of 5.5 ug/l which is greater than the GPS of 5 ug/l. However, it should be noted that the cobalt concentration in 16MW9 is below the cobalt concentration in POC well 16WC1B discussed above, and below the recently revised VDEQ alternate concentration limit (ACL) for cobalt (6 ug/l), effective February 15, 2016. **A verification event will be scheduled on or before June 30, 2016**, in order to confirm or refute the concentration reported in POC well 16MW9.

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

- Total barium was detected in plume monitoring wells 16-2, 16-3, and 16Spring at concentrations of 180 ug/l, 750 ug/l, and 180 ug/l, respectively, which are greater than the site-specific background concentration of 175.4 ug/l. However, these concentrations are less than the USEPA MCL for barium of 2,000 ug/l. Higher 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 2016 total barium concentrations detected in plume monitoring wells 16-2, 16-3, and 16Spring is recommended at this time.

The following Appendix IX constituents were detected at or above the detection limit (DL) at HWMU-16:

Well Location	Constituent	Concentration	DL	Units
16C1	Tetrahydrofuran	13 J	2	ug/l
16MW8	Tetrahydrofuran	2.2 J	2	ug/l
16WC1A	Tetrahydrofuran	4.6 J	2	ug/l
16MW8	Cyanide	13 J	5	ug/l
16MW9	Cyanide	8.5 J	5	ug/l
16WC1A	Cyanide	19 J	5	ug/l
16MW9	Vinyl Chloride	0.2 J	0.2	ug/l
16WC1A	Vinyl Chloride	0.2 J	0.2	ug/l

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

A verification event will be scheduled on or before June 30, 2016, in order to confirm or refute the detections of the Appendix IX constituents listed in the table above, with the exception of tetrahydrofuran in upgradient well 16C1. Tetrahydrofuran detected in upgradient well 16C1 will not be verified, as upgradient well 16C1 is the background well rather than a POC well. Furthermore, sampling of well 16C1 for Appendix IX constituents is not required per the Post-Closure Care Permit for the Unit; therefore, tetrahydrofuran will be added to the groundwater compliance monitoring list for HWMU-16 **only** if verified in POC well 16MW8 and 16WC1A, respectively.

To summarize, **samples will be collected from the following wells on or before June 30, 2016**, in order to verify or refute the initial reported detection discussed above:

Well Location	Constituent(s)
HWMU-16	
16MW9	Cobalt, Cyanide, Vinyl Chloride
16MW8	Tetrahydrofuran, Cyanide
16WC1A	Tetrahydrofuran, Cyanide, Vinyl Chloride

Complete details regarding the Second Quarter 2016 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 2016*, which is due to the VDEQ by August 15, 2016.

If you have any questions or concerns, please contact Mr. Allen Patton at 540/639-8504 (mark.patton@baesystems.com).

Sincerely,

Jay Stewart
Environmental Manager
BAE Systems, Ordnance Systems Inc.

c: w/attachments
Aziz Farahmand, VDEQ-BRRO
Brett Fisher, VDEQ-CO

Coordination: J. McKenna

bc: BAE Administrative File
J. McKenna, Army Staff
Allen Patton, BAE Staff
Mike Lawless, Draper Aden Associates
Env. File

Concerning the following:

CY 2016 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

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SIGNATURE: _____

PRINTED NAME: ALICIA M. MASSON
TITLE: LTC, CM
Commanding

SIGNATURE: _____

PRINTED NAME: William M. Barnett
TITLE: General Manager
BAE Systems

BAE Systems, Ordnance Systems Inc. is contracted by the Army to conduct semiannual compliance groundwater monitoring at HWMU-16 and corrective action groundwater monitoring at HWMU-5. This letter summarizes groundwater monitoring results for HWMUs 5 and 16 during Second Quarter 2016. A verification event at HWMU 16 will be conducted at select monitoring wells on or before June 30, 2016.

Lisa Kitchens

From: Kochan, Kurt (DEQ) <Kurt.Kochan@deq.virginia.gov>
Sent: Thursday, September 29, 2016 7:42 AM
To: Stewart, Jay (US)
Cc: McKenna, Jim; Patton, Mark (US); Hawks, Jody (US); Mike Lawless; Janet Frazier
Subject: RE: Cobalt ASD Report HWMU 16

Mr. Stewart-

The proposed timeline is acceptable to the Department. Please call with any questions. Thanks.

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: Stewart, Jay (US) [mailto:jay.stewart@baesystems.com]
Sent: Tuesday, August 30, 2016 2:08 PM
To: Kochan, Kurt (DEQ); Farahmand, Aziz (DEQ); Fisher, Brett (DEQ)
Cc: McKenna, Jim; Patton, Mark (US); Hawks, Jody (US); Michael D. Lawless (mlawless@daa.com); Janet Frazier
Subject: Cobalt ASD Report HWMU 16

Mr. Kochan,

Attached please find the response from RFAAP concerning the Cobalt Alternative Source Determination for HWMU 16.

A complete certified copy of this letter will follow in 10 to 15 days.

Jay Stewart
Environmental Manager
BAE SYSTEMS, Ordnance Systems Inc.
Radford Army Ammunition Plant
4050 Peppers Ferry Road
Radford, Virginia 24141
Phone (540) 639-7785
Cell (540) 200-9536

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Street address: 629 East Main Street, Richmond, Virginia 23219
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www.deq.virginia.gov

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

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
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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

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December 1, 2016

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

Re: Class 1 Modification Approval for the Post-Closure Care Permit
Radford Army Ammunition Plant, Radford, VA
EPA ID No.VA1210020730

Dear Mr. Stewart,

On November 21, 2016, the Department of Environmental Quality's (DEQ) Office of Financial Responsibility and Waste Programs received the Radford Army Ammunition Plant (RAAP) facility's Class 1 modification request to modify the post-closure care permit to revise the quantitation limits for antimony, lead and zinc; revise the method detection limits for zinc and cyanide; add tetrahydrofuran to the groundwater compliance monitoring list for HWMU-16; and revise the method suffixes for Methods 8260B and 8270C to Methods 8260 and 8270. In addition, enclosed in the transmittal were the proposed red line and strikeout changes, and the revised pages of the post-closure care permit.

Based on the review of the submitted request and supporting documents, the DEQ concurs that the request has established sufficient documentation to support the Class 1 permit modification of RAAP's Permit. Therefore, in accordance with 40 CFR §270.42, Appendix I.C.2 and 40 CFR 270.42(a)(1), the DEQ approves the Class 1 permit modification. The DEQ is incorporating the revised copy of the following permit sections into its copy of the RAAP Permit; please ensure that RAAP's copy of the permit is updated accordingly:

- **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 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)

Under 40 CFR § 270.42 (a)(1)(ii), this Class 1 permit modification requires the Permittee to send notice of the modification to all persons on the facility mailing list (Enclosure) 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, etc.) when available.

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 an appeal by filing a notice of appeal with:

David K. Paylor, Director
Department of Environmental Quality
P.O. Box 1105
Richmond, Virginia 23218

In the event that this decision is served to you by mail, three days are added to this period. Please refer to Part 2A of the rules of the Supreme Court of Virginia, which describes the required contents of the Notice of Appeal, including specification of the Circuit Court to which the appeal is taken, and additional requirements governing appeals from decisions of administrative agencies.

If you should have any questions concerning this permit action, please contact Mr. Ashby Scott of my staff at (804) 698-4467 or by email at Ashby.Scott@deq.virginia.gov.

Sincerely,

Leslie A. Romanchik

Leslie A. Romanchik
Hazardous Waste Program Manager
Office of Financial Responsibility and
Waste Programs

cc: Catherine McGoldrick, EPA, Region III (3LC50)
Elizabeth Lohman, DEQ, Blue Ridge Regional Office
Leslie A. Romanchik, Kurt Kochan, Brett Fisher, Maria Livaniou DEQ, CO
Central Hazardous Waste Files

Jim McKenna, Radford Army Ammunition Plant