RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

Performance Based Acquisition
Solid Waste Management Unit 40 (RAAP-009)
Landfill Nitro Area
Interim Measures Work Plan

FINAL

AUGUST 2011

PREPARED BY:

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Contract No. W912DY-10-D-0027
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DEPARTMENT OF THE ARMY
US ARMY INSTITUTE OF PUBLIC HEALTH
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ABERDEEN PROVING GROUND MARYLAND 21010-5403

MCHB-IP-REH

2 SEP 2011

MEMORANDUM FOR Office of Environmental Quality, Radford Army Ammunition Plant (SJMRF-OP-EQ/Mr. Jim McKenna), P.O. Box 2, Radford, VA 24143-0002

SUBJECT: Review of Draft Final Performance Based Acquisition SWMU 40, Landfill Nitro Area Interim Measures Work Plan, Radford Army Ammunition Plant, Virginia, November 2010

1. The Army Institute of Public Health reviewed the subject document on behalf of the Office of The Surgeon General pursuant to Army Regulation 200-1 (Environmental Protection and Enhancement). We appreciate the opportunity to review this report.

2. We concur that the proposed interim measures are protective of human health and the environment.

3. This document was reviewed by Mr. Jeffrey Leach, Environmental Health Risk Assessment Program. He can be reached at DSN 584-2953, commercial (410) 436-2953 or electronic mail, Jeff.Leach@us.army.mil.

FOR THE DIRECTOR:

JEFFREY S. KIRKPATRICK
Portfolio Director, Health Risk Management

CF:
HQDA (DASG-PPM-NC)
USACE (CEHNC-CX-ES)
PHCR-North

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

August 26, 2011

Commander,
Radford Army Ammunition Plant
Attn: SJMRF-OP-EQ (Jim McKenna)
P.O. Box 2
Radford, VA 24141-0099

P.W. Holt
Environmental Manager
Alliant Techsystems, Inc.
Radford Army Ammunition Plant
P.O. Box 1
Radford, VA 24141-0100

VIA Electronic Mail

Re: Radford Army Ammunition Plant, Radford, Virginia
Solid Waste Management Unit 40
Interim Measures Work Plan

Dear Mr. McKenna and Ms. Holt:

The U.S. Environmental Protection Agency (EPA) and Virginia Department of Environmental Quality (VDEQ) have reviewed the U.S. Army's (Army's) Solid Waste Management Unit 40 (SWMU), Landfill Nitro Area Interim Measures Work Plan, for SWMU 40 located at the Radford Army Ammunition Plant (RFAAP) in Radford, Virginia. Based upon our review, the Work Plan is approved, and in accordance with Part II. (E)(5) of RFAAP's Corrective Action Permit, the Work Plan is considered final. If you have any questions, please call me at 215-814-3284.

Sincerely,

Erich Weissbart

Erich Weissbart, P.G.
RCRA Project Manager
Office of Remediation (3LC20)

c: James Cutler, VDEQ

ATK Armament Systems
Energetic Systems
Radford Army Ammunition Plant
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Radford, VA 24143-0100

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August 23, 2011

Mr. Erich Weissbart and Mr. William Geiger
RCRA General Operations Branch, Mail Code: 3WC23
Waste and Chemicals Management Division
U. S. Environmental Protection Agency, Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Mr. James L. Cutler, Jr.
Virginia Department of Environmental Quality
629 East Main Street
Richmond, VA 23219

Subject: With Certification, Solid Waste Management Unit 40 (RAAP-009) Landfill Nitro Area, Interim Measures Work Plan, Final, August 2011
EPA ID# VA1 210020730

Dear Mr. Weissbart, Mr. Geiger and Mr. Cutler:

Enclosed is the certification for the subject document that was sent to you on August 22, 2011. Also enclosed is the 22 August 2011 transmittal email.

Please coordinate with and provide any questions or comments to myself at (540) 639-8658, Jeremy Flint, ATK staff (540) 639-7668 or Jim McKenna, ACO Staff (540) 731-5782.

Sincerely,

P.W. Holt

P.W. Holt, Environmental Manager
Alliant Techsystems Inc.

c: Karen Sismour
Virginia Department of Environmental Quality
P. O. Box 1105
Richmond, VA 23218

E. A. Lohman
Virginia Department of Environmental Quality
Blue Ridge Regional Office
3019 Peters Creek Road
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11-815-118
JMcKenna

Rich Mendoza
US Army Environmental Center
11711 North IH 35, Suite 110
Attn: Richard Mendoza (C-23)
San Antonio, TX 78233

Tom Meyer
Corps of Engineers, Baltimore District
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11-815-118
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bc: Administrative File
J. McKenna, ACO Staff
Rob Davie-ACO Staff
P.W. Holt
J. J. Redder
Env. File

Coordination: J. McKenna M. A. Miano

11-815-118
JMcKenna

Concerning the following:

Radford Army Ammunition Plant
Solid Waste Management Unit 40 (RAAP-009)
Landfill Nitro Area
Interim Measures Work Plan
Final
August 2011

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: Wm Byron Penland
TITLE: Lieutenant Colonel, US Army
Commanding

SIGNATURE:
PRINTED NAME: Kent Holiday
TITLE: Vice President and General Manager
ATK Energetics Systems

11-815-118
JMcKenna

Greene, Anne

From:	McKenna, Jim
Sent:	Monday, August 22, 2011 6:49 AM
To:	Weissbart.Erich@epamail.epa.gov; Cutler,Jim
Cc:	Radford; Mary Lou Rochotte; Meyer, Tom NAB02; Mendoza, Richard R Mr CIV USA IMCOM AEC; Flint, Jeremy; Redder, Jerome; Greene, Anne
Subject:	Radford AAP Final SMWU-40 IMWP (UNCLASSIFIED)
Attachments:	Redline Section 9 SWMU 40 LTM rev 07_29_11.pdf; RTC Rev 01 SWMU40 DF IMWP 8-1-11 jjm edit 5 Aug.pdf
Importance:	High

Classification: UNCLASSIFIED
Caveats: FOUO

All,

The contractor will ship the subject document to the POCs with tracking numbers listed below. Certification will follow under separate cover. A copy of our response to comments is attached to this email.

Thank you for your support of the Radford AAP Installation Restoration Program.
Jim McKenna

Jim McKenna - Two (2) paper copies + two (2) CDs - FedEx Tracking # 7950 9997 8886

Meyer - One (1) paper copy + one (1) CD - FedEx Tracking # 7950 9999 8693

Erich Weissbart, P.G. - Two (2) paper copies + two (2) CDs - FedEx Tracking # 7951 0046 1943

James Cutler - One (1) paper copy + one (1) CD - FedEx Tracking # 7951 0003 0391

Karen Sismour - One (1) CD - FedEx Tracking # 7951 0007 8216

Elizabeth A. Lohman - One (1) CD - FedEx Tracking # 7974 3148 2415

Rich Mendoza, USAEC - One (1) paper copy + one (1) CD - FedEx Tracking # 7974 3143 8419

Jeffrey Leach, USAIPH - One (1) paper copy + one (1) CD - FedEx Tracking # 7974 3221 9995
Classification: UNCLASSIFIED
Caveats: FOUO

RESPONSES TO USEPA, REGION 3 AND VDEQ COMMENTS ON DRAFT FINAL IMWP 40, NOVEMBER 2010

On December 03, 2010, RFAAP transmitted the *Draft Final Solid Waste Management Unit 40 (RAAP-009) Landfill Nitro Area Interim Measures Work Plan,* November 2010 (IMWP) to USEPA and VDEQ for review and comment or concurrence. Comments on the IMWP were received via email on February 23, 2011. The comments, which included input from US EPA, Region 3 and VDEQ, are repeated below in italic font, with the Army's response following each comment.

Comment 1: *Subsequent to the installation and development of new monitoring well 40MW7, and as part of the IM Implementation Report, include the well development logs.*

Response: Agree. In response to this comment, Section 3.6 has been revised to state that well development logs will be provided in the IM Implementation Report.

Comment 2: *The workplan referenced SOP 30.2, groundwater sampling, but the SOP was not included on the CD. Please update the workplan to include SOP 30.2.*

Response: Field SOPs are presented in the IMWP as part of the QAPP (Appendix B). Appendix B has been revised to include SOP 30.2.

Comment 3: *Text in 9.0 states the monitoring program will be optimized further - please provide the details of the proposed optimization so that future optimization is captured by the workplan and won't have to be negotiated down the road.*

Response: The monitoring program at SMWU 40 is modeled after a solid waste detection monitoring program. The initial screening of the groundwater data will be a comparison to the background concentration to evaluate whether a release may have occurred, as indicated by an assessment of an increase in levels of any of the monitored constituents. As the CMS data and human health risk assessment (CMS Section 6.6.1) determined, the SWMU 40, RAAP-009 total risk for each receptor from exposure to groundwater is below or within USEPA's target risk range of 1E-06 to 1E-04 with the exception of the "hypothetical future lifetime resident due primarily due to chloroform in groundwater". The Army is revising Section 9.0 of the Interim Measures Work Plan to clarify expected optimization of the monitoring program. Any analytes that are not detected above laboratory Limit of Quantitation (LOQ) during the first four quarters of monitoring will be eliminated from the analytical reporting list for future sampling events. The four quarters of monitoring in the upgradient well will be used to calculate background for the detected analytes. The down gradient wells will be compared to the calculated background values and any analyte below background in all three down gradient wells will be eliminated from the analytical reporting list for future sampling events. Please note that the analyte lists with the applicable limits of detection and quantitation are presented in the IMWP Appendix B.

Following the development of the background concentrations, the monitoring network analytical results will be comparedc to MCLs and laboratory Limit of Detection (LOD) to evaluate the significance of groundwater analyte detections.

Section 9.0 has been revised to include additional detail on the optimization strategy, including each of the following elements:

- **Elimination of unnecessary analytes** – The LTM text will be modified to add the following optimization criteria to those already established:

Following completion of the first four quarters of data collection and development of the background dataset, the analytical data will be evaluated to identify analytes that meet one or more of the following criteria for purposes of reduction of the analyte list for continued LTM. Groundwater data that meet one or more of the following criteria will be eliminated from monitoring requirements :

1) not detected at or above the laboratory LOD for three (3) consecutive monitoring events;

2) detected concentration does not exceed the established background concentration or;

3) detected concentration does not exceed half the MCL or half the relevant RSL for 3 successive samples and the results display a static or downward trend.

- **Reduction in sampling frequency** – In accordance with the approved CMS, initial quarterly sampling will be conducted to establish seasonal variations. After completion of the first year of data collection, sampling frequency will be reduced to every 9 months for years 2-5. Further reduction in monitoring frequency will occur in subsequent years as deemed appropriate based upon the site specific data. Factors that may be considered to support a further reduction in monitoring frequency include: variations due to changes in precipitation (wet versus dry years); slope of the observed trend lines; the degree to which empirical data match predictions.

  If the data evaluation supports further reductions in monitoring frequency, a written request will be submitted to USEPA, Region 3 and VDEQ. As presented in EPA 542-R-05-003, May 2005, *Road-Map to Long-Term Monitoring Optimization*, and similar Army and USEPA optimization documents, long-term monitoring is only required when there is uncertainty regarding fate and transport of contaminants and the effectiveness of remedies that are implemented. Reduction in uncertainty occurs as data is collected and evaluated through time, thus reducing the need for LTM.

RFAAP agrees that the analyte list should be optimized based on site specific information. While the IMWP ideally would provide final details of the precise means to do so, it is important that the data from the initial 4 quarters of monitoring be available to determine the appropriate means of data evaluation. Therefore, it is recommended that any changes to the optimization plan as outlined in the revised Section 9.0 be submitted as an addendum to the LTM Plan following completion of the first 4 quarters of sampling and analysis. This will allow the Army, its contractor and regulators to review the initial data and jointly make a decision that clarifies background groundwater values for SWMU 40, remaining analytes to be included in ongoing LTM, and provides more specific decision criteria to apply for optimization of the LTM program.

Please also see response to comment number 8. A redline version of Section 9.0 of the Interim Measures Work Plan is attached to illustrate the LTM text changes presented in these responses to comments.

Comment 4: *One of the comparison criteria proposed for groundwater is background. Background concentrations need to be statistically represented and therefore the statistics proposed for background calculations need to be presented and agreed upon in the workplan (Attachment).*

Response: At this time, a data set for development of background concentrations has not been collected and existing data from the background monitoring point, LFMW01, is insufficient to determine the appropriate statistical method for establishing background conditions. After completion of data collection during the first 4 quarters, an evaluation will be conducted to select an appropriate method for determining a statistically valid background for analytes of interest, based upon detections occurring in the first 4 quarters. This evaluation will include determination of validity and applicability of parametric methods, etc. Based upon this initial data evaluation, a statistical evaluation method will be selected. It is expected that one or more of the following methods will be evaluated and/or recommended: confidence interval testing; tolerance limits; trend line or trend band analysis. Should the data evaluation indicate insufficient sample size, interdependence, or other deviation which could result in invalidation of the data or methods, a recommendation may be made to expand the background data set.

For constituents that exceed MCLs or laboratory LOQs, and are present in background samples during the first four quarters of sampling and analysis, a statistically valid data set will be collected and site specific background values calculated from the data set. The specific statistical procedure cannot be identified until sufficient data are available to support an evaluation of statistical independence, stationarity, lack of outliers and normality. Once sufficient data are available to assure that the data set meet the required underlying assumptions to support application of a statistical method, an appropriate statistical evaluation technique will be proposed. The development of background values for comparison to data from the monitoring network will be conducted following the first four quarters of data collection and will be based on recommendations presented in EPA 530/R-09-007 *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance, March 2009.*

Comment 5: *Section 3.4 – It is not clear how the areal extent of the cap (as shown on Figure 6) will be bounded. The purpose of the cap appears to be two-fold; to repair visible erosion and to provide a barrier to unacceptable exposure to PCB concentrations above industrial levels. If that is the case then site data and/or additional sampling should be used to delineate the cap. It is anticipated that the SWMU boundary will be redrawn and that an IC will be developed to restrict disturbance/excavation into the cap. An additional IC will also be required for any additional land where residential levels are exceeded.*

Response: The purpose of the cap repair specified in the IMWP is to maintain containment of the landfill material at the site and implement necessary controls to prevent future uncontrolled human exposure to waste material within the landfill, and to stabilize and repair the landfill cover at the northern edge of the landfill area to prevent any further mass transport of soil material in this area. Figure 6 of the IMWP illustrates the approximate extent to which repair is needed to address erosional features caused by surface water runoff. The figure has been revised to indicate that cover material will extend downslope to the location of soil boring 40SS17, to assure that any potential location at which PCBs in soil may exceed the adjusted I-RBC are covered. This will provide the most conservative and definitive demonstration that this element of the site CMO regarding potential human exposure is achieved.

Additionally, to address the commentor's questions regarding geospatial data, Section 3.5 has been modified to clarify that GPS data will be collected in the field to define the extent of the repaired area. The GPS data will be used to construct a map illustrating the horizontal extent of the repaired area and the extent of cover material placed to limit potential human exposure (as described in the IMWP). The resultant map will be included in the IM Completion Report.

With regard to ICs, the IMWP noted that signage will be placed at SWMU 40 (see Section 3.7) to denote the site as a closed unit. As discussed in a July 29, 2011 teleconference among RFAAP, USEPA, VDEQ and UXB-KEMRON, applicable ICs will be maintained as specified in the final RCRA Corrective Action permit. The redline text of the IMWP has been edited to reflect the July 29 teleconference discussion. It is noted that there are no plans to transfer SWMU 40 or any other portion of the RFAAP facility out of government control, and site access is strictly controlled.

Comment 6: *Section 3.5, Geospatial Data - please define what is proposed in detail. I'm assuming this section refers to a survey.*

Response: Geospatial data will be collected to determine the limits of pertinent site activities, such as capping downgradient of the limit of SWMU40 on the northern toe of the slope (around 40SS1), and the location of monitoring well 40MW7 that will be installed. Geospatial data includes collection of GPS points in the field using a Trimble GeoXT unit, or equivalent, to define the extent of cap repair, and surveying all four monitoring wells included in the groundwater long term monitoring plan. The well survey will be conducted by a licensed surveyor. Survey data will be included in the IM Completion Report, and the delineation of horizontal extent of the repair area at SWMU 40 will be illustrated on a map to be included in the report as well. The text has been modified to provide these clarifications.

Comment 7: *Section 9.0 - Monitoring well 40MW3 should be included as a downgradient monitoring well; however, include in the optimization the criteria by which monitoring wells can be dropped from the network.*

Response: The groundwater monitoring requirements as part of the LTM are presented in Section 10.2.3 of the Final CMS, which has been approved by the EPA and VDEQ. The IMWP has been drafted in accordance with Section 10.2.3 of the approved CMS and does not include downgradient monitoring well 40MW3. No changes have been made to the IMWP text. Briefly during the resolution of EPA/DEQ review comments on the draft RFI/CMS Report the EPA, DEQ, Army discussed and agreed that the monitoring objectives would be to detect releases from the landfill as well as to confirm RFI/CMS results and further agreed that 40MW5, 40MW6 and 40MW7 (when installed) would be in the best position to do that. See RFAAP/ATK letter dated May 5, 2009 that certified and transmitted the final RFI/CMS Report with responses to comments, See General Comment 1 and Specific Comment 4. The RFI/CMS report was subsequently approved by EPA/DEQ on June 30, 2009. Although 40MW3 was not specifically discussed, it was understood it is not close enough and not really in the flow path to effectively perform this function. As discussed in a July 29, 2011 teleconference, 40MW3 will not be included in the current monitoring network. There are no plans to close this well and it remains available if future water level and/or laboratory analytical results from the approved monitoring well network established by the CMS indicate that the well needs to be included.

Comment 8: General Comment- *As a general comment I don't find text included in section 1.1.2, Site History, paragraph 3, starting with "The lack of detections and absence of................" to be particularly constructive. Not knowing the entire history of communications on this unit I have no preconceived thoughts on the analysis for chloroform in groundwater; however, the text leads the reader to believe that chloroform is either unnecessary or what - an ASD for chloroform is forthcoming? Which leads me to my last comment. There appears to be a rather lengthy list of constituents on the monitoring list. The workplan states that any constituents ND for the first 4 quarters will be eliminated. That still leaves a long list of metals that likely have nothing to do with waste disposal practices at SWMU 40, nor contribute to a degradation of* *groundwater quality. Consider those constituents that exceed SSLs. This should be part of the optimization proposed in the workplan - how to remove inorganic constituents not exceeding background or possibly not exceeding risk (or MCLs). You may want to refer to guidance generated by VADEQ in their regulated waste programs.*

Response: The text referenced by the commentor regarding chloroform detections is based on the responses to regulatory comments and text presented in the CMS as approved by USEPA and VDEQ. An alternate source demonstration (ASD) is not planned for SWMU 40. The RFI/CMS presents the data from extensive sampling within and adjacent to SWMU 40 with any potential chloroform source within the landfill being absent. As presented in the approved RFI/CMS, the low concentrations of chloroform groundwater detections elsewhere at RFAAP, the presence of developed areas nearby that include older drinking water supply lines, the absence of a chloroform source with 91 soil samples that were analyzed for VOCs, and the absence of any other VOC detections in groundwater taken together indicate that a chloroform source is not present at SWMU 40. Nevertheless, to address regulatory concerns, RFAAP has agreed to include chloroform in the LTM program.

RFAAP agrees that the analyte list should be optimized based on site specific information. While the IMWP ideally would provide final details of the precise means to do so, it is important that the data from the initial 4 quarters of monitoring be available to determine the appropriate means of data evaluation. The CMS includes the list of analytical parameters to be included in the groundwater monitoring. Table 1 of the IMWP includes the list of analytes that will be included in the initial sampling events. This table will be followed during the first four quarters of sampling.

The Army agrees with the commentor's suggestion that SSLs may be useful in optimizing monitoring. Based on the CMS data, SWMU 40 groundwater does not pose significant risk with future use remaining military/industrial (see human health risk assessment conclusions in CMS). Considering the RFI/CMS data and conclusions, the Army does not anticipate the groundwater monitoring program at SWMU 40 will be complex or protracted. The data from the site will be evaluated on an on-going basis as described in the revised IMWP Section 9.0 text (attached in redline version), and the site will be evaluated holistically, with the soil data considered when evaluating any groundwater detections. SSL DAF 20 values and site-specific SSLs that were included in the CMS will be considered in this data evaluation process. SSLs were used in selection of analytes to be incorporated into the LTM program (see Sections 4.1, 4.3 and 5.0 of final 2009 RFI/CMS). The only COPCs identified for SWMU 40 groundwater were chloroform, which was not detected in any landfill soil/waste sample analysis, and perchlorate (included based upon inclusion of data from a cross-gradient well).

A remedy effectiveness review will be conducted within the first five years of the LTM program as described in the IMWP Section 9.0. The groundwater monitoring program will be assessed as part of the remedy effectiveness review. The Army anticipates that data from groundwater monitoring presented in the effectiveness review may indicate that the list of analytes should be further reduced, the frequency of monitoring should be further reduced, or that further monitoring will not be necessary.

The LTM program as presented in November 2010 Section 9 has been modified based on regulatory comment and the redline text is appended to these responses to comments.

The analytes detected throughout the LTM program will be assessed via the LTM reports. Groundwater analytical results will be compared to background and promulgated Federal Safe Drinking Water Act Maximum Contaminant Levels (MCLs). Analytes for which a promulgated MCL does not exist will be evaluated with respect to EPA Regional Screening Levels (RSLs). Analytes that are not detected above laboratory method detection limits as specified in the project QAPP will not require further technical evaluation."

The Section 9 IMWP text has been corrected to state that the laboratory Limit of Quantitation (LOQ) will be used to eliminate analytes during the first four quarters of sampling, consistent with the USEPA Unified Guidance. Establishment and use of a background dataset will eliminate analytes that are below background and thus not associated with SWMU 40. The LTM Plan will be expanded to include the following additional optimization criteria:

Following completion of the first four quarters of data collection, the analytical data will be evaluated to identify analytes that meet one or more of the following criteria:

1) not detected at or above the laboratory LOD for three (3) consecutive monitoring events;
2) detected concentrations do not exceed the established background concentration for three consecutive events;
3) detected concentrations do not exceed half the relevant MCL or RSL for 3 successive samples and the results display a static or downward trend.

As identified in the approved final RFI/CMS, monitoring well LFMW01 will be the upgradient (background) monitoring well. Data resulting from sampling of this well will be used for comparison to the downgradient wells 40MW5, 40MW6 and 40MW7 (new well to be installed), using the statistical method determined to be appropriate after collection of the initial four quarters of data.

The changes to Section 9.0 of the IMWP is attached in redline version for regulator review and concurrence.

9.0 LONG TERM MONITORING PLAN

~~SWMU 40 Groundwater Monitoring Plan~~ This Section establishes the Groundwater Monitoring Plan for SWMU 40 in conformance with the USEPA and VDEQ approved Final RFI/CMS for SWMU 40, RAAP-009 (URS, 2009).

9.1 Groundwater Monitoring Program

The selected remedy for SWMU 40 includes installation of one additional groundwater monitoring well in the downgradient direction, to be identified as 40MW7. The location selected and documented within the Final RFI/CMS is illustrated on Figure 4 in this IMWP.

The groundwater monitoring network at SWMU 40 will consist of one upgradient well, LFMW01, and three downgradient wells. The three downgradient wells include existing wells 40MW5, 40MW6, and the new well to be installed as 40MW7. Installation of this new well is presented elsewhere in this IMWP. Table 1 summarizes the long term monitoring program that will be implemented as part of the Corrective Measures at SWMU 40.

Table 1 - Long Term Groundwater Monitoring Program, SWMU 40, RAAP-009:

Monitoring Well Designation	Relative Position to SWMU 40	Monitoring Frequency	Analytical Parameters
LFMW01	Upgradient	Year 1: Quarterly Years 2-5: Every 9 months Years 6-30: Annual	Field water quality: pH, turbidity, specific conductance, temperature, dissolved oxygen, oxidation/reduction potential TCL VOCS, SW846 Method 8260B; TCL SVOCs, SW846 Method 8270C SIM; TCL Pesticides, SW846 Method 8081A; TAL Metals, SW846 Method 6000/7000; Perchlorate, SW846 6850; Dioxins/furans, SW846 Method 8290 included in initial sampling event only
40MW5	Detection Well at edge of landfill boundary		
40MW6	Detection Well at edge of landfill boundary		
40MW7	Well downgradient of Landfill		

The first year of long term monitoring (LTM) will include four quarterly monitoring events. Dioxins and furans will be sampled and analyzed solely in the first quarterly sampling event of the first year of LTM. In years 2-5 of LTM, groundwater sampling and analysis will be conducted every nine (9) months. This program will allow the LTM program to include evaluation for seasonal variations. ~~Annual sampling and analysis is anticipated for years 6-30 of LTM.~~

LTM reports will be prepared and submitted following the completion of the first four quarters of sampling, and after each of the following events. It is anticipated the fourth sampling event conducted on a 9-month time interval will be included in a combined LTM and remedy effectiveness review report. ~~on an annual basis.~~

Each LTM report will summarize the sampling and analysis conducted and will present both summarized LTM results and complete laboratory analytical results. Complete laboratory analyses will be presented in electronic form (e.g., CD ROM or equivalent).

Any analytes that are not detected above laboratory ~~method detection limits~~limit of quantitation (LOQ) during the first four quarters of monitoring will be eliminated from the analytical reporting list for future sampling events. In addition, the four quarters of monitoring in the upgradient well will be used to calculate background for the detected analytes. The down gradient wells will be compared to the calculated background values and any analyte below background in all three down gradient wells will be eliminated from the analytical reporting list for future sampling events. This information will be noted in the first LTM report for the first four quarters of data. Retention of analytes in the LTM monitoring and reporting will be evaluated in reports for each subsequent sampling and analysis event based upon the site specific dataset that will be included and evaluated. ~~Over time, the Army will seek to optimize the monitoring program further.~~

The analytes detected throughout the LTM program will be assessed via the LTM reports. Groundwater analytical results will be compared to background and promulgated Federal Safe Drinking Water Act Maximum Contaminant Levels (MCLs). Analytes for which a promulgated MCL does not exist will be evaluated with respect to EPA Regional Screening Levels (RSLs). Analytes that are not detected above laboratory method detection limits as specified in the project QAPP will not require further technical evaluation. A list of the specific analytes included in the groundwater LTM program and their associated reporting limits and method detection limits are presented in Appendix B (Master Work Plan Addendum #30, Quality Assurance Project Plan for SWMU 40).

At a minimum, the following criteria will be applied to data evaluation and optimization of the monitoring program after the first four quarters of data have been generated:

1) Analytes that do not exceed the laboratory LOD during three (3) consecutive monitoring events will not require further sampling and analysis;
2) Analyte detections that do not exceed the established background concentration for 3 successive sampling events will not require further sampling and analysis;
3) Analyte detections that do not exceed half the relevant MCL or half the relevant RSL for 3 successive sampling events and the results display a static or downward trend will not require further sampling and analysis.

Within the first ~~After~~ five years of monitoring ~~have been completed~~, a remedy effectiveness evaluation will be conducted for SWMU 40. The remedy effectiveness evaluation will include a presentation of the groundwater data collected throughout the LTM program to date. The analytical results will be statistically evaluated against the background dataset, and to determine if any trends are exhibited. The site specific data will be evaluated using appropriate statistical methodologies, and data assessment will be conducted in general conformance with the recommendations of USEPA guidance entitled *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance, March 2009* (EPA 530/R-09-007).

The remedy effectiveness review will be used to determine if exposure assumptions in the Final RFI/CMS remain correct, ~~and~~ whether the remedy continues to achieve CMOs, and will be used to determine what, if any, continuing groundwater monitoring is appropriate for SWMU 40. It is anticipated the fourth 9-month interval sampling event will be completed and included in an expanded ~~and will be provided in the~~ LTM report that will include the remedy effectiveness review. At the Army's discretion, remedy effectiveness evaluations may be conducted more frequently than once per five years.

Assuming that stable to decreasing concentrations of analytes are demonstrated in the LTM reports, RFAAP may request to decrease the frequency of monitoring from that specified in Table 1, up to and including termination of groundwater monitoring.

9.~~1~~2 Long Term Inspection and Maintenance Plan

Additional long term maintenance would also be conducted at SWMU 40, RAAP-009; including inspection of the landfill cap to ensure that the landfill cap integrity is maintained. Inspections would be conducted in conjunction with groundwater monitoring events and thus will follow the same schedule specified in Table 1, Long Term Groundwater Monitoring Program.

Inspections will include visual evaluation and documentation of negative effects of the following:

1. Precipitation run-on and runoff;
2. Water and/or wind erosion;
3. Rodent and/or vector activity;
4. Deep root vegetation;
5. Vegetative stress and other cover condition;
6. Subsidence or cracks in cap;
7. Excavation or other manmade intrusive work conducted within the landfill footprint.

The landfill cap inspection form included in Appendix D or equivalent would be used to document inspection results, and maintenance, repair or corrective action. Photos also may be used to illustrate the condition of the landfill. ~~The completed I~~inspections will be conducted and documented as specified in the final RCRA Corrective Action permit~~is to be included in each annual LTM report. Should groundwater monitoring no longer be required, signage at SWMU 40 will be maintained but formal landfill inspections and reporting will not be required.~~

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9.~~2~~3 LTM Reporting

The results of groundwater monitoring and landfill inspections, maintenance, repair and corrective action will be presented in LTM reports submitted ~~each year~~following the first four quarterly sampling events. ~~The initial LTM report will be submitted after the first four quarters of monitoring have been completed.~~ Subsequent reports will be submitted for regulatory review after receipt of laboratory analyses, data review and validation, and review of the draft report by RFAAP.

The initial annual LTM report will include calculation of a background dataset, based upon the first four sampling events. The dataset from these events will provide the first opportunity to evaluate background. After opportunity is provided to evaluate these first 4 quarters of data, additional information is expected to be available to further optimize the groundwater monitoring program. The refined optimization will be included in recommendations of the remedy effectiveness review, which will be submitted for regulatory review and approval.

~~Should groundwater monitoring requirements terminate in the future, signage at SWMU 40 will be maintained but formal landfill inspections and reporting will not be required.~~

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9.4 Maintenance of Institutional Controls

~~Consistent with Section 3.7 of this Work Plan, signage will be placed and maintained at SWMU 40 to denote the site as a closed unit.~~ Applicable Institutional Controls (ICs) and Engineering Controls (ECs) will be maintained, and inspections conducted, as specified in the final RCRA Corrective Action permit.

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From: McKenna, Jim J Mr CIV USA AMC [jim.mckenna@us.army.mil]
Sent: Monday, August 22, 2011 6:49 AM
To: Weissbart.Erich@epamail.epa.gov; Cutler,Jim
Cc: Radford; Mary Lou Rochotte; Meyer, Tom NAB02; Richard Mendoza (External); jeremy.flint@atk.com; jerome.redder@atk.com; anne.greene@atk.com
Subject: Radford AAP Final SMWU-40 IMWP (UNCLASSIFIED)
Attachments: Redline Section 9 SWMU 40 LTM rev 07_29_11.pdf; RTC Rev 01 SWMU40 DF IMWP 8-1-11 jjm edit 5 Aug.pdf

Importance: High

Classification: UNCLASSIFIED
Caveats: FOUO

All,

The contractor will ship the subject document to the POCs with tracking numbers listed below. Certification will follow under separate cover. A copy of our response to comments is attached to this email.

Thank you for your support of the Radford AAP Installation Restoration Program.
Jim McKenna

Jim McKenna - Two (2) paper copies + two (2) CDs - FedEx Tracking # 7950 9997 8886

om Meyer - One (1) paper copy + one (1) CD - FedEx Tracking # 7950 9999 8693

Erich Weissbart, P.G. - Two (2) paper copies + two (2) CDs - FedEx Tracking # 7951 0046 1943

James Cutler - One (1) paper copy + one (1) CD - FedEx Tracking # 7951 0003 0391

Karen Sismour - One (1) CD - FedEx Tracking # 7951 0007 8216

Elizabeth A. Lohman - One (1) CD - FedEx Tracking # 7974 3148 2415

Rich Mendoza, USAEC - One (1) paper copy + one (1) CD - FedEx Tracking # 7974 3143 8419

Jeffrey Leach, USAIPH - One (1) paper copy + one (1) CD - FedEx Tracking # 7974 3221 9995
Classification: UNCLASSIFIED
Caveats: FOUO

From: McKenna, Jim J Mr CIV USA AMC [jim.mckenna@us.army.mil]
Sent: Wednesday, August 17, 2011 6:45 AM
To: Andy Kassoff; Jonah Anderson; jeremy.flint@atk.com; jerome.redder@atk.com; Mary Lou Rochotte; Richard Mendoza (External); Meyer, Tom NAB02
Cc: Cutler,Jim; Weissbart.Erich@epamail.epa.gov
Subject: FW: SWMU 40 IMWP July 29 2011 conference call (UNCLASSIFIED)

Importance: High

Classification: UNCLASSIFIED
Caveats: FOUO

All,
Note email below. Ok to revise and submit SWMU 40 IMWP as final.

Thank you for your support of the Radford AAP Installation Restoration Program.
JJM

-----Original Message-----
From: Weissbart.Erich@epamail.epa.gov
[mailto:Weissbart.Erich@epamail.epa.gov]
Sent: Tuesday, August 16, 2011 8:11 AM
To: McKenna, Jim J Mr CIV USA AMC
Cc: Cutler,Jim
Subject: Re: SWMU 40 IMWP July 29 2011 conference call (UNCLASSIFIED)

Jim,
The response to comments and revised sections are fine. Please submit the revised Unit 40 IM Workplan for approval. Thanks.

Erich Weissbart P.G.
Land and Chemicals Division (3LC20)
US EPA Region III
1650 Arch Street
Philadelphia, PA 19103
Phone: 215-814-3284
e-mail: weissbart.erich@epa.gov

From: "McKenna, Jim J Mr CIV USA AMC" <jim.mckenna@us.army.mil>
To: Erich Weissbart/R3/USEPA/US@EPA, "Cutler,Jim"
<James.Cutler@deq.virginia.gov>
Cc: "Mary Lou Rochotte" <mrochotte@kemron.com>, "Jonah Anderson"
<janderson@kemron.com>, "Andy Kassoff" <akassoff@eee-consulting.com>, "Meyer, Tom NAB02"
<Tom.Meyer@usace.army.mil>, <jeremy.flint@atk.com>, <jerome.redder@atk.com>, "Mendoza, Richard R Mr CIV USA IMCOM AEC"
<richard.r.mendoza@us.army.mil>
Date: 08/10/2011 01:41 PM
Subject: SWMU 40 IMWP July 29 2011 conference call (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: FOUO

All,

Attached are:

1. July 29 conference call notes,
2. Redline revised Section 9 of the IMWP 3. revised RTCs

Let me know if they are ok.
Thanks,
JJM

Classification: UNCLASSIFIED
Caveats: FOUO

[attachment "RTC Rev 01 SWMU40 DF IMWP 8-1-11 jjm edit 5 Aug.pdf"
deleted by Erich Weissbart/R3/USEPA/US] [attachment "Redline Section 9 SWMU 40 LTM rev 07_29_11.pdf"
deleted by Erich Weissbart/R3/USEPA/US] [attachment "SWMU 40 IMWP Telecon Summary 7-29-2011 jjm edit 9 Aug.pdf"
deleted by Erich Weissbart/R3/USEPA/US]

Classification: UNCLASSIFIED
Caveats: FOUO

From: McKenna, Jim J Mr CIV USA AMC [jim.mckenna@us.army.mil]
Sent: Thursday, August 11, 2011 1:29 PM
To: Weissbart.Erich@epamail.epa.gov
Cc: Andy Kassoff; Cutler,Jim; Jonah Anderson; jeremy.flint@atk.com; jerome.redder@atk.com; Mary Lou Rochotte; Richard Mendoza (External); Meyer, Tom NAB02
Subject: RE: SWMU 40 IMWP July 29 2011 conference call (UNCLASSIFIED)
Attachments: Redline Section 9 SWMU 40 LTM rev 07_29_11.pdf; RTC Rev 01 SWMU40 DF IMWP 8-1-11 jjm edit 5 Aug.pdf; SWMU 40 IMWP Telecon Summary 7-29-2011 jjm edit 11 Aug.pdf

Importance: High

Classification: UNCLASSIFIED
Caveats: FOUO

Erich and all,

The revised conference call notes are attached. I have also attached the redline revised Section 9 of the IMWP and the revised RTCs from my original email.

Thanks,
JJM

-----Original Message-----
From: Weissbart.Erich@epamail.epa.gov [mailto:Weissbart.Erich@epamail.epa.gov]
Sent: Thursday, August 11, 2011 8:05 AM
To: McKenna, Jim J Mr CIV USA AMC
Cc: Andy Kassoff; Cutler,Jim; Jonah Anderson; jeremy.flint@atk.com; jerome.redder@atk.com; Mary Lou Rochotte; Mendoza, Richard R Mr CIV USA IMCOM AEC; Meyer, Tom NAB02
Subject: Re: SWMU 40 IMWP July 29 2011 conference call (UNCLASSIFIED)

I have a single clarification on the notes from the conference call.
The reason intrawell statistics are not appropriate is because the monitoring wells were not installed and sampled prior to the unit being constructed. Intrawell statistics are appropriate for solid waste facilities given the previous sentence is satisfied.

Erich Weissbart P.G.
Land and Chemicals Division (3LC20)
US EPA Region III
1650 Arch Street
Philadelphia, PA 19103
Phone: 215-814-3284
e-mail: weissbart.erich@epa.gov

From: "McKenna, Jim J Mr CIV USA AMC" <jim.mckenna@us.army.mil>
To: Erich Weissbart/R3/USEPA/US@EPA, "Cutler,Jim" <James.Cutler@deq.virginia.gov>
Cc: "Mary Lou Rochotte" <mrochotte@kemron.com>, "Jonah Anderson" nderson@kemron.com>, "Andy Kassoff" <akassoff@eee-consulting.com>, "Meyer, Tom NAB02" <Tom.Meyer@usace.army.mil>, <jeremy.flint@atk.com>, <jerome.redder@atk.com>, "Mendoza, Richard R Mr CIV USA IMCOM AEC"

<richard.r.mendoza@us.army.mil>
Date: 08/10/2011 01:41 PM
Subject: SWMU 40 IMWP July 29 2011 conference call (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: FOUO

All,

Attached are:

1. July 29 conference call notes,
2. Redline revised Section 9 of the IMWP 3. revised RTCs

Let me know if they are ok.
Thanks,
JJM

Classification: UNCLASSIFIED
Caveats: FOUO

[attachment "RTC Rev 01 SWMU40 DF IMWP 8-1-11 jjm edit 5 Aug.pdf" deleted by Erich Weissbart/R3/USEPA/US] [attachment "Redline Section 9 SWMU 40 LTM rev 07_29_11.pdf" deleted by Erich Weissbart/R3/USEPA/US] [attachment "SWMU 40 IMWP Telecon Summary 7-29-2011 jjm edit 9 Aug.pdf" deleted by Erich Weissbart/R3/USEPA/US]

Classification: UNCLASSIFIED
Caveats: FOUO

Teleconference Call Summary – 29 July 2011

July 29, 2011 Teleconference participants:
Erich Weissbart, USEPA, Region 3 (EW)
Jim Cutler, VDEQ (JC)
Tom Meyer, USACE COR (TM)
Jim McKenna, RFAAP (JM)
Jeremy Flint, ATK (JF)
Jerry Redder, ATK (JR)
Mary Lou Rochotte, UXB-KEMRON PM (MLR)
Charlie Martin, UXB-KEMRON Project Geologist (CM)
Jonah Anderson, UXB-KEMRON Task Manager (JA)
NOTE: Rich Mendoza, USAEC ERM was unavailable for this call

- Above parties participated in a teleconference call regarding discussion of the "Responses to USEPA, Region 3 and VDEQ Comments on Draft Final IMWP 40 Work Plan" comments letter submitted to the Army on February 23, 2011, as well as July 2011 email exchanges related to the comments and responses.
- JM led the call.

General Discussions on Monitoring Program:

- JM provided a brief review of SWMU 40 history. It was summarized that the site consisted of an unpermitted trash dump which was closed in the 1980's. No releases were identified from this unit in the RFI/CMS. General trash was found to be present in the SWMU, but there were no drums or hazardous wastes present. No significant monitoring has been conducted after closure and under VDEQ standards, monitoring would not be necessary. EW asked if this was due to closure in the 1980's; JM indicated yes.
- JM noted that while no release was present, the Army committed to performance of additional monitoring, from a good stewardship standpoint. There was an indication of chloroform in groundwater on another site for which an ASD was performed, and one cross-gradient SWMU 40 well had a chloroform detection. The CMS provides intervals for sampling recommendations, but 30 yrs is not expected to be necessary. The Army anticipates minimizing monitoring, with ramp-down strategy to be prepared after initial monitoring. The facility is not considered to be subject to Subpart F. A detection monitoring plan could be developed, boiled down from the CMS, with eventual ramp-down.
- EW indicated he was expecting to see a focused list of constituents for testing in the work plan with indicator parameters identified. MLR indicated the work plan indicates a broad list of constituent groups, and referenced Appendix B of the QAPP for individual analytes.
- JC suggested eventually reducing the list of COCs to site-detected COCs following a period of time. Some soil detections >SSLs could have an impact on groundwater. JC indicated that that this was not a typical landfill, that it was a known landfill. JM indicated that there was no hazardous waste at this location. Soil sample data pertains to cover soil data primarily.
- MLR indicated that available soil quality information is based from 32 surface soil, 24 subsurface soil, and 16 other material samples, per the RFI/CMS. JM indicated that some hits from soil were seen for metals, benzo(a)pyrene, etc. CMS Table 4-4 summarizes detections, and Table 1 is distilled from that information.
- JF indicated that a broad list of analytical constituents is proposed for initial monitoring. General discussion identified the list as including VOC, SVOC, metals, dioxin/furans, herbicides/pesticides, and perchlorate.
- MLR indicated that 4 quarters of monitoring would be conducted for the first year. She noted that the complete analyte list is provided in the IMWP Appendix B, with each analyte LOD and LOQ provided. If detections are not greater than the LOQ, then no more monitoring would be further required. Section 4.1 of the RFI/CMS is the basis for the proposed monitoring program. JF reviewed detections from the CMS table of COPCs.
- JC indicated that his initial impression was that the site would be nastier than it is; he had not recalled that drums weren't present.

- EW indicated that after the first year, the COC list could be reduced to a detection list for LTM. He indicated we would probably have detections for metals and chloroform. JM indicated that perchlorate may be seen at very low levels because the lab reporting limits are now so low compared to historic data.
- JM indicated that statistical evaluation of the initial data sets would be made, using EPA guidance, to determine LTM requirements. The SWMU has been closed for 30 years. It was expected that if there were any release, contaminants would have been identified in the RFI sampling.
- EW questioned the type of statistical testing to conduct, and that it would probably not include intra-well testing as indicated in the initial response to comments, as this is not appropriate for SWMU 40. EW said the reason intrawell statistics are not appropriate is because the monitoring wells were not installed and sampled prior to the unit being constructed.

<u>Institutional Controls:</u>

- Discussions were had relative to institutional controls (ICs) for the SWMU with regard to LTM. JM indicated that the facility will have signs in place but no regular inspections after groundwater monitoring is no longer required.
- EW indicated that some post-closure care would typically be expected such as cap monitoring/inspections, etc.
- JC indicated that the work plan should specify what ICs will be in place, and asked how that will be presented.
- JM indicated that the property would continue to be a DOD facility with similar access control and envisioned that the corrective action permit when reissued would capture the IC requirements for the sites listed in the Statement of Basis. At that time RFAAP would incorporate them into the operating contract for implementation and that would best be done with a single plan for all of the sites that have an IC.
- After significant discussion, MLR suggested the Section 9 text be modified to delete language about ceasing formal inspections, and instead insert language indicating that ICs would be maintained in accordance with the final RCRA Corrective Action permit. EW indicated that would be acceptable.

<u>Additional Monitoring Program Discussions:</u>

- Discussions were had relative to installation of another well or incorporation of existing well 40MW3 into a monitoring program for the site.
- JC indicated that indicator parameters are important due to the site set-up. Not a lot of comfort with the current network due to karst conditions.
- EW indicated that EPA would prefer 40MW3 be included, but dioxins/furans monitoring would not be necessary.
- JM and JF indicated that the CMS established the monitoring network and that all had previously agreed that MW3 was not needed based on gradient, and that a new well installation would address down-gradient flow. JM referenced the groundwater potentiometric map within the CMS.
- JC indicated that a new well would be needed based on gradient due to river. JM indicated an anomaly was also identified on the geophysical survey, and that was key in selecting the new well location. JM reiterated that the CMS defines program requirements.
- EW asked why the well installation is an issue. JM responds that the well network contracted is defined by the approved CMS. Can't implement more that the approved CMS. JM indicated that the CMS specifies the scope of work. The CMS states which wells and what constituents are determined necessary, and the contract cost is based on this.
- JF thought that MW3 could be monitored, if MW7 were to not be installed.
- JC disagreed, saying MW7 is necessary.
- JM confirmed that the CMS is a strict scope of work, and that there is no reason at this time to go through a significant effort to modify it. If monitoring results indicate different site conditions, then MW3 could be used to define a plume boundary in the future if applicable. If the program were required to adjust to a release monitoring scenario, then the contract effort would likely need to be modified. However, currently there is no indication there is any plume, and the approved CMS is what the Army contracted and has management support to implement. Therefore since the CMS specifies the new well, it will be installed and monitored.

Potentiometric Surface Conditions Discussions:

- Some additional discussion was had relative to potentiometric surface conditions.
- JC indicated he would rather see spatial data (more wells) and have a more limited well analyte list.
- EW indicated that water level monitoring should include wells MW3, 5, and 6.
- JF questioned if EPA and VDEQ were indicating that if nothing is found in wells 5 and 6, something in well 3, then the detections would be assumed to be from SWMU 40?
- JC indicated perhaps, based on unpredictable flow in karst.
- EW questioned whether the Army plans to close 40MW3; JF and JM responded there are no plans to close that monitoring well.
- EW stated that since the well won't be closed, there should be no change in the monitoring plan for now regarding the wells to include. As long as well is not closed, and based on Army and UXB-KEMRON's submittal of the first four quarters of monitoring data to USEPA and VDEQ prior to beginning optimization, it can be decided after a year of monitoring if the monitoring network is sufficient. EW stated that it is important to clarify that the IMWP's exclusion of 40MW3 does not mean that if the data don't show groundwater flow as illustrated in the CMS, and/or if the analytes indicate a release, then the monitoring plan will have to be re-evaluated. JM agreed that if the new well is put in and monitoring data indicate conditions are different than portrayed in the CMS, then the Army would need to re-evaluate and that would provide a basis for contract modifications as well if the site conditions merit.
- JM summarized that he understood from the discussion that the groundwater monitoring plan would proceed as proposed, with Army and regulator joint re-evaluation at the end of 4 quarters of monitoring.
- EW agreed with JM's restatement of the conclusions, but wanted to know if the site would be walked away from without inspections or other ICs and evaluation after groundwater monitoring ceases. MLR explained segmentation vs. holistic handling of the site, noting that the IMWP is for only this SWMU and it was her understanding that regulatory personnel and the Army both desired a more holistic approach for ICs at RFAAP. JM indicated that an IC Plan is anticipated as part of the facility permit, and that requirements would be presented there.
- JC recommended consideration of retaining potential list of analyte COCs for continued monitoring after review of the first year's data, potentially including potential COCs which might have not been detected yet, for example COCs found in soil above SSLs, any COCs in groundwater that have established MCLs.
- JM reiterated that RFAAP has completed significant evaluation within the RFI/CMS effort which considered the findings in soil and groundwater and that the report addressed this concern. The RFI/CMS has been approved and provides the decision for the site. Unless the monitoring data indicates something unexpected, RFAAP wants to be able to reduce the monitoring and to close out this site as they have others. MLR commented that the soil data and SSLs, fate and transport, etc were discussed in detail in the RFI/CMS, and that the SSLs also were further considered in the risk assessment.

CONCLUSIONS AND ACTION ITEMS

UXB-KEMRON will revise the responses to comments and the redline IMWP Section 9 text and RFAAP will send out for regulator final approval. RFAAP and Army contractor will schedule implementation after receiving final regulatory approval of the IMWP.

UXB-KEMRON will prepare notes from the teleconference and RFAAP will issue for regulatory review and agreement.

No changes in the monitoring program design, regarding analytes and wells to be included, is necessary at this time.

Following the first 4 quarters of monitoring, the data will be evaluated per the IMWP and the findings will be submitted to USEPA and VDEQ. Decisions regarding optimization will begin to be made after the first four quarters of data are available.

RESPONSES TO USEPA, REGION 3 AND VDEQ COMMENTS ON DRAFT FINAL IMWP 40, NOVEMBER 2010

On December 03, 2010, RFAAP transmitted the *Draft Final Solid Waste Management Unit 40 (RAAP-009) Landfill Nitro Area Interim Measures Work Plan,* November 2010 (IMWP) to USEPA and VDEQ for review and comment or concurrence. Comments on the IMWP were received via email on February 23, 2011. The comments, which included input from US EPA, Region 3 and VDEQ, are repeated below in italic font, with the Army's response following each comment.

Comment 1: *Subsequent to the installation and development of new monitoring well 40MW7, and as part of the IM Implementation Report, include the well development logs.*

Response: Agree. In response to this comment, Section 3.6 has been revised to state that well development logs will be provided in the IM Implementation Report.

Comment 2: *The workplan referenced SOP 30.2, groundwater sampling, but the SOP was not included on the CD. Please update the workplan to include SOP 30.2.*

Response: Field SOPs are presented in the IMWP as part of the QAPP (Appendix B). Appendix B has been revised to include SOP 30.2.

Comment 3: *Text in 9.0 states the monitoring program will be optimized further - please provide the details of the proposed optimization so that future optimization is captured by the workplan and won't have to be negotiated down the road.*

Response: The monitoring program at SMWU 40 is modeled after a solid waste detection monitoring program. The initial screening of the groundwater data will be a comparison to the background concentration to evaluate whether a release may have occurred, as indicated by an assessment of an increase in levels of any of the monitored constituents. As the CMS data and human health risk assessment (CMS Section 6.6.1) determined, the SWMU 40, RAAP-009 total risk for each receptor from exposure to groundwater is below or within USEPA's target risk range of 1E-06 to 1E-04 with the exception of the "hypothetical future lifetime resident due primarily due to chloroform in groundwater". The Army is revising Section 9.0 of the Interim Measures Work Plan to clarify expected optimization of the monitoring program. Any analytes that are not detected above laboratory Limit of Quantitation (LOQ) during the first four quarters of monitoring will be eliminated from the analytical reporting list for future sampling events. The four quarters of monitoring in the upgradient well will be used to calculate background for the detected analytes. The down gradient wells will be compared to the calculated background values and any analyte below background in all three down gradient wells will be eliminated from the analytical reporting list for future sampling events. Please note that the analyte lists with the applicable limits of detection and quantitation are presented in the IMWP Appendix B.

Following the development of the background concentrations, the monitoring network analytical results will be comparedc to MCLs and laboratory Limit of Detection (LOD) to evaluate the significance of groundwater analyte detections.

Section 9.0 has been revised to include additional detail on the optimization strategy, including each of the following elements:

- **Elimination of unnecessary analytes –** The LTM text will be modified to add the following optimization criteria to those already established:

Following completion of the first four quarters of data collection and development of the background dataset, the analytical data will be evaluated to identify analytes that meet one or more of the following criteria for purposes of reduction of the analyte list for continued LTM. Groundwater data that meet one or more of the following criteria will be eliminated from monitoring requirements :

1) not detected at or above the laboratory LOD for three (3) consecutive monitoring events;

2) detected concentration does not exceed the established background concentration or;

3) detected concentration does not exceed half the MCL or half the relevant RSL for 3 successive samples and the results display a static or downward trend.

- **Reduction in sampling frequency –** In accordance with the approved CMS, initial quarterly sampling will be conducted to establish seasonal variations. After completion of the first year of data collection, sampling frequency will be reduced to every 9 months for years 2-5. Further reduction in monitoring frequency will occur in subsequent years as deemed appropriate based upon the site specific data. Factors that may be considered to support a further reduction in monitoring frequency include: variations due to changes in precipitation (wet versus dry years); slope of the observed trend lines; the degree to which empirical data match predictions.

  If the data evaluation supports further reductions in monitoring frequency, a written request will be submitted to USEPA, Region 3 and VDEQ. As presented in EPA 542-R-05-003, May 2005, *Road-Map to Long-Term Monitoring Optimization*, and similar Army and USEPA optimization documents, long-term monitoring is only required when there is uncertainty regarding fate and transport of contaminants and the effectiveness of remedies that are implemented. Reduction in uncertainty occurs as data is collected and evaluated through time, thus reducing the need for LTM.

RFAAP agrees that the analyte list should be optimized based on site specific information. While the IMWP ideally would provide final details of the precise means to do so, it is important that the data from the initial 4 quarters of monitoring be available to determine the appropriate means of data evaluation. Therefore, it is recommended that any changes to the optimization plan as outlined in the revised Section 9.0 be submitted as an addendum to the LTM Plan following completion of the first 4 quarters of sampling and analysis. This will allow the Army, its contractor and regulators to review the initial data and jointly make a decision that clarifies background groundwater values for SWMU 40, remaining analytes to be included in ongoing LTM, and provides more specific decision criteria to apply for optimization of the LTM program.

Please also see response to comment number 8. A redline version of Section 9.0 of the Interim Measures Work Plan is attached to illustrate the LTM text changes presented in these responses to comments.

Comment 4: *One of the comparison criteria proposed for groundwater is background. Background concentrations need to be statistically represented and therefore the statistics proposed for background calculations need to be presented and agreed upon in the workplan (Attachment).*

Response: At this time, a data set for development of background concentrations has not been collected and existing data from the background monitoring point, LFMW01, is insufficient to determine the appropriate statistical method for establishing background conditions. After completion of data collection during the first 4 quarters, an evaluation will be conducted to select an appropriate method for determining a statistically valid background for analytes of interest, based upon detections occurring in the first 4 quarters. This evaluation will include determination of validity and applicability of parametric methods, etc. Based upon this initial data evaluation, a statistical evaluation method will be selected. It is expected that one or more of the following methods will be evaluated and/or recommended: confidence interval testing; tolerance limits; trend line or trend band analysis. Should the data evaluation indicate insufficient sample size, interdependence, or other deviation which could result in invalidation of the data or methods, a recommendation may be made to expand the background data set.

For constituents that exceed MCLs or laboratory LOQs, and are present in background samples during the first four quarters of sampling and analysis, a statistically valid data set will be collected and site specific background values calculated from the data set. The specific statistical procedure cannot be identified until sufficient data are available to support an evaluation of statistical independence, stationarity, lack of outliers and normality. Once sufficient data are available to assure that the data set meet the required underlying assumptions to support application of a statistical method, an appropriate statistical evaluation technique will be proposed. The development of background values for comparison to data from the monitoring network will be conducted following the first four quarters of data collection and will be based on recommendations presented in EPA 530/R-09-007 *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance, March 2009.*

Comment 5: *Section 3.4 – It is not clear how the areal extent of the cap (as shown on Figure 6) will be bounded. The purpose of the cap appears to be two-fold; to repair visible erosion and to provide a barrier to unacceptable exposure to PCB concentrations above industrial levels. If that is the case then site data and/or additional sampling should be used to delineate the cap. It is anticipated that the SWMU boundary will be redrawn and that an IC will be developed to restrict disturbance/excavation into the cap. An additional IC will also be required for any additional land where residential levels are exceeded.*

Response: The purpose of the cap repair specified in the IMWP is to maintain containment of the landfill material at the site and implement necessary controls to prevent future uncontrolled human exposure to waste material within the landfill, and to stabilize and repair the landfill cover at the northern edge of the landfill area to prevent any further mass transport of soil material in this area. Figure 6 of the IMWP illustrates the approximate extent to which repair is needed to address erosional features caused by surface water runoff. The figure has been revised to indicate that cover material will extend downslope to the location of soil boring 40SS17, to assure that any potential location at which PCBs in soil may exceed the adjusted I-RBC are covered. This will provide the most conservative and definitive demonstration that this element of the site CMO regarding potential human exposure is achieved.

Additionally, to address the commentor's questions regarding geospatial data, Section 3.5 has been modified to clarify that GPS data will be collected in the field to define the extent of the repaired area. The GPS data will be used to construct a map illustrating the horizontal extent of the repaired area and the extent of cover material placed to limit potential human exposure (as described in the IMWP). The resultant map will be included in the IM Completion Report.

With regard to ICs, the IMWP noted that signage will be placed at SWMU 40 (see Section 3.7) to denote the site as a closed unit. As discussed in a July 29, 2011 teleconference among RFAAP, USEPA, VDEQ and UXB-KEMRON, applicable ICs will be maintained as specified in the final RCRA Corrective Action permit. The redline text of the IMWP has been edited to reflect the July 29 teleconference discussion. It is noted that there are no plans to transfer SWMU 40 or any other portion of the RFAAP facility out of government control, and site access is strictly controlled.

Comment 6: *Section 3.5, Geospatial Data - please define what is proposed in detail. I'm assuming this section refers to a survey.*

Response: Geospatial data will be collected to determine the limits of pertinent site activities, such as capping downgradient of the limit of SWMU40 on the northern toe of the slope (around 40SS1), and the location of monitoring well 40MW7 that will be installed. Geospatial data includes collection of GPS points in the field using a Trimble GeoXT unit, or equivalent, to define the extent of cap repair, and surveying all four monitoring wells included in the groundwater long term monitoring plan. The well survey will be conducted by a licensed surveyor. Survey data will be included in the IM Completion Report, and the delineation of horizontal extent of the repair area at SWMU 40 will be illustrated on a map to be included in the report as well. The text has been modified to provide these clarifications.

Comment 7: *Section 9.0 - Monitoring well 40MW3 should be included as a downgradient monitoring well; however, include in the optimization the criteria by which monitoring wells can be dropped from the network.*

Response: The groundwater monitoring requirements as part of the LTM are presented in Section 10.2.3 of the Final CMS, which has been approved by the EPA and VDEQ. The IMWP has been drafted in accordance with Section 10.2.3 of the approved CMS and does not include downgradient monitoring well 40MW3. No changes have been made to the IMWP text. Briefly during the resolution of EPA/DEQ review comments on the draft RFI/CMS Report the EPA, DEQ, Army discussed and agreed that the monitoring objectives would be to detect releases from the landfill as well as to confirm RFI/CMS results and further agreed that 40MW5, 40MW6 and 40MW7 (when installed) would be in the best position to do that. See RFAAP/ATK letter dated May 5, 2009 that certified and transmitted the final RFI/CMS Report with responses to comments, See General Comment 1 and Specific Comment 4. The RFI/CMS report was subsequently approved by EPA/DEQ on June 30, 2009. Although 40MW3 was not specifically discussed, it was understood it is not close enough and not really in the flow path to effectively perform this function. As discussed in a July 29, 2011 teleconference, 40MW3 will not be included in the current monitoring network. There are no plans to close this well and it remains available if future water level and/or laboratory analytical results from the approved monitoring well network established by the CMS indicate that the well needs to be included.

Comment 8: General Comment- *As a general comment I don't find text included in section 1.1.2, Site History, paragraph 3, starting with "The lack of detections and absence of................" to be particularly constructive. Not knowing the entire history of communications on this unit I have no preconceived thoughts on the analysis for chloroform in groundwater; however, the text leads the reader to believe that chloroform is either unnecessary or what - an ASD for chloroform is forthcoming? Which leads me to my last comment. There appears to be a rather lengthy list of constituents on the monitoring list. The workplan states that any constituents ND for the first 4 quarters will be eliminated. That still leaves a long list of metals that likely have nothing to do with waste disposal practices at SWMU 40, nor contribute to a degradation of* *groundwater quality. Consider those constituents that exceed SSLs. This should be part of the optimization proposed in the workplan - how to remove inorganic constituents not exceeding background or possibly not exceeding risk (or MCLs). You may want to refer to guidance generated by VADEQ in their regulated waste programs.*

Response: The text referenced by the commentor regarding chloroform detections is based on the responses to regulatory comments and text presented in the CMS as approved by USEPA and VDEQ. An alternate source demonstration (ASD) is not planned for SWMU 40. The RFI/CMS presents the data from extensive sampling within and adjacent to SWMU 40 with any potential chloroform source within the landfill being absent. As presented in the approved RFI/CMS, the low concentrations of chloroform groundwater detections elsewhere at RFAAP, the presence of developed areas nearby that include older drinking water supply lines, the absence of a chloroform source with 91 soil samples that were analyzed for VOCs, and the absence of any other VOC detections in groundwater taken together indicate that a chloroform source is not present at SWMU 40. Nevertheless, to address regulatory concerns, RFAAP has agreed to include chloroform in the LTM program.

RFAAP agrees that the analyte list should be optimized based on site specific information. While the IMWP ideally would provide final details of the precise means to do so, it is important that the data from the initial 4 quarters of monitoring be available to determine the appropriate means of data evaluation. The CMS includes the list of analytical parameters to be included in the groundwater monitoring. Table 1 of the IMWP includes the list of analytes that will be included in the initial sampling events. This table will be followed during the first four quarters of sampling.

The Army agrees with the commentor's suggestion that SSLs may be useful in optimizing monitoring. Based on the CMS data, SWMU 40 groundwater does not pose significant risk with future use remaining military/industrial (see human health risk assessment conclusions in CMS). Considering the RFI/CMS data and conclusions, the Army does not anticipate the groundwater monitoring program at SWMU 40 will be complex or protracted. The data from the site will be evaluated on an on-going basis as described in the revised IMWP Section 9.0 text (attached in redline version), and the site will be evaluated holistically, with the soil data considered when evaluating any groundwater detections. SSL DAF 20 values and site-specific SSLs that were included in the CMS will be considered in this data evaluation process. SSLs were used in selection of analytes to be incorporated into the LTM program (see Sections 4.1, 4.3 and 5.0 of final 2009 RFI/CMS). The only COPCs identified for SWMU 40 groundwater were chloroform, which was not detected in any landfill soil/waste sample analysis, and perchlorate (included based upon inclusion of data from a cross-gradient well).

A remedy effectiveness review will be conducted within the first five years of the LTM program as described in the IMWP Section 9.0. The groundwater monitoring program will be assessed as part of the remedy effectiveness review. The Army anticipates that data from groundwater monitoring presented in the effectiveness review may indicate that the list of analytes should be further reduced, the frequency of monitoring should be further reduced, or that further monitoring will not be necessary.

The LTM program as presented in November 2010 Section 9 has been modified based on regulatory comment and the redline text is appended to these responses to comments.

The analytes detected throughout the LTM program will be assessed via the LTM reports. Groundwater analytical results will be compared to background and promulgated Federal Safe Drinking Water Act Maximum Contaminant Levels (MCLs). Analytes for which a promulgated MCL does not exist will be evaluated with respect to EPA Regional Screening Levels (RSLs). Analytes that are not detected above laboratory method detection limits as specified in the project QAPP will not require further technical evaluation."

The Section 9 IMWP text has been corrected to state that the laboratory Limit of Quantitation (LOQ) will be used to eliminate analytes during the first four quarters of sampling, consistent with the USEPA Unified Guidance. Establishment and use of a background dataset will eliminate analytes that are below background and thus not associated with SWMU 40. The LTM Plan will be expanded to include the following additional optimization criteria:

> Following completion of the first four quarters of data collection, the analytical data will be evaluated to identify analytes that meet one or more of the following criteria:
>
> 1) not detected at or above the laboratory LOD for three (3) consecutive monitoring events;
> 2) detected concentrations do not exceed the established background concentration for three consecutive events;
> 3) detected concentrations do not exceed half the relevant MCL or RSL for 3 successive samples and the results display a static or downward trend.

As identified in the approved final RFI/CMS, monitoring well LFMW01 will be the upgradient (background) monitoring well. Data resulting from sampling of this well will be used for comparison to the downgradient wells 40MW5, 40MW6 and 40MW7 (new well to be installed), using the statistical method determined to be appropriate after collection of the initial four quarters of data.

The changes to Section 9.0 of the IMWP is attached in redline version for regulator review and concurrence.

9.0 LONG TERM MONITORING PLAN

~~SWMU 40 Groundwater Monitoring Plan~~ This Section establishes the Groundwater Monitoring Plan for SWMU 40 in conformance with the USEPA and VDEQ approved Final RFI/CMS for SWMU 40, RAAP-009 (URS, 2009).

9.1 Groundwater Monitoring Program

The selected remedy for SWMU 40 includes installation of one additional groundwater monitoring well in the downgradient direction, to be identified as 40MW7. The location selected and documented within the Final RFI/CMS is illustrated on Figure 4 in this IMWP.

The groundwater monitoring network at SWMU 40 will consist of one upgradient well, LFMW01, and three downgradient wells. The three downgradient wells include existing wells 40MW5, 40MW6, and the new well to be installed as 40MW7. Installation of this new well is presented elsewhere in this IMWP. Table 1 summarizes the long term monitoring program that will be implemented as part of the Corrective Measures at SWMU 40.

Table 1 - Long Term Groundwater Monitoring Program, SWMU 40, RAAP-009:

Monitoring Well Designation	Relative Position to SWMU 40	Monitoring Frequency	Analytical Parameters
LFMW01	Upgradient	Year 1: Quarterly Years 2-5: Every 9 months Years 6-30: Annual	Field water quality: pH, turbidity, specific conductance, temperature, dissolved oxygen, oxidation/reduction potential TCL VOCS, SW846 Method 8260B; TCL SVOCs, SW846 Method 8270C SIM; TCL Pesticides, SW846 Method 8081A; TAL Metals, SW846 Method 6000/7000; Perchlorate, SW846 6850; Dioxins/furans, SW846 Method 8290 included in initial sampling event only
40MW5	Detection Well at edge of landfill boundary		
40MW6	Detection Well at edge of landfill boundary		
40MW7	Well downgradient of Landfill		

The first year of long term monitoring (LTM) will include four quarterly monitoring events. Dioxins and furans will be sampled and analyzed solely in the first quarterly sampling event of the first year of LTM. In years 2-5 of LTM, groundwater sampling and analysis will be conducted every nine (9) months. This program will allow the LTM program to include evaluation for seasonal variations. ~~Annual sampling and analysis is anticipated for years 6-30 of LTM.~~

LTM reports will be prepared and submitted following the completion of the first four quarters of sampling, and after each of the following events. It is anticipated the fourth sampling event conducted on a 9-month time interval will be included in a combined LTM and remedy effectiveness review report.~~on an annual basis.~~

Each LTM report will summarize the sampling and analysis conducted and will present both summarized LTM results and complete laboratory analytical results. Complete laboratory analyses will be presented in electronic form (e.g., CD ROM or equivalent).

Any analytes that are not detected above laboratory method detection limitslimit of quantitation (LOQ) during the first four quarters of monitoring will be eliminated from the analytical reporting list for future sampling events. In addition, the four quarters of monitoring in the upgradient well will be used to calculate background for the detected analytes. The down gradient wells will be compared to the calculated background values and any analyte below background in all three down gradient wells will be eliminated from the analytical reporting list for future sampling events.— This information will be noted in the first LTM report for the first four quarters of data. Retention of analytes in the LTM monitoring and reporting will be evaluated in reports for each subsequent sampling and analysis event based upon the site specific dataset that will be included and evaluated. Over time, the Army will seek to optimize the monitoring program further.

The analytes detected throughout the LTM program will be assessed via the LTM reports. Groundwater analytical results will be compared to background and promulgated Federal Safe Drinking Water Act Maximum Contaminant Levels (MCLs). Analytes for which a promulgated MCL does not exist will be evaluated with respect to EPA Regional Screening Levels (RSLs). Analytes that are not detected above laboratory method detection limits as specified in the project QAPP will not require further technical evaluation. A list of the specific analytes included in the groundwater LTM program and their associated reporting limits and method detection limits are presented in Appendix B (Master Work Plan Addendum #30, Quality Assurance Project Plan for SWMU 40).

At a minimum, the following criteria will be applied to data evaluation and optimization of the monitoring program after the first four quarters of data have been generated:

1) Analytes that do not exceed the laboratory LOD during three (3) consecutive monitoring events will not require further sampling and analysis;
2) Analyte detections that do not exceed the established background concentration for 3 successive sampling events will not require further sampling and analysis;
3) Analyte detections that do not exceed half the relevant MCL or half the relevant RSL for 3 successive sampling events and the results display a static or downward trend will not require further sampling and analysis.

Within the first After five years of monitoring have been completed, a remedy effectiveness evaluation will be conducted for SWMU 40. The remedy effectiveness evaluation will include a presentation of the groundwater data collected throughout the LTM program to date. The analytical results will be statistically evaluated against the background dataset, and to determine if any trends are exhibited. The site specific data will be evaluated using appropriate statistical methodologies, and data assessment will be conducted in general conformance with the recommendations of USEPA guidance entitled *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance, March 2009* (EPA 530/R-09-007).

The remedy effectiveness review will be used to determine if exposure assumptions in the Final RFI/CMS remain correct, and whether the remedy continues to achieve CMOs, and will be used to determine what, if any, continuing groundwater monitoring is appropriate for SWMU 40. It is anticipated the fourth 9-month interval sampling event will be completed and included in an expanded and will be provided in the LTM report that will include the remedy effectiveness review. At the Army's discretion, remedy effectiveness evaluations may be conducted more frequently than once per five years.

Assuming that stable to decreasing concentrations of analytes are demonstrated in the LTM reports, RFAAP may request to decrease the frequency of monitoring from that specified in Table 1, up to and including termination of groundwater monitoring.

9.21 Long Term Inspection and Maintenance Plan

Additional long term maintenance would also be conducted at SWMU 40, RAAP-009; including inspection of the landfill cap to ensure that the landfill cap integrity is maintained. Inspections would be conducted in conjunction with groundwater monitoring events and thus will follow the same schedule specified in Table 1, Long Term Groundwater Monitoring Program.

Inspections will include visual evaluation and documentation of negative effects of the following:

1. Precipitation run-on and runoff;
2. Water and/or wind erosion;
3. Rodent and/or vector activity;
4. Deep root vegetation;
5. Vegetative stress and other cover condition;
6. Subsidence or cracks in cap;
7. Excavation or other manmade intrusive work conducted within the landfill footprint.

The landfill cap inspection form included in Appendix D or equivalent would be used to document inspection results, and maintenance, repair or corrective action. Photos also may be used to illustrate the condition of the landfill. The completed Iinspections will be conducted and documented as specified in the final RCRA Corrective Action permitis to be included in each annual LTM report. Should groundwater monitoring no longer be required, signage at SWMU 40 will be maintained but formal landfill inspections and reporting will not be required.

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9.23 LTM Reporting

The results of groundwater monitoring and landfill inspections, maintenance, repair and corrective action will be presented in LTM reports submitted each yearfollowing the first four quarterly sampling events. The initial LTM report will be submitted after the first four quarters of monitoring have been completed. Subsequent reports will be submitted for regulatory review after receipt of laboratory analyses, data review and validation, and review of the draft report by RFAAP.

The initial annual LTM report will include calculation of a background dataset, based upon the first four sampling events. The dataset from these events will provide the first opportunity to evaluate background. After opportunity is provided to evaluate these first 4 quarters of data, additional information is expected to be available to further optimize the groundwater monitoring program. The refined optimization will be included in recommendations of the remedy effectiveness review, which will be submitted for regulatory review and approval.

Should groundwater monitoring requirements terminate in the future, signage at SWMU 40 will be maintained but formal landfill inspections and reporting will not be required.

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9.4 Maintenance of Institutional Controls

Consistent with Section 3.7 of this Work Plan, signage will be placed and maintained at SWMU 40 to denote the site as a closed unit. Applicable Institutional Controls (ICs) and Engineering Controls (ECs) will be maintained, and inspections conducted, as specified in the final RCRA Corrective Action permit.

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From: Weissbart.Erich@epamail.epa.gov [mailto:Weissbart.Erich@epamail.epa.gov]
Sent: Wednesday, February 23, 2011 9:41 AM
To: McKenna, Jim J Mr CIV USA AMC
Cc: Richard Mendoza; Cutler,Jim; Parks, Jeffrey N; jeremy.flint@atk.com; jerome.redder@atk.com; Mary Lou Rochotte; Timothy.Leahy@shawgrp.com; Meyer, Tom NAB02
Subject: RE: SWMU 40 & SWMU 54 comments (UNCLASSIFIED)

Yes, they are all the comments generated by DEQ/EPA. O.k., will separate the comments by SWMU going forward.

Erich Weissbart P.G.
Land and Chemicals Division (3LC20)
US EPA Region III
1650 Arch Street
Philadelphia, PA 19103
Phone: 215-814-3284
e-mail: weissbart.erich@epa.gov

From: "McKenna, Jim J Mr CIV USA AMC" <jim.mckenna@us.army.mil>
To: Erich Weissbart/R3/USEPA/US@EPA
Cc: <jeremy.flint@atk.com>, <jerome.redder@atk.com>, "Meyer, Tom NAB02" <Tom.Meyer@usace.army.mil>, "Richard Mendoza" <havnfn2@gmail.com>, "Mary Lou Rochotte" <mrochotte@kemron.com>, <Timothy.Leahy@shawgrp.com>, "Parks, Jeffrey N" <Jeffrey.Parks@shawgrp.com>, "Cutler,Jim" <James.Cutler@deq.virginia.gov>
Date: 02/23/2011 09:36 AM
Subject: RE: SWMU 40 & SWMU 54 comments (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: FOUO

Erich,

Are these all of the comments from EPA and DEQ? Just want to confirm.

Going forward, as there are multiple contractors working on this program it might be best to send comments to me with cc to Jerry Redder, Jeremy Flint, ATK, Tom Meyer, CENAB and Rich Mendoza, USAEC.

Also I would suggest future comments be separated and sent to me/us for each SWMU/site. In this way Tom and/or I can get them to the appropriate contractor.

Thanks,
JJM

-----Original Message-----
From: Weissbart.Erich@epamail.epa.gov
[mailto:Weissbart.Erich@epamail.epa.gov]
Sent: Wednesday, February 23, 2011 8:11 AM
To: McKenna, Jim J Mr CIV USA AMC
Subject: SWMU 40 & SWMU 54 comments

Jim,
Please forward comments to whomever necessary and going forward I'll rely on you to tell me who to cc on these emails. We have discussed and reviewed Interim Measures Workplans for the two referenced Solid Waste Management Units above.

Comments for SWMU Unit 40:
1. Subsequent to the installation and development of new monitoring well 40MW7, and as part of the IM Implementation Report, include the well development logs.
2. The workplan referenced SOP 30.2, groundwater sampling, but the SOP was not included on the CD. Please update the workplan to include SOP 30.2.
3. Text in 9.0 states the monitoring program will be optimized further - please provide the details of the proposed optimization so that future optimization is captured by the workplan and won't have to be negotiated down the road.
4. One of the comparison criteria proposed for groundwater is background. Background concentrations need to be statistically represented and therefore the statistics proposed for background calculations need to be presented and agreed upon in the workplan (Attachment).
5. Section 3.4 - It is not clear how the areal extent of the cap (as shown on Figure 6) will be bounded. The purpose of the cap appears to be two-fold; to repair visible erosion and to provide a barrier to unacceptable exposure to PCB concentrations above industrial levels. If that is the case then site data and/or additional sampling should be used to delineate the cap. It is anticipated that the SWMU boundary will be redrawn and that an IC will be developed to restrict disturbance/excavation into the cap. An additional IC will also be required for any additional land where residential levels are exceeded.
6. Section 3.5, Geospatial Data - please define what is proposed in detail. I'm assuming this section refers to a survey.
7. Section 9.0 - Monitoring well 40MW3 should be included as a downgradient monitoring well; however, include in the optimization the criteria by which monitoring wells can be dropped from the network.

As a general comment I don't find text included in section 1.1.2, Site History, paragraph 3, starting with "The lack of detections and absence of................" to be particularly constructive. Not knowing the entire history of communications on this unit I have no preconceived thoughts on the analysis for chloroform in groundwater; however, the text leads the reader to believe that chloroform is either unnecessary or what - an ASD for chloroform is forthcoming? Which leads me to my last comment. There appears to be a rather lengthy list of constituents on the monitoring list. The workplan states that any constituents ND for the first 4 quarters will be eliminated. That still leaves a long list of metals that likely have nothing to do with waste disposal practices at SWMU 40, nor contribute to a degradation of groundwater quality. Consider those constituents that exceed SSLs. This should be part of the optimization proposed in the workplan - how to remove inorganic constituents not exceeding background or possibly not exceeding risk (or MCLs). You may want to refer to guidance generated by VADEQ in their regulated waste programs.

Comments on the IM Workplan for SWMU 54:
I will caveat my comments by restating from above: I have no historical basis and no preconceived notion of the utility of the selected remedy.
1. On first take the monitoring network appears to be very large considering the purpose - demonstrating MNA. All wells in an MNA monitoring network, and for that matter any monitoring network, should have a purpose. Please define the purpose of all wells proposed for the monitoring network in the context of an MNA demonstration: performance, sentinel, background, etc.
2. Provide historical concentrations for existing wells, a recent groundwater potentiometric surface map, and include some characterization in the report, i.e. groundwater velocity, surface water affects, etc. so the reviewer has the context for an MNA demonstration.
3. Quarterly monitoring is appropriate to begin a natural attenuation monitoring program for establishing a baseline and possibly necessary for up to two years to demonstrate MNA, but to continue quarterly monitoring into perpetuity is overkill; unless groundwater is moving at such a rate that quarterly monitoring is necessary. The footnote reducing quarterly to semiannual with 4 quarters below RGs is noted, which leads to why not to annual if the wells are below RGs? Also, what are the provisions for removing wells from the network? Last, monitoring programs typically allow for the removal of constituents after either 2 or 3 years (not quarters) below RGs. Once again I would refer you to guidance promulgated by VADEQ.
4. What is the contingency plan if consituents do not decline after a defined period of time? There has to be a discussion of what remedy the facility will employ if MNA is unsuccessful. Similarly, there has to be a discussion on how the MNA program will be evaluated and what constitutes success.
5. The report claims to be monitoring daughter products but I don't see any daughter products in the monitoring list. Also, monitoring geochemical indicator parameters are not evidence of attenuation (ferrous iron, manganese 2+, nitrate, and sulfate); only a demonstration that conditions are favorable or not. Daughter constituents need to be added to the monitoring list, e.g. chlorate, chlorite, choride for perchlorate breakdown and formaldehyde and methanol for breakdown of RDX - this list is provided as an example and not meant to be comprehensive; the facility should propose a list of daughter products. Add methane sampling and analysis to SOP as needed. For example, if sulfate concentrations in ground water are less than 0.5 mg/L, methane concentrations are greater than 0.5 mg/L, and H2 concentrations are in the 5 to 20 nM range, it can be concluded with a high degree of certainty that methanogenesis is the predominant redox process in the aquifer.
6. What is the evidence for natural attenuation? Please include a discussion or demonstration that MNA is occurring.

Subsection 2.2
The work plan states that compliance will be achieved at the point of compliance wells in the aquifer downgradient of SWMU 54. Note that RCRA requires compliance for the entire plume (vertically and horizontally). Compliance may be measured at POC wells.

The work plan states: "Natural Attenuations is therefore, a passive remedial approach reliant upon natural transport and degradation processes."

Monitored natural attenuation is appropriate as a remedial approach only when it can be demonstrated capable of achieving a site's remedial objectives within a time frame that is reasonable compared to that offered by other methods and where it meets the applicable remedy selection program for a particular OSWER program. EPA, therefore, expects that monitored natural attenuation typically will be used in conjunction with active remediation measures (e.g., source control), or as a follow-up to active remediation measures that have already been implemented. (EPA/600/R-98/128 September 1998)

Describe how the active remediation measures taken/to be taken to achieve the remedial objectives for this site will be used to support the monitored natural attenuation approach to site remediation.

Subsection 2.4.1
Please include the results of pore water/surface water sampling (subsection 3.1.1) in the annual report analytical result/data summary.

Please include waste characterization and off-site disposal reports in the annual report.

Please include all historic ground water and soil/sediment data in the annual report.

Subsection 2.5
Work outside the scope of this WP is not to be performed without the approval of the USEPA, Region III. Amendments or supplements to this WP must be submitted in writing to the USEPA for approval prior to being implemented by project personnel.

Subsection 2.6.1
The basis for a decision to terminate MNA must include results from pore water/surface water sampling.

Erich Weissbart P.G.
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Classification: UNCLASSIFIED
Caveats: FOUO

[attachment "Fact Sheet Unified Guidance 2009.pdf" deleted by Erich Weissbart/R3/USEPA/US]

United States Environmental Protection Agency EPA 530-F-09-020 March 2009

Fact Sheet

Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities—Unified Guidance

Features of the Unified Guidance

What's new in the guidance? The March 2009 version of the Unified Guidance represents more than a decade of input from EPA Regions, states, statisticians working with groundwater monitoring, and results of a formal peer review. While the RCRA regulatory programs have been established for some time, existing guidance does not fully cover newer methods and experience gained in implementing the program. Major features include:

- Updated guidance for RCRA Subtitles C & D groundwater monitoring regulations covering all specified tests and performance criteria
- A suggested systematic detection monitoring framework to balance false positive errors and power in light of multiple comparisons
- Newer statistical methods for prediction limits, outlier, normality, autocorrelation and non-detect data diagnostic evaluations, and expanded use of non-parametric test methods
- Use of trend testing when stationarity assumptions cannot be met
- Expanded single-sample tests for compliance and corrective action monitoring, considering false positive errors and power

Organization. The guidance is laid out in four parts, with extensive Appendix statistical tables to support individual test methods:

- Part I identifies the key RCRA regulatory provisions and general recommendations for implementing these rules. It addresses issues of ***statistical design***: factors such as developing and updating background data and strategies for constructing an effective statistical monitoring program.
- Part II covers diagnostic evaluations for checking key assumptions—outliers, normality, autocorrelation, non-detect data, spatial and temporal dependence. Useful exploratory techniques and tests are provided.
- Part III presents formal testing procedures for detection monitoring, covering both 40 CFR Parts 265, 264, and 258 requirements.
- Part IV is devoted to compliance and corrective action formal tests. Strategies are provided for a range of conditions including parametric and non-parametric alternatives.

What is the Unified Guidance?

This latest version of **Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities** is termed the Unified Guidance, since it integrates and supersedes two guidance documents of the same title released in 1989 and 1992. It resolves certain problems in earlier guidance while providing newer statistical methods and strategies developed in the mid-1990's and later. The guidance applies to both RCRA Subtitle C and D regulations. The focus is on RCRA hazardous and solid waste facility regulatory requirements, although the general statistical guidance is useful in other regulatory monitoring applications.

The guidance contains a compilation of statistical methods recommended for groundwater monitoring at RCRA and other facilities. It provides comprehensive strategies for designing the statistical aspects of facility detection, compliance, or corrective action monitoring systems. Interpretations are suggested for key statistical provisions of the RCRA groundwater monitoring regulations.

How was this guidance developed?

In the mid-1990's, the EPA Office of Solid Waste convened a task group consisting of state and EPA personnel, industry representatives, and statisticians closely involved with groundwater monitoring issues. The goal was to develop more current and relevant RCRA statistical guidance. Following a number of preliminary drafts, a full version was circulated in 2004 to interested state regulatory personnel for their comments, as well as to three expert peer reviewers in 2005. The various drafts were produced by Science Applications International Corporation (SAIC), using the technical expertise of statistician Dr. Kirk Cameron (MacStat Consulting Ltd). The Unified Guidance has been substantially modified and expanded to address the issues raised by commenters.

Who are potential users of this guidance?

The guidance is aimed at the informed professional working in the groundwater monitoring field, assuming a limited background in statistics. The primary users are expected to be:

- Owners, operators, and personnel at Subtitle C hazardous waste or Subtitle D solid waste facilities
- State and EPA regulatory personnel concerned with permits, enforcement and compliance at these facilities
- Consultants and statisticians providing technical assistance to regulated facilities; and
- Other ground water and regulatory monitoring program personnel such as in the CERCLA program.

Features of the Unified Guidance

Part I-- Introductory Framework

- Regulatory Issues
  - Hypothesis testing frameworks
  - Sampling requirements
  - Limitations of certain tests like ANOVA
- The groundwater monitoring context
- Basic statistical concepts
- The nature of hypothesis testing
- Establishing and updating background data

- Detection Monitoring Design
  - Control of false positive errors with multiple comparisons
  - Sitewide False Positive Error Rate [SWFPR] application
  - Minimum power reference criteria
  - Using multiple test methods
  - Effect size power evaluation
  - Appropriate tests including trend analysis

- Compliance/Corrective Action Monitoring Design
  - Use of single sample tests against a fixed standard
  - Hypothesis framework
  - Centrality versus upper percentile parameters
  - Test types (parametric vs. non-parametric, trends)
  - Testing Against a Background Standard

Part II-- Diagnostic Evaluation and Testing

- Exploratory data tools
- Goodness-of-fit testing
  - Importance of the normal distribution
  - Other normalizing transformations (logarithmic, ladder-of-powers)
- Outliers
- Equality of Variance
- Managing Non-Detect Data
- Spatial Dependence
- Types of Temporal Dependence
  - autocorrelation, trends, seasonality, etc.

Part III-- Detection Monitoring Tests

- Coverage of all regulatory tests
  - t-tests, ANOVA, control charts, prediction and tolerance limits
- Parametric versus non-parametric methods
- Tests when non-detect data are present
- Use of trend analyses
- Emphasis on prediction limits for systematic design

Part IV-- Compliance/Corrective Action Tests

- Test of means versus upper percentiles
- Control of false positive errors and power
- Fixed standards vs. background limits

What legal limitations does this guidance impose?

EPA makes it clear at the outset of the document that this present work is **guidance only**, and does not confer any legal requirements or obligations on regulated entities or regulatory programs. While it is necessary to make interpretations of regulatory language to apply statistical measures, those found in the guidance are only suggested. Other approaches and statistical methods can work equally well or better in specific instances. As a practical matter, it is recognized that states may choose to adopt requirements similar to guidance recommendations. While we believe that the document offers reasonable current guidance, experience and statistical applications in this field are continually evolving.

What regulations and issues are covered?

The guidance covers the statistical aspects of groundwater monitoring regulations for 40 CFR Parts 265, 264, and 258. These include monitoring under Subtitle C interim status and RCRA permits, as well as for Subtitle D solid waste facilities. These rules span a considerable period of time from 1980 forward, with significant modifications to the Part 264 regulations in 1988 and 2006. Key portions of regulatory language pertaining to groundwater monitoring and statistical testing are provided in the guidance. These include the specified test procedures, performance criteria, sampling requirements, and identification of relevant groundwater protection standards.

Basic statistical interpretations include identifying the appropriate hypothesis testing frameworks, meeting performance criteria, the application of certain sampling data requirements, and the use and limitation of designated tests. For some applications, the regulations do not explicitly identify appropriate test methods; the Unified Guidance makes reasonable judgments as to the more appropriate procedures. One particular issue stressed throughout the guidance is the need to utilize statistically **independent** data as identified in 1988 and later RCRA regulatory language. Certain regulatory restrictions also dictate the appropriate responses for RCRA applications, but may not be limiting in other monitoring situations.

How is this document organized?

The guidance follows a logical progression from simple and general discussions to more detailed coverage of specific test methods. After presenting the regulatory context in Part I, a chapter is devoted to basic statistical concepts. These include the assumptions found in the RCRA performance criteria but are more broadly extended to include other standard statistical factors. Terms such as independence, statistical significance, stationarity, random sampling, spatial and temporal dependence, normality, equality of variance, outliers and non-detect data are defined and explained. The overall groundwater monitoring context is presented, with special emphasis on hypothesis testing and the related false positive and negative errors. A separate chapter discusses developing, assessing and updating background data.

General design considerations are provided for developing a detection monitoring system. The guidance provides a systematic approach to integrating false positive errors and power in a site design. We specifically recommend a 10% Site-Wide False Positive Rate [SWFPR] partitioned among the total number of tests per year. EPA Reference Power Curves [ERPC] are provided as minimum criteria for sufficient statistical power, used to gauge the effectiveness of particular detection monitoring tests.

Design of compliance or corrective action monitoring systems follows. Because most groundwater protection standards [GWPS] are in the form of fixed, risk- or health-based limits, the design differs along with the appropriate types of statistical tests. Unlike highly site-specific detection programs, key decisions need to be made by regulatory agencies. These include the appropriate type of parameter for comparison to the GWPS, false positive and negative error rates, and the form of hypothesis testing. The use of a background GWPS is also discussed.

Following a summary chapter of recommended methods, detailed consideration of diagnostic evaluations and testing of data are provided in Part II. These include general exploratory techniques such as box plots or probability plots, testing for goodness-of-fit, outliers, non-detect data, equality of variance, spatial and temporal dependence. If assumptions critical to statistical tests are not met, the guidance suggests potential data adjustments for these situations.

Part III provides the specific detection monitoring tests found in the RCRA regulations. Each test is discussed in overall terms including necessary assumptions, followed by a detailed procedure and example. All formal tests in the guidance follow this same approach.

Part IV contains detailed methods for compliance and assessment monitoring using confidence intervals. Consideration is given to the design aspects presented earlier, including the parameter choice and hypothesis framework. A discussion of cumulative false positive errors and power is provided. Depending on whether compliance or corrective action monitoring is involved, false positive error and power criteria can vary based on different perspectives of the regulated entity and agency. The guidance offers recommendations which place priority on EPA and state regulatory needs to enhance protection of public health and the environment.

The appendices contain references, a glossary and index, as well as extensive tables for specific test methods which span the range of conditions likely to occur at regulated facilities.

Why is it recommended to use the SWFPR and ERPC in detection monitoring design?

These criteria stem from problems historically experienced at facilities conducting multiple statistical tests for a wide range of monitoring constituents at numerous compliance wells. This is the classic **multiple comparisons problem**. When many tests are conducted at a fixed error rate, the chances of one or more false positive errors (a condition when one concludes that a release has occurred when there is in fact none) can become unreasonably high. A second and very important consideration is that statistical tests must have sufficient ability (or power) to detect such a release when it occurs.

Within the limits of the RCRA regulations, certain opportunities were afforded to control this potentially high rate of false positive error. This is especially true if prediction limits are used as tests, although two other identified methods—control charts and tolerance limits—can be similarly designed. By maintaining a consistent overall annual error rate, all regulated facilities will be afforded the same risk.

Based on earlier work by EPA and others, prediction limit tests typical of the RCRA groundwater monitoring context were identified as a minimally acceptable criterion for power to detect real releases to groundwater. While a relative measure, it can be applied universally to all detection monitoring tests. The March 2009 Unified Guidance extends this approach to consider the cumulative power of tests, based on the number of annual evaluations per year. It provides a common framework for considering both cumulative false positive errors and power.

The guidance also discusses effect size power as an alternative to the relative power criteria. This approach requires a regulatory agency determination of a specific increase of concern. At present, there are few if any such criteria established. This approach may find use in specific applications discussed in the guidance.

While the SWFPR and ERPC approaches are recommended for detection monitoring, the guidance reaches different conclusions for compliance and corrective action monitoring when fixed limits are used as standards. The situation is too uncertain and problematic to apply the same concepts, and other strategies are recommended.

Why is diagnostic testing important and when should it be used?

In addition to addressing the RCRA regulatory requirements for performance criteria, it is good statistical practice to know one's data closely. Checking key assumptions is critical to proper performance of any statistical test. Misapplication can also generate results which do not follow the expected outcomes of a given test. Diagnostic testing is performed primarily during permit or remedial action plan development. Once a set of tests is selected for formal permit or remedial plan monitoring, diagnostic testing might only be periodically expected (e.g., for updating background data).

Many important statistical tests assume a **normal distribution. Goodness-of-fit** techniques for identifying a probable normal distribution are found in the guidance. In many situations, a transformation of data (e.g., logarithmic, square root) can result in approximately normal data. Other parametric distributions may work equally well or better in some situations, but the guidance generally focuses on the family of normal distributions. If no transformation is suitable, non-parametric test methods can be used.

Equality of variance is an additional assumption necessary for some tests. The guidance provides both exploratory measures and a formal statistical test.

Outliers, often very large values of dubious quality, can significantly weaken the ability of tests to perform as expected. The guidance offers two test methods for identifying outliers, and suggestions for when they might be removed, replaced or otherwise avoided.

Spatial variability is a very important consideration. If background monitoring constituent mean data vary by well, assumptions for certain detection monitoring tests like Analysis of Variance (ANOVA) will not be met. More importantly, it will generally be impossible to determine if mean well differences are due to existing background conditions or a true release. Parametric or non-parametric ANOVAs are recommended in the guidance as diagnostic tests to initially establish if prior spatial differences exist. The outcomes may vary with the types of constituents being monitored.

Several forms of **temporal variation** can occur. Temporal variation is some non-random pattern in data over time. It could include autocorrelation, seasonal variation, well-to-well constituent correlation, correlation among monitoring constituents in a well, and the presence of trends. Each of these types of temporal dependence requires somewhat different diagnostic testing and potential adjustments provided in the guidance.

Non-detect values are a common feature of many RCRA constituent data sets. Those containing multiple non-detect limits are of particular concern. The Unified Guidance provides a number of non-detect data adjustment procedures, including two fairly recent methods for multiple non-detect limits.

Which detection monitoring tests are recommended?

While the guidance covers all of the regulatory tests, there is a clear preference for prediction limits or control charts as detection monitoring tests. The guidance specifically recommends the Shewhart-CUSUM option when choosing control charts.

For interim status or facilities with few annual tests, variants of the Student-t or alternative non-parametric two-sample tests may be sufficient. Other facilities will need to apply tests which account for the multiple comparisons. Both because of the common presence of spatial variability and regulatory restrictions, neither parametric nor non-parametric ANOVA tests are likely to be used frequently. Tolerance limits are similar to prediction limits, but their usefulness in designing a systematic detection monitoring program is more limited. Prediction limits provide the greatest flexibility, and the guidance provides the most extensive details for this method. By careful use of repeat testing, prediction limits can minimize future sampling requirements and meet the SWFPR and ERPC criteria. Nine different parametric and six non-parametric variants are provided to address most monitoring situations.

Which compliance/corrective action monitoring tests are recommended?

The regulatory agency first determines the appropriate form of comparison to groundwater protection standards [GWPS]. The guidance offers a number of single-sample tests for centrality parameters such as the arithmetic mean, geometric mean, arithmetic mean of a lognormal distribution, and median tests. If the decision is that a maximum limit is appropriate, the guidance offers parametric or non-parametric upper percentiles as options. Confidence intervals around trend lines may be appropriate in some instances. Testing background GWPS can either use options provided here or those for detection monitoring.

Where can the public get more information about this guidance?

The guidance will be available on the EPA website: http://www.epa.gov/epawaste/hazard/correctiveaction/resources/guidance/sitechar/gwstats/index.htm. For further assistance, please contact Mike Gansecki, EPA Region 8 (email: gansecki.mike@epa.gov or by phone: (303-312-6150).

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December 6, 2010

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Subject: With Certification, Solid Waste Management Unit 40 (RAAP-009) Landfill Nitro Area, Interim Measures Work Plan, Draft Final, November 2010
EPA ID# VA1 210020730

Dear Mr. Geiger and Mr. Cutler:

Enclosed is the certification for the subject document that was sent to you on December 3, 2010. Also enclosed is the 3 December 2010 transmittal email.

Please coordinate with and provide any questions or comments to myself at (540) 639-8658, Jerry Redder ATK staff (540) 639-7536 or Jim McKenna, ACO Staff (540) 731-5782.

Sincerely,

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Concerning the following:

Radford Army Ammunition Plant
Solid Waste Management Unit 40 (RAAP-009)
Landfill Nitro Area
Interim Measures Work Plan,
Draft Final, November 2010

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.

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Subject:	Draft SWMU 40 IMWP Nov 2010 FedEx Tracking (UNCLASSIFIED)
Importance:	High

Classification: UNCLASSIFIED
Caveats: FOUO

All,

The contractor will ship the subject document to the POCs with tracking numbers listed below. Certification will follow under separate cover.

Thank you for your support of the Radford AAP Installation Restoration Program.
Jim McKenna

-Jim McKenna 2 CDs as well (2 paper copies previously transmitted). 7941 7437 7187

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PERFORMANCE BASED ACQUISITION
INTERIM MEASURES WORK PLAN
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Appendix C Interim Measures Specifications

Appendix D Landfill Cap Inspection Form

LIST OF ABBREVIATIONS AND ACRONYMS

AEDB-R	Army Environmental Database-Restoration
ATK	Alliant Techsystems
CFR	Code of Federal Regulations
CMO	Corrective Measures Objectives
CMS	Corrective Measures Study
COC	Contaminants/Chemicals of Concern
COPC	Contaminant of Potential Concern
CQCP	Contractor Quality Control Plan
DERP	Defense Environmental Restoration Program
DFW	Definable Feature of Work
DOD	Department of Defense
DQO	Data Quality Objective
EC	Engineering Controls
EPA	United States Environmental Protection Agency
EPP	Environmental Protection Plan
ESCP	Erosion and Sedimentation Control Plan
FAR	Federal Acquisitions Regulations
FS	Field Supervisor
ft msl	Feet above Mean Sea Level
HTRW	Hazardous, Toxic and Radioactive Waste
IC	Institutional Controls
IDM	Investigative-Derived Material
IMWP	Interim Measures Work Plan
IRP	Installation Restoration Program
LTM	Long Term Management/Monitoring
LUCs	Land Use Controls
MMA	Main Manufacturing Area
MWP	Master Work Plan
NRU	New River Unit
NTP	Notice to Proceed
PBA TO	Performance Based Acquisition Task Order
PBC	Performance Based Contract
PM	Project Manager
PMP	Project Management Plan
PPE	Personal Protection Equipment
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QCM	Quality Control Manager
QCR	Quality Control Reports
QIP	Quality Improvement Process
RFAAP	Radford Army Ammunition Plant
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment

RFI	RCRA Facility Investigation
RFI/CMS	RCRA Facility Investigation/ Corrective Measures Study
RGs	Remedial Goals
SAP	Sampling and Analysis Plan
SM	Site Manager
SOP	Standard Operating Procedure
SSHO	Site Safety and Health Officer
SSHSP	Site Specific Health and Safety Plan
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TO	Task Order
TSDF	Treatment, Storage and Disposal Facility
USCS	Unified Soil Classification System
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Command
USEPA	United States Environmental Protection Agency
UXB-KEMRON	UXB-KEMRON Remediation Services, LLC
VESCLR&C	Virginia Erosion and Sedimentation Control Law, Regulations, & and Certifications
VDEQ	Virginia Department of Environmental Quality
WTDP	Waste Transportation and Disposal Plan
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

UXB-KEMRON Remediation Services, LLC (UXB-KEMRON) has been contracted by the U.S. Army Corps of Engineers (USACE) to perform an Interim Measures (IM) action at the Landfill Nitro Area, Solid Waste Management Area 40 (RAAP-009), at Radford Army Ammunition Plant (RFAAP), Radford, Virginia.

The following Interim Measures Work Plan (IMWP) includes details of mobilization, installation of one additional downgradient monitoring well, repairs to the landfill cap (specifically the north slope) and implementing institutional controls (ICs). Appendix A contains the Project Schedule, Appendix B contains the Draft Quality Assurance Project Plan (QAPP), Appendix C contains the Project Specifications, and Appendix D contains the Landfill Cap Inspection Form.

This IMWP is presented as an addendum to the *RFAAP Master Work Plan (MWP)* [URS Corporation (URS), 2003], and incorporates by reference the elements of the MWP, including Section 8, which discusses entry to the Installation and security concerns and requirements. The IMWP also incorporates details specified in the *Solid Waste Management Unit 40 and 71 (RAAP-022) Final Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI)/Corrective Measures Study (CMS) Report* (URS, 2009).

This remedy is being performed under a Performance Based Acquisition Firm Fixed Price Task Order (PBA TO) for environmental remediation services for three (3) sites at the Radford Army Ammunition Plant (RFAAP), including SWMU 40. All three (3) sites are being addressed under the Installation Restoration Program (IRP). The Department of Defense (DoD) established the Defense Environmental Restoration Program (DERP) to address environmental contamination located on current and former military installations. The contract was issued by the United States Army Corps of Engineers (USACE) – Baltimore located at 10 S. Howard Street, Box 1715, Room 7000 in Baltimore, Maryland. This TO # DA01 was issued under UXB-KEMRON's Worldwide Environmental Remediation Services contract, number W912DY-10-D-0027, with an award date of 30 June 2010 and a Notice to Proceed (NTP) date of 15 July 2010.

1.1 Background

1.1.1 Site Description

RFAAP is a government owned contractor operated manufacturing facility located in southwestern Virginia approximately 8 miles southwest of Blacksburg. ATK Energetics Systems is the current operator along with a variety of other tenants. RFAAP consists of two noncontiguous areas, the Main Manufacturing Area (MMA) and the New River Unit (NRU). RFAAP is operating under a 2000 RCRA Corrective Action permit, with a new permit currently being negotiated. The environmental work is being conducted under the Installation Restoration Program (IRP) of the Department of Defense.

SWMU 40 is located within the south-central portion of the MMA at RFAAP (Figure 1). Figure 2 shows the site layout, which includes the approximate 2-acre landfill area that comprises SWMU 40.

SWMU 40 consists of an undeveloped open area covered with grass. A gravel covered area used for temporary storage of asbestos located at the eastern edge of the site (Figure 2). A paved road, named Landfill South Road for purposes of the IMWP, is located immediately south of the landfill area and undeveloped land borders the landfill area to the north (field) and west (wooded area).

1.1.2 Site History

The RCRA Facility Assessment (RFA) was conducted by the USEPA in 1987 and identified SWMU 40 as having the potential to release contaminants into the environment. Both of these SWMUs are included in the RFAAP RCRA Permit for Corrective Action (USEPA, 2000b).

According to the Final RFI/CMS (URS, 2009) in the 1970s and early 1980s, SWMU 40 was used for the burial materials, such as paper, office trash, concrete, and rubber tires. The unit was not permitted by the Commonwealth of Virginia as a solid waste landfill. Operations ceased and the unit was closed with a clay cap and grass cover. Subsequently, areas located northeast of the unit were used to stockpile soil derived from construction-related activities. In approximately 1991, a fenced enclosure was constructed in the northeastern corner of the SWMU 40 area for use as temporary asbestos accumulation area (Figure 2).

The results of the human health risk assessment included in the Final RFI/CMS (URS, 2009) identified that calculated cancer risks and hazard indices, when taking target organs and background into consideration, are within the USEPA target risk range for each receptor with the exception of the cumulative risk for the hypothetical future lifetime resident due primarily to arsenic and PCBs in soil. A future construction worker also had potential risk based upon potential aluminum exposure via the inhalation pathway. Additionally, the Final RFI/CMS identified chloroform as a groundwater Contaminant of Potential Concern (COPC). Chloroform was not detected in any SWMU-40 soil samples, many of which were collected from the landfill material and soil below the landfill material. The lack of detections and absence of other volatile organic constituents in groundwater samples suggests a potential alternate source for chloroform in groundwater at SWMU-40. The Final RFI/CMS notes that the landfill area is located downgradient of developed areas containing water lines that could be leaking, and which may be the source of chloroform in groundwater at SWMU-40. Therefore, based upon the site specific data, a chloroform source is not identifiable. Based upon the groundwater detections of this constituent however, it has been retained as a COPC in groundwater at this time. Perchlorate also has been retained as a COPC for groundwater.

A screening level ecological risk assessment also was included in the SWMU 40 Final RFI/CMS, with conclusion presented that no further action is necessary at SWMU 40 based upon potential risk to ecological receptors.

The RAAP-009, SWMU 40 Final RFI/CMS has been reviewed and approved by USEPA and VDEQ (letter dated 30 June 2009). The USEPA and VDEQ have agreed to the use of Interim Measures as a means to accelerate closure of this site and begin long-term maintenance and monitoring. This Interim Measures Work Plan (IMWP) has been prepared in conformance with the specifications detailed for Alternative 2 in the approved Final RFI/CMS and includes the installation of one additional downgradient monitoring well, repair to the landfill cap in areas impacted by surface erosion (specifically the north slope) and initiation of Long Term Maintenance (LTM) activities associated with cap maintenance and monitoring. This IMWP includes the LTM Plan in Section 9.

1.1.3 Physiography

The Master Work Plan (MWP) (URS, 2003) General Physiography of RFAAP and the MMA is discussed in Section 3.2 of the MWP. The site is located within a portion of the MMA that is characterized by gently to steeply sloping ridges, the presence of landforms indicative of karst topography (e.g., sinkholes), and a general downward slope toward the northwest. SWMU 40 is situated topographically lower than areas to the east, south, and west, and topographically higher than areas to the north (Figure 2).

The Final RFI/CMS describes local erosion features, which consist of small swales and gullies at the north central edge of the landfill and cut into the northern edge/slope of the landfill. Topography indicates small scale depositional features present at the base of the landfill slope. Occasional pieces of metal debris are scattered on the surface and are visible along the landfill slope.

1.1.4 Surface water

Figure 3 shows surface-water drainage patterns in the site area presented in the Final RFI/CMS. Few surface water bodies are present in the area and storm water drainage has been described as occurring primarily via infiltration and overland flow in ditches along engineered roadways. Surface water runoff from the landfill flows toward the north along several distinct gullies and swales, which cut into the northern edge/slope of the landfill. The RFI/CMS determined that overland flow has deposited material at the base of the landfill slope. Figure 3, the conceptual site model from the Final RFI/CMS, illustrates the deposition of sediment from storm water erosion of the north slope of SWMU 40.

1.1.5 Site soils

Information on the soil types found in the MMA of RFAAP is presented in Section 3.5.1 of the MWP and Section 2.3 of the Final RFI/|CMS. Soil at SWMU 40 has been mapped locally as Unison-Urban Land Complex (URS, 2003). Undisturbed soil typically consists of a 14-inch thick layer of dark brown loam (surface) and a 43-inch thick subsoil of yellowish-red, sticky plastic clay, which is underlain by a red sandy clay loam to a depth of 58 inches (URS, 2009). The permeability of the soil is moderate, natural fertility is low, and organic matter content is low to moderate. It is typically medium to strongly acidic with a pH of 4.5 to 5.5 (USDA, 1995). However, land-surface disturbances have removed the surface loam and parts of the underlying soil horizons. Specific physical properties of site soil were evaluated for the RFI by submitting four soil samples to URS' laboratory in Totowa New Jersey for physical testing for various parameters as summarized in Table 2-1 of the Final RFI/CMS.

1.1.6 Site Geology

Regional and general geology at RFAAP are discussed in Sections 3.6 and 3.7 of the MWP, respectively. Geologic and subsurface conditions at SWMU 40 were assessed during the RFI by completing geophysical surveys, soil borings and rock borings, test pits, installation of groundwater monitoring wells, and geological site reconnaissance. Section 2.6 of the Final RFI/CMS provides additional details regarding the site geology.

Landfill

A landfill cover is present at the surface across SWMU 40. The Final RFI/CMS presents the thickness of landfill cover encountered at boring and test pit locations within SWMU 40 ranging from 1 ft to 6.5 feet below ground surface (ft bgs). The landfill cover has been described as generally consisting of dark brown to yellowish brown lean clay (CL) and sandy lean clay (CL) with variable gravel at the surface or near surface (URS, 2009).

Landfill material underlies the landfill cover within the SWMU 40 boundary. In general, this material consists of gray to black clay, sand, gravel, and cinders mixed with abundant paper, glass, plastic, metal, wood chips, rubber, and bagged garbage. Landfill material was described as moist to wet with an odor ranging from sulfurous to strongly acrid and bitter. Soil below landfill material generally consists of brown to yellowish red clay (CL or CH) with variable sand content and occasional gravel.

1.1.7 Site Hydrogeology

Regional hydrogeology and general hydrogeology information for RFAAP is included in Section 3.8 of the MWP. Site-specific hydrogeologic conditions are discussed below.

Groundwater in the area of SWMU 40 occurs within bedrock in fractures and water saturated karst features. The first zone of groundwater encountered in bedrock during drilling ranged from143 and 122 ft bgs during the RFI. Stabilized potentiometric levels in the wells after drilling and during RFI groundwater sampling were approximately 100 to 106 ft bgs. The overall groundwater flow direction is west and northwest toward the New River. Dye test results at SWMU 17 identified a preferential pathway of groundwater flow from the vicinity of SWMU 40 toward the west, primarily through relatively well-developed karst conduits. Potentiometric surface maps, cross-sections and results from geophysical studies are presented in the Final RFI/CMS.

1.1.8 Previous Investigations

A RCRA Facility Assessment (RFA) conducted by the USEPA in 1987 identified SWMU 40 as having the potential to release contaminants into the environment. A RCRA Facility Investigation was completed to fill data gaps from previous site investigations, assess the nature and extent of the landfill area at SWMU 40 including cap material, landfill material, and soil underlying landfill material to evaluate potential releases to groundwater, to evaluate potential risks to human health and the environment using the physical and chemical data collected at the site; and collect data to support completion of a CMS. The Final RFI/CMS dated April 2009 presents additional details.

1.2 Development of Corrective Measures Objectives

The following Corrective Measures Objectives (CMOs) have been developed in the CMS for SWMU 40 based on the results of the site, risk, and fate and transport assessments. A summary of the CMOs are presented below, which will be achieved by implementation of Interim Measures as requested by USEPA and VDEQ:

- Maintain containment of the landfill material at the site and implement necessary controls to prevent future uncontrolled human exposure to this landfill material.
- Implement any necessary measures to stabilize and repair the landfill cover at the northern edge of the landfill area to prevent any further mass transport of soil material in this area.

1.3 Interim Measures Scope

Establishment of numerical remedial goals (RGs) for media at SWMU 40 (i.e., soil and groundwater) was not part of the CMS because it was determined that it was not required based on the results of the site, risk, and fate and transport assessment, given that the expected future land use of the site will be in adherence to the current and foreseeable use of the property in support of the Army mission remain a closed landfill area.

In accordance with the *SWMU 40 Final RFI/CMS, April* 2009, IMs are to be performed at SWMU 40. The IMs are being conducted to accelerate closure of this site and begin long-term maintenance and monitoring. The IMs include:

1. **Engineering Controls (EC) and Landfill Cap Repairs:** Engineering Controls (ECs) include repairs to the landfill cap where evidence of erosion has been noted, primarily the north face of the unit. Repaired areas will be stabilized and seeded to support a vegetative cover and minimize additional erosion.

2. **Monitoring Well Installation:** 40MW7 will be installed on the downgradient side of SWMU 40. The location of the well is approximately 135 feet west-northwest of the landfill area as indicated and more fully described in the approved RAAP-009 SWMU 40 Final RFI/CMS. Figure 4 illustrates the location in which the new well will be installed during implementation of this IMWP, following plan approval.
3. **Interim Measures Completion Report:** An Interim Measures Completion Report will be prepared and submitted for review and approval. The Interim Measures Completion Report will document completion of the approved elements of selected Corrective Measures Alternative Number 2.
4. **Long Term Monitoring and Maintenance:** Long Term Monitoring and Maintenance will be conducted in accordance with the parameters detailed in the approved RAAP-009, SWMU 40 Final RFI/CMS and as well is detailed in the LTM Plan in Section 9.

1.4 Work Plan Content

This IMWP is composed of an Introduction (*Section 1.0*), eight sub-plans (*Sections 2.0 through 9.0*), and references (*Section 10.0*). Detailed Health and Safety requirements for this scope of work are presented in the UXB-KEMRON Accident Prevention Plan (APP) prepared for this project. All UXB-KEMRON employees, subcontractors and visitors to the Site during the IM implementation will be required to review and abide by the APP. The Site Specific Health and Safety Plan (SSHSP) is included as an attachment to the APP. The eight sub-plans are as follows:

<u>Section 2 – Organization</u>
Identifies the UXB-KEMRON project staff and subcontractors, their roles and responsibilities.

<u>Section 3 – Technical Approach</u>
Provides the details regarding the technical approach to the followed for the IM.

<u>Section 4 – Project Schedule</u>
Presents the milestone events for the IM.

<u>Section 5 –Field Sampling Plan</u>
Describes the sampling rationale and field sampling procedures that will be used to collect field samples

<u>Section 6 – Environmental Protection Plan</u>
Details the procedures that will be taken to minimize and/or eliminate introduction of chemicals to the environment during IM work.

<u>Section 7 – Erosion and Sediment Control Plan</u>
Defines the steps that will be taken to minimize and/or eliminate erosion and sedimentation during IM work.

<u>Section 8 – Waste Transportation and Disposal Plan</u>
Identifies safe handling, transportation, and disposal procedures for waste material resulting from IM.

<u>Section 9 – Long Term Monitoring Plan</u>
Establishes the Groundwater Monitoring Plan for SWMU 40 in conformance with the USEPA and VDEQ approved Final RFI/CMS for SWMU 40, RAAP-009 (URS, 2009).

1.5 Work Plan Changes

Work outside the scope of this work plan will not to be performed without the prior discussion and agreement to any deviations among the Army, UXB-KEMRON, USEPA and VDEQ.

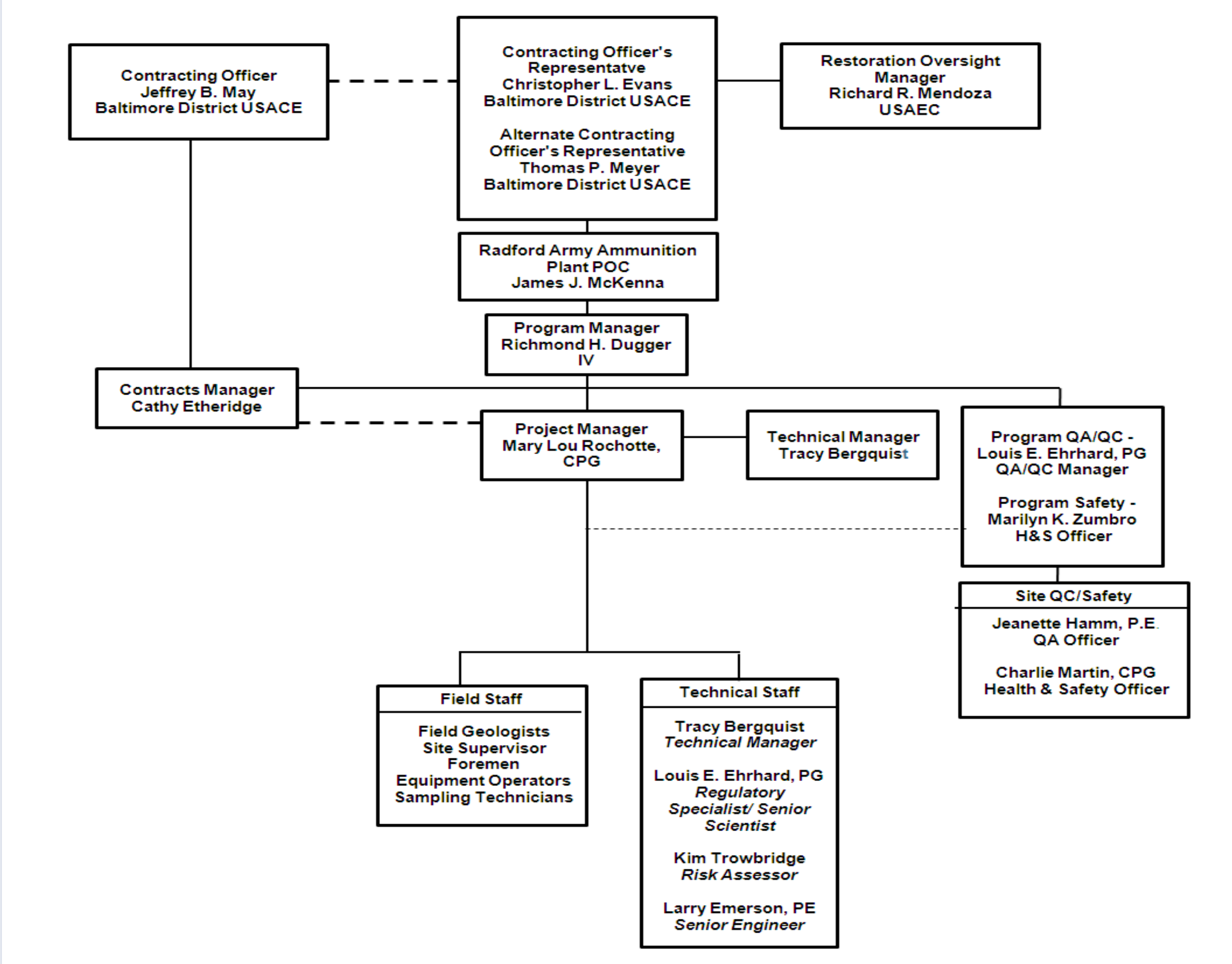
2.0 ORGANIZATION

This section describes the organization and activities to be conducted to accomplish the IM at SWMU 40. Specifically, this section outlines the organization and responsibilities for project personnel as well as presents the step by step approach to be performed for each of the IM tasks.

The duties and responsibilities of the key members of this organization are described below in flow chart form, and are further described in Appendix B.

2.1 Organization and Responsibilities

RFAAP Organizational Chart



The management of this contract involves multiple authorities, including the United States Army Environmental Command (USAEC), Baltimore District of the USACE, and RFAAP Army and ATK personnel. The Baltimore District, USACE is responsible for contract execution and oversight and provides technical reviews of contractor deliverables. RFAAP personnel, including both the Army and ATK, are the primary points of contact regarding coordination with regulatory personnel; USAEC and the Baltimore District support regulatory coordination. UXB-KEMRON is responsible for all technical issues, including development and negotiation of remediation and long term monitoring project standards and requirements.

The Baltimore District has made the following assignments for this contract: Jeffrey B. May, Contracting Officer; Christopher L. Evans, Contracting Officer's Representative; Thomas P. Meyer, Alternate Contracting Officer's Representative. UXB-KEMRON has been instructed that Mr. Meyer is our primary point of contact (POC) for day to day contracting matters.

Richard Mendoza has been assigned as the USAEC Environmental Restoration Manager (ERM). James McKenna, RFAAP Installation Restoration Program Manager, is the key POC for UXB-KEMRON site activities. Jerome Redder is the lead POC for the site operations contractor, Alliant Techsystems (ATK). Matthew Alberts is the ATK POC regarding field access and site work activities.

Mary Lou Rochotte will serve as the Project Manager. Ms. Rochotte, a Certified Professional Geologist, has been successfully managing Performance Based Contracts (PBCs) since 2002 and has managed a $7.6 million project located in Region III. She will be supported by a team of qualified environmental professionals including Louis Ehrhard as the Senior Scientist and Risk Assessor and Kim Trowbridge as the Risk Assessor. Mr. Ehrhard and Ms. Trowbridge also bring relevant and recent experience on PBCs in USEPA Region III. Additional scientists, chemists, engineers and technicians will support the project.

As the Project Manager, Ms. Rochotte is responsible for all day to day activities and coordination of such activities with Mr. Mendoza, Mr. Meyer and Mr. McKenna, as well as ATK representatives including Mr. Redder and Mr. Alberts. She will have work stoppage authority and/or will authorize field supervisors to have work stoppage authority in her absence from the field. She will coordinate closely with the project Quality Assurance Officer, and will oversee project quality control reviews of project deliverables.

The Project Manager and Quality Assurance Officer will maintain contact with the project chemists/project managers at all subcontracted analytical laboratories, and will also coordinate review and validation of all decision making data generated for the project.

UXB-KEMRON will select subcontractors as the project proceeds for field activities such as drilling, waste transport and disposal, surveying, and other specialty subcontracting project needs. The subcontractors will be selected through a competitive bidding process after safety prequalification and based upon task specific requirements such as required licensure or certification.

3.0 TECHNICAL APPROACH

The IM Work Plan is being prepared for implementation of alternative 2 presented and selected in the CMS. This includes implementation of ICs, cap repair, and LTM activities related to the landfill cover and groundwater monitoring. Remedy effectiveness evaluations will occur at five year intervals. Specific details on the LTM activities, including the locations, frequency, analytical requirements, management of Investigative Derived Material (IDM), reporting requirements, and a contingency plan if a significant release is identified are presented in a LTM Plan, included as Section 9 of the IM WP.

The following sections describe technical approach to the SWMU 40 IM. The field activities to be performed include: site preparation, landfill cap repair, implementing IC and EC, monitoring well installation, and preparation of the Interim Measures Completion Report.

Interim measures implementation will occur following receipt of written regulatory approval of the IMWP. UXB-KEMRON will address all RFAAP permitting requirements prior to initiation of the field work described in this plan. USEPA and VDEQ will be provided advance notice of mobilization to the site.

Interim measures implementation activities will be documented in multiple ways and in conformance to quality assurance standards established in site plans. At a minimum, notes of activities will be documented in field books, sampling logs/forms will be completed, and activities and site progress will be photodocumented. Remedial action specifications are presented in Appendix B.

3.1 Definable Features of Work

The field work for the RFAAP SWMU 40, RAAP-009, Nitro Landfill involves the following Definable Features of Work (DFWs):

1. Mobilization and Site preparation;
2. Landfill Cap Repair;
3. Institutional Controls;
4. Monitoring Well Installation;
5. Site Restoration;
6. IDW Characterization and Disposal; and,
7. LTM Plan initiation.

3.2 Three Phases of Control Procedures

The Project Manager (PM) and Field Supervisor (FS) will ensure that a three-phase control process is implemented for each definable feature of work. Each control phase is important for obtaining a quality product. However, the preparatory and initial inspections will be particularly valuable in preventing problems. Production work will not be performed on a DFW until a successful preparatory and initial phase inspection has been completed.

3.2.1 Preparatory Phase Inspection

A Preparatory Phase Inspection will be performed prior to beginning each DFW. The purpose of this inspection will be to review applicable specifications and verify the necessary resources, conditions, and controls are in place before the start of work activities.

The PM will verify with RFAAP representatives that all pre-construction submittals have been received and approved, and that lessons learned during previous projects have been incorporated, as appropriate, into the project procedures to prevent recurrence. The FS will meet with the PM, and the staff responsible for a DFW. Work plans and operating procedures will be reviewed by the PM to ensure they describe pre-qualifying requirements or conditions, equipment and materials, appropriate sequence, methodology, and QC requirements.

The PM and/or FS will verify the following:

- All plans have been prepared, reviewed, and approved, and are available to field personnel;
- All associated materials have been submitted and approved, have been properly stored, and are available on site;
- Appropriate field equipment is available, functional, and properly calibrated;
- Responsibilities have been assigned and communicated;
- The job hazards in the APP and SSHSP have been communicated and the necessary safety measures are in place and ready for use;
- Field personnel have the necessary knowledge, qualifications/expertise, and information to perform their duties; and
- Arrangements for support services have been made and the prerequisite site work has been completed.

Discrepancies between existing conditions and approved plans and/or procedures will be verified as resolved by the FS prior to the PM granting approval for work to begin.

3.2.2 Initial Phase Inspection

An Initial Phase Inspection will be performed by the FS or his/her designee the first time a DFW is performed. The purpose of the inspection is to:

- Check the preliminary work for compliance with procedures and contract specifications, as identified in the Preparatory Phase;
- Verify inspection and testing, as applicable;
- Discuss the acceptable level of workmanship with assigned personnel;
- Ensure safety compliance; and
- Check for omissions, deficiencies; and resolve differences of interpretation.

The PM ensures that discrepancies between site practices and the drawings and specifications are identified and resolved before granting approval to proceed.

3.2.3 Follow-up Phase Inspections

Follow-up Phase Inspections will be performed routinely during each DFW. The purpose of these inspections is to ensure continued compliance and quality workmanship and materials. The FS will monitor the practices and operations and verify continued compliance with the approved interim measures work plans. A Stop Work Order will be issued by the PM if a work stoppage is required to correct a deficient procedure or practice.

The FS will also verify that a daily safety and health inspection is performed and documented as prescribed in the SSHSP. The PM will oversee and observe the same activities as under the initial inspection. Discrepancies between site practices and the approved plans and/or procedures will be resolved by the PM prior to granting approval to continue work.

At the discretion of the COR, RFAAP representative or PM, additional inspections may be required on the same DFW. Such instances may be:

- Unsatisfactory work, as determined by UXB-KEMRON, the COR or RFAAP representative;
- Change in key personnel, or resumption of work after a substantial (2 weeks or more) period of inactivity ; and
- Changes to the project SOW and/or specifications.

3.2.4 Completion Inspections

Completion Inspections will be performed at the conclusion of a work feature or group of features to verify that project requirements are satisfied. A list of any deficient items will be prepared with due dates and space to document corrections made by the field team, with documentation of completed responses will be submitted to the Army, if such responses are necessary.

3.3 Mobilization and Site Preparation

Site preparation actions include performing a pre-existing site condition inspection, establishing temporary facilities (if necessary), installing decontamination areas, and establishing work zones.

Site mobilization operations will be completed prior to commencing the prescribed project operations. Site mobilization includes mobilization of required personnel and equipment to the SWMU. The anticipated main staging area will be located on the south site of SWMU 40 on top of the landfill (Figure 5). Mobilization of most resources will occur at the onset of the project. UXB-KEMRON will minimize disturbance to the landfill cap in this staging area, to ensure that no additional exposure to or release from the landfill occurs due to materials staging.

KEMRON will mobilize project personnel from areas both inside and outside the local region. All personnel working at the Site will possess the appropriate skills and knowledge necessary to function in their specified capacity. They will all have completed the necessary health and safety training and physical evaluations to ensure they are able and fit to complete their assigned duties in a safe and efficient manner. An Accident Prevention Plan (APP), which includes a Site Specific Health and Safety Plan (SSHSP), has been prepared for the RFAAP UXB-KEMRON project. All UXB-KEMRON employees and subcontractors, as well as all visitors to the site during UXB-KEMRON field work activities, will be required to conform to the APP. Equipment will be mobilized as needed and released when no longer required.

Equipment anticipated to be required for the work will include, but not necessarily be limited to:

- Crew vehicles;
- Dozer D-5;
- Front end loader;
- Drill Rig;
- Compactor;
- Various support and decontamination equipment.

All equipment will be maintained in good working condition and possess all required safety and operational controls. Inspections upon delivery are required in the APP. Daily safety and operational checklists will be completed for all equipment in use.

Minor clearing and grubbing may be conducted as part of the monitoring well installation. Sediment and erosion controls will be installed and are presented as Section 7.

3.4 Landfill Cap Repair

SWMU 40 requires cap repair along the north face in order to eliminate impacts associated with erosion (Figure 6). Surface water from the Asbestos Storage Areas and south of the landfill flows across the surface of the landfill and accumulates in a localized portion of the north face of the landfill slope. Over time, surface water run-off in this portion of the north face of the landfill slope has caused erosion damage/small gullies that are localized and are estimated to be less than 1-foot in depth. Engineering Controls (ECs) will include repairs to the existing landfill cap along the northern edge of the landfill area where erosion has occurred. Repaired areas will be stabilized and seeded.

As part of the IMWP, sheet flow across the landfill will not be re-directed and excavation into the landfill will not occur. Surface water overland flow on the landfill will be prevented from flowing over the top edge of the north face and down the landfill north slope by re-establishing soil berms along the top edge of the landfill slopes (that may be terraced) to direct surface water into a lined, rip-rap drainage swale. The drainage swale will be shaped to collect surface water at the top of the landfill slope and discharge it at the base of the landfill slope. The drainage swale will be shaped by placing and compacting clean backfill within an existing erosion gully. The compacted soil swale will be covered with a geotextile liner and riprap. The geotextile liner will help stabilize the slope and support the riprap, and riprap will be placed to help reduce the velocity of the surface water. The rip-rap will be approximately 6-inches nominal diameter and 1.5-feet in depth within the drainage swale. This action will not include any excavating or digging into the existing landfill cap to create the shape of the drainage swale. Figure 3 shows the anticipated location of the drainage swale and a typical cross-section of the riprap downdrain. .

The drainage swale will be installed in the area of the largest existing gullies. Once installed, the area surrounding the drainage swale will be backfilled to fill in any other existing gullies and the existing grade will be maintained to allow for mowing and maintenance of the north face of the landfill. Furthermore, the surrounding slope that shows evidence of erosion will be backfilled and the slope will be graded and seeded.

The backfill will be similar in composition to the material used on the existing cap, which has been classified as clay (CL) according to the Unified Soil Classification System (USCS). Backfill with be brought on-site in a dump truck and will be placed in the gullies in 1-foot lifts using a Dozer D-5. Soil will be compacted between lifts and the process will be repeated until the gullies and drainage swale have been restored to the surrounding or final grade. Rip-rap will be placed around the bottom of the drainage swale to prevent localized erosion and pooling of surface water.

As part of the IM, a 2-foot thick clay cover cap will be placed over the exposed PCBs detected during the RFI at location 40SS1 (Figure 6). The purpose of the cap is to eliminate exposure to PCBs caused by erosion of the landfill slope. The cap will consist of a clay (CL) and will serve to be a protective cover with low permeability. The clay cover cap will be compacted with a dozer, backhoe or power tamper as directed by the field foreman until the cover has been compacted appropriately. Six inches of top soil will be placed over the emplaced clay to ensure appropriate substrate for re-establishment of vegetation. The dozer will be decontaminated prior to use, after completion of the capping phase of the PCB area, and after completion of the project. All construction equipment will be decontaminated in accordance with the SOP for drill rigs (SOP 80.1), which utilizes pressure washers. The decontamination pad will be set up in the main staging area and will consist of a lined containment berm designed to collect decontamination water, such that it can be pumped out and containerized, sampled and staged prior to disposal. Decontamination procedures will follow those in SOP 80.1 for a drill rig.

3.5 Geospatial Data

Appropriate geospatial data will be collected as part of the IM implementation. Geospatial data will be collected to determine the limits of pertinent site activities, such as capping downgradient of the limit of

SWMU 40 on the northern toe of the slope (around RFI sample location 40SS1), and the location of monitoring well 40MW7 that will be installed. Geospatial data includes collection of GPS points in the field using a Trimble GeoXT unit, or equivalent, to define the extent of cap repair, and surveying all four monitoring wells included in the groundwater long term monitoring plan. The well survey will be conducted by a licensed surveyor. Survey data will be included in the IM Completion Report, and the delineation of horizontal extent of the repair area at SWMU 40 will be illustrated on a map to be included in the report as well.

3.6 Monitoring Well Installation

40MW7 will be installed on the downgradient side of SWMU 40. The location of the well is approximately 135 feet west-northwest of the landfill area as indicated and more fully described in the approved RAAP-009 Final RFI/CMS and on Figure 4. Limited clearing and grubbing will be required to access the proposed location of 40MW7. If tree removal is required to access the planned monitoring well location, then the trees will be cut down and placed on the ground outside of the access and well installation area. This will be conducted in accordance with the procedures specified in the Erosion and Sedimentation Control Plan, Section 7.0 of the IMWP.

Monitoring well 40MW7 will be designed and installed similar to existing wells at SWMU 40. 40MW7 will be installed following the procedures outlined in SOP 20.1 of the MWP and as described in Section 5.2 of the MWP (URS, 2003) for installation of multi-cased wells. A truck mounted, air rotary drill rig will be use to install 40MW7. A 10-inch diameter roller bit will be used to advance the boring through the overburden to the top of bedrock. A 10-inch diameter air hammer bit will be used to drill in bedrock to the target depth for installation of outer steel casing into competent bedrock. After the borehole is advanced to the target depth, a 6-inch steel diameter steel casing will be lowered to the bottom of the boring and tremie grouted in-place until undiluted grout reaches the surface in the annulus between the outer casing and borehole wall. The grout will be allowed to cure a minimum of 24 hours before further drilling inside the casing. The boring will then be advanced inside the casing with a 5-5/8-inch air-hammer bit to the termination depth of the well boring. Based on historic geophysics performed at the site, a “possible karst feature or fractures zone” may be located at an approximate elevation of 1850 ft mean sea level and lower. This elevation will be the target for the screened interval of the monitoring well. Boring logs will be completed as described in SOP 10.3 of the MWP and drilling activities will be documented in the field notebook as described in SOP 10.1 of the MWP. Downhole drill rig tools and equipment will be decontaminated before and after use following SOP 80.1 of the MWP.

40MW7 will be constructed with 2-inch diameter, Schedule 40 polyvinyl chloride (PVC) 0.01-inch factory slotted screen and riser pipe with threaded joints. Twenty foot long screens will be used, to be consistent with previous monitoring well construction at the site. The screen will be positioned to intercept the depth and fracture zone where the first significant water is encountered during drilling. The boring log, well development log and well construction diagram for 40MW7 will be included in the Interim Measures Completion Report.

Prior to groundwater sampling, 40MW7will be developed consistent with SOP 20.2 and as described in Section 5.2 of the MWP (URS, 2003). Initially, predevelopment of the well will be performed by airlifting techniques before final grouting and completion of the wells to remove accumulated fines and sediments. Three equivalent well volumes will be removed from the monitoring well during predevelopment. Final development will be completed after well completion and stabilization using a surge block, disposable bailer, and stainless steel, adjustable flow rate submersible pump, or equivalent with new disposable tubing. Development will be continued at the monitoring well until a minimum of three equivalent well volumes will be purged, water quality indicator parameters stabilize, development water is clear to the unaided eye, and any remaining sediment is removed from the well.

The new and existing monitoring wells will be surveyed using the U.S. State [Virginia (South Zone)] Plane Coordinate System (measured in U.S. survey ft) using the North American Datum 1983 to ensure accuracy of future water level measurements. Vertical elevations of top of casing will be surveyed to the nearest 0.01 ft using the National Vertical Datum of 1988.

3.7 Site Restoration

After cap repair and well installation activities have been completed, the site will be restored prior to de-mobilization from the site. The area of the landfill cap repair will be permanently stabilized to reduce erosion and sedimentation. Additionally, a sign will be posted at SWMU 40 to identify it as a closed unit. Labeling on the sign will be similar to signs at other closed units at RFAAP.

3.8 IDM characterization and Disposal

IDM generated at the site will include soil and groundwater from well installation and development activities, and through decontamination of non-dedicated equipment. Representative soil and groundwater will be sampled to determine the appropriate disposal option. It is anticipated that soil generated during well installation will be classified as a non-hazardous waste will be disposed in a RCRA Subtitle D Landfill. The decontamination fluid and well development water that is characterized as non-hazardous waste will be containerized and disposed off-site at an appropriate facility based upon waste characteristics. In the event that the RFAAP wastewater treatment plant determines the water to be acceptable and has the capacity to accept the IDM, the water may be disposed in the RFAAP wastewater treatment plant.

UXB-KEMRON will act as the agent for the Army for treatment and disposal of the wastes. UXB-KEMRON will select the final disposal facility for the waste based on several factors, including but not necessarily limited to:

1. Subtitle D Landfill.

2. Solicitation of bids.

3. Verification of permits and insurance (at time of award).

4. The disposal facility must meet the permit compliance requirements.

RFAAP will be consulted regarding the selection of the disposal facility. Contact information for the disposal facility(ies) selected for the SWMU 40 IM will be presented in writing after final selection.

IDM accumulation and labeling will be conducted as outlined in MWP SOP 70.1. Labeled drums will be transferred to the Installation's approved container accumulation area pending analysis for characterization and disposal. UXB-KEMRON will provide an inventory of generated IDM to the RFAAP for its records.

4.0 PROJECT SCHEDULE

The field activities to be performed as part of the SWMU 40 IM are anticipated to commence in December 2010. The proposed schedule of project tasks is provided in Appendix A.

Please note that the project schedule will be updated in each subsequent version of this work plan and will be updated and maintained throughout the project. The firm mobilization date will be coordinated with RFAAP and regulatory personnel will be provided at least two (2) weeks prior notice of the mobilization date. KEMRON anticipates implementing the IMWP for SWMU 40 in conjunction with the IMWP for SWMU 57.

5.0 FIELD SAMPLING PLAN

This Field Sampling Plan (FSP) describes the field defines the procedures and methods that will be used to collect field samples during implementation of the IMWP. Contents included in this FSP include: procedures for collection of waste characterization samples for soil and groundwater; borrow material. The requirements for sample chain-of-custody (COC), sampling management, such as sampling handling, holding times, documentation, and shipping are presented in the QAPP Addendum (Appendix B). This FSP was developed in accordance with USACE EM 200-1-3, *Requirements for the Preparation of Sampling and Analysis Plans* (USACE, 2001), and is to be used in conjunction with the RFAAP Master Work Plan, and the QAPP Addendum found in Appendix B.

5.1 Project Description

The project history and the planned remedial action is been presented in the Introduction, *Section 1.0*, the Organization, *Section 2.0*, and Technical Approach Plan, *Section3.0*, of this IMWP, respectively. Field sampling activities will be conducted as part of the planned remedial action. The field sampling activities are discussed below.

5.2 Project Organization

A discussion of project personnel organization and responsibilities was previously provided in *Section 2.0* of this IMWP. Coordination of sample collection activities will be the responsibility of the Field Supervisor, who is responsible for running site operations. Field sampling technicians, under supervision of the Project Manager and the FS, will be responsible for collection and delivery of samples to the laboratory. After delivery, the Project Chemist will be responsible for ensuring proper analysis and timely delivery of sample results by the analytical laboratory.

5.3 Objectives and Scope

Samples to be collected during the IM include sampling IDM (solids and groundwater) for waste characterization, and sampling clean backfill material.

The QAPP Addendum in Appendix B of this IMWP describes the policy, organization, functional activities, analytical methods, and quality assurance (QA) and QC protocols necessary to achieve the project DQOs. This QAPP was developed in accordance with USACE *EM 200-1-3, Requirements for the Preparation of Sampling and Analysis Plans* (USACE, 2001) and the Intergovernmental Data Quality Task Force *Uniform Federal Policy for Implementing Environmental Quality Systems* (UFP QAPP, IDQTF, 2005), and is to be used in conjunction with the FSP in *Section 5.0.* Field QC samples, such as field duplicate samples, rinse blanks, matrix spike/matrix spike duplicate (MS/MSD), etc., are also be collected as described in the QAPP. The following sections describe the function of each type of field sample.

5.4 Waste Characterization Samples

Waste characterization samples will be collected and analyzed to determine the appropriate disposal methods of waste streams resulting from the IM at SWMU 40. Two types of waste streams will be generated during the IM: solid (soil/rock) and liquid (decontamination water and ground water).

Soil that will be generated during monitoring well installation activities will be characterized to evaluate whether it is a RCRA characteristic hazardous waste as described in Part 40 of the Code of Federal Regulations (CFR) Part 261, Subpart C (as referenced in the Virginia Hazardous Waste Management Regulations).

Waste characterization samples will be collected after the material is drummed for on-site temporary storage. The drums will be sampled to assess the appropriate disposal options for the solids and water. The samples with be give the identifiers 40WC1, 40WC2, etc. The sample(s) will be submitted to the analytical laboratory and analyzed as necessary for TCLP metals and RCRA waste characteristics (corrosivity as pH, reactivity, and ignitability) and any other parameter required by the selected disposal facility, which could include TCLP VOCs and the Paint Filter Test. Liquid waste characterization samples from decontamination procedures and purge waters from groundwater monitoring wells will be submitted to the analytical laboratory and analyzed for appropriate analysis based upon the RFAAP WWTP requirements, and/or off-site disposal facility characterization requirements.

UXB-KEMRON will identify a permitted off-site disposal facility for disposal, and also will coordinate with RFAAP wastewater treatment plant (WWTP) personnel regarding the necessary waste characterization.

Documentation of final disposition of all IDM will be documented in the Interim Measures Completion Report.

5.5 Borrow Material Soil Samples

The borrow material will be sampled at a rate of 1 sample/1,000 cubic yards (i.e., estimated as one sample from the borrow material). Erosion control measures will be implemented as described in this IMWP and excavation areas will be seeded. The borrow material and top soil will be analyzed for TAL metals, PAHs, pesticides/PCBs, and pH, and will have the following identifier, 40BF1, 40BF1, etc.

5.6 Groundwater Samples

Groundwater samples will be conducted as part of the LTM Plan implementation. The groundwater monitoring network at SWMU 40 will consist of one upgradient well, LFMW01, and three downgradient wells. The three downgradient wells include existing wells 40MW5 and 40MW6, as well as the new well to be installed as 40MW7. Monitoring wells are shown on Figure 4.

Sampling will be conducted in conformance with approved standard operating procedure SOP 30.2 and as described in the Section 5.2.10 of the MWP (URS, 2003). Groundwater sampling will be conducted using low flow purge and sampling, consistent with past sampling events. Section 9 presents the long term monitoring plan for groundwater as part of the IMWP. All non-dedicated sampling equipment will be decontaminated in accordance with SOP 80.1 of the MWP.

6.0 ENVIRONMENTAL PROTECTION PLAN

This Environmental Protection Plan (EPP) has been prepared by UXB-KEMRON to establish site procedures to protect existing environmental conditions at the RFAAP and to minimize potential harmful impacts caused by interim measures to the environment. During active interim measures, a copy of the EPP will be maintained on-site at all times. The EPP will be supplemented as necessary before land disturbance activities other than those indicated are performed.

This EPP serves the following purposes:

- To identify potential sources of pollution that could impact the quality of storm water discharges associated with the remediation and construction activities from the site.

- To describe chemical spill controls and countermeasures associated with construction activity from this site.

- To detail hazardous substances that could be used on the job site and a contamination prevention plan for these materials.

6.1 Applicable Regulations

The following potentially applicable Federal Regulations will be addressed by UXB-KEMRON through use of appropriate erosion and sediment controls in the field:

- Phase II storm water substantive permitting elements for small construction sites (40 CFR 122)

6.2 Pre Construction Survey of Existing Conditions

UXB-KEMRON will conduct a preliminary survey of the pre-existing conditions at the project site prior to any intrusive activities. The initial survey will include a record of existing vegetation, utilities, and other appropriate site conditions. Existing site conditions will be recorded in a photographic log.

6.3 Previously Used Equipment

All UXB-KEMRON equipment will be decontaminated and cleaned prior to arrival at the subject site. Appropriate measures will be conducted to prevent any type of cross contamination from non related sites or improperly cleaned equipment. Dedicated equipment will be utilized when appropriate to minimize potential cross contamination.

6.4 Protection of Land Resources

The interim measures activities will include intrusive actions which may potentially affect local land resources. UXB-KEMRON will provide erosion and sedimentation control measures around the perimeter of the project area. The project area will be permanently stabilized following the backfilling and grading tasks to improve the pre- existing conditions and reduce the effects of storm water runoff and erosion. The erosion and sedimentation control measures are discussed in greater detail in Section 7.0 of this report.

6.4.1 Work Area Limits/Traffic Control

The project work area will be isolated from surrounding areas by a perimeter silt fence. UXB-KEMRON will also utilize a staging area which also will be isolated by a silt fence. The staging area will provide all UXB-KEMRON employees, subcontractors, and site visitors a location to park and stage project specific equipment and materials. An improved construction entrance will be installed next to the staging area which will minimize sediment tracking from the project site onto permanent roadways. An effort will be made to keep all project operations within the perimeter silt fenced area to minimize any disturbances to surrounding land.

6.4.2 Landscape

Vegetation within the project areas may be cleared prior the project activities. In the event that particular trees or shrubs are to be protected within this area, then they will be marked with a ribbon.

UXB-KEMRON does not anticipate the disturbance or removal of any vegetation outside of the project area.

6.4.3 Unprotected Erodible Soils

UXB-KEMRON does not anticipate the disturbance of soil outside of the project area. Erosion control protection measures will be installed when appropriate within the project area for disturbed soils. Temporary stabilization measures will be implemented and designed to be incorporated into the permanent stabilization plan. Permanent vegetative stabilization is considered part of the site restoration task and will be conducted once all backfilling and grading activities are complete.

6.4.4 Disturbed Areas

Appropriate erosion and sedimentation controls will be installed prior to the disturbance of any soils. The protective measures shall reduce the potential risk of migration of sediments from the excavation area to surrounding land. Temporary erosion control measures will include silt fencing, construction entrances, and other appropriate structures. The erosion and sedimentation control measures are discussed in greater detail in Section 7.0 of this report.

6.4.5 Staging and Work Areas

The work areas for the interim measures will include a project area for soil backfilling and regrading and a staging area. A construction entrance will be installed to access the staging area from permanent roadways. The location of the site features is illustrated in Figure 5.

6.5 Water Resources

The interim measures are designed to improve erosion and stormwater runoff impacted soils. The measures include backfilling with soil and grading the land to minimize future erosion damage. The erosion and sedimentation control plan details the protective measures which will be installed to prevent materials from migrating outside the interim measures work area.

6.5.1 Wastewaters

Water will be generated during the interim measures by one process, the decontamination procedures. The fluids generated during decontamination will be contained in tanks or approved containers and will be disposed at an approved offsite facility. All fluids will be properly sampled for disposal characteristics prior to disposal. All disposal records will be kept in the project file.

6.5.2 Diversion Operations

It is not anticipated that dewatering activities will take place for this interim measure.

6.5.3 Fish and Wildlife

It is not anticipated that the activities associated with the interim measure will negatively impact surrounding fish or wildlife habitats. There are currently no listed endangered species in the interim measures work area.

6.6 Air Resources

Dust control may be implemented as needed once site excavation activities have been initiated and during windy conditions while site grading and remediation activities are occurring. Dust from the site will be controlled by using a mobile pressure-type distributor truck to apply water to disturbed areas. The mobile unit will apply water at a rate to prevent runoff and ponding. Water will be applied whenever the dryness of the soil warrants it based on air monitoring results.

6.7 Noise

The interim measures will be conducted in an area that will not affect residential areas, and will have limited potential impact to RFAAP workers. While it is anticipated the majority of work will be conducted during normal working hours, noise from the project site, weekend or extended hours of work will not have a negative impact on the local environment or onsite workers. Threshold levels for onsite noise and proper protective equipment are detailed in the Site Specific Health and Safety Plan.

6.8 Waste Disposal

Waste will be generated during the interim measures by two processes, well installation and typical solid waste accumulation. All waste generated will be properly sampled for disposal characteristics prior to disposal. All disposal records will be kept in the project file.

6.8.1 Solid Wastes

Typical solid waste will be contained in an onsite storage device such as a 10 yard roll-off. Solid waste will be disposed of on a regular basis at an offsite facility. All waste streams will be properly segregated and isolated to prevent any cross contamination.

6.8.2 Chemical Wastes

Any chemical wastes generated during the interim measures will be containerized in appropriated containers such as drums. The chemical wastes shall be stored onsite in the staging area until proper disposal is arranged at an approved offsite disposal facility.

6.8.3 Hazardous Waste

It is not anticipated that hazardous wastes will be generated during the interim measures execution. All wastes will be appropriately characterized to ensure hazardous waste is properly identified if it is encountered. If hazardous waste is encountered, appropriate segregation, labeling, management, storage, inspection and disposal will be conducted.

6.9 Burning

There will be no burning activities associated with the interim measures.

6.10 Historical, Archaeological and Cultural Resources

It is not anticipated that any historical resources will be encountered during the interim measures. Such resources may include: human remains, bones, structures, and artifacts. However, in the event that such resources are encountered then the project manager will stop work and contact the COR and RFAAP point of contact.

6.11 Post-Remedy Cleanup

Once the interim measures are complete UXB-KEMRON will conduct site restoration to bring the project areas back to pre-construction conditions. All solid wastes associated with the project will be removed from the site prior to closeout.

6.12 Restoration of Landscape Damage

Once the interim measures are complete UXB-KEMRON will conduct site restoration to bring the project areas back to pre-construction conditions. Vegetation will be permanently stabilized and erosion control measures will be removed once stabilization is complete. Care will be taken throughout the interim measures implementation to ensure the landfill cap is not damaged such that no landfill materials are exposed or released.

6.13 Maintenance of Erosion Control Facilities

Any permanent or temporary erosion control measures will be maintained during the entire course of the project and until permanent stabilization is achieved.

6.14 Training of Personnel

All UXB-KEMRON personnel will be provided training for their assigned project tasks. A complete listing of training requirements is included in the APP.

6.15 Spill Prevention and Response

This Spill Prevention and Response Plan has been developed to prevent the contamination of soils, water, atmosphere, uncontaminated areas, equipment or material by the uncontrolled release of hazardous waste and materials during field operations involved in this project.

6.15.1 Potential Spill Types

The following is a generalized list of materials or substances that are anticipated to be stored on site during the proposed interim measures:

- Detergents for decontamination efforts;
- Diesel fuel, hydraulic oil, and other vehicle maintenance substances; and
- Small quantities of lubricants, cleaners, marking paints, and/or landscaping materials (fertilizer, peat, lime, etc.).

All petroleum products and other hazardous materials will be stored in secondary containment basins, spill pallets, or in double walled tanks to contain the materials in the event of a spill, and will be kept covered by tarps or other appropriate cover when not in use to prevent any potential leak or spill from contaminating rain water. Fueling operations to fuel heavy earthmoving equipment will be conducted using 100-gallon fuel tanks mounted in pickup trucks. All other materials will be commercially available lubricants, cleaners, or landscaping materials that may be utilized during the remediation effort. Any materials brought onsite will be logged on a Hazardous Materials List. This list will include the MSDS and any appropriate spill protection measures.

6.15.2 Spill Prevention

To prevent the introduction of any potentially hazardous substance into any undisturbed media the following actions will be followed by KEMRON. Detergents and small containers of oil, grease, antifreeze, hydraulic fluids, etc., if any, will be stored within an enclosed storage container. Containers 5-gallons or greater will be stored within a secondary containment area or on secondary containment pallets. Diesel fuel will be stored in portable tanks located in truck beds. Any spill basins/pallets utilized will be designed to contain at least 100 percent of the total contents of all materials stored in the area plus an allowance for precipitation. A small sump or low point will be designed to serve as a monitoring point for any leaks or spills from the containers.

Small quantities of lubricants, cleaners, marking paints, and/or landscaping materials may be stored on site during the interim measures. These materials, when not in use, will be stored in a compatible storage cabinet located in a staging area. Practices that will be followed to reduce risks associated with these materials are as follows:

- Products will be kept in original containers unless they are not re-sealable.
- Original labels and material safety data sheets (MSDS) will be retained onsite.
- If surplus product must be disposed, manufacturers' or local- and State- recommended methods for proper disposal will be followed.

The following Good Housekeeping material management practices will be used to reduce the risk of spills or other accidental exposure of materials and substances to storm water runoff. These practices will be employed during the interim measures:

- An effort will be made to store only enough products required to accomplish the task.
- All materials stored on site will be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof or other enclosure.
- Products will be kept in their original containers with the original manufacturers' labels.
- Substances will not be mixed with one another unless recommended by the manufacturer.
- Whenever possible, all of a product will be used before disposing of the container.
- Manufacturers' recommendations for proper use and disposal will be followed.
- The assigned individuals will inspect areas daily to ensure proper use and disposal of materials on site.
- Sanitary facilities will be serviced regularly and will be subject to inspection. Sanitary deficiencies will be corrected within 24 hours of the inspection.
- Construction cleanup will proceed as construction progresses and will consist of the removal of mud, oil, grease, soil, gravel, trash, scrap, debris, and excess materials that are unsightly or may cause the slipping or tripping of site workers. Construction cleanup on roadways, work access and staging areas will occur daily.
- Solid waste generated by KEMRON will be placed in containers which are emptied regularly at an approved offsite facility. Handling, storage, and disposal will be conducted to prevent contamination. All environmental and investigational wastes segregated from solid wastes which will be transported in compliance with Federal, State, and local solid waste disposal requirements. A Subtitle D RCRA permitted landfill is the minimum acceptable off-site disposal option.
- Fuel, oil, and chemical dispensing operations will be inspected daily for leaks and spills. Spill wastes will be classified, managed, stored and disposed in accordance with Federal, State, and local solid waste disposal requirements.

6.15.3 Spill Countermeasures

In the event of a spill or release of a solid, UXB-KEMRON will remove and place contaminated materials in a drum with a cover. The container should be appropriately labeled and disposed of as soon as possible.

Liquid spills (e.g., oil from vehicles, etc.) will be absorbed with sand or other appropriate absorbent material (sand would only be used over an impervious substrate such as asphalt paving). The absorbent material will be placed in a drum with a cover. The container should be appropriately labeled and disposed of as soon as possible.

In the event of a discharge of liquid into the soil, UXB-KEMRON's project manager or designee will immediately identify the location of the discharge and take appropriate remedial actions to eliminate further spillage. The discharged liquid material will be controlled and disposed of as described above. If a reportable discharge of any material stored in drums, tanks, or other containers, etc. occurs, the following steps will be followed:

1. Notify the RFAAP representative and RFAAP Security Police Dispatcher (540 639 7323), SSHO, and the Installation Spill Response; in the event of a reportable quantity discharge, notify the National Response Center (800) 424-8802.
2. Contain and eliminate the discharge (if not prevented by safety considerations).
3. Remove/retrieve any discharged liquids (if not prevented by safety considerations).
4. Isolate the spill area restricting access to unauthorized personnel.
5. Decontaminate the spill area, if necessary.
6. Prepare a spill report.

The project manager, or his designee, will be responsible for completing the spill reporting form and for reporting the spill to the appropriate state or local agency.

The Spill Report will contain the following:

- Description of the material spilled including identity, quantity, and a copy of any waste manifests or bills of lading. Identify the cause of the spill. (If possible, MSDS sheets for spilled material and material used to clean it up will be included in any Spill Reports generated.)
- Exact time and location of the spill and a description of the area involved.
- Containment procedures utilized.
- A description of the corrective actions implemented during the spill including the disposal of the cleanup residues.
- A summary of the communications between UXB-KEMRON and Government officials.

Because no large quantities of hazardous liquids will be involved, no additional supplies or equipment beyond those previously specified are expected to be needed for the duration of this project.

6.15.4 Spill Mitigation Equipment

Spill control equipment will be available in the event of a spill or release at the site. The following quantities of materials are based on a small scale spill, less than 50 gallons of liquid waste and 500 lbs of solid waste:

- Oil absorbent pads (one bale)
- Oil absorbent material (100 lbs.)
- Oil absorbent booms (40 feet)
- Front-end loader or excavator
- 55-gallon drums, DOT 17 E or 17H UN1A1 UN1A2 (2 total)
- Shovels
- Decontamination supplies and PPE
- Hand operated pump

Spill response equipment will be inspected and maintained as necessary to replace any materials used in spill response activities. Regardless of the type of spill (liquid or solid), the following measures will be taken to isolate the spilled material:

- The PM will be notified immediately when a spill, or the threat of a spill, is observed.
- The PM will assess the situation and determine the appropriate response and contact RFAAP and Operating Contractor.
- Isolate and contain the spill area.
- Restrict access of unauthorized personnel.
- Prevent contact with the spilled material.
- Relocate upwind and upgradient of the spilled material.
- Take air, soil, or appropriate samples to determine if cleanup is complete.

6.15.5 Notification Procedures

In the event of a spill the project manager will contact the COR and RFAAP immediately. If authorized by the COR or RFAAP point of contact, UXB-KEMRON will notify appropriate authorities as identified below.

CHEMTREC	800-424-9300
National Response Center	800-424-8802
National Poison Control Center	800-362-9922
Federal Emergency Management Agency	202-646-2400
Centers for Disease Control	800-232-4636
Poison Control Center	800-222-1222
UXB-KEMRON Environmental Services, Inc.	800-548-6938
Radford Army Ammunition Plant Contact – James McKenna	540-731-5782
Installation Fire Department	16 (on post)
Installation Security Police	540 639-7325
Installation Safety Department	540-639-7294
Installation Spill Response	540-639-7324
Installation Medical Facility	540-639-7325
Emergency Fire	911
Emergency Police	911
Emergency Medical Services (EMS)	911

(*) Hospital:
New River Valley Medical Center
2900 Lamb Circle
Christiansburg, VA 24073
(540) 731-2530

(*) The above emergency agencies shall be contacted and notified on the specific hazards on this project. Coordination for special emergency response requirements with these agencies shall be completed upon arrival.

7.0 EROSION AND SEDIMENTATION CONTROL PLAN

7.1 General Purpose

This Erosion and Sediment Control Plan (ESCP) for the RFAAP interim measures has been prepared by UXB-KEMRON to identify and address erosion control regulations and protection measures. The objective of this ESCP is to establish site procedures to control storm water and prevent the transport of sediments or contaminants from the project site. This ESCP was prepared in accordance with the minimum standards and specifications of the Virginia Erosion and Sediment Control Handbook, the Virginia Erosion and Sediment Control Law, Regulations, and Certification (VESCLR&C) Regulations. KEMRON will ensure that all personnel are qualified to perform the work as outlined within the regulations. During active project operations, a copy of this ESCP will be maintained on-site at all times. The ESCP will be supplemented as necessary before land disturbance activities other than those indicated are performed.

7.2 Applicable Regulations and Plan Approval

The following applicable Federal and State Regulations will be followed by UXB-KEMRON:

- Erosion and Sediment Control (4 VAC 50-30-40)
- Storm water Management (9 VAC 25-690)

It is not anticipated that the interim measures for this project will disturb more than one (1) acre of land, therefore VDEQ approval of the Erosion and Sedimentation Control Plan is not required.

7.3 Erosion and Sedimentation Control Plan

As part of the interim measures being performed at the SWMU 40, UXB-KEMRON will:

- Perform cover repair and install lined, rip-rap drainage swale to prevent future erosion on the north face of the landfill;
- Install clay cap cover in area of exposed PCBs;
- Install planned monitoring well;
- Restore the SWMU 40 excavation areas affected by the removal activities.

The anticipated major land disturbance will consist of the following activities:

1. Installation of construction access road;
2. Installation of perimeter silt fencing and other erosion control devices;
3. Clearing of trees, brush and all surface vegetation within the footprint of the SWMU 40 project area as necessary;
4. Grading and backfilling of the project area by use of heavy equipment; and
5. Restoration of all disturbed areas.

The erosion and sediment control measures will be implemented, installed, inspected, and maintained with consideration given to the minimum standards and specifications of the Virginia Department of Conservation *Erosion and Sediment Control Handbook* (1992). The locations of required erosion, sediment, and storm water control measures are shown in Figure 5.

Temporary erosion and sediment control structures must be in place and functional before earth moving disturbance activities begin. Portions of the temporary erosion control measures may be removed at the beginning of each day as required to complete the work, but will be replaced at the end of the day.

Structural, Vegetative, Management Strategies, Material Handling and Waste Management will be utilized for erosion and sediment control at the SWMU 40 project. A description of the Best Management Practices (BMPs), Installation Schedule, Maintenance and Inspections, and Responsible Personnel for the project are provided below.

7.3.1 Structural Practices

Stabilized Construction Entrance

BMP Description: One (1) construction entrance will be installed adjacent to the staging area. The construction entrance will intersect with Landfill East Road (Figure 5). This entrance will be installed to control the tracking of dirt off the project site. The location of the Construction entrance is illustrated in Figure 5.

Installation Schedule: The stabilized construction entrance will be installed before remedial actions begin on the site. The construction entrance will remain in place until the excavation activities are complete and final stabilization vegetation is installed at the site.

Maintenance and Inspection: During active remediation of the site, the construction entrance road will be inspected every 14 calendar days and within 24 hours after storm events of 0.5 inches or greater or more frequently during periods of heavy use. The construction entrance will be maintained in a condition that will prevent tracking offsite. This could require adding additional crushed stone. All sediment tracked, spilled, dropped, or washed onto Landfill East Road will be swept up daily.

Responsible Staff: UXB-KEMRON or Subcontractor(s).

Silt Fence

BMP Description: Silt fencing will be placed along the perimeter of the project area as illustrated in Figure 5. Standard silt fence will be utilized for this project unless it becomes necessary to upgrade to a stronger variety. Standard silt fence will be used along the down gradient limits of the staging area.

Installation Schedule: The silt fences will be installed before any remedial actions begin or any materials are brought onsite and as determined necessary by the UXB-KEMRON project manager and the RFAAP representative.

Maintenance and Inspection: After initial installation, the silt fencing will be inspected every 14 calendar days and within 24 hours after storm events of 0.5 inches or greater during active remediation to ensure it is intact and that there are no gaps where the fence meets the ground or tears along the length of the fence. If gaps or tears are found during the inspection, the fabric will be repaired or replaced. Accumulated sediment will be removed from the fence base if it causes “bulging” or reaches one-third the height of the fabric height. If accumulated sediment is creating noticeable strain on the fabric and the fence might fail from a sudden storm event, the sediment will be removed more frequently. Before the fence is removed from the project area, the sediment will be removed. The anticipated life span of the silt fence is 6 months.

Responsible Staff: UXB-KEMRON or Subcontractor(s).

7.3.2 Vegetative Practices

Surface Roughening

BMP Description: The surface of re-graded areas will be roughened to reduce runoff velocity and to aid in the establishment of vegetative cover.

Installation Schedule: To be completed following re-grading activities and prior to ground cover establishment and permanent stabilization.

Maintenance and Inspection: Stabilized areas will be inspected every 14 calendar days and within 24 hours of storm events of 0.5 inches or greater until a dense cover of vegetation has become established.

Responsible Staff: UXB-KEMRON or Subcontractor(s).

<u>Topsoiling</u>

BMP Description: Topsoiling will be placed on all restored surfaces as necessary to allow permanent stabilization and vegetative growth. Imported topsoil will contain 5-10% organic matter. Maximum particle size, ¾ inch with maximum 3% retained on ¼ inch screen. Topsoil shall be free of sticks, stones, roots, and other debris.

Installation Schedule: Topsoil will be installed within 14 days of re-grading following remediation activities.

Maintenance and Inspection: Stabilized areas, topsoiled and seeded, will be inspected every 14 calendar days and within 24 hours of storm events of 0.5 inches or greater until a dense cover of vegetation has become established.

Responsible Staff: UXB-KEMRON or Subcontractor(s).

<u>Temporary Stabilization/Seeding</u>

BMP Description: All re-graded areas that will be left dormant for greater than 30 days shall be seeded with fast-germinating temporary vegetation immediately following grading. Seeding will be performed dependent on the time of year, in accordance with the Seeding Chart in the Virginia Erosion and Sediment Control Handbook.

Installation Schedule: Temporary or permanent stabilization of the SWMU 40 Site will be completed within 14 days of final grading or earth moving activities, unless construction activity will resume on a portion of the site within 30 days from when activities ceased.

Maintenance and Inspection: Temporarily stabilized areas will be inspected every 14 calendar days and within 24 hours of storm events of 0.5 inches or greater until a dense cover of vegetation has become established. If failure is noticed at the seeded area, the area will be reseeded within one week.

Responsible Staff: UXB-KEMRON or Subcontractor(s).

<u>Permanent Stabilization/Seeding</u>

BMP Description: All areas disturbed by construction will be stabilized with permanent seeding following finished grading or when areas are left dormant for more than 30 days. Erosion control matting may be used for steep slopes, as determined necessary by the project manager, and mulch will be used for mild slopes to secure seeding. The permanent seed mixture for the SWMU #40 interim measures will conform to the Virginia Erosion and Sediment Control Handbook and seasonal considerations.

Installation Schedule: All areas disturbed by the remedial activities will be stabilized with permanent seeding within 14 days of final grading or earth moving activities, unless construction activity will resume on a portion of the site within 30 days from when activities ceased. Sediment control measures will not be removed until permanent vegetative cover is established.

Maintenance and Inspection: All seeded or re-vegetated areas will be inspected every 14 calendar days and within 24 hours after storm events of 0.5 inches or greater until a dense cover of vegetation has become established. If failure is observed, the area will be reseeded, fertilized, and/or mulched. After remedial actions are completed at the site, permanently stabilized areas will be monitored until final stabilization is reached.

Responsible Staff: UXB-KEMRON or Subcontractor(s).

7.3.3 Management Strategies

Initial Site Preparation Work

BMP Description: UXB-KEMRON will be responsible for the implementation and execution of the specified erosion and sediment controls. The work schedule will be sent to RFAAP and regulatory agencies a minimum of 2 weeks in advance to any site work or land disturbance. The site preparation work that will be completed prior to the full scale remedial actions include the installation of erosion control devices and storm water runoff controls such as silt fences. Additional pre-construction activities include clearing and grubbing of excavation areas without disturbing soil and surveying and staking of the site. The location and type of control measures to be used are illustrated in Figure 5.

Installation Schedule: Erosion, sediment, and storm water control features will be installed and/or constructed before the start of any earth-disturbance activities. All erosion control features will remain in place until permanent vegetation is established over disturbed surfaces.

Maintenance and Inspection: The UXB-KEMRON project manager will be responsible for ensuring the installation and maintenance of all erosion, sediment, and storm water control practices and all site control measures will be inspected no less than once every fourteen (14) calendar days and within 24 hours after storm events of 0.5 inches or greater until a dense cover of vegetation during final stabilization has become established. Inspections will be documented and any non-functional or damaged control structure will be repaired within 24 hours. Any silt fence control device with 50% accumulated sediment will be either replaced or the sediment removed.

Responsible Staff: UXB-KEMRON or Subcontractor(s).

Water Used to Control Dust

BMP Description: Dust control will be implemented as needed once site excavation activities have been initiated and during windy conditions while site grading and remediation activities are occurring. Dust from the site will be controlled by using a mobile pressure-type distributor truck to apply water to disturbed areas. The mobile unit will apply water at a rate to prevent runoff and ponding. Water will be applied whenever the dryness of the soil warrants it based on air monitoring results.

Installation Schedule: Dust control will be implemented as needed once soil excavation has been initiated and during windy conditions while excavation is occurring. Spraying of water will be performed as the dryness of the soil warrants it based on air monitoring levels for dust.

Maintenance and Inspection: At least one watering unit will be available at all times to distribute water to control dust in the remediation areas. Each mobile unit will be equipped with a positive shutoff valve to prevent over watering of the remediation area.

Responsible Staff: UXB-KEMRON or Subcontractor(s).

Street Cleaning/Sweeping
BMP Description: Street sweeping will be conducted as needed if sediment is observed to be transported onto paved roads or parking areas. Sweeping or cleaning of the roads may be done with air blowers, manually by hand sweeping, or by machine. Sediment recovered by hand methods will be returned to the site.

Installation Schedule: Street cleaning/sweeping will occur as needed as determined by on-site project management.

Responsible Staff: UXB-KEMRON or Subcontractor(s).

Post Construction
BMP Description: The pre- and post-construction runoff volumes will remain relatively the same with no significant changes due to the remedial actions. Project-derived pollutant run-off is not expected to occur after construction operations have been completed and the site has been stabilized. Once final vegetation has developed, all remaining erosion and sediment controls will be removed.

Installation Schedule: Once final vegetation has developed, all remaining erosion and sediment controls will be removed.

Maintenance and Inspection: The UXB-KEMRON project manager will be responsible for ensuring the competency of all erosion, sediment, and storm water control practices at the site. Following remedial activities the protective measures will be inspected no less than once every fourteen (14) calendar days and within 24 hours after storm events of 0.5 inches or greater until a dense cover of vegetation during final stabilization has become established. Inspections will be documented and any non-functional or damaged control structure will be repaired within 24 hours. Any silt fence control device with 50% accumulated sediment will be either replaced or the sediment removed.

Responsible Staff: UXB-KEMRON or Subcontractor(s).

General Maintenance and Inspections
BMP Description: The inspection schedule and documentation procedures have been designed so that vegetation, erosion, sediment control measures, and other protective measures are kept in good and effective operating condition.

The following list includes, but is not limited to, areas that will be inspected by qualified personnel at least once every (14) fourteen calendar days and within 24-hours of the end of a storm that is 0.5 inches or greater:

- Disturbed areas of the construction site that have not undergone final stabilization;
- Areas used for the storage of materials that are exposed to precipitation that have not undergone final stabilization;
- Structural control measures; and
- Locations of vehicle ingress and egress.

Installation Schedule: In general, during the remedial actions, all erosion, sediment, and storm water control measures will be visually inspected daily but at a minimum a formal inspection will occur at least every fourteen (14) days and after each runoff-producing rainfall event. Any required repairs will be made within 24 hours of detection. Based on the results of the inspection, any inadequate control measures or control measures in disrepair will be replaced, modified, or repaired as soon as practicable (i.e., before the next rain event if possible) but in no case more than twenty-four (24) hours after the need is identified. In general, all repairs to the erosion and sediment control structures shall be made within twenty-four (24) hours or as soon as practicable.

Maintenance and Inspection: The stabilized areas will be checked regularly to ensure that a good stand of vegetation is reached. Areas will be fertilized and reseeded as deemed necessary by the project manager.

Responsible Staff: UXB-KEMRON or Subcontractor(s).

Staging Area

BMP Description: The primary staging area for the project will accommodate parking, work trailers, portajohns, materials containment, and a solid waste dumpster. All hazardous materials such as petroleum products and equipment maintenance fluids will be properly stored in this area. The location of staging area is illustrated in Figure 5.

Installation Schedule: The staging area will be constructed after clearing and grubbing and some light grading work is conducted at the site.

Maintenance and Inspection: The staging area will be inspected every 14 calendar days and within 24 hours after storm events of 0.5 inches or greater. The staging area will be kept clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored. Material safety data sheets, material inventory, and emergency contact numbers will be maintained by the UXB-KEMON project manager.

Responsible Staff: UXB-KEMRON or Subcontractor(s).

Vehicle Fueling and Maintenance

BMP Description: Several types of vehicles and equipment will be used on site throughout the project, including, trucks and trailers, excavators, and bulldozers. All major equipment/vehicle fueling and maintenance will be performed onsite by a subcontractor or UXB-KEMRON personnel. A small, 100-gallon pickup bed fuel tank may be used to refuel equipment. Only minor equipment maintenance will occur on site. Significant equipment repairs will not be conducted on site unless equipment failure occurs and repairs must be completed on site. All equipment fluids generated from maintenance activities will be disposed of into designated drums and stored onsite until proper disposal is setup.

Installation Schedule: Equipment and vehicle maintenance and fueling practices will be implemented at the beginning of active construction on site.

Maintenance and Inspection: Fuel and or dispensing operations will be visually inspected daily for leaks and spills. Inspect equipment/vehicle storage areas, fueling points, and fuel tanks every 14 calendar days and within 24 hours after storm events of 0.5 inches or greater. Vehicles and equipment will be inspected each day of use. Leaks will be repaired as soon as possible, or the problem vehicle(s) or equipment will be removed from the project site. Keep ample supply of spill-cleanup materials on site and immediately clean up spills. Absorbent pads will be placed under any tool or vehicle being fueled to catch any incidental drips or spills from reaching the ground surface. All spill cleanup materials used will be disposed of properly.

Responsible Staff: UXB-KEMRON or Subcontractor(s).

7.3.4 Material Handling and Waste Management

General Refuse/Waste Management

BMP Description: All general refuse/waste materials will be collected and disposed of into dumpsters located in the staging area. Dumpsters and other trash receptacles will be placed away from stormwater conveyances and drains, and meet all federal, state, and local solid waste management regulations. Only trash and construction debris from the site will be deposited in the dumpsters and other trash receptacles. All personnel will be instructed, during daily tailgate safety sessions, regarding the correct procedure for disposal of trash and construction debris. On-site management will be responsible for ensuring general refuse and construction wastes are managed appropriately.

Installation Schedule: Dumpsters and other trash receptacles will be installed once the staging area is established at the site.

Maintenance and Inspection: The dumpsters and trash receptacles will be inspected every 14 calendar days and within 24 hours after storm events of 0.5 inches or greater. The dumpsters and trash receptacles will be emptied as needed by a subcontractor in accordance with local, state, and federal regulations.

Responsible Staff: UXB-KEMRON or Subcontractor(s).

Sanitary Waste

BMP Description: At least one (1) temporary sanitary facility (portable toilet) will be provided at the site in the staging area. Additional toilets may also be utilized as is deemed necessary by the UXB-KEMRON project manager. The toilet will be away from concentrated flow paths and traffic flow and will have collection pans underneath to contain waste and provide secondary containment.

Installation Schedule: The portable toilet(s) will be brought to the site once the staging area is established and prior to remedial actions.

Maintenance and Inspection: All sanitary waste will be collected from the portable toilet(s) a minimum of once per week by a local subcontractor. The toilet(s) will be inspected at least every 14 calendar days for evidence of leaking holding tanks. Toilets with leaking holding tanks will be removed from the site and replaced with new portable toilets.

Responsible Staff: UXB-KEMRON or Subcontractor(s).

8.0 WASTE TRANSPORTATION AND DISPOSAL PLAN

This Waste Transportation and Disposal Plan (WTDP) has been prepared by UXB-KEMRON to establish site procedures for handling, transportation, and disposal of waste materials generated from the interim measures actions at the SWMU 40 site. During active interim measures, a copy of the WTDP will be maintained on-site at all times, which may be supplemented as necessary as deemed appropriate by the UXB-KEMRON project manager as site conditions dictate.

8.1 Applicable Regulations and Plan Approval

The wastes generated during the interim measures will be handled in accordance with applicable Federal, State, and local regulations which included:

- 40 CFR 268: Land Disposal Restrictions
- 9 VAC 20-60-262 Adoption of 40 CFR Part 262 by reference

8.2 Anticipated Waste Streams

The wastes generated during the interim measures may include the following waste streams:

- Interim Measures Derived Wastes
- Secondary Wastes

8.2.1 Interim Measures Derived Wastes

Any wastes which are generated by the remedial actions of the interim measures will be considered Interim Measures Derived Wastes. All interim measures derived wastes generated during the project will be properly contained and stored in a designated storage area, which is located near Landfill South Road near the Nitro Landfill or SWMU 40. The generated wastes will be removed from the project site daily. The anticipated Interim Measures Derived Wastes will include the following waste streams:

- Purge water generated during groundwater sampling.
- Soil and rock generated during groundwater well installation
- Decontamination fluids

8.2.2 Secondary Wastes

Any wastes which are generated by the general activities of the project site during the interim measures will be considered Secondary Wastes. The anticipated Secondary Waste will include the following waste stream:

- Typical non-hazardous solid waste
- Personal Protective Equipment
- Soil and erosion control devices

8.3 Waste Management Procedures

8.3.1 Waste Minimization

Waste minimization practices will be implemented during the interim measures to control the amount of wastes generated and potential segregate waste streams. The segregated waste streams will include contaminant impacted wastes and non-impacted secondary wastes. The impacted waste can further segregated into two waste streams which include hazardous and non-hazardous wastes. The waste streams will be characterized prior the generation in an effort to minimize the retention times of segregated wastes on the project site.

8.3.2 Onsite Waste Labeling

The following practices will be maintained to indentify and label each container and waste stream generated at the SWMU 40 project site. The information will be used for proper transport and disposal of the materials.

- Generation activity and location
- Type of material
- Comments or Special handling instructions
- Date

8.3.3 Sampling and Characterization

Each of the wastes streams generated during the interim measures at the SWMU 40 site will be sampled for disposal characterization either prior to generation or immediately following waste generation. Waste characterization sampling will follow the procedures specified in the QAPP, or as dictated by the disposal facility. Profiles of each waste stream will be submitted to offsite facilities for approval prior to the transportation of any wastes. Wastes will be transported off site for disposal within 90 days of generation.

8.3.4 Recordkeeping

UXB-KEMRON will maintain records of waste disposal on the project site and in the project file. The records maintained will include the following:

- Waste Characterization Sampling Results
- Signed and Approved Waste Profiles
- Signed Manifests and/or Bills of Lading

Although hazardous waste is not anticipated to be generated during implementation of the IM, if hazardous waste is encountered, hazardous waste manifests will be coordinated with the operating contractor for approval, signature and recordkeeping.

8.3.5 Spill Response Materials

Spill response materials will be available in the event of a spill or release at the site. The following quantities of materials are based on a small scale spill, less than 50 gallons of liquid waste and 500 lbs of solid waste:

- Oil absorbed pads (one bale)
- Oil absorbent material (100 lbs.)
- Oil absorbent booms (40 feet)
- Front-end loader or excavator
- 55-gallon drums, DOT UN1A1 UN1A2 (2 total)
- Shovels
- Decontamination supplies and PPE
- Hand operated pump

8.4 Offsite Transportation and Disposal

8.4.1 Identification of Offsite Disposal Facility

UXB-KEMRON will contact waste disposal facilities to determine the most appropriate disposal facility. The factors for selection of the facility will include, but not necessarily be limited to:

- Current facility licensure
- Cost per unit rate of materials
- Transportation costs
- Disposal options (landfilling, incinerations, etc.)
- Types of wastes received

8.4.2 Transportation of Waste

UXB-KEMRON will inspect all containers and maintain the labeling and manifesting of waste has been properly conducted prior to any wastes be removed from the project site. All container loading and segregation of wastes will be conducted under the supervision of UXB-KEMRON employees.

8.5 Documentation and Reporting

8.5.1 Complete Manifest Package

UXB-KEMRON will provide manifest packages for all waste streams which are to be removed from the project site to be disposed of at an offsite facility. All wastes transported from the project site will be contained and labeled in accordance with the DOT requirements. UXB-KEMRON will also maintain a record of the manifest package onsite which will include the following:

- Waste Characterization Sampling Results
- Signed and Approved Waste Profiles
- Signed Manifests and/or Bills of Lading

The final disposal facility tickets will be included into the project file once they have been received by UXB-KEMRON.

8.5.2 Transportation and Disposal Reporting Requirements

UXB-KEMRON will maintain records of all wastes leaving the SWMU #40 site. These records will provide a clear trail of the waste generation and disposal operations. These records will include the following:

- Waste type
- Date generated
- Manifest package
- Date Transported offsite
- Transportation company and driver name
- Date of disposal
- Name of disposal facility

9.0 LONG TERM MONITORING PLAN

This Section establishes the Groundwater Monitoring Plan for SWMU 40 in conformance with the USEPA and VDEQ approved Final RFI/CMS for SWMU 40, RAAP-009 (URS, 2009).

9.1 Groundwater Monitoring Program

The selected remedy for SWMU 40 includes installation of one additional groundwater monitoring well in the downgradient direction, to be identified as 40MW7. The location selected and documented within the Final RFI/CMS is illustrated on Figure 4 in this IMWP.

The groundwater monitoring network at SWMU 40 will consist of one upgradient well, LFMW01, and three downgradient wells. The three downgradient wells include existing wells 40MW5, 40MW6, and the new well to be installed as 40MW7. Installation of this new well is presented elsewhere in this IMWP. Table 1 summarizes the long term monitoring program that will be implemented as part of the Corrective Measures at SWMU 40.

Table 1 - Long Term Groundwater Monitoring Program, SWMU 40, RAAP-009:

Monitoring Well Designation	Relative Position to SWMU 40	Monitoring Frequency	Analytical Parameters
LFMW01	Upgradient	Year 1: Quarterly Years 2-5: Every 9 months Years 6-30: Annual	Field water quality: pH, turbidity, specific conductance, temperature, dissolved oxygen, oxidation/reduction potential TCL VOCS, SW846 Method 8260B; TCL SVOCs, SW846 Method 8270C SIM; TCL Pesticides, SW846 Method 8081A; TAL Metals, SW846 Method 6000/7000; Perchlorate, SW846 6850; Dioxins/furans, SW846 Method 8290 included in initial sampling event only
40MW5	Detection Well at edge of landfill boundary		
40MW6	Detection Well at edge of landfill boundary		
40MW7	Well downgradient of Landfill		

The first year of long term monitoring (LTM) will include four quarterly monitoring events. Dioxins and furans will be sampled and analyzed solely in the first quarterly sampling event of the first year of LTM. In years 2-5 of LTM, groundwater sampling and analysis will be conducted every nine (9) months. This program will allow the LTM program to include evaluation for seasonal variations.

LTM reports will be prepared and submitted following the completion of the first four quarters of sampling, and after each of the following events. It is anticipated the fourth sampling event conducted on a 9-month time interval will be included in a combined LTM and remedy effectiveness review report.

Each LTM report will summarize the sampling and analysis conducted and will present both summarized LTM results and complete laboratory analytical results. Complete laboratory analyses will be presented in electronic form (e.g., CD ROM or equivalent).

Any analytes that are not detected above laboratory limit of quantitation (LOQ) during the first four quarters of monitoring will be eliminated from the analytical reporting list for future sampling events. In addition, the four quarters of monitoring in the upgradient well will be used to calculate background for the detected analytes. The down gradient wells will be compared to the calculated background values and any analyte below background in all three down gradient wells will be eliminated from the analytical reporting list for future sampling events. This information will be noted in the first LTM report for the first four quarters of data. Retention of analytes in the LTM monitoring and reporting will be evaluated in reports for each subsequent sampling and analysis event based upon the site specific dataset that will be included and evaluated.

The analytes detected throughout the LTM program will be assessed via the LTM reports. Groundwater analytical results will be compared to background and promulgated Federal Safe Drinking Water Act Maximum Contaminant Levels (MCLs). Analytes for which a promulgated MCL does not exist will be evaluated with respect to EPA Regional Screening Levels (RSLs). Analytes that are not detected above laboratory method detection limits as specified in the project QAPP will not require further technical evaluation. A list of the specific analytes included in the groundwater LTM program and their associated reporting limits and method detection limits are presented in Appendix B (Master Work Plan Addendum #30, Quality Assurance Project Plan for SWMU 40).

At a minimum, the following criteria will be applied to data evaluation and optimization of the monitoring program after the first four quarters of data have been generated:

1) Analytes that do not exceed the laboratory LOD during three (3) consecutive monitoring events will not require further sampling and analysis;
2) Analyte detections that do not exceed the established background concentration for 3 successive sampling events will not require further sampling and analysis;
3) Analyte detections that do not exceed half the relevant MCL or half the relevant RSL for 3 successive sampling events and the results display a static or downward trend will not require further sampling and analysis.

Within the first five years of monitoring, a remedy effectiveness evaluation will be conducted for SWMU 40. The remedy effectiveness evaluation will include a presentation of the groundwater data collected throughout the LTM program to date. The analytical results will be statistically evaluated against the background dataset, and to determine if any trends are exhibited. The site specific data will be evaluated using appropriate statistical methodologies, and data assessment will be conducted in general conformance with the recommendations of USEPA guidance entitled *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance, March 2009* (EPA 530/R-09-007).

The remedy effectiveness review will be used to determine if exposure assumptions in the Final RFI/CMS remain correct, whether the remedy continues to achieve CMOs , and will be used to determine what, if any, continuing groundwater monitoring is appropriate for SWMU 40. It is anticipated the fourth 9-month interval sampling event will be completed and included in an expanded in the LTM report that will include the remedy effectiveness review. At the Army's discretion, remedy effectiveness evaluations may be conducted more frequently than once per five years.

Assuming that stable to decreasing concentrations of analytes are demonstrated in the LTM reports, RFAAP may request to decrease the frequency of monitoring from that specified in Table 1, up to and including termination of groundwater monitoring.

9.2 Long Term Inspection and Maintenance Plan

Additional long term maintenance would also be conducted at SWMU 40, RAAP-009; including inspection of the landfill cap to ensure that the landfill cap integrity is maintained. Inspections would be conducted in conjunction with groundwater monitoring events and thus will follow the same schedule specified in Table 1, Long Term Groundwater Monitoring Program.

Inspections will include visual evaluation and documentation of negative effects of the following:

1. Precipitation run-on and runoff;
2. Water and/or wind erosion;
3. Rodent and/or vector activity;
4. Deep root vegetation;
5. Vegetative stress and other cover condition;
6. Subsidence or cracks in cap;
7. Excavation or other manmade intrusive work conducted within the landfill footprint.

The landfill cap inspection form included in Appendix D or equivalent would be used to document inspection results, and maintenance, repair or corrective action. Photos also may be used to illustrate the condition of the landfill. Inspections will be conducted and documented as specified in the final RCRA Corrective Action permit.

9.3 LTM Reporting

The results of groundwater monitoring and landfill inspections, maintenance, repair and corrective action will be presented in LTM reports submitted following the first four quarterly sampling events. Subsequent reports will be submitted for regulatory review after receipt of laboratory analyses, data review and validation, and review of the draft report by RFAAP.

The initial annual LTM report will include calculation of a background dataset, based upon the first four sampling events. The dataset from these events will provide the first opportunity to evaluate background. After opportunity is provided to evaluate these first 4 quarters of data, additional information is expected to be available to further optimize the groundwater monitoring program. The refined optimization will be included in recommendations of the remedy effectiveness review, which will be submitted for regulatory review and approval.

9.4 Maintenance of Institutional Controls

Applicable Institutional Controls (ICs) and Engineering Controls (ECs) will be maintained, and inspections conducted, as specified in the final RCRA Corrective Action permit.

10.0 REFERENCES

Alliant Techsystems, Inc. (ATK), 2005. *Safety, Security and Environmental Rules for Contractors, Subcontractors, Tenants and Government Employees.* March 2005.

Intergovernmental Data Quality Task Force, 2005. *Uniform Federal Policy for Implementing Environmental Quality Systems; Evaluating, Assessing, and Documenting Environmental Data Collection/Use and Technology Program* (UFP QAPP), Final, Version 2. March 2005.

URS Corporation (URS), 2009. SWMU 40 (RAAP-009) and 71 (RAAP-002) *RCRA Facility Investigation/Corrective Measures Study Report.* Final. April 2009.

URS Corporation (URS), 2003. *Final Master Work Plan, Quality Assurance Plan, Health and Safety Plan*. Radford Army Ammunition Plant, Radford, Virginia. Prepared for the U.S. Army Corps of Engineers, Baltimore District. August 2003.

U.S. Army Corps of Engineers (USACE), 2001. *EM200-1-3, Requirements for the Preparation of Sampling and Analysis Plans*.

U.S. Environmental Protection Agency (USEPA), 2000a. *Permit for Corrective Action and Waste Minimization*: Pursuant to the Resource Conservation and Recovery Act as Amended by the Hazardous and Solid Waste Amendment of 1984, Radford Army Ammunition Plant, Radford, Virginia. VA1210020730.

Virginia Department of Conservation and Recreation, Division of Soil and Water Conservations, 1992. *Virginia Erosion and Sediment Control Handbook.* Third Edition, 1992.

FIGURES

0 500 1000 2000 3000 4000
Feet

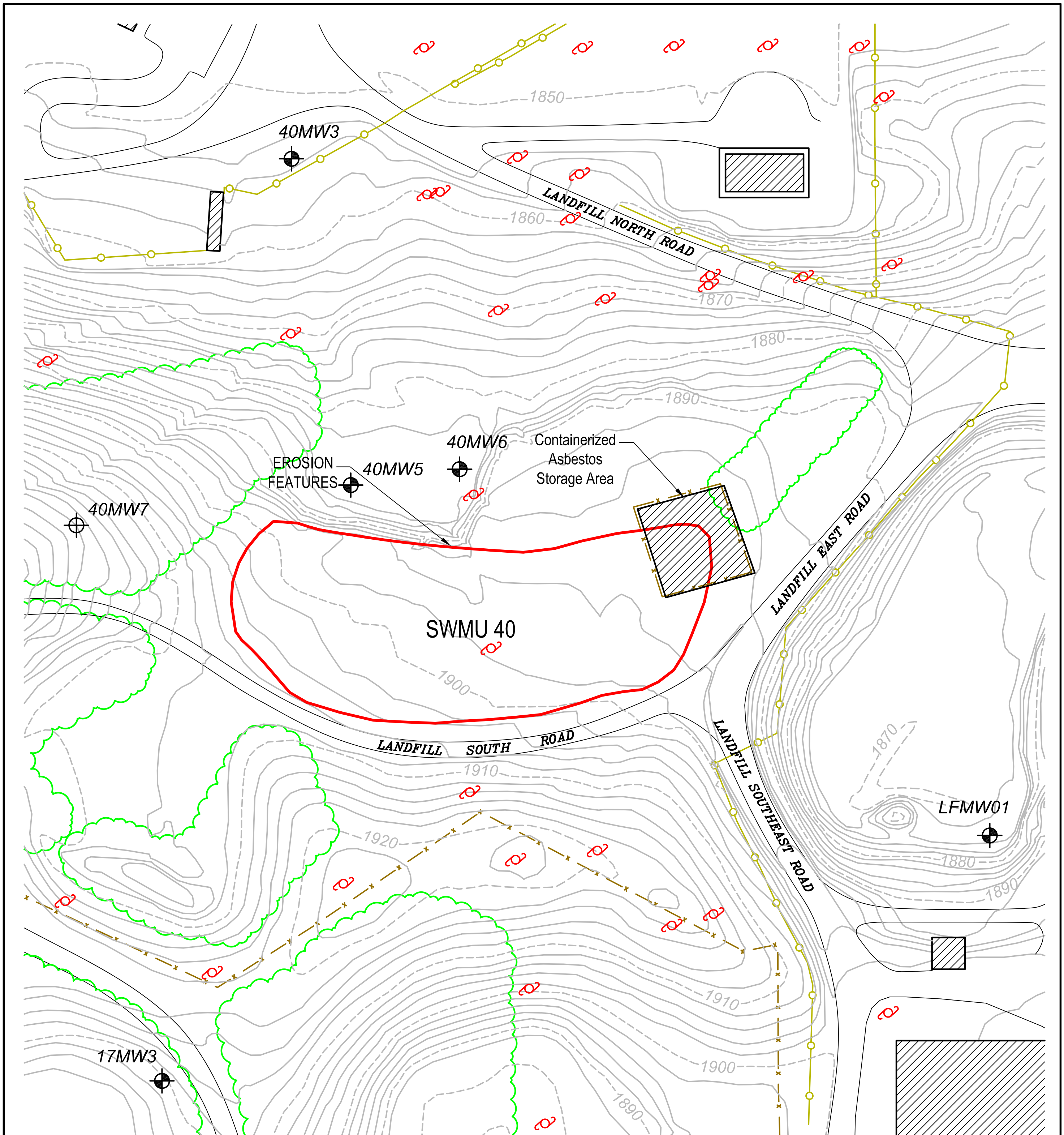
N

Source: Google Earth; Imagery Date: February 1, 2007

KEMRON ENVIRONMENTAL SERVICES

KEMRON Environmental Services
1359-A Ellsworth Industrial Blvd.
Atlanta, GA 30318

PROJECT NO. RADFORD		DRAWING DATE: 09/15/2010	
DESIGNED DRP	SITE LOCATION MAP SWMU 40 IMWP		
DETAILED DRP			
CHECKED KR	LOCATION: RADFORD ARMY AMMUNITION PLANT, RADFORD, VIRGINIA		FIGURE: 1



LEGEND

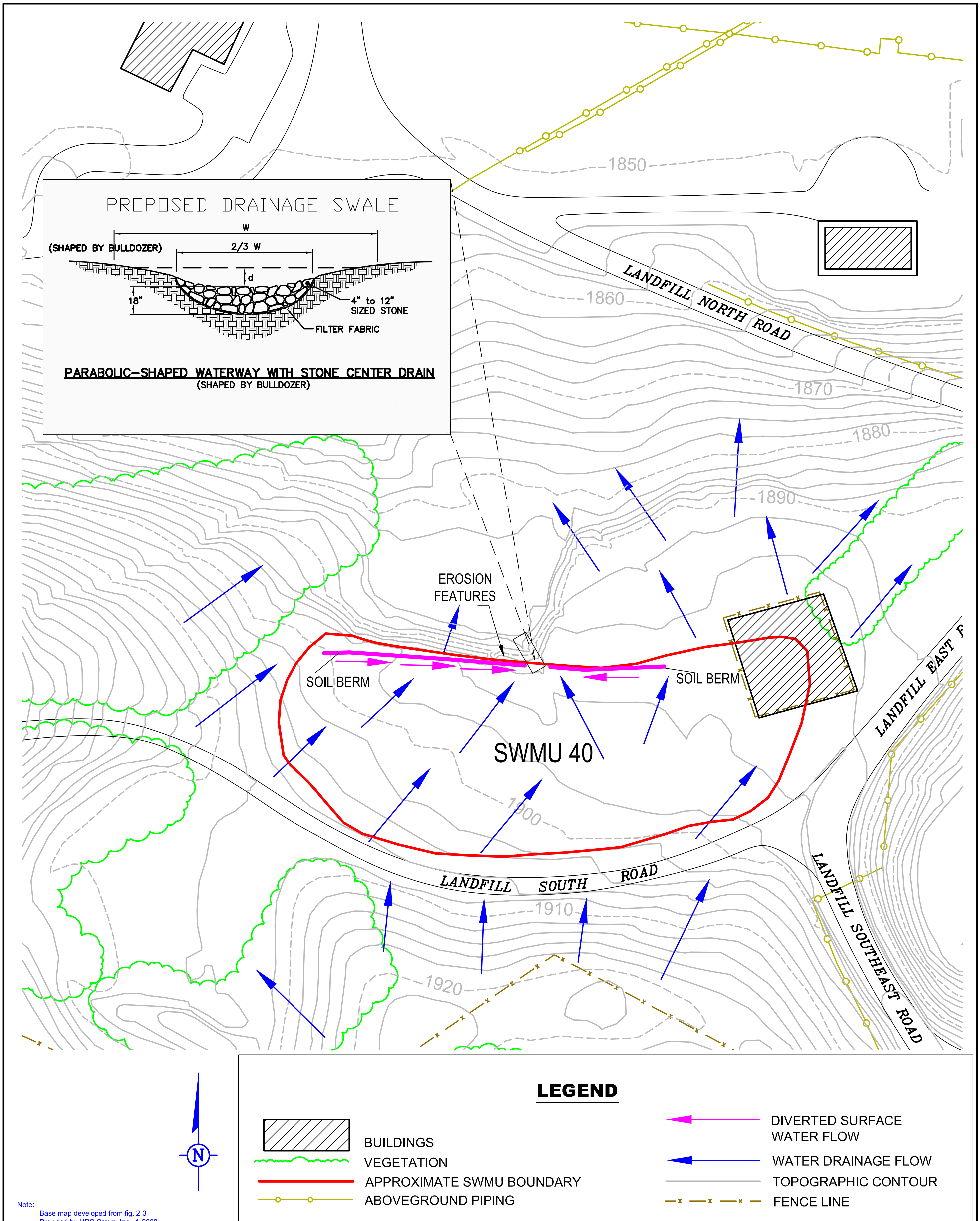
(hatched box)	BUILDINGS
(green scalloped line)	VEGETATION
(red line)	APPROXIMATE SWMU BOUNDARY
(yellow line with circles)	ABOVEGROUND PIPING
40MW6	MONITORING WELL LOCATION
40MW7	PLANNED NEW MONITORING WELL LOCATION
(red symbol)	OVERHEAD ELECTRIC POLE
(grey line)	TOPOGRAPHIC CONTOUR
—x—x—	FENCE LINE

Note:
Base map developed from fig. 2-2
Provided by URS Group, Inc., 1-2008

KEMRON ENVIRONMENTAL SERVICES

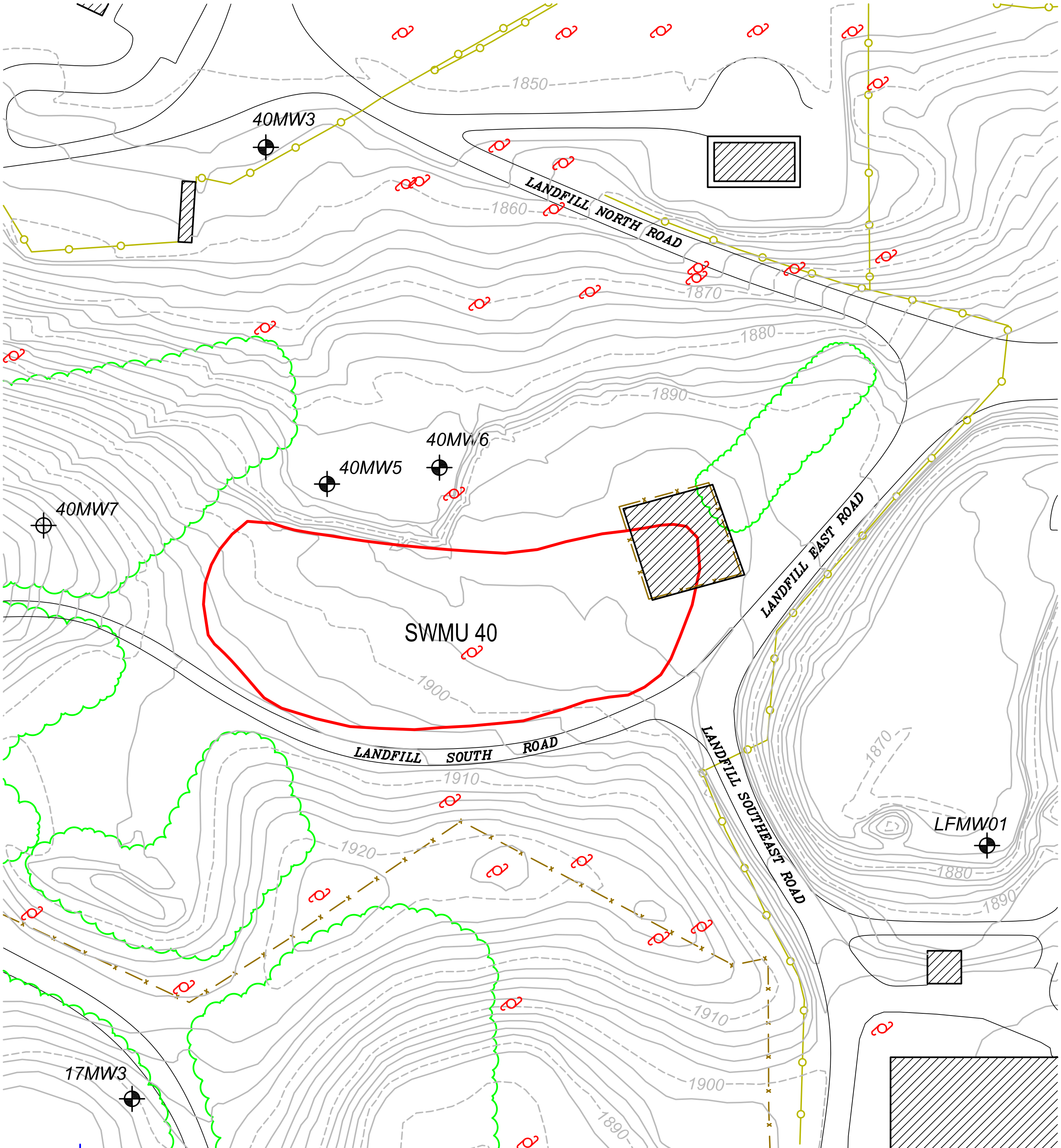
0 60 120 SCALE 1"=120' (Approximate)	DRAWN BY: KG	DATE 23 AUGUST 2010	FIGURE 2
	REVIEWED: KR / R 5	PROJECT NO. MR0669-200-001	
	APPROVED:	DWG. FILE NO. SWMU 40. SITE MAP	

IMWP SWMU 40
SITE LAYOUT
RADFORD ARMY AMMUNITION PLANT-009
RADFORD, VIRGINIA



Note:
Base map developed from fig. 2-3
Provided by URS Group, Inc,. 1-2008

KEMRON ENVIRONMENTAL SERVICES	0 50 100 SCALE 1"=100' (Approximate)	DRAWN BY: KG REVIEWED: KR — R 5 APPROVED:	DATE 15 SEPTEMBER 2010 PROJECT NO. MR0669-200-001 DWG. FILE NO. SURF. WTR.DRANG.	FIGURE 3	IMWP SWMU 40 SURFACE WATER DRAINAGE & SWALE DETAIL MAP RADFORD ARMY AMMUNITION PLANT-009 RADFORD, VIRGINIA



LEGEND

- BUILDINGS
- 40MW6 MONITORING WELL LOCATION
- 40MW7 PLANNED NEW MONITORING WELL LOCATION
- OVERHEAD ELECTRIC POLE
- VEGETATION
- APPROXIMATE SWMU BOUNDARY
- ABOVEGROUND PIPING
- TOPOGRAPHIC CONTOUR
- FENCE LINE

Note:
Base map developed from fig. 10-2.
Provided by URS Group Inc., 1-2009

KEMRON ENVIRONMENTAL SERVICES

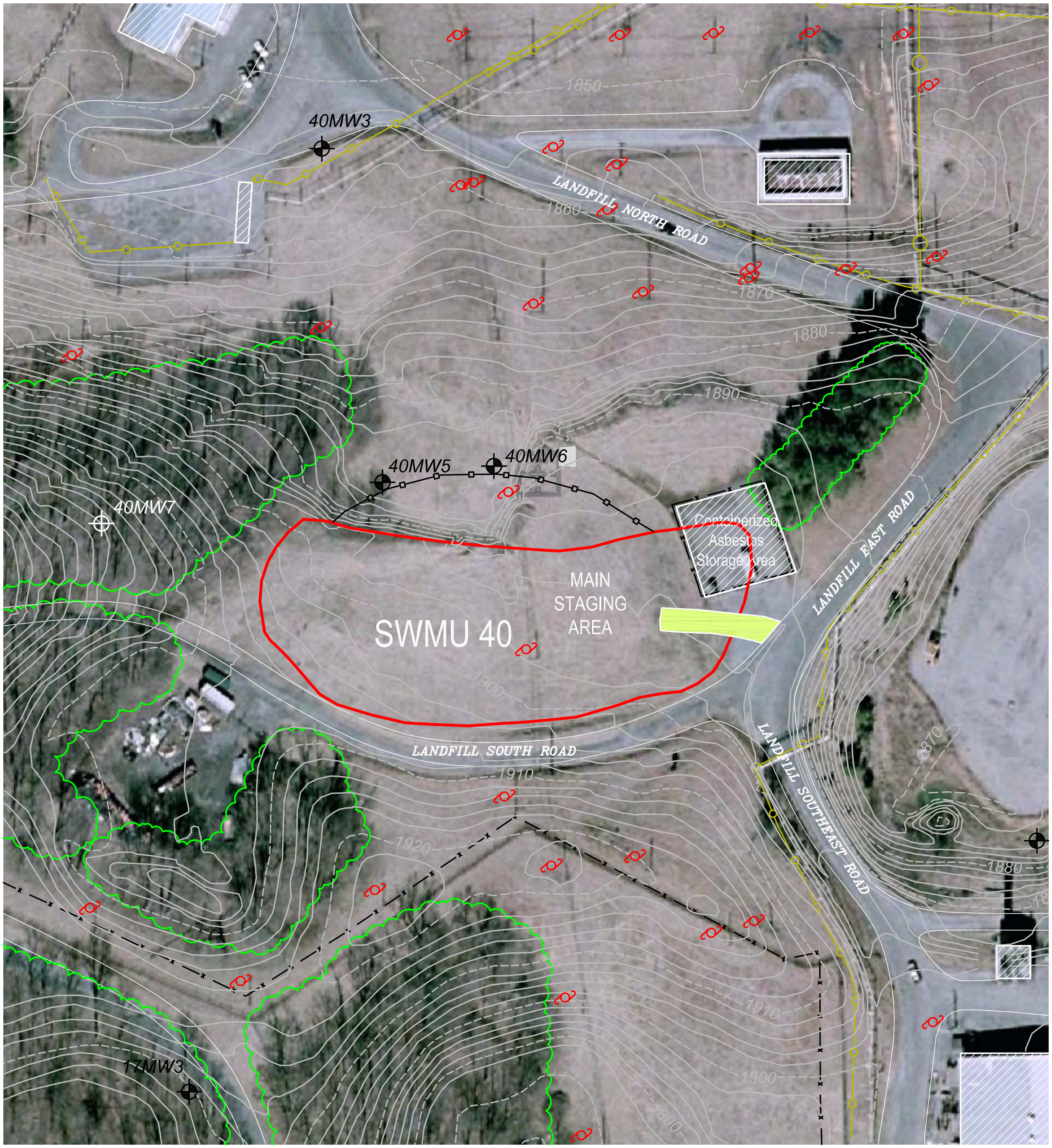
0 60 120
SCALE 1"=120'
(Approximate)

DRAWN BY: KG		DATE 23 AUGUST 2010	
REVIEWED: KR	R 5	PROJECT NO. MR0669-200-001	
APPROVED:		DWG. FILE NO. SWMU 40	

FIGURE 4

IMWP SWMU 40
PLANNED WELL LOCATION
RADFORD ARMY AMMUNITION PLANT-009
RADFORD, VIRGINIA

FILE PATH: (LOVETON) M:\MARIETTA\0 MR 0669 003-001\200\MR0669. FIG. 4. SWMU 40. PLANNED WELL LOCATION.DWG [FIG. 4] 8/25/10 PLOTTED: August 25, 2010 - 3:36 PM, BY: Karen Grigoryan



LEGEND

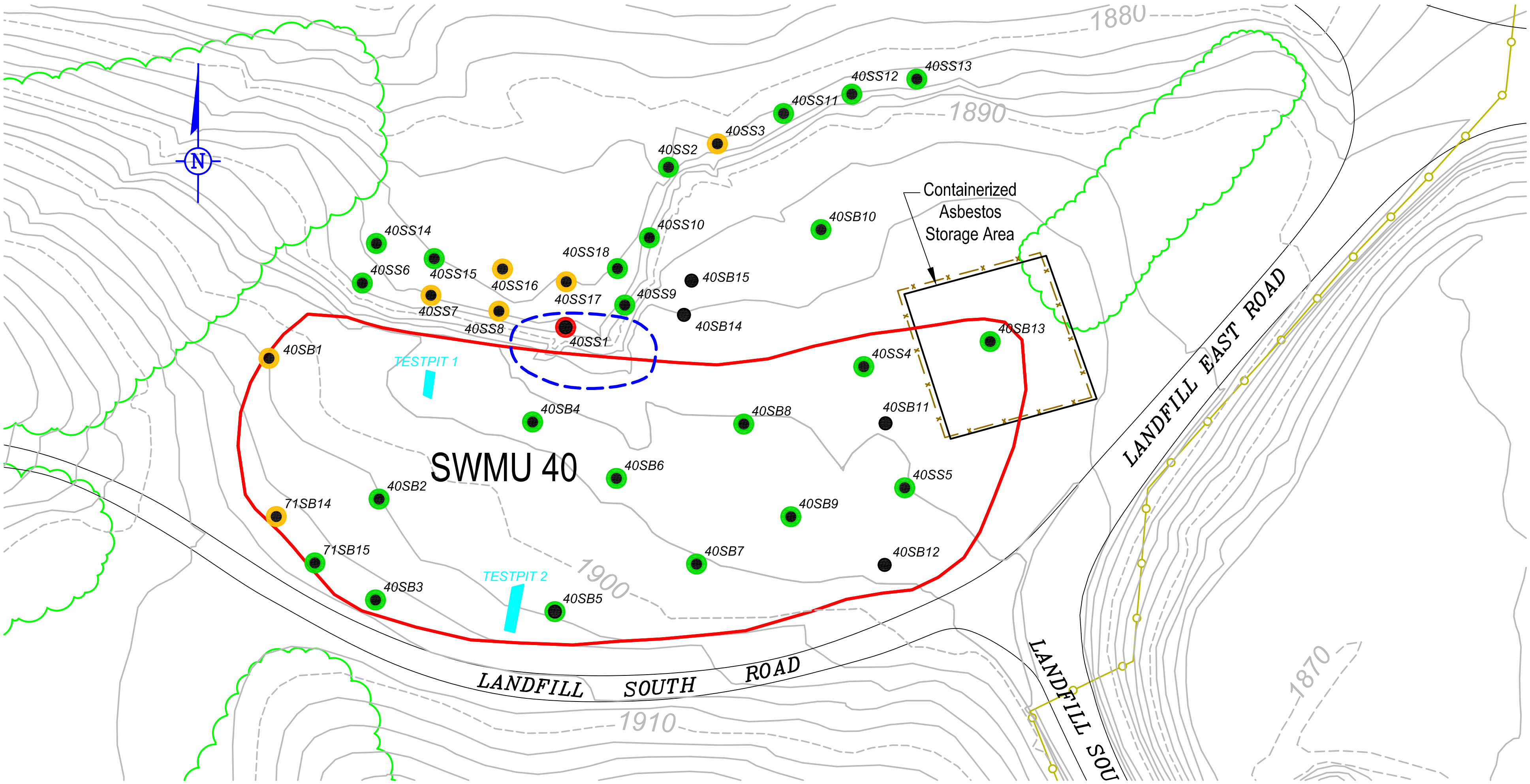
- 40MW6 — MONITORING WELL LOCATION
- 40MW7 — PLANNED NEW MONITORING WELL LOCATION
- VEGETATION
- APPROXIMATE SWMU BOUNDARY
- ABOVEGROUND PIPING
- BUILDINGS
- CONSTRUCTION ENTERANCE/EXIT
- SILT FENCE
- TOPOGRAPHIC CONTOUR
- FENCE LINE
- OVERHEAD ELECTRIC POLE

Note:
Areal Photo From
Google Earth, 2009

KEMRON ENVIRONMENTAL SERVICES

0 60 120
SCALE 1"=120'
(Approximate)

DRAWN BY: KG	DATE 23 AUGUST 2010	FIGURE 5	IMWP SWMU 40 PLANNED STAGING AREA RADFORD ARMY AMMUNITION PLANT-009 RADFORD, VIRGINIA
REVIEWED: KR / R 5	PROJECT NO. MR0669-200-001		
APPROVED:	DWG. FILE NO. PRP. STAGING AREA		



LEGEND

EXCEEDS ADJUSTED RESIDENTIAL RISK-BASED CONCENTRATION (R-RBC) OF 156ug/kg FOR AROCLOR 1254 AND 319 ug/kg FOR ARCOLOR 1260

EXCEEDS ADJUSTED R-RBC AND ADJUSTED INDUSTRIAL RBC (I-RBC) OF 1,431ug/kg FOR BOTH AROCLOR 1254 AND ARCOLOR 1260

APPROXIMATE SWMU BOUNDARY
AREA OF CAP REPAIR
ABOVEGROUND PIPING
VEGETATION
TOPOGRAPHIC CONTOUR
FENCE LINE

SB/SS
SOIL BORING/SURFACE SAMPLE LOCATION
PARAMETERS DO NOT EXCEED ADJUSTED RBCs
PARAMETERS EXCEED ADJUSTED RESIDENTIAL RBCs ONLY
PARAMETERS EXCEED ADJUSTED R-RBC & ADJUSTED I-RBC

Note:
Base map developed from fig. 2-2
Provided by URS Group, Inc., 1-2008

KEMRON ENVIRONMENTAL SERVICES

0 40 80
SCALE 1"=80'
(Approximate)

DRAWN BY: KG	DATE 23 AUGUST 2010	FIGURE 6	IMWP SWMU 40 LOCATION OF CORRECTIVE MEASURES RADFORD ARMY AMMUNITION PLANT-009 RADFORD, VIRGINIA
REVIEWED: KR / R 5	PROJECT NO. MR0669-200-001		
APPROVED:	DWG. FILE NO. SWMU 40. SITE MAP		

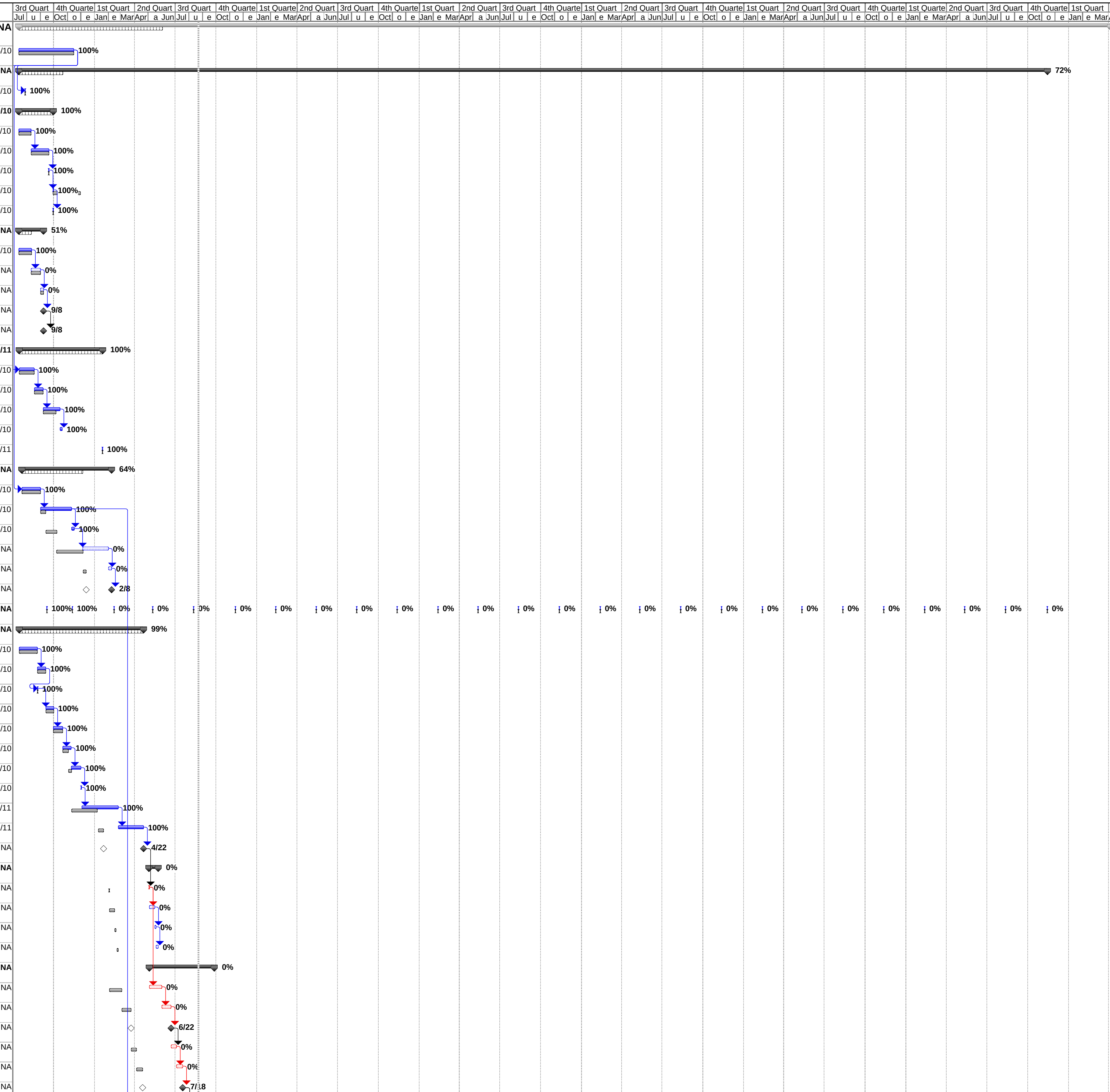
PLOTTED: August 24, 2010 - 2:28 PM, BY: Karen Grigoryan

FILE PATH: (LOVETON) M:\MARIETTA\0 MR 0669 003-001\200\MR0669. FIG. 6. SWMU 40.LOCATION OF CORRECTIVE MEASURES.DWG [FIG. 2] 8/23/10

APPENDIX A

Interim Measures Schedule

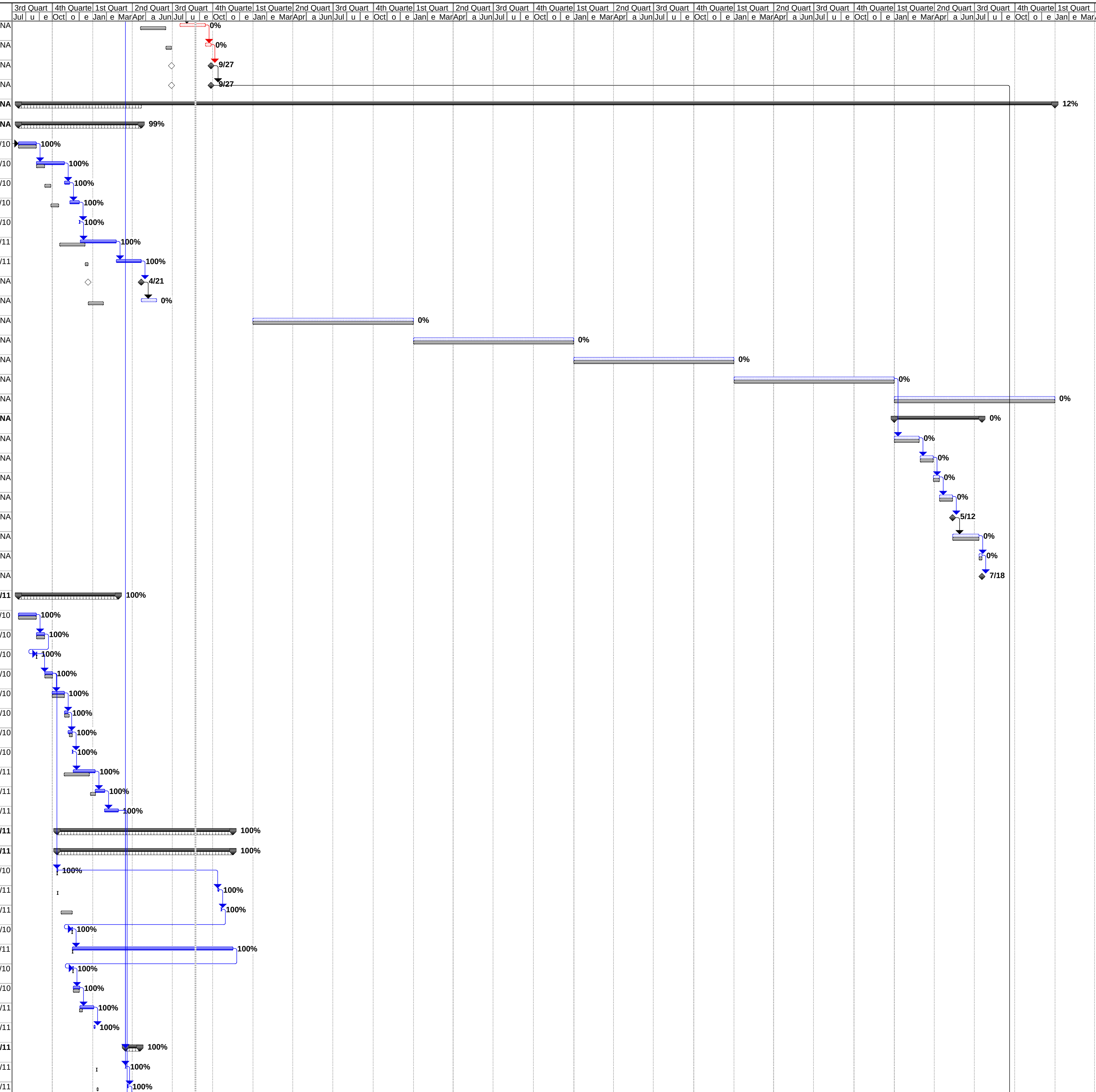
ID	% Complete	Task Name	Actual Start	Actual Finish
0	**35%**	**Radford AAP Schedule**	**Thu 7/15/10**	**NA**
1	100%	Notice to Proceed	Thu 7/15/10	Mon 11/15/10
2	**72%**	**(Task 1) Project Management Plan (PMP) / Quality Assurance Surveillance Plan (QASP) / Site Wide Plans**	**Thu 7/15/10**	**NA**
3	100%	1a Kick off Meeting	Thu 7/29/10	Thu 7/29/10
4	**100%**	**1b Project Management Plan (PMP)**	**Thu 7/15/10**	**Thu 9/30/10**
5	100%	Preparation of Army Draft PMP	Thu 7/15/10	Wed 8/11/10
6	100%	Army Review	Thu 8/12/10	Mon 9/20/10
7	100%	Incorporate Army Comments in Final PMP	Mon 9/20/10	Mon 9/20/10
8	100%	Final PMP Approved by Army	Thu 9/30/10	Thu 9/30/10
9	100%	Performance Objective Achieved	Thu 9/30/10	Thu 9/30/10
10	**51%**	**1c Quality Assurance Surveillance Plan (QASP)**	**Thu 7/15/10**	**NA**
11	100%	Preparation of Army Draft QASP	Thu 7/15/10	Thu 8/12/10
12	0%	Army Review	Thu 8/12/10	NA
13	0%	Incorporate Army Comments in Final QASP	NA	NA
14	0%	Final QASP Approved by Army	NA	NA
15	0%	Performance Objective Achieved	NA	NA
16	**100%**	**1d Accident Prevention Plan (APP) / Site Safety and Health Plan (SSHP)**	**Fri 7/16/10**	**Wed 1/19/11**
17	100%	Preparation of Army Draft APP/SSHP	Fri 7/16/10	Wed 8/18/10
18	100%	Army Review	Thu 8/19/10	Tue 9/7/10
19	100%	Incorporate Army Comments in Final APP/SSHP	Wed 9/8/10	Fri 10/15/10
20	100%	Final APP/SSHP Approved by Army	Fri 10/15/10	Wed 10/20/10
21	100%	Final APP Submitted	Wed 1/19/11	Wed 1/19/11
22	**64%**	**1e Quality Assurance Project Plan (QAPP)/Master Work Plan Addendum**	**Thu 7/22/10**	**NA**
23	100%	Preparation of QAPP/Master Work Plan Addendum	Thu 7/22/10	Wed 9/1/10
24	100%	Army Review	Thu 9/2/10	Wed 11/10/10
25	100%	Incorporate Army Comments into Draft Final QAPP Addendum	Thu 11/11/10	Tue 11/16/10
26	0%	Regulator Review	Mon 12/6/10	NA
27	0%	Incorporate Regulator Comments into Final QAPP/Master Work Plan Addendum	NA	NA
28	0%	Final QAPP/Master Work Plan Addendum Approved by Regulator	NA	NA
29	**8%**	**1F RAB Meetings/Stakeholder Communication**	**Thu 9/16/10**	**NA**
56	**99%**	**(Task 2) Interim Measures Implementation Work Plan (IMI Work Plan) - RAAP-009: Landfill Nitro Area (S40)**	**Fri 7/16/10**	**NA**
57	100%	Preparation of Army Draft IMI Work Plan	Fri 7/16/10	Wed 8/25/10
58	100%	Army Review	Thu 8/26/10	Mon 9/13/10
59	100%	Army Acceptance of Army Draft IMI Work Plan	Thu 8/26/10	Thu 8/26/10
60	100%	Incorporate Army Comments in Draft Final IMI Work Plan	Tue 9/14/10	Fri 10/1/10
61	100%	Army Review of Draft Final IMI Work Plan	Fri 10/1/10	Thu 10/21/10
62	100%	Incorporate Army Review of Draft Final IMI Work Plan	Fri 10/22/10	Tue 11/9/10
63	100%	Army Second Review of Draft Final Work Plan	Wed 11/10/10	Wed 12/1/10
64	100%	Draft Final IMI Work Plan Approved by Army	Thu 12/2/10	Thu 12/2/10
65	100%	Regulator Review	Sat 12/4/10	Wed 2/23/11
66	100%	Respond to, Resolve and Incorporate Regulator Comments into Final IMI Work Plan	Thu 2/24/11	Thu 4/21/11
67	0%	Final IMI Work Plan Approved by Army and Regulator	Fri 4/22/11	NA
68	**0%**	**(Task 3) Interim Measures Implementation - RAAP-009: Landfill Nitro Area (S40)**	**NA**	**NA**
69	0%	3a Mobilization of Equipment and Personnel	NA	NA
70	0%	3b Landfill cap repairs	NA	NA
71	0%	3c Implementation of Institutional Controls	NA	NA
72	0%	3d Well Installation	NA	NA
73	**0%**	**(Task 4) Interim Measures Completion Report (IMC Report) - RAAP-009: Landfill Nitro Area (S40)**	**NA**	**NA**
74	0%	Preparation of Army Draft IMC Report	NA	NA
75	0%	Army Review	NA	NA
76	0%	Army Acceptance of Army Draft IMC Report	NA	NA
77	0%	Incorporate Army Comments in Draft Final IMC Report	NA	NA
78	0%	Army Review of Draft Final IMC Report	NA	NA
79	0%	Draft Final IMC Report Approved by Army	NA	NA



Project: Radford AAP Schedule
Date: Mon 8/22/11

Critical | Critical Progress | Split | Baseline | Baseline Milestone | Summary Progress | Project Summary | External Milestone
Critical Split | Task | Task Progress | Baseline Split | Milestone | Summary | External Tasks | Deadline

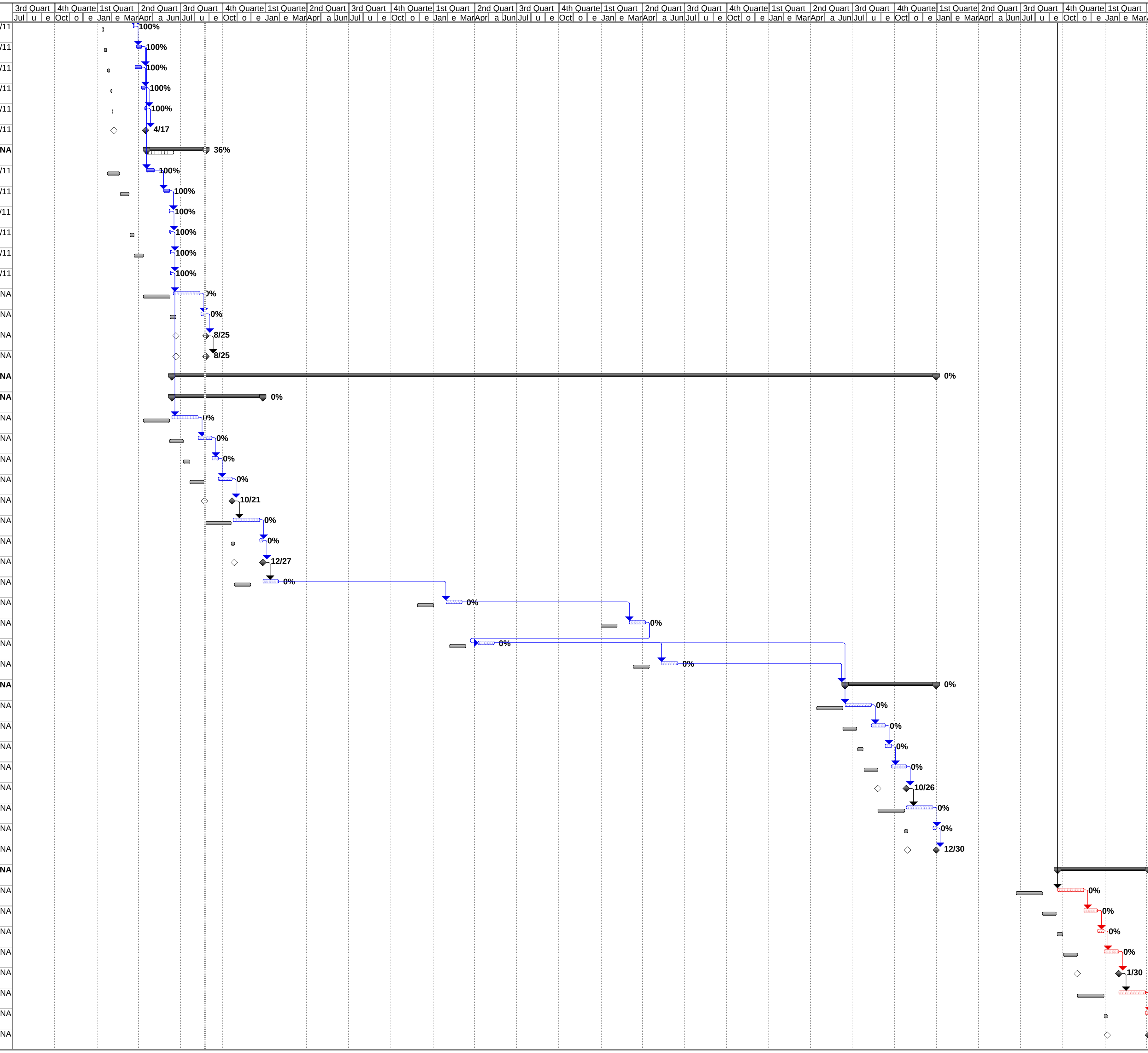
ID	% Complete	Task Name	Actual Start	Actual Finish
80	0%	Regulator Review	NA	NA
81	0%	Incorporate Regulator Comments into Final IMC Report	NA	NA
82	0%	Final IMC Report Approved by Army and Regulator	NA	NA
83	0%	Response Completed Performance Objective Achieved	NA	NA
84	**12%**	**(Task 5) Long Term Monitoring (LTM)**	**Fri 7/16/10**	**NA**
85	**99%**	**5a LTM Plan**	**Fri 7/16/10**	**NA**
86	100%	Preparation of Army Draft LTM Plan	Fri 7/16/10	Wed 8/25/10
87	100%	Army Review	Thu 8/26/10	Thu 10/28/10
88	100%	Incorporate Army Comments into Draft Final LTM Plan	Fri 10/29/10	Tue 11/9/10
89	100%	Army Review of Draft Final LTM Plan	Wed 11/10/10	Wed 12/1/10
90	100%	Draft Final LTM Plan Approved by Army	Thu 12/2/10	Thu 12/2/10
91	100%	Regulator Review	Sat 12/4/10	Wed 2/23/11
92	100%	Respond to, Resolve and Incorporate Regulator Comments into Final IMC Work Plan	Thu 2/24/11	Thu 4/21/11
93	0%	Final LTM Plan Approved by Regulator	NA	NA
94	0%	5b LTM and Reporting - Year 1 (2011)	NA	NA
95	0%	5c LTM and Reporting - Year 2 (2012)	NA	NA
96	0%	5d LTM and Reporting - Year 3 (2013)	NA	NA
97	0%	5e LTM and Reporting - Year 4 (2014)	NA	NA
98	0%	5f LTM and Reporting - Year 5 (2015)	NA	NA
99	0%	5g LTM and Reporting - Year 6 (2016)	NA	NA
100	**0%**	**5h Preparation of Ramp Down Strategy**	**NA**	**NA**
101	0%	Preparation of Army Draft Ramp Down Strategy	NA	NA
102	0%	Army Review	NA	NA
103	0%	Incorporate Army Comments into Draft Final Ramp Down Strategy	NA	NA
104	0%	Army Review of Draft Final Ramp Down Strategy	NA	NA
105	0%	Draft Final Ramp Down Strategy Approved by Army	NA	NA
106	0%	Regulator Review	NA	NA
107	0%	Incoporate Regulator Comments into Final Ramp Down Strategy	NA	NA
108	0%	Final Ramp Down Strategy Approved by Regulator	NA	NA
109	**100%**	**(Task 6) Interim Measures Implementation Work Plan (IMI Work Plan) - RAAP-022: Pond by Buildings 4931 and 4928**	**Fri 7/16/10**	**Mon 2/28/11**
110	100%	Preparation of Army Draft IMI Work Plan	Fri 7/16/10	Wed 8/25/10
111	100%	Army Review	Thu 8/26/10	Mon 9/13/10
112	100%	Army Acceptance of Army Draft IMI Work Plan	Thu 8/26/10	Thu 8/26/10
113	100%	Incorporate Army Comments in Draft Final IMI Work Plan	Tue 9/14/10	Fri 10/1/10
114	100%	Army Review of Draft Final IMI Work Plan	Fri 10/1/10	Thu 10/28/10
115	100%	Incorporate Army Comments into Draft Final IMI Work Plan	Fri 10/29/10	Fri 11/5/10
116	100%	Army Second Review of Draft Final IMI Work Plan	Sat 11/6/10	Mon 11/15/10
117	100%	Draft Final IMI Work Plan Approved by Army	Tue 11/16/10	Tue 11/16/10
118	100%	Regulator Review	Thu 11/18/10	Thu 1/6/11
119	100%	Incorporate Regulator Comments into Final IMI Work Plan	Fri 1/7/11	Fri 1/28/11
120	100%	Final IMI Work Plan Approved by Army and Regulator	Fri 1/28/11	Mon 2/28/11
121	**100%**	**(Task 7) Interim Measures Implementation - RAAP-022: Pond by Buildings 4931 and 4928**	**Tue 10/12/10**	**Wed 11/16/11**
122	**100%**	**7a Pre-excavation Sampling**	**Tue 10/12/10**	**Wed 11/16/11**
123	100%	Notify USEPA of Intent to Conduct Confirmation Sampling	Tue 10/12/10	Wed 10/13/10
124	100%	USEPA Approval to Conduct Confirmation Groundwater Sampling	Thu 10/13/11	Sat 10/15/11
125	100%	Pre Work Meeting with RFAAP, Badging and Permitting	Fri 10/21/11	Fri 10/21/11
126	100%	Mobilization of Personnel and Equipment	Mon 11/15/10	Mon 11/15/10
127	100%	Conduct Sampling for Confirmation Groundwater	Tue 11/16/10	Wed 11/16/11
128	100%	Demobilization of Personnel and Equipment	Wed 11/17/10	Wed 11/17/10
129	100%	Anlaytical Analysis of Samples / Data Review	Thu 11/18/10	Thu 12/2/10
130	100%	Prepare Results and Information Meeting with RFAAP and Regulator	Fri 12/3/10	Mon 1/3/11
131	100%	Army and Regulatory Review of Data and Agreement to Clean Closure Decision	Tue 1/4/11	Thu 1/6/11
132	**100%**	**7b Implementation of IMWP**	**Thu 3/17/11**	**Mon 4/18/11**
133	100%	Mobilization of Personnel and Equipment	Thu 3/17/11	Thu 3/17/11
134	100%	Abandon Wells and Collect Waste Characterization	Tue 3/22/11	Tue 3/22/11



Project: Radford AAP Schedule
Date: Mon 8/22/11

Critical	Critical Progress	Split	Baseline	Baseline Milestone	Summary Progress	Project Summary	External Milestone
Critical Split	Task	Task Progress	Baseline Split	Milestone	Summary	External Tasks	Deadline

ID	% Complete	Task Name	Actual Start	Actual Finish
135	100%	Establish Erosion Controls	Mon 3/21/11	Tue 3/22/11
136	100%	Excavate Pond and Drainage Swale, Confirmation Sampling	Mon 3/28/11	Thu 4/7/11
137	100%	Analytical Analysis of Confirmation Sampling	Fri 3/25/11	Thu 4/7/11
138	100%	Backfill Placement	Fri 4/8/11	Fri 4/15/11
139	100%	Restore Site	Fri 4/15/11	Mon 4/18/11
140	100%	Demobilize Personnel and Equipment	Sun 4/17/11	Mon 4/18/11
141	**36%**	**(Task 8) Interim Measures Completion Report (IMC Report) - RAAP-022: Pond by Buildings 4931 and 4928**	**Tue 4/19/11**	**NA**
142	100%	Preparation of Army Draft IMC Report	Tue 4/19/11	Thu 5/5/11
143	100%	Army Review	Thu 5/26/11	Tue 6/7/11
144	100%	Army Acceptance of Army Draft IMC Report	Tue 6/7/11	Wed 6/8/11
145	100%	Incorporate Army Comments in Draft Final IMC Report	Wed 6/8/11	Fri 6/10/11
146	100%	Army Review of Draft Final IMC Report	Fri 6/10/11	Fri 6/10/11
147	100%	Draft Final IMC Report Approved by Army	Fri 6/10/11	Fri 6/10/11
148	0%	Regulator Review	Thu 6/16/11	NA
149	0%	Incorporate Regulator Comments into Final IMC Report	NA	NA
150	0%	Final IMC Report Approved by Army and Regulator	NA	NA
151	0%	Site Closure Performance Objective Achieved	NA	NA
152	**0%**	**(Task 9) Long Term Monitoring (LTM) - RAAP-010: CAS04 TRMT/DISP (S37**	**NA**	**NA**
153	**0%**	**9a LTM Plan**	**NA**	**NA**
154	0%	Preparation of Army Draft LTM Plan	NA	NA
155	0%	Army Review	NA	NA
156	0%	Incorporate Army Comments into Draft Final LTM Plan	NA	NA
157	0%	Army Review of Draft Final LTM Plan	NA	NA
158	0%	Draft Final LTM Plan Approved by Army	NA	NA
159	0%	Regulator Review	NA	NA
160	0%	Incoporate Regulator Comments into Final LTM Plan	NA	NA
161	0%	Final LTM Plan Approved by Regulator	NA	NA
162	0%	9b LTM and Reporting - Year 1 (2010)	NA	NA
163	0%	9c LTM and Reporting - Year 2 (2011)	NA	NA
164	0%	9d LTM and Reporting - Year 3 (2012)	NA	NA
165	0%	9e LTM and Reporting - Year 4 (2013)	NA	NA
166	0%	9f LTM and Reporting - Year 5 (2014)	NA	NA
167	**0%**	**9g Preparation of Ramp Down Strategy**	**NA**	**NA**
168	0%	Preparation of Army Draft Ramp Down Strategy	NA	NA
169	0%	Army Review	NA	NA
170	0%	Incorporate Army Comments into Draft Final Ramp Down Strategy	NA	NA
171	0%	Army Review of Draft Final Ramp Down Strategy	NA	NA
172	0%	Draft Final Ramp Down Strategy Approved by Army	NA	NA
173	0%	Regulator Review	NA	NA
174	0%	Incoporate Regulator Comments into Final Ramp Down Strategy	NA	NA
175	0%	Final Ramp Down Strategy Approved by Regulator	NA	NA
176	**0%**	**(Task 10) Remedy Reviews (RAAP-09)**	**NA**	**NA**
177	0%	Preparation of Army Draft Remedy Review	NA	NA
178	0%	Army Review	NA	NA
179	0%	Incorporate Army Comments into Draft Final Remedy Review	NA	NA
180	0%	Army Review of Draft Final Remedy Review	NA	NA
181	0%	Draft Final Remedy Review Approved by Army	NA	NA
182	0%	Regulator Review	NA	NA
183	0%	Incoporate Regulator Comments into Final Remedy Review	NA	NA
184	0%	Final Remedy Review Approved by Regulator	NA	NA



Project: Radford AAP Schedule
Date: Mon 8/22/11

Critical | Critical Progress | Split | Baseline | Baseline Milestone | Summary Progress | Project Summary | External Milestone
Critical Split | Task | Task Progress | Baseline Split | Milestone | Summary | External Tasks | Deadline

APPENDIX B

Quality Assurance Project Plan

APPENDIX B

RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

Performance Based Acquisition
Solid Waste Management Unit 40 (RAAP-009)
Landfill Nitro Area
Quality Assurance Project Plan

DRAFT FINAL
NOVEMBER 2010
REVISION 1

PREPARED BY:

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Contract No. W912DY-10-D-0027
Delivery Order Number: DA01

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LIST OF ABBREVIATIONS AND ACRONYMS

AES	Auger Electron Spectrometry
APP	Accident Prevention Plan
ASTM	American Society for Testing and Materials
bgs	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COC	Contaminants of Concern
COE	Corps of Engineers
COPC	Constituent of Potential Concern
COR	Contracting Officer Representative
DODELAP	Department of Defense Environmental Laboratory Accreditation
DQI	Data Quality Indicators
DQO	Data Quality Objective
GC	Gas Chromatography
H&S	Health and Safety
HAZWOPER	Hazardous Waste Operations and Emergency Response
HPLC	High Pressure Liquid Chromatography
IDW	Investigative-Derived Waste
IMWP	Interim Measures Work Plan
KEMRON	KEMRON Environmental Services, Inc.
kg	Kilogram
LCS	Laboratory Control Sample
LIMS	Laboratory Information Management System
LQAP	Laboratory Quality Manual
LTM	Long-Term Monitoring
LOD	Limit of Detection
LOQ	Limit of Quantitation
MB	Method Blank
MCL	Maximum Contaminant Level
Mg	Milligram
mg/kg	Milligrams per Kilogram
MMRP	Military Munitions Response Program
MPC	Maximum Permissible Concentrations
MRS	Munitions Response Site
MS	Mass Spectrometry
MSR	Management Systems Review
MTBE	Methyl Tertiary Butyl Ether
MW	Monitoring Well
N/A	Not Applicable
NELAP	National Environmental Laboratory Accreditation Program
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
OVA	Organic Vapor Analyzer

OWSER	Office of Solid Waste and Emergency Response (US EPA)
PAH	Polycyclic Aromatic Hydrocarbon
PBA	Performance Based Acquisition
PCB	Polychlorinated Biphenyls
PDF	Portable Document Format (Adobe Acrobat)
PE	Professional Engineer
PG	Professional Geologist
PM	Project Manager
PRG	Preliminary Remediation Goal
PQOs	Project Quality Objectives
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
RA	Remedial Action
RFAAP	Radford Army Ammunition Plant
RPD	Relative Percent Difference
RPM	Remedial Project Manager
SOP	Standard Operating Procedure
SSL	Soil Screening Levels
SVOC	Semi Volatile Organic Compounds
TAL	Target Analyte List
TBD	To be determined
TCLP	Total Characteristic Leaching Procedure
TO	Task Order
TOC	Total Organic Carbons
UFP	Uniform Federal Policy
USACE	US Army Corps of Engineers
USAEC	US Army Environmental Command
USEPA	United States Environmental Protection Agency
UXB	UXB International, Inc.
UXB-KEMRON	UXB-KEMRON Remediation Services, LLC
VDEQ	Virginia Department of Environmental Quality
VOC	Volatile Organic Compounds
VSWMR	Virginia Solid Waste Management Regulations

SECTION 1. INTRODUCTION

The Quality Assurance Project Plan (QAPP) establishes function-specific responsibilities and authorities for data quality and defines procedures that will ensure that site investigative activities will result in the generation of reliable data. Inherent in the quality assurance program (QA) is the implementation of quality control (QC) measures. These measures provide assurance that the monitoring of quality-related events has occurred, and that the data gathered in support of the project are complete, accurate, and precise. The implementation of the QAPP will help ensure the validity of the data collected and will establish a firm foundation for decisions regarding fieldwork performed at Radford Army Ammunition Plant (RFAAP) by UXB-KEMRON under TO # DA01 of Worldwide Environmental Remediation Services contract, number W912DY-10-D-0027.

This QAPP is developed as an addendum to the *Final Master Work Plan, Radford Army Ammunition Plant, Radford, Virginia* (URS, 2003), which has been reviewed and approved by USEPA and VDEQ. This Addendum provide information to supplement existing documentation and is specific to work that will be conducted by UXB-KEMRON at two SWMUs, SWMU 40, RAAP-009 and SWMU 57, RAAP-022.

1.1 Project Objectives

Project objectives are specified in Section 3 of the Interim Measures Work Plan (IMWP), and are taken from the USEPA and VDEQ approved Final RFI/CMS for this site.

1.2 QAPP Distribution List

The following provides a distribution list for this document.

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James J. McKenna, RFAAP Environmental Engineer
Jerome Redder, ATK
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Jeanette Hamm, UXB-KEMRON Project Quality Assurance Officer
Stephanie Mossburg, Laboratory Project Manager, Microbac Ohio Valley Division
Nicole Brown, Project Manager, Columbia Analytical Services
Jeanne Peterson, Senior Chemist, Analytical Quality Associates (AQA)

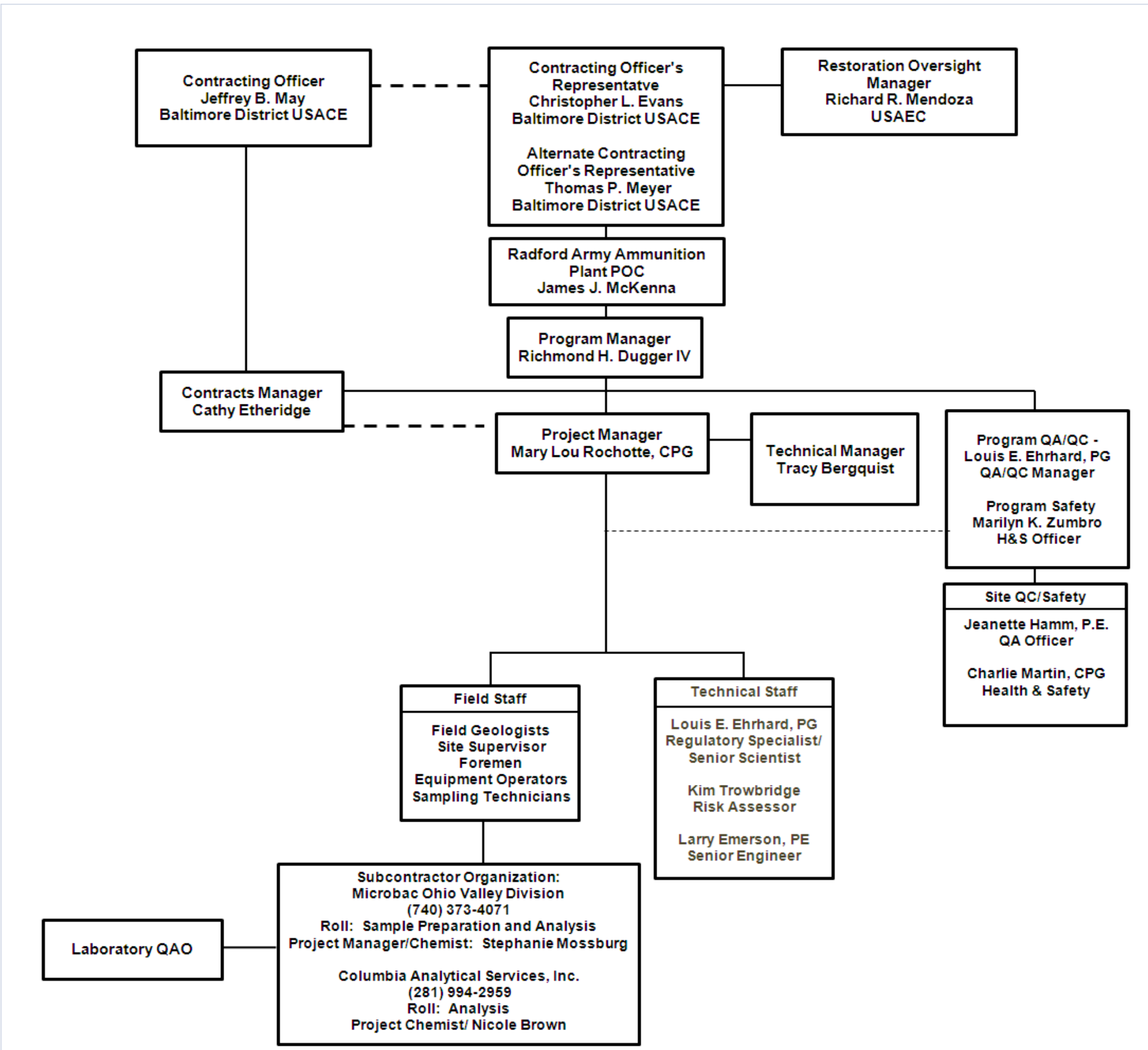
SECTION 2. PROJECT ORGANIZATION AND RESPONSIBILITIES

The UXB-KEMRON project organization strategy consists of a streamlined approach for effective and efficient execution of project activities. The overall project organizational chart can be found in Section 2.1 of the IMWP. Figure 2.1 below illustrates the flow of communication with the laboratory as well. Responsibilities for the implementation of the project QA/QC contractual obligation lie principally with the project staff and subcontractors. The Project Manager (PM) and QA Officer jointly have the primary responsibility to ensure the reliability and the validity of project activities and deliverables in compliance with the project QA program.

2.1 Key Project Personnel

Contractor personnel responsible for implementing technical, quality, and health and safety programs are described in the following subsections, and illustrated in Figure 2.1.

FIGURE 2.1



2.1.1 Contracting Officer Representative

The Contracting Officer Representative (COR) is the main point of contact between the contractor and the U.S. Army Corps of Engineers (USACE). Responsibilities of the COR include:

- Communicating frequently with the contracting project manager (PM) with regard to daily progress of the project;
- Evaluating progress
- Interfacing with regulatory agencies;
- Acting as liaison between USACE, RFAAP, and the designated contractor; and
- Requiring completion of corrective actions, when indicated.

2.1.2 UXB-KEMRON Program Manager

The Program Manager is responsible for ensuring that the contract is adhered to throughout project performance. The Program Manager, assisted by the Project Manager, serves as the primary liaison with the COR on issues relating to contract performance. The Program Manager evaluates progress and provides guidance and resources to the Project Manager. The Program Manager is a corporate officer with direct authority to interface with regulatory agencies as needed.

2.1.3 UXB-KEMRON Project Manager

The PM is responsible for ensuring that activities are conducted in accordance with contractual specifications, the Statement of Work (SOW), and approved work plans. The PM will also provide technical coordination with the designated counterpart of the Installation. The PM is responsible for management of operations conducted for this project. In addition, the PM will ensure that personnel assigned to the project, including subcontractors, will review the technical plans prior to each task associated with the project is initiated. The PM will monitor the project budget and schedule and will ensure availability of necessary personnel, equipment, subcontractors, and services. The PM will participate in the development of the field program, evaluation of data, reporting, and the development of conclusions and recommendations.

2.1.4 UXB-KEMRON Quality Assurance Officer

The QA Officer is responsible for ensuring that the QA procedures and objectives in the project-specific work plans are met, reviewing field and analytical data to ensure adherence to QA/QC procedures, and approving the quality of data prior to inclusion in associated reports. This may include the performance of field and laboratory audits during the investigation. In addition, the QA Officer will be responsible for the review, evaluation, and validation of analytical data for the project and will participate in interpreting and presenting analytical data. QC coordination is under the technical guidance of the QA Officer to direct the task leaders on a day-to-day or as-needed basis to ensure the application of QA/QC procedures.

2.1.5 Risk Assessor

Risk Assessment comprises Human Health and Ecological Assessments. The Human Health and Ecological Risk Assessments for this site have been completed and approved by USEPA and VDEQ within the Final RFI/CMS (URS, 2009). Therefore, no further risk assessment work is anticipated.

2.1.6 UXB-KEMRON Field Supervisor

The Field Supervisor will provide management of the field activities during the field work and will report daily progress and concerns to the PM. The Field Supervisor is responsible for ensuring that technical matters pertaining to the field program are addressed. He/she will participate in data interpretation, report writing, and preparation of deliverables, and will ensure that work is being conducted as specified in the technical plans. In addition, the Field Supervisor is responsible for ensuring all field personnel conform to QA/QC procedures, and for safety-related issues. Prior to initiation of field activities, the Field Supervisor will conduct a field staff orientation and briefing to acquaint project personnel with the sites and assign field responsibilities.

2.1.7 Project Chemist

The Project Chemist is an employee of the subcontracted analytical laboratory, and is responsible for knowing and monitoring the laboratory's compliance with the elements of the SOW issued to the laboratory by the contractor, and for day-to-day communications with the Analytical Laboratory. The Project Chemist is the first contact with the laboratory for receiving confirmation of sample delivery, receipt, and analysis; for tracking sample analysis within the required holding times and within the period of performance specified in the SOW; and for the receipt of data deliverables.

2.1.8 Laboratory Quality Manager

The Laboratory Quality Manager will be responsible for the technical quality of the laboratory and adherence to the Laboratory QA Program. The contract laboratory will analyze environmental samples for parameters of interest with complete data documentation. The contractor QA Officer will monitor laboratory activities.

2.1.9 Project Data Coordinator

A UXB-KEMRON Project Data Coordinator (PDC) will be responsible for receipt of field and laboratory data using a computerized data management system or database management system (DBMS). The PDC is responsible for the accuracy of data entered into the data management system. The PDC will also be responsible for providing the PM periodic data management summaries, ensuring all project chemical data are received from the laboratory in the Army's ERIS electronic data deliverable (EDD) format, and uploading the data into ERIS as required by Army standards.

2.1.10 Contract Specialist

The Contract Specialist is responsible for tracking funds for labor and materials procurement. Responsibilities include:

- Oversight of the financial status of the project;
- Preparation of monthly cost reports and invoices;
- Administration of equipment rental, material purchases, and inventory of supplies;
- Administration and negotiation of subcontracts and interaction with the Administration Contracting Officer and Procurement Contracting Officer on contract and subcontract issues;
- Preparation of project manpower estimates; and
- Administration of contract documents.

2.1.11 Health and Safety Officer

The Health and Safety Manager will review and internally approve the Accident Prevention Plan (APP), which includes a Site Specific Health and Safety Plan (SSAPP. In consultation with the PM, the Health and Safety Officer will ensure that an adequate level of personal protection exists for anticipated potential hazards for field personnel. On-site health and safety will the responsibility of the on-site Health & Safety Officer who will work in coordination with the PM and the project Health and Safety Officer.

2.2 Key Points of Contact

Table 2-1 provides the names and points of contact for UXB-KEMRON personnel and subcontractors.

Table 2-1
Contractor and Subcontractor Key Points of Contact
Radford Army Ammunition Plant, Radford, VA

Contractor	Title	Email	Key Point of Contact
Mary Lou Rochotte, CPG	Project Manager	mrochotte@kemron.com	UXB-KEMRON 156 Starlite Drive Marietta, OH T (740) 373-4308 F (740) 376-2536
Jeanette Hamm	Project QA Officer	jhamm@kemron.com	UXB-KEMRON 1359-A Ellsworth Industrial Blvd. Atlanta, GA 30318 T (404) 636-0928 F (404) 636-7162
Charlie Martin	Project H&S Officer	cmartin@kemron.com	UXB-KEMRON 156 Starlite Drive Marietta, OH 45750 T (740) 373-1024 F (740) 376-2536
Subcontractor	**Title**	**Email**	**Key Point of Contact**
Stephanie Mossburg	Laboratory Project Manager	Stephanie.Mossburg@microbac.com	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 T (740) 373-4071 F (740) 373-4835

Table 2-1
Contractor and Subcontractor Key Points of Contact
Radford Army Ammunition Plant, Radford, VA

David Bumgarner	Laboratory QA Officer	David.Bumgarner@microbac.com	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 T (740) 373-4071
Andrew Biddle	Laboratory QA Officer	abiddle@caslab.com	Columbia Analytical Services 19408 Park Row; Suite 320 Houston, TX 77084 T (713) 266-1599
Nicole Brown	Project Chemist	nbrown@caslab.com	Columbia Analytical Services 19408 Park Row; Suite 320 Houston, TX 77084 T (713) 266-1599

SECTION 3. PROBLEM DEFINITION AND PROJECT QUALITY OBJECTIVES

At SWMU 40, RAAP-009, erosion has occurred in small gullies on the north face of the landfill slope. Limited potential human health exposure to PCBs in soil has occurred. Landfill cap repair is necessary to eliminate potential current and future exposure to the PCB contaminated soil and otherwise limit potential human exposure to landfill materials. Additionally, groundwater monitoring is necessary at this site to conform to applicable regulatory standards. The project work will conform to the site IMWP, which is based upon the USEPA and VDEQ approved Final RFI/CMS. No environmental sampling is required as part of the cap repair; all necessary landfill solids sampling was completed during the RFI. All existing data in the Final RFI/CMS are fully useable and can be relied upon for decision making in this project. Groundwater monitoring requirements are as specified in the Final RFI/CMS. A proposed Long Term Monitoring program for the SWMU 40, RAAP-009 monitoring well network is included in the IMWP.

The Army will use field records and information from the cap repair at SWMU 40 to demonstrate achievement of the Corrective Measures Objectives (CMOs) defined in the Final RFI/CMS. The SWMU 40 CMOs are:

- Maintain containment of the landfill material at the site and implement necessary controls to prevent future uncontrolled human exposure to this landfill material.
- Implement any necessary measures to stabilize and repair the landfill cover at the northern edge of the landfill area to prevent any further mass transport of soil material in this area.

Field documentation and reports on the completion of the IM will provide documentation to demonstrate achievement of the CMOs.

The data generated from this project will include both decision making data and waste characterization data. Decision making data will include sampling and analysis of groundwater monitoring wells for groundwater quality evaluation. All decision making data will be based upon sampling conducted by UXB-KEMRON on a schedule specified in the IMWP. The decision making data will be evaluated by and presented by the Army in annual long term monitoring reports during the landfill monitoring period.

Data from the landfill cap repair and installation of a new monitoring well will be reported in summary form in an Interim Measures Completion Report, with complete laboratory analytical reports also provided in electronic form (e.g., CD-ROM or equivalent) and as EDDs uploaded to the Army's ERIS system. Future long term monitoring data will be provided in LTM reports as defined in the IMWP.

Additionally, clean soils will be brought to the site for placement as cover/repair material for the eroded landfill face. The soil will be sampled and analyzed to demonstrate its acceptability prior to transport and placement at SWMU 40.

SECTION 4. QUALITY ASSURANCE OBJECTIVES

QA is defined as the overall system of activities for assuring the reliability of data produced. Conformance with appended SOPs, excerpted from the approved *Final Master Work Plan, Radford Army Ammunition Plant, Radford, Virginia* will ensure attainment of QA objectives. The system integrates the quality planning, assessment, and corrective actions of various groups in the organization to provide the independent QA program necessary to establish and maintain an effective system for collection and analysis of environmental samples and related activities. The program encompasses the generation of complete data with its subsequent review, validation and documentation.

The Data Quality Objective (DQO) process is a strategic planning approach to ensure environmental data is of the appropriate type, quantity, and quality for decision making.

The overall QA objective is to develop and implement procedures for sample and data collection, shipment, evaluation, and reporting that will allow reviewers to assess whether the field and laboratory procedures meet the criteria and endpoints established in the DQOs. DQOs are qualitative and quantitative statements that outline the decision-making process and specify the data required to support corrective actions. DQOs specify the level of uncertainty that will be accepted in results derived from environmental data. *Guidance for the Data Quality Objectives Process* (USEPA 1994), and *Data Quality Objective Process for Hazardous Waste Sites* (USEPA 2000a) formed the basis for the DQO process and development of RFAAP data quality criteria and performance specifications.

4.1 Chemical Data Measurements

4.1.1 Accuracy

Accuracy is a measure of system bias and is defined quantitatively as the degree of agreement of a measurement (or an average of measurements of the same parameter), X, with an accepted reference or true value, T. The accuracy of RFAAP field activities will be qualitatively controlled through the use of standard operating procedures (SOPs) that have been developed to standardize data collection. For chemical data, accuracy of the extraction and analysis procedures will be checked quantitatively by using matrix and surrogate spikes, and blanks. The accuracy will be calculated based on the percent recovery of the spikes and concentrations of target analytes in the blanks as specified in Equation 1.

Equation 1

$$\text{Percent Recovery (\%R)} = \frac{\text{Test Value}}{\text{True Value}} \times 100$$

Field documentation will be used as evidence that investigative protocols follow the appropriate SOPs as presented in Attachment A. Field inspection performed by the contractor QA Officer will be used to identify deviations and execute corrective action (see Section 10.0). Consistent and proper calibration of equipment throughout site investigations, as described in this QAPP, will ensure the accuracy of the measurements.

4.1.2 Precision

Precision refers to the level of agreement among repeated measurements of the same parameter. It is usually stated in terms of standard deviation, relative standard deviation, relative percent difference, range, or relative range. The overall precision of data is a mixture of sampling and analytical factors. The analytical precision is easier to control and quantify because sampling precision is unique to each site.

Sampling precision will be evaluated by obtaining one duplicate sample for every ten samples collected for each type of media (10%) and by assessing the relative percent difference (RPD) between results. The RPD will be calculated according to Equation 2:

Equation 2

$$RPD\ (\%) = \frac{(XA - XB)}{XM} \times 100$$

Where:

XA, XB = duplicate analyses

XM = mean value of duplicate analyses (XA + XB)/2

The RPD will be calculated for each analytical parameter that was detected in an environmental sample. Duplicate results for aqueous matrices should have an RPD less than 25% and solid matrices will have a RPD less than 35%. If these criteria are not met, a careful examination of the sampling techniques, sample media, and analytical procedure will be conducted to identify the cause of the high RPD and the usefulness of the data.

Analytical precision will be addressed by analysis of matrix spikes (MS) for inorganic analyses; MS and matrix spike duplicates (MSDs) for organic analyses; and laboratory duplicate sample analyses. The RPD for each MS, MSD, and duplicate analysis will be calculated and compared to control criteria. If these criteria are not met, an examination of the data will be conducted to identify the cause of the variability and usefulness of the data. The data will be qualified in accordance with U.S. Environmental Protection Agency (USEPA) Region III criteria (USEPA 1993a, 2000).

4.1.3 Representativeness

Representativeness is a measure of the degree to which the measured results accurately reflect the medium being sampled. It is a qualitative parameter, which is addressed through the proper design of the sampling program in terms of sample location, number of samples, and actual material collected as a “sample” of the population.

Sampling protocols have been developed to assure that samples collected are representative of the media. Field handling protocols (e.g., storage, handling in the field, and shipping) have also been designed to protect the representativeness of the collected samples. Proper field documentation and QC inspections will be used to establish that protocols have been followed and that sample identification and integrity have been maintained.

4.1.4 Completeness

Completeness is a measure of the amount of information that must be collected during field investigations to allow for successful achievement of investigation objectives. An adequate amount and type of data must be collected for conclusions to be valid. Missing data may reduce the precision of estimates or introduce bias, thus lowering the confidence level of the conclusions. While completeness has been historically presented as a percentage of the data that is considered valid, this does not take into account critical sample locations or critical analytical parameters.

The amount and type of data that may be lost due to sampling or analytical error cannot be predicted or evaluated in advance. The importance of lost or suspect data will be evaluated in terms of the sample location, analytical parameter, nature of the problem, decision to be made, and the consequence of an erroneous decision. Critical locations or parameters for which data is identified as inadequate will either be re-sampled and re-analyzed or the data will be appropriately qualified based on the decision of the Project Officer. The completeness goal percentage of valid data is set at 90±2% for field activities at RFAAP and will be quantitatively evaluated using Equation 3:

Equation 3

$$\text{Completeness Goal Percentage (\%C)} = \frac{\text{Number of Successful Analyses (useful data)}}{\text{Number of Requested Analyses}} \times 100$$

4.1.5 Comparability

Comparability is the confidence with which one data set can be compared to another. Comparability will be controlled by using SOPs that have been developed to standardize investigative activities. Consistent and proper calibration of equipment throughout the field exercises, as described in this QAP, will assist in the comparability of measurements. Field documentation, reviews and audits will be used to establish that protocols for sampling and measurement follow appropriate SOPs.

4.1.6 Sensitivity

Sensitivity requirements are expressed differently for various methods. The instrument detection limits (IDLs), the method detection limits (MDLs), and the practical quantitation limits (PQLs) published within USEPA methods are based upon a reagent water matrix, and are not reflective of typical sample matrices; therefore, care will be taken in establishing limits for laboratory analysis. The published limits may not be achievable for environmental samples, but they should compare reasonably with control samples. This compliance will be verified during data validation. Target analytes detected above the IDL or MDL but less than the PQL limits will be reported as estimated values. Target analytes detected in samples above the upper calibration standard will be diluted and re-run by the contract laboratory.

The overall QA objective is to develop and implement procedures for sample and data collection, sample shipment, and reporting that will allow QA data users to establish whether the field and laboratory data collected during the investigation meet the criteria and endpoints established in the DQOs. The QA objective will be achieved through the implementation of specific procedures for sampling, field data collection, chain-of-custody, calibration, internal QC, audits, preventive maintenance, and corrective actions as described in this QAPP.

4.2 Levels of Concern

An integral part of the identification of DQOs is the determination of Levels of Concern (LOCs). These levels are compared with analytical method reporting limits (RLs) to ensure the method is capable of addressing project DQOs, preclude occurrence of false negative issues, and assess best available technology limitations. LOCs have been defined for SWMU 40 based upon the Final CMS as approved by USEPA and VDEQ.

4.2.1 LOCs for Groundwater

Groundwater LOCs for RFAAP SWMU 40 groundwater analytes during the long term monitoring program will include the following hierarchy of screening values, using quantitative values consistent with those in the Final RFI/CMS as approved by USEPA and VDEQ:

1. Site specific background concentration;
2. Federal Maximum Contaminant Levels (MCLs);
3. Tap Water Risk Based Screening Levels.

4.2.2 LOCs for Backfill Soil and Clay for Cover

Potential backfill sources will be evaluated per the IMWP, with LOCs based upon:

- USEPA Regional risk based screening levels.

SECTION 5. SAMPLING LOCATIONS AND RATIONALE

A summary of the sampling locations and rationale are provided in the IMWP, including:

- Background/upgradient samples;
- Contaminants of concern;
- Investigative objective;
- Levels of concern;
- Data use priorities;
- Project scope;
- Associated field and laboratory QA/QC samples;
- Number of samples;
- Sample type;
- Sample location;
- Specific site features that will affect sample collection, such as depth or flow conditions;
- Sampling procedures;
- Analytical methods;

Project staff is responsible for becoming familiar with the details of the IMWP as they pertain to their assigned work. The PM and Field Supervisor will ensure that project staff receive appropriate briefings on the scope of work and project specific requirements.

5.1 Decontamination Procedures

Decontamination procedures will follow those in SOP 80.1 Decontamination.

SECTION 6. SAMPLE MANAGEMENT

6.1 Sample Number and Type

The number and types of environmental and QC samples to be collected during a specific sampling event are identified in the site IMWP. The existing RFI data will be used in conjunction with new data generated by UXB-KEMRON.

For SWMU 40, decision making data will include groundwater monitoring data. Groundwater monitoring data, including existing RFI data, will be used by UXB-KEMRON and the Army to demonstrate the absence of groundwater impacts from the SWMU. Field reports and data, including data demonstrating placement of clean cap repair soil at SWMU 40, will be used to demonstrate the landfill cap integrity restoration to achieve CMOs. Chemical data also will be generated to demonstrate that soil emplaced to repair the SWMU 40 landfill cap is free of contaminant concentrations that could create new environmental concerns at the site.

QC samples are discussed in Section 9.0. Sample collection, preservation, handling, storage, and shipping will be performed in a manner that minimizes damage, loss, deterioration, and contamination. Procedures described are designed to eliminate external contamination and to ensure data quality by using approved standardized sampling procedures. References to methods of collection and detailed SOPs are provided in Attachment A.

6.2 Sample Containers

The integrity of containers for aqueous and solid samples is ensured by the use of appropriate cleaning techniques. Microbac will provide pre-cleaned sample bottles for chemical analyses according to good laboratory practices. Table 6-1 specifies the sample containers requirements that may be applicable for the UXB-KEMRON work under this QAPP.

6.3 Sample Preservatives

Preservatives will be used, as applicable, to retard hydrolysis of chemical compounds and complexes, to reduce volatility of constituents, and to retard biological action during transit and storage prior to laboratory analysis. Sample containers will be pre-preserved by the laboratory. In addition to chemical preservatives, samples for chemical analysis will be transported to the laboratory in temperature-controlled coolers. Double-bagged ice will be used to maintain the internal cooler temperature required for preservation. A temperature blank will be included in each shipping container to monitor the internal temperature. Tables 6-1 specifies the sample preservative requirements.

6.4 Holding Times

Sample holding time is defined as the interval between sample collection and sample extraction/analysis, such that a sample may be considered valid and representative of the sample matrix. The laboratory QA program will be responsible for ensuring the adequacy of the sample tracking system in precluding holding time deficiencies. Tables 6-1 specifies the holding time requirements. Table 6-2 shows analytical services to be provided.

Table 6-1 Summary of Sample Container and Sample Preservations Requirements SWMU 40				
Parameter	Sample Container[1,2]		Preservation Methods	Holding Times
	Quantity	Type		
Solid Samples				
Pesticides/Aroclors	2	250-mL wide-mouth glass amber container	Cool to 4 ± 2°C	Extraction: 7 days Analysis: 40 days
Metals	1	125-mL glass container, Teflon® lined cap	Cool to 4 ± 2°C	6 months
PAHs	1	125-mL glass amber, Teflon® lined cap	Cool to 4 ± 2°C	Extraction: 14 days Analysis: 40 days
Corrosivity (pH)	1	60-mL glass container	Cool to 4 ± 2°C	Immediately
Waste Samples				
TCLP Metals	1	250-mL wide mouth glass container, Teflon® lined cap	Cool to 4 ± 2°C	Leaching: 14 days Analysis: 2 months
Corrosivity, Paint Filter	1	250-mL wide mouth glass container, Teflon® lined cap	Cool to 4 ± 2°C	Corrosivity: 7 days Reactivity: 7 days
Reactivity	1	250-mL wide mouth glass container, Teflon® lined cap	--	--
Ignitability	1	250-mL wide mouth glass container, Teflon® lined cap	--	--
Aqueous Samples				
Volatile Organic Compounds	3	40-mL glass vials, Teflon®-lined septum cap	HCl to pH <2, Cool to 4 ± 2°C	14 days
Semivolatile Organic Compounds	2	1-liter narrow mouth amber glass, Teflon® lined cap	Cool to 4 ± 2°C	Extraction: 7 days Analysis: 40 days
Pesticides	4	1-liter narrow mouth amber glass, Teflon® lined cap	Cool to 4 ± 2°C	Extraction: 7 days Analysis: 40 days
Metals	1	500-mL high density polyethylene (HDPE) with 10% headspace	HNO_3 to pH <2, Cool to 4 ± 2°C	6 months
Corrosivity (pH)	1	60-mL glass container	Cool to 4 ± 2°C	Immediately

Table 6-1 Summary of Sample Container and Sample Preservations Requirements SWMU 40				
Dioxins/Furans	2	1-liter narrow-mouth amber glass container	Cool to 4 ± 2°C	Extraction: 30 days Analysis: 45 days
Perchlorate	1	125-mL polyethylene container	Cool to 4 ± 2°C	28 days

[1] The sample containers used for each chemical parameter must be certified as being clean or have been decontaminated by the laboratory.
[2] The type and number of containers required may be adjusted to reflect the requirements of the individual laboratories selected to perform the analyses. The laboratories may allow combining analyses requested per jar to reduce the number of jars required.

Notes:
mL = milliliter
°C= Celsius
g = gram
HCL = Hydrochloric Acid
HNO_3 = Nitric Acid

Table 6-2
Analytical Services
Radford Army Ammunition Plant, Radford, Virginia

Matrix	Analytical Group	Data Package Turnaround Time	Laboratory / Organization (Name and Address, Contact Person and Tel. No.)	Backup Laboratory / Organization (Name and Address, Contact Person and Tel. No.)
Solid (soil or sediment) and Aqueous (Groundwater)	8082 6850 8270C 8270 8260B 6010B 6020 7471A 8290	CD-ROM Level 4 CLP Like & EDD 30 Days	Microbac Laboratories, Inc. 158 Starlite Drive Marietta, OH 45750 Stephanie Mossburg (740) 373-4071	Columbia Analytical Services, Inc. 19408 Park Row; Suite 320 Houston, TX 77084 Nicole Brown (713) 266-1599
	8081A			

6.5 Sample Identification

The sample identification number will consist of an alphanumeric designation related to the sampling location (and/or well identification for groundwater samples), media type, and sequential order according to the sampling event. If previous sampling has been performed at the site, new sample IDs will follow the previous identification scheme as closely as possible. QA/QC sample identification numbers will be numbered as above. The sample identification number should not exceed 20 alphanumeric characters.

Site Location Code: The first two characters will be the SWMU number (i.e., 40 for SWMU 40).

Sample/Media Type: The next two characters will be the sample/media types. In this case, the characters will be GW for groundwater, SC for soil confirmation, SW for surface water, WCS for waste characterization soil, BF for backfill, and SB for soil boring.

Sampling Location Number: The next one or two characters will be the number of the sampling location (e.g., 3, 4, 5).

Sample Depth: The sample representing 2.5 feet will be designated with -2.5' after the boring number. The sample collected from 5 feet will be designated with -5' following the boring number.

Duplicate: Duplicate samples will be identified with a "D" designation followed by a numeric designation corresponding to the sequence of duplicates collected (e.g., D-1). A record of the sample that corresponds to the duplicate will be kept in the field logbook. In this manner, duplicates will be submitted as blind duplicates, eliminating the potential for laboratory bias in analysis.

Sample Identification Examples:
1) A groundwater sample collected at boring location four at SWMU 40 would be identified as sample 40GW4 (for SWMU 40 and groundwater sample location four).

2) Quality Control Samples: QC samples will be identified by date (month, day, year), followed by QC sample type, and sequential order number at one digit. The QC sample types include Matrix Spike (MS), Matrix Spike Duplicate (MSD), Rinse Blank (R), and Trip Blank (T).

6.6 Documentation Requirements
Information pertinent to the sampling effort will be recorded in a field logbook and the sample traced by a chain-of-custody form. Entries will be made in indelible ink on consecutively numbered pages, and corrections will consist of line out deletions that are initialed and dated (refer to SOP 10.1, Attachment A).

At a minimum, field logbook entries include the following:

- Project name (cover);
- Name and affiliation of personnel on site;
- Contractor project number;
- Weather conditions;
- General description of the field activity;
- Sample location;
- Sample identification number;
- Time and date of sample collection;
- Specific sample attributes (e.g. sample collection depth flow conditions, or matrix);
- Sampling methodology (grab or composite sample);
- Sample preservation, as applicable;
- Analytical request/methods;

- Associated QA/QC samples;
- Field measurements/observations, as applicable; and
- Signature and date of personnel responsible for documentation.

SOP 10.2 in Attachment A provides specific protocols for recording for recording soil, surface water, and groundwater sampling information, as well as instrument field calibration data in field logbooks.

Each sample container will be annotated in waterproof ink, with the installation name, sample number, sampling date, analytes, and preservatives. The sample label will be permanently affixed to the sample container using polyethylene tape (refer to SOP 50.1 in Attachment A).

Telephone communication will be documented for scope of work changes and/or conditions that impact task deliverables. Related records include telephone logs, e-mail, and facsimiles.

Specific records related to investigative activities may include:

- Boring logs (refer to SOP 10.3 in Attachment A);
- Well construction diagrams (refer to SOP 20.1 in Attachment A);
- Well development records (refer to SOP 20.2 in Attachment A);
- Monitoring well and boring abandonment (SOP 20.3);
- Aquifer test records;
- Laboratory data; and
- Subcontractor permits and qualifications, and utility clearance.

6.7 Chain-of-Custody Requirements

Sampling will be evidenced through the completion of a chain-of-custody form, which accompanies the samples from the field to the laboratory. The chain-of-custody form will be annotated to indicate time and date that samples are relinquished. In addition, shipping containers will be affixed with custody seals. Once samples are relinquished to the laboratory, the laboratory chain-of-custody procedures, as described in Section 9.3, will be followed. SOP 10.4 in Attachment A describes specific protocols for using chain-of-custody forms. An example chain of custody form is provided in Figure 10.4-a.

Table 6-3
Analytical Services Summary – SWMU 40, RAAP-009

Analytical Services Summary					
Matrix	**Analytical Group**	**Analytical SOP**	**Data Package Turnaround Time**	**Laboratory/Organization (Name and Address, Contact Person, and Telephone Number)**	**Backup Laboratory/Organization (Name and Address, Contact Person, and Telephone Number)**
Groundwater	pH, turbidity, temperature, specific conductance redox potential, dissolved oxygen		N/A - Field Screening	UXB-KEMRON 156 Starlite Drive Marietta, OH Mary Lou Rochotte (740) 373-4308	None
Groundwater	TCL VOCs	See Attachment C	30 days from sample receipt	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 Stephanie Mossburg (740) 373-4071	None
Groundwater	TAL Metals	See Attachment C	30 days from sample receipt	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 Stephanie Mossburg (740) 373-4071	None
Groundwater	TCL SVOCs	See Attachment C	30 days from sample receipt	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 Stephanie Mossburg (740) 373-4071	None
Groundwater	TCL Pesticides	See Attachment C	30 days from sample receipt	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 Stephanie Mossburg (740) 373-4071	None
Groundwater	Perchlorate	See Attachment C	30 days from sample receipt	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 Stephanie Mossburg (740) 373-4071	None
Groundwater	Dioxins/Furans	See Attachment C	30 days from sample receipt	Columbia Analytical Services 19408 Park Row Ste. 320 Houston, TX 77084 Nicole Brown (281) 994-2959	None
Soil	TAL Metals	See Attachment C	30 days from sample receipt	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 Stephanie Mossburg (740) 373-4071	None
Soil	TCL VOCs	See Attachment C	30 days from sample receipt	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 Stephanie Mossburg (740) 373-4071	None

Analytical Services Summary					
Matrix	**Analytical Group**	**Analytical SOP**	**Data Package Turnaround Time**	**Laboratory/Organization (Name and Address, Contact Person, and Telephone Number)**	**Backup Laboratory/Organization (Name and Address, Contact Person, and Telephone Number)**
Soil	TCL Pesticides/PCBs	See Attachment C	30 days from sample receipt	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 Stephanie Mossburg (740) 373-4071	None
Soil	PAHs	See Attachment C	30 days from sample receipt	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 Stephanie Mossburg (740) 373-4071	None
Leachate	Metals	See Attachment C	30 days from sample receipt	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 Stephanie Mossburg (740) 373-4071	None
Leachate	VOCs	See Attachment C	30 days from sample receipt	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 Stephanie Mossburg (740) 373-4071	None
Water/Soil	Chemical Oxygen Demand (COD)	See Attachment C	30 days from sample receipt	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 Stephanie Mossburg (740) 373-4071	None
Water/Soil	Ignitability	See Attachment C	30 days from sample receipt	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 Stephanie Mossburg (740) 373-4071	None
Water/Soil	Corrosivity	See Attachment C	30 days from sample receipt	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 Stephanie Mossburg (740) 373-4071	None
Water/Soil	Reactivity	See Attachment C	30 days from sample receipt	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 Stephanie Mossburg (740) 373-4071	None
Solids	Paint Filter Tests	See Attachment C	30 days from sample receipt	Microbac – Ohio Valley Div. 158 Starlite Drive Marietta, Ohio 45750 Stephanie Mossburg (740) 373-4071	None

SECTION 7. ANALYTICAL PROCEDURES

7.1 Field Testing and Screening

During the environmental sample collection activities conducted at RFAAP, selected physical and chemical parameters at the site should be measured. For example, specific conductance, pH, temperature, redox potential, and dissolved oxygen measurements will generally be collected in conjunction with the chemical data for groundwater and surface water characterization.

Equipment and general procedures for analysis of field samples should reference appropriate SOPs in Attachment A. Because field instrumentation and analytical methodology are continually being updated, field personnel are required to consult manufacturers' instruction manuals for operating procedures.

7.2 Laboratory Procedures for Chemical Analyses

The choice of analytical method is based on the following consideration:

- Regulatory program requirements as specified in USEPA and VDEQ approved site specific RCRA submittals;
- DQOs; and
- Consideration of other practical constraints (temporal, financial, geographic).

Analytical methods will be derived from standard, published methods having regulatory standing. Examples include USEPA SW-846 Test Methods, test methods specified in the Code of Federal Regulations (Title 40 Code of Federal Regulations Part 136 (40 CFR 136) and 40 CFR 261) Standard Methods for the Examination of Water and Wastewater (APHA 1992), U.S. Geological Survey, etc.

Groundwater sample analyses will be in accordance with USEPA SW-846 Test Methods as specified in the long term monitoring plan, contained within the IMWP. The analyses include:

- TCL VOCs;
- TCL SVOCs;
- TCL Pesticides;
- TAL Metals
- Perchlorate;
- Dioxins and furans (initial sampling event only)

Please note that Columbia Laboratories has been subcontracted to perform the analysis of dioxins/furans.

Samples of IDM (decontamination water and soil from monitoring well installation) will be characterized as required by the disposals facility and are anticipated to include:

- TCLP VOCs;
- TCLP Metals;
- Chemical Oxygen Demand (COD);
- Ignitability;
- Corrosivity;
- Reactivity; and

- Paint Filter Test (solids).

Backfill soil samples will be collected and analyzed as presented in the IMWP, with analyses including:

- TAL metals;
- TCL PAHs;
- Pesticides/PCBs;
- pH.

7.2.1 Organics

The following techniques will be used for determination of organic constituents.

7.2.1.1 VOCs by SW8260B

The aqueous samples are prepared for analysis by purge-and-trap Method 5030 and the solid samples are prepared by purge-and-trap Method 5035. The volatile compounds are introduced into the gas chromatograph by the purge-and-trap method or by other methods (see Section 1.2 of Method SW8260B). The analytes are introduced directly to a wide-bore capillary column or cryofocused on a capillary pre-column before being flash evaporated to a narrow-bore capillary for analysis. The column is temperature-programmed to separate the analytes, which are then detected with a mass spectrometer (MS) interfaced to the gas chromatograph (GC). Analytes eluted from the capillary column are introduced into the mass spectrometer via a jet separator or a direct connection. (Wide-bore capillary columns normally require a jet separator, whereas narrow-bore capillary columns may be directly interfaced to the ion source.) Identification of target analytes is accomplished by comparing their mass - spectra with the electron impact (or electron impact-like) spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitation) ion relative to an internal standard using a five-point calibration curve.

7.2.1.2 SVOCs by SW8270C

The samples are prepared for analysis by GCMS using Method 3520C for aqueous media and Method 3540C for solid media, or other appropriate methods. The semivolatile compounds are introduced into the GC/MS by injecting the sample extract into a GC with a narrow-bore fused-silica capillary column.

The GC column is temperature-programmed to separate the analytes, which are then detected with a MS, connected to the gas chromatograph. Analytes eluted from the capillary column are introduced into the mass spectrometer via a jet separator or a direct connection. Identification of target analytes is accomplished by comparing their mass spectra with the electron impact (or electron impact-like) spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitation) ion relative to an internal standard using a five-point calibration curve.

7.2.1.3 Pesticides by SW8081A

A measured volume or weight of sample (approximately one liter for liquids, and two to 30 grams for solids) is extracted using the appropriate matrix-specific sample extraction technique. Liquid samples are extracted at neutral pH with methylene chloride using Method 3520C (continuous liquid-liquid extractor), or other appropriate technique. Solid samples are using Method 3540C (Soxhlet) or other appropriate technique. A variety of cleanup steps may be applied to the extract, depending on the nature of the matrix interferences and the target analytes. Suggested cleanups include alumina (Method 3610), Florisil (Method 3620), silica gel (Method 3630), gel permeation chromatography (Method 3640), and sulfur (Method 3660). After cleanup, the extract is analyzed by injecting a one microliter (pL) sample into a gas chromatograph with a narrow- or wide-bore fused silica capillary column and electron capture detector (ECD) or an electrolytic conductivity detector (ELCD).

7.2.1.4 PCBs by SW8082

A measured volume or weight of sample (approximately one liter for liquids, and two to 30 grams for solids) is extracted using the appropriate matrix-specific sample extraction technique. Aqueous samples are extracted at neutral pH Method 3520C (continuous liquid-liquid extractor), or other appropriate technique. Solid samples are extracted Method 3540C (Soxhlet) or other appropriate technique. Extracts for PCB analysis may be subjected to a sulfuric acid/potassium permanganate cleanup (Method 3665) designed specifically for these analytes. This cleanup technique will remove (destroy) many single component organochlorine or organophosphate pesticides. Therefore, Method 8082 is not applicable to the analysis of those compounds. Instead, use Method 8081. After cleanup, the extract is analyzed by injecting a 2 µL aliquot into a gas chromatograph with a narrow- or wide-bore fused silica capillary column and ECD. The chromatographic data may be used to identify the seven Aroclors found in Section 1.1 of Method SW8082, individual PCB congeners, or total PCBs.

7.2.1.5 PAHs by 8270-SIM

Method 8270 SIM is a Gas Chromatography/Mass Spectroscopy (GC/MS) method that relies on a mass-selective detector to measure the breakdown fractions of compound. In the SIM mode (Selective Ion Monitoring), the GC/MS can look for specific ions of a limited target compound list. This allows the analyst to achieve much lower reporting limits than standard Method 8270 that operates in a full scan mode. Method 8270 SIM provides for the detection of parts per billion (ppb) levels of certain PAHs in water and soil matrices. Samples are extracted then concentrated by evaporation. Compounds of interest are separated by capillary column GC and quantitated using the method of internal standards. The MS is tuned prior to analysis to give an acceptable spectrum.

7.2.1.6 Dioxin and Furans by SW8290

Method 8290 provides procedures for the detection and quantitative measurement of polychlorinated dibenzo-pdioxins (tetra- though octa-chlorinated homologues; PCDDs) and polychlorinated dibenzofhrans (tetra- though octa-chlorinated homologues; PCDFs) in a variety of environmental matrices and at parts-per-trillion @pt) to parts-perquadrillion (ppq) concentrations. A specified amount of sample is spiked with a solution containing specified amounts of each of the nine isotopically ($^{l3}C_{12}$) labeled PCDDs/PCDFs. The sample is then extracted according to a matrix specific extraction procedure. The samples are prepared for analysis by high-resolution gas chromatography high-resolution mass spectrometry (HRGC/HRMS) using the matrix specific extraction (refer to Method 8290) and analyte specific cleanup procedures (refer to Method 8290). A high-resolution capillary column (60 m DB-5, J&W Scientific, or equivalent) is used in this method. However, no single column is known to resolve all isomers.

In order to ascertain the concentration of the 2,3,7,8-TCDF (if detected on the DB-5 column), the sample extract must be reanalyzed on a column capable of 2,3,7,8-TCDF isomer specificity (e.g., DB-225, SP-2330, SP-2331, or equivalent). Quantitation of the individual congeners, total PCDDs and total PCDFs is achieved in conjunction with the establishment of a multi-point (five points) calibration curve for each homologue, during which each calibration solution is analyzed once. The identification of 1,2,3,4,6,7,8,9-octachlorodibenzo-p-dioxin (OCDD) and nine of the fifteen 2,3,7,8- substituted congeners, for which a ^{13}C-labeled standard is available in the sample fortification and recovery standard solutions, is based on their elution at their exact retention time (within 0.005 retention time units measured in the routine calibration) and simultaneous detection of the two most abundant ions in the molecular ion region. The remaining six 2,3,7,8-substituted congeners (i.e., 2,3,4,7,8-PeCDF; 1,2,3,4,7,8-HxCDD; 1,2,3,6,7,8-HxCDF; 1,2,3,7,8,9-HxCDF; 2,3,4,6,7,8-HxCDF, and 1,2,3,4,7,8,9-HpCDF), for which no carbon-labeled internal standards are available in the sample fortification solution, and other identified PCDD/PCDF congeners are identified by their relative retention times from the routine calibration data, and the simultaneous detection of the two most abundant ions in the molecular ion region. The identification of 1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF) is based on its retention time relative to $^{13}C_{12}$-OCDD and the simultaneous detection of the two most abundant ions in the molecular ion region. Confirmation is based on a comparison of the ratios of the integrated ion abundance of the molecular ion species to their theoretical abundance ratios. A calculation of the toxicity equivalent concentration (TEQ) of each sample is made using international consensus toxicity I equivalence factors (TEFs), and the TEQ is used to identify if the concentrations of target compounds in the sample are high enough to warrant confirmation of the results on a second GC column.

7.2.1.7 Perchlorate by SW6850

Method 6850 provides high performance liquid chromatography (HPLC) coupled with electrospray ionization (ESI) mass spectrometry (MS) or tandem mass spectrometry (MS/MS) for the determination of perchlorate in surface water, groundwater, wastewater, salt water, and soil. Solids are first extracted prior to analysis using reagent water. Aqueous samples and extracts are filtered, and analyzed via HPLC/MS (with or without fragmentation) or HPLC/MS/MS. Perchlorate is detected and quantified using mass-to-charge (m/z) ratio 83 (or 99) for native perchlorate and internal standard calibration, based on the m/z ion 89 (or 107). Additional confirmation of perchlorate identification is provided by monitoring the abundance ratio of the isotopic ions, m/z 83 (or 99) and 85 (or 101). Method 6850 confirms perchlorate detection and overcomes many of the interference problems encountered when using IC/conductivity suppression analysis for perchlorate (Method 9058). The method allows analytical flexibility - a variety of chromatographic conditions and analysis options have been validated and are provided in the test method.

7.2.2 Inorganics

The following techniques will be used for determination of inorganic constituents.

7.2.2.1 Metals by ICP

Prior to analysis, samples are prepared by Method 3010A for aqueous media and Method 3050B for solid media, or other appropriate methods. When analyzing groundwater samples for dissolved constituents, acid digestion is not necessary if the samples are filtered and acid preserved before analysis. This method describes multi-elemental determinations by Inductively Coupled Plasma (ICP) - Atomic

Emission Spectroscopy (AES) using sequential or simultaneous optical systems and axial or radial viewing of the plasma. The instrument measures characteristic emission spectra by optical spectrometry.

Samples are nebulized and the resulting aerosol is transported to the plasma torch. Element-specific emission spectra are produced by radio-frequency inductively coupled plasma. The spectra are dispersed by a grating spectrometer, and the intensities of the emission lines are monitored by photosensitive devices.

Background correction is required for trace element determination. Background must be measured adjacent to analyte lines on samples during analysis. The position selected for the background-intensity measurement, on either or both sides of the analytical line, will be defined by the complexity of the spectrum adjacent to the analyte line. In one mode of analysis the position used should be as free as possible from spectral interference and should reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result. The possibility of additional interferences named in Section 3.0 of Method 3050B should also be recognized and appropriate corrections made; tests for their presence are described in Section 8.5 of Method 3035B.
Alternatively, users may choose multivariate calibration methods. In this case, point selections for background correction are superfluous since whole spectral regions are processed.

7.2.3 Waste Samples

7.2.3.1 TCLP Extraction

For liquid wastes (i.e., those containing less than 0.5% dry solid material), the waste, after filtration through a 0.6 to 0.8-micrometer (µm) glass fiber filter, is defined as the TCLP extract. For wastes containing greater than or equal to 0.5% solids, the liquid, if present, is separated from the solid phase and stored for later analysis; the particle size of the solid phase is reduced, if necessary. The solid phase is extracted with an amount of extraction fluid equal to 20 times the weight of the solid phase. The extraction fluid employed is a function of the alkalinity of the solid phase of the waste. A special extractor vessel is used when testing for volatile analytes. Following extraction, the liquid extract is separated from the solid phase by filtration through a 0.6 to 0.8-pm glass fiber filter. If compatible (i.e., multiple phases will not form on combination), the initial liquid phase of the waste is added to the liquid extract, and these are analyzed together. If incompatible, the liquids are analyzed separately and the results are mathematically combined to yield a volume-weighted average concentration. Extracts are analyzed using the analytical methods described above.

7.2.3.2 Ignitability

For liquid wastes, the sample is heated at a slow, constant rate with continual stirring. A small flame is directed into the cup at regular intervals with simultaneous interruption of stirring. The flash point is the lowest temperature at which application of the test flame ignites the vapor above the sample. For solid wastes, in a preliminary test, the test material is formed into an unbroken strip or powder train 250 millimeters (mm) in length. *An* ignition source is applied to one end of the test material to learn whether combustion will propagate along 200 mm of the strip within a specified time. Materials that propagate **-** burning along a 200-mm strip within the specified time are then subjected to a burning rate test.

Materials that do not ignite or propagate combustion as described above do not require further testing. In the burning rate test, the burning time is measured over a distance of 100 mm and the rate of burning is calculated. The test method described here is based on the test procedure adopted by the U.S. Department of Transportation from the United Nations regulations for the international transportation of dangerous goods and is contained in Appendix E to Part 173 of Title 49 of the Code of Federal Regulations (CFR).

7.2.3.3 Corrosivity

The corrosivity of a sample will be based on its pH. The pH of a liquid sample is either analyzed electrometrically using a glass electrode in combination with a reference potential or a combination electrode. The measuring device is calibrated using a series of standard solutions of known pH. For soil/solid waste samples, the sample is mixed with reagent water, and the pH of the resulting aqueous solution is measured. The same procedure is used for pH determination of water and soil samples.

7.2.3.4 Reactivity

An aliquot of acid is added to a fixed weight of waste in a closed system. The generated gas is swept into a scrubber. The analyte is quantitated for cyanide and sulfide as follows. (1) In the colorimetric measurement, the cyanide is converted to cyanogen chloride (CNCI) by reaction of cyanide with chloramine-T at a pH less than eight. After the reaction is complete, color is formed on the addition of pyridine-barbituric acid reagent. The absorbance is read at 578 nm for the complex formed with pyridine-barbituric acid reagent and CNCI. To obtain colors of comparable intensity, it is essential to have the same salt content in both the sample and the standards. The titration measurement uses a standard solution of silver nitrate to titrate cyanide in the presence of a silver sensitive indicator. (2) Sulfide is extracted from the sample by a preliminary distillation procedure and precipitated in a zinc acetate scrubber as zinc sulfide. The sulfide is oxidized to sulfur by adding a known excess amount of iodine. The excess iodine is quantified by titration with a standard solution of phenyl arsine oxide (PAO) or sodium thiosulfate until the blue iodine starch complex disappears. As the use of standard sulfide solutions is not possible because of oxidative degradation, quantitation is based on the PAO or sodium thiosulfate.

7.3 Method Detection Limits

In order to ensure comparability of analytical results across sites, over time, and regardless of contractor, it is necessary to clearly establish uniform definitions for the various detection limits and uniform terminology. Tables 7-1 through 7-9 identify analytical methods to be used and associated MDLs and RLs.

7.3.1 Limit of Detection

The limit of detection (LOD) is the lowest concentration level that can be established as statistically different from a blank. The standard deviation (used to establish the LOD) was defined by replicate measures of the difference between the lowest concentration of analyte instrumentally detectable and a blank value.

7.3.2 Method Detection Limit

USEPA defines the MDL as, “the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is established from analysis of a sample in a given matrix containing the analyte.”

7.3.3 Sample Quantitation Limit

The sample quantitation limit (SQL) is using the MDL modified by such factors as dilution, dry weight, etc.

7.3.4 Limit of Quantitation

The limit of quantitation (LOQ) of an individual analytical procedure is the lowest amount of analyte in a sample, which can be quantitatively established with suitable precision and accuracy. The quantitation limit is a parameter of quantitative assays for low levels of compounds in sample matrices and is used particularly for the determination of impurities and/or degradation products.

7.3.5 Reporting Limit

The RL is using the MDL multiplied by an arbitrary factor intended to assure minimum acceptable levels of precision and accuracy.

Table 7-1
Summary of Reporting Limits and Data Quality Levels for Metals
Soil Samples
Radford Army Ammunition Plant, Radford, Virginia

Analyte	CAS Number	Analytical Method	Achievable Laboratory Limits[1]	
			LODs (mg/kg)	LOQs (mg/kg)
Aluminum	7429-90-5	6010B	10	20
Zirconium	7440-67-7	6010B	12.5	25
Arsenic	7440-38-2	6010B	0.5	5
		6020	0.075	0.3
Barium	7440-39-3	6010B	0.1	0.5
		6020	0.075	0.3
Beryllium	7440-41-7	6010B	0.0125	0.5
Boron	7440-42-8	6010B	2.5	5
Cadmium	7440-43-9	6010B	0.05	0.5
		6020	0.025	0.1
Calcium	7440-70-2	6010B	5	10
Chromium	7440-47-3	6010B	0.125	1
		6020	0.1	0.4
Cobalt	7440-48-4	6010B	0.125	1
		6020	0.125	0.5
Copper	7440-50-8	6010B	0.5	1
		6020	0.15	0.6
Iron	7439-89-6	6010B	1	3
Lead	7439-92-1	6010B	0.5	5
		6020	0.1	0.2
Lithium	7439-93-2	6010B	2.5	5
Magnesium	7439-95-4	6010B	12	25
Manganese	7439-96-5	6010B	0.1	0.5
		6020	0.05	0.2
Molybdenum	7439-98-7	6010B	1.5	5
Mercury	7439-97-6	7471	0.01	0.25
Nickel	7440-02-0	6010B	0.5	2
		6020	0.2	0.8
Potassium	9/7/7440	6010B	25	50

Table 7-1 Summary of Reporting Limits and Data Quality Levels for Metals Soil Samples Radford Army Ammunition Plant, Radford, Virginia				
			Achievable Laboratory Limits[1]	
Analyte	CAS Number	Analytical Method	LODs (mg/kg)	LOQs (mg/kg)
Selenium	7782-49-2	6010B	0.5	5
		6020	0.1	0.2
Silver	7440-22-4	6010B	0.25	2
		6020	0.05	0.2
Sodium	7440-23-5	6010B	5	25
Strontium	7440-24-6	6010B	0.25	0.5
Thallium	7440-28-0	6010B	1	25
		6020	0.01	0.02
Tin	7440-31-5	6010B	5	25
Titanium	7440-32-6	6010B	0.5	2
Vanadium	7440-62-2	6010B	0.25	0.5
		6020	0.125	0.5
Zinc	7440-66-6	6010B	0.5	1
		6020	0.625	2.5
Phosphorus	7723-14-0	6010B	25	50
Antimony	7440-36-0	6010B	0.5	10
		6020	0.05	0.1
Uranium	7440-61-1	6020	0.1	0.4

[1] Achievable LODs and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method.

Table 7-2 Summary of Reporting Limits and Data Quality Levels for Metals Water Samples Radford Army Ammunition Plant, Radford, Virginia				
			Achievable Laboratory Limits[1]	
Analyte	CAS Number	Analytical Method	LODs (mg/L)	LOQs (mg/L)
Calcium	7440-70-2	6010B	0.1	0.2
Vanadium	7440-62-2	6010B	0.005	0.01
		6020	0.00025	0.001
Colbalt	7440-48-4	6010B	0.0025	0.02
		6020	0.00025	0.001
Copper	7440-50-8	6010B	0.005	0.02
		6020	0.0005	0.002
Iron	7439-89-6	6010B	0.025	0.1
Lead	7439-92-1	6010B	0.01	0.1
		6020	0.00025	0.001
Lithium	7439-93-2	6010B	0.05	0.1
Magnesium	7439-95-4	6010B	0.25	0.5
Manganese	7439-96-5	6010B	0.005	0.01
		6020	0.0005	0.002
Molybdenum	7439-98-7	6010B	0.005	0.1
Mercury	7439-97-6	7470A	0.01	0.2
Nickel	7440-02-0	6010B	0.005	0.04
		6020	0.001	0.004
Potassium	7440-09-7	6010B	0.25	1
		6010B	0.04	0.08

Table 7-2 Summary of Reporting Limits and Data Quality Levels for Metals Water Samples Radford Army Ammunition Plant, Radford, Virginia				
			Achievable Laboratory Limits[1]	
Analyte	CAS Number	Analytical Method	LODs (mg/L)	LOQs (mg/L)
Selenium	7782-49-2	6020	0.0005	0.001
Silicon	7440-21-3	6010B	0.25	1
Silver	7440-22-4	6010B	0.005	0.01
		6020	0.00025	0.001
Sodium	7440-23-5	6010B	0.25	0.5
Strontium	7440-24-6	6010B	0.005	0.01
Thallium	7440-28-0	6010B	0.1	1
		6020	0.00005	0.0002
Zinc	7440-66-6	6010B	0.005	0.02
		6020	0.005	0.025
Aluminum	7429-90-5	6010B	0.05	0.1
Antimony	7440-36-0	6010B	0.05	0.2
		6020	0.00025	0.001
Arsenic	7440-38-2	6010B	0.01	0.1
		6020	0.00025	0.001
Barium	7440-39-3	6010B	0.0025	0.01
		6020	0.0005	0.003
Beryllium	7440-41-7	6010B	0.005	0.01
Boron	7440-42-8	6010B	0.05	0.1
Cadmium	7440-43-9	6010B	0.0025	0.01
		6020	0.000125	0.0005
Silica, Calculated as SiO_2		6010B	0.25	1
Phosphorus	7723-14-0	6010B	0.5	1
Zirconium	7440-67-7	6010B	0.25	0.5
Tin	7440-31-5	6010B	0.05	0.5
Titanium	7440-32-6	6010B	0.005	0.03
Chromium	7440-47-3	6010B	0.0025	0.02
		6020	0.0005	0.002
Uranium	7440-61-1	6020	0.0025	0.001

1 Achievable LODs and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method.

Table 7-3 Summary of Reporting Limits and Data Quality Levels for PCBs Soil Samples Radford Army Ammunition Plant, Radford, Virginia				
			Achievable Laboratory Limits[1]	
Analyte	CAS Number	Analytical Method	LODs (ug/kg)	LOQs (ug/kg)
Aroclor-1254	11097-69-1	8082	8.25	16.5
Aroclor-1260	11096-82-5	8082	8.25	16.5
Aroclor-1016	12674-11-2	8082	8.25	16.5
Aroclor-1242	53469-21-9	8082	8.25	16.5
Aroclor-1248	12672-29-6	8082	8.25	16.5
Aroclor-1221	11104-28-2	8082	8.25	16.5
Aroclor-1232	11141-16-5	8082	8.25	16.5

1 Achievable LODs and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method.

Table 7-4 Summary of Reporting Limits and Data Quality Levels for Pesticides Soil Samples Radford Army Ammunition Plant, Radford, Virginia				
Analyte	CAS Number	Analytical Method	Achievable Laboratory Limits[1]	
			LODs (mg/L)	LOQs (mg/L)
4,4'-DDD	72-54-8	8081A	0.33	1.65
4,4'-DDE	72-55-9	8081A	0.33	1.65
4,4'-DDT	50-29-3	8081A	0.33	1.65
Aldrin	309-00-2	8081A	0.33	1.65
alpha-BHC	319-84-6	8081A	0.33	1.65
alpha-Chlordane	5103-71-9	8081A	0.33	1.65
gamma-Chlordane	5103-74-2	8081A	0.33	1.65
beta-BHC	319-85-7	8081A	0.33	1.65
delta-BHC	319-86-8	8081A	0.33	1.65
Dieldrin	60-57-1	8081A	0.33	1.65
Endosulfan I	959-98-8	8081A	0.33	1.65
Endosulfan II	33213-65-9	8081A	0.33	1.65
Endosulfan sulfate	1031-07-8	8081A	0.33	1.65
Endrin	72-20-8	8081A	0.33	1.65
Endrin aldehyde	7421-93-4	8081A	0.33	1.65
Endrin ketone	53494-70-5	8081A	0.33	1.65
gamma-BHC (Lindane)	58-59-9	8081A	0.33	1.65
Heptachlor	76-44-8	8081A	0.33	1.65
Heptachlor epoxide	1024-57-3	8081A	0.33	1.65
Methoxychlor	72-43-5	8081A	0.33	1.65
Toxaohene	8001-35-2	8081A	16.7	33.0

1 Achievable LODs and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method.

Table 7-5 Summary of Reporting Limits and Data Quality Levels for Pesticides Water Samples Radford Army Ammunition Plant, Radford, Virginia				
Analyte	CAS Number	Analytical Method	Achievable Laboratory Limits[1]	
			LODs (mg/L)	LOQs (mg/L)
4,4'-DDD	72-54-8	8081A	0.01	0.05
Methoxychlor	72-43-5	8081A	0.01	0.05
Toxaphene	8001-35-2	8081A	0.3	1
4,4'-DDE	72-55-9	8081A	0.01	0.05
4,4'-DDT	50-29-3	8081A	0.01	0.05
Aldrin	309-00-2	8081A	0.01	0.05
alpha-BHC	319-84-6	8081A	0.01	0.05
alpha Chlordane	5103-71-9	8081A	0.01	0.05
beta-BHC	319-85-7	8081A	0.01	0.05
delta-BHC	319-86-8	8081A	0.01	0.05
Dieldrin	60-57-1	8081A	0.01	0.05
Endosulfan I	959-98-8	8081A	0.01	0.05
Endosulfan II	33213-65-9	8081A	0.01	0.05
Endosulfan sulfate	1031-07-8	8081A	0.01	0.05
Endrin	72-20-8	8081A	0.01	0.05
Endrin aldehyde	7421-93-4	8081A	0.01	0.05
Endrin ketone	53494-70-5	8081A	0.01	0.05

Table 7-5 Summary of Reporting Limits and Data Quality Levels for Pesticides Water Samples Radford Army Ammunition Plant, Radford, Virginia				
			Achievable Laboratory Limits[1]	
Analyte	CAS Number	Analytical Method	LODs (mg/L)	LOQs (mg/L)
gamma-BHC (Lindane)	58-89-9	8081A	0.01	0.05
gamma Chlordane	5103-74-2	8081A	0.01	0.05
Heptachlor	76-44-8	8081A	0.01	0.05
Heptachlor epoxide	1024-57-3	8081A	0.01	0.05

1 Achievable LODs and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method.

Table 7-6 Summary of Reporting Limits and Data Quality Levels for PAHs Soil Samples Radford Army Ammunition Plant, Radford, Virginia				
			Achievable Laboratory Limits[1]	
Analyte	CAS Number	Analytical Method	LODs (ug/kg)	LOQs (ug/kg)
Phenanthrene	85-01-8	8270	1.25	2.5
Indeno(1,2,3-cd)pyrene	193-39-5	8270	1.25	2.5
Naphthalene	91-20-3	8270	1.25	2.5
Acenaphthene	83-32-9	8270	1.25	2.5
1-Methylnaphthalene	90-12-0	8270	1.25	2.5
Acenaphthylene	208-96-8	8270	1.25	2.5
Anthracene	120-12-7	8270	1.25	2.5
Benzo(a)anthracene	56-55-3	8270	1.25	2.5
Benzo(a)pyrene	50-32-8	8270	1.25	2.5
Benzo(b)fluoranthene	205-99-2	8270	1.25	2.5
Benzo(g,h,i)perylene	191-24-2	8270	1.25	2.5
Benzo(k)fluoranthene	207-08-9	8270	1.25	2.5
Chrysene	218-01-9	8270	1.25	2.5
Pyrene	129-00-0	8270	1.25	2.5
Dibenzo(a,h)anthracene	53-70-3	8270	1.25	2.5
Fluoranthene	206-44-0	8270	1.25	2.5
Fluorene	86-73-7	8270	1.25	2.5
2-Methylnaphthalene	91-57-6	8270	1.25	2.5

1 Achievable LODs and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method.

Table 7-7 Summary of Reporting Limits and Data Quality Levels for SVOCs Water Samples Radford Army Ammunition Plant, Radford, Virginia				
			Achievable Laboratory Limits[1]	
Analyte	CAS Number	Analytical Method	LODs (ug/L)	LOQs (ug/L)
1,2,4-Trichlorobenzene	120-82-1	8270C	2.5	5
1,2-Dichlorobenzene	95-50-1	8270C	2.5	5
1,3-Dichlorobenzene	541-73-1	8270C	2.5	5
1,4-Dichlorobenzene	106-46-7	8270C	2.5	5
2,4,5-Trichlorophenol	95-95-4	8270C	2.5	5
2,4,6-Trichlorophenol	88-06-2	8270C	2.5	5

Table 7-7 Summary of Reporting Limits and Data Quality Levels for SVOCs Water Samples Radford Army Ammunition Plant, Radford, Virginia				
Analyte	CAS Number	Analytical Method	Achievable Laboratory Limits[1]	
			LODs (ug/L)	LOQs (ug/L)
2,4-Dichlorophenol	120-83-2	8270C	2.5	5
2,4-Dimethylphenol	105-67-9	8270C	2.5	5
2,4-Dinitrophenol	51-28-5	8270C	12.5	25
2,4-Dinitrotoluene	121-14-2	8270C	2.5	5
2,6-Dinitrotoluene	606-20-2	8270C	2.5	5
2-Chloronaphthalene	91-58-7	8270C	2.5	5
2-Chlorophenol	95-57-8	8270C	2.5	5
2-Methylnaphthalene	91-57-6	8270C	2.5	5
Phenol	108-95-2	8270C	2.5	5
Pyrene	129-00-0	8270C	2.5	5
2-Methylphenol	95-48-7	8270C	2.5	5
2-Nitroaniline	88-74-4	8270C	12.5	25
2-Nitrophenol	88-75-5	8270C	2.5	5
3,3'-Dichlorobenzidine	91-94-1	8270C	2.5	10
3-,4-Methylphenol	106-44-5	8270C	2.5	5
3-Nitroaniline	99-09-2	8270C	12.5	25
4,6-Dinitro-2-methylphenol	534-52-1	8270C	12.5	25
4-Bromophenyl-phenylether	101-55-3	8270C	2.5	5
4-Chloro-3-methylphenol	59-50-7	8270C	2.5	5
4-Chloroaniline	106-47-8	8270C	2.5	5
4-Chlorophenyl-phenyl ether	7005-72-3	8270C	2.5	5
4-Nitroaniline	100-01-6	8270C	12.5	25
4-Nitrophenol	100-02-7	8270C	12.5	25
Acenaphthene	83-32-9	8270C	2.5	5
Acenaphthylene	208-96-8	8270C	2.5	5
Anthracene	120-12-7	8270C	2.5	5
Benzo(a)anthracene	56-55-3	8270C	2.5	5
Benzo(a)pyrene	50-32-8	8270C	2.5	5
Benzo(b)fluoranthene	205-99-2	8270C	2.5	5
Benzo(g,h,i)perylene	191-24-2	8270C	2.5	5
Benzo(k)fluoranthene	207-08-9	8270C	2.5	5
Benzoic acid	65-85-0	8270C	12.5	25
Benzyl alcohol	100-51-6	8270C	2.5	5
Bis(2-Chloroethoxy)Methane	111-91-1	8270C	2.5	5
Bis(2-Chloroethyl)ether	111-44-4	8270C	2.5	5
bis(2-Chloroisopropyl)ether	108-60-1	8270C	2.5	5
bis(2-Ethylhexyl)phthalate	117-81-7	8270C	3	10
Butylbenzylphthalate	85-68-7	8270C	2.5	5
Chrysene	218-01-9	8270C	2.5	5
Di-N-Butylphthalate	84-74-2	8270C	2.5	5
Di-n-octylphthalate	117-84-0	8270C	2.5	5
Dibenzo(a,h)Anthracene	53-70-3	8270C	2.5	5
Dibenzofuran	132-64-9	8270C	2.5	5
Diethylphthalate	84-66-2	8270C	2.5	5
Dimethylphthalate	131-11-3	8270C	2.5	5
Fluoranthene	206-44-0	8270C	2.5	5
Fluorene	86-73-7	8270C	2.5	5
Hexachlorobenzene	118-74-1	8270C	2.5	5
Hexachlorobutadiene	87-68-3	8270C	2.5	5
Hexachlorocyclopentadiene	77-47-4	8270C	2.5	5
Hexachloroethane	67-72-1	8270C	2.5	5

Table 7-7 Summary of Reporting Limits and Data Quality Levels for SVOCs Water Samples Radford Army Ammunition Plant, Radford, Virginia				
Analyte	CAS Number	Analytical Method	Achievable Laboratory Limits[1]	
			LODs (ug/L)	LOQs (ug/L)
Indeno(1,2,3-cd)pyrene	193-39-5	8270C	2.5	5
Isophorone	78-59-1	8270C	2.5	5
N-Nitrosodiphenylamine	86-30-6	8270C	2.5	5
N-Nitrosodipropylamine	621-64-7	8270C	2.5	5
Naphthalene	91-20-3	8270C	2.5	5
Nitrobenzene	98-95-3	8270C	2.5	5
Pentachlorophenol	87-86-5	8270C	12.5	25
Phenanthrene	85-01-8	8270C	2.5	5

[1] Achievable LODs and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method.

Table 7-8 Summary of Reporting Limits and Data Quality Levels for VOCs Water Samples Radford Army Ammunition Plant, Radford, Virginia				
Analyte	CAS Number	Analytical Method	Achievable Laboratory Limits[1]	
			LODs (ug/L)	LOQs (ug/L)
1,1,1,2-Tetrachloroethane	630-20-6	8260B	0.25	1.0
1,1,1-Trichloroethane	71-55-6	8260B	0.25	1.0
1,1,2,2-Tetrachloroethane	79-34-5	8260B	0.25	1.0
1,1,2-Trichloroethane	79-00-5	8260B	0.25	1.0
1,1-Dichloroethane	75-34-3	8260B	0.125	1.0
1,1-Dichloroethene	75-35-4	8260B	0.5	1.0
1,1-Dichloropropene	563-58-6	8260B	0.25	1.0
1,2,3-Trichlorobenzene	87-61-6	8260B	0.15	1.0
1,2,3-Trichloropropane	96-18-4	8260B	0.5	1.0
1,2,4-Trichlorobenzene	120-82-1	8260B	0.2	1.0
1,2,4-Trimethylbenzene	95-63-6	8260B	0.25	1.0
1,2-Dibromo-3-chloropropane	96-12-8	8260B	1	5
1,2-Dibromoethane	106-93-4	8260B	0.25	1.0
1,2-Dichlorobenzene	95-50-1	8260B	0.125	1.0
1,2-Dichloroethane	107-06-2	8260B	0.25	1.0
1,2-Dichloropropane	78-87-5	8260B	0.2	1.0
1,3,5-Trimethylbenzene	108-67-8	8260B	0.25	1.0
1,3-Dichlorobenzene	541-73-1	8260B	0.25	1.0
1,3-Dichloropropane	142-28-9	8260B	0.2	1.0
1,4-Dichlorobenzene	106-46-7	8260B	0.125	1.0
2,2-Dichloropropane	594-20-7	8260B	0.25	1.0
2-Butanone	78-93-3	8260B	2.5	10
2-Chloroethyl vinyl ether	110-75-8	8260B	2	10
2-Chlorotoluene	95-49-8	8260B	0.125	1.0
2-Hexanone	591-78-6	8260B	2.5	10
4-Chlorotoluene	106-43-4	8260B	0.25	1.0
4-Methyl-2-pentanone	108-10-1	8260B	2.5	10
Acetone	67-64-1	8260B	2.5	10
Benzene	71-43-2	8260B	0.125	1.0
Bromobenzene	108-86-1	8260B	0.125	1.0
Bromochloromethane	74-97-5	8260B	0.2	1.0
Bromodichloromethane	75-27-4	8260B	0.25	1.0

Table 7-8 Summary of Reporting Limits and Data Quality Levels for VOCs Water Samples Radford Army Ammunition Plant, Radford, Virginia				
			Achievable Laboratory Limits[1]	
Analyte	CAS Number	Analytical Method	LODs (ug/L)	LOQs (ug/L)
Bromoform	75-25-2	8260B	0.5	1.0
Bromomethane	74-83-9	8260B	0.5	1.0
Carbon disulfide	75-15-0	8260B	0.5	1.0
Carbon tetrachloride	56-23-5	8260B	0.25	1.0
Chlorobenzene	108-90-7	8260B	0.125	1.0
Chloroethane	75-00-3	8260B	0.5	1.0
Chloroform	67-66-3	8260B	0.125	1.0
Chloromethane	74-87-3	8260B	0.5	1.0
cis-1,2-Dichloroethene	156-59-2	8260B	0.25	1.0
cis-1,3-Dichloropropene	10061-01-5	8260B	0.25	1.0
Chlorodibromomethane	124-48-1	8260B	0.25	1.0
Dibromomethane	74-95-3	8260B	0.25	1.0
Dichlorodifluoromethane	75-72-8	8260B	0.25	1.0
Ethylbenzene	100-41-4	8260B	0.25	1.0
Hexachlorobutadiene	87-68-3	8260B	0.25	1.0
Isopropylbenzene	98-82-8	8260B	0.25	1.0
m-,p-Xylene	179601-23	8260B	0.5	1.0
Methylene chloride	75-09-02	8260B	0.25	5
n-Butylbenzene	104-51-8	8260B	0.25	1.0
n-Propylbenzene	103-65-1	8260B	0.125	1.0
Naphthalene	91-20-3	8260B	0.2	1.0
o-Xylene	95-47-6	8260B	0.25	1.0
p-Isopropyltoluene	99-87-6	8260B	0.25	1.0
sec-Butylbenzene	135-98-8	8260B	0.25	1.0
Styrene	100-42-5	8260B	0.125	1.0
tert-Butylbenzene	98-06-6	8260B	0.25	1.0
Tetrachloroethene	127-18-4	8260B	0.25	1.0
Toluene	108-88-3	8260B	0.25	1.0
trans-1,2-Dichloroethene	156-60-5	8260B	0.25	1.0
trans-1,3-Dichloropropene	10061-02-6	8260B	0.5	1
Trichloroethene	79-01-6	8260B	0.25	1.0
Trichlorofluoromethane	75-69-4	8260B	0.25	1.0
Vinyl acetate	108-05-4	8260B	2.5	10
Vinyl chloride	75-01-4	8260B	0.25	1.0

1 Achievable LODs and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method.

Table 7-9 Summary of Reporting Limits and Data Quality Levels for Dioxins/Furans Water Samples Radford Army Ammunition Plant, Radford, Virginia				
			Achievable Laboratory Limits[1]	
Analyte	CAS Number	Analytical Method	LODs (pg/L)	LOQs (pg/L)
2378-Tetrachlorodibenzo-p-dioxin (TCDD)	1746-01-6	8290	3	10
12378-Pentachlorodibenzo-p-dioxin (PeCDD)	40321-76-4	8290	7.5	25
123478-Hexachlorodibenzo-p-	39227-28-6	8290	7.5	25

Table 7-9 Summary of Reporting Limits and Data Quality Levels for Dioxins/Furans Water Samples Radford Army Ammunition Plant, Radford, Virginia				
			Achievable Laboratory Limits[1]	
Analyte	CAS Number	Analytical Method	LODs (pg/L)	LOQs (pg/L)
dioxin (HxCDD)				
123678-HxCDD	57653-85-7	8290	7.5	25
123789-HxCDD	19408-74-3	8290	7.5	25
1234678-Heptachlorodibenzo-p-dioxin (HpCDD)	35822-46-9	8290	7.5	25
Octachlorodibenzo-p-dioxin (OCDD)	3268-87-9	8290	15	50
2378-Tetrachlorodibenzofuran (TCDF)	51207-31-9	8290	3	10
12378-Pentachlorodibenzofuran (PeCDF)	57117-41-6	8290	7.5	25
23478-PeCDF	57117-31-4	8290	7.5	25
123478-Hexachlorodibenzofuran (HxCDF)	70648-26-9	8290	7.5	25
123678-HxCDF	57117-44-9	8290	7.5	25
123789-HxCDF	72918-21-9	8290	7.5	25
234678-HxCDF	60851-34-5	8290	7.5	25
1234678-Heptachlorodibenzofuran (HpCDF)	67562-39-4	8290	7.5	25
1234789-HpCDF	55673-89-7	8290	7.5	25
Octachlorodibenzofuran (OCDF)	39001-02-0	8290	15	50

1 Achievable LODs and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method.

Table 7-10 Summary of Reporting Limits and Data Quality Levels for Perchlorate Water Samples Radford Army Ammunition Plant, Radford, Virginia				
			Achievable Laboratory Limits[1]	
Analyte	CAS Number	Analytical Method	LOD (ug/L)	LOQ (ug/L)
Perchlorate	14797-73-0	6850	0.1	0.2

1 Achievable LODs and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method.

7.4 Physical Testing Methods

Soil samples from the SWMU 40 newly install monitoring well will be collected and analyzed by the project scientist using Unified Soil Classification System (USCS) designation. No other physical analyses are anticipated for this project.

7.4.1 Unified Soil Classification System

When specified in the IMWP, classification of soils for engineering purposes or the USCS will be based on laboratory determination of particle-size characteristics, liquid limit, and plasticity index using ASTM Method D 2487-00 (ASTM 2000b).

SECTION 8. CALIBRATION PROCEDURES

8.1 Laboratory Calibration

Prior to sample analysis, chemical calibration of each target analyte/compound must be performed to ensure analytical instrumentation is functioning within the established sensitivity range. Laboratory calibration protocols will be specified in an analytical QAPP to be either retained within the contractor's file or appended to the IMWP. Areas to be discussed include solution validation, initial, and continuing calibration. Analytical instruments will be calibrated initially and periodically checked to ensure that the initial calibration remains valid. Generally, this verification will take the form of analysis of at calibration standard, usually at the mid-point of the calibration range, and a comparison of the percent difference or percent drift (both are abbreviated as %D) between the initial calibration response and the calibration check. The %D is calculated as:

Equation 4

$$\text{Percent Difference/Percent Drift (\%D)} = \frac{\text{Calibration Check Response or Amount}}{\text{Initial Calibration Response or Amount}} \; 3\ 100$$

8.2 Instrument/Field Equipment Testing, Inspection, and Maintenance

Equipment and supplies purchased in support of these activities will be purchased according to the provisions of this plan, which requires a documented review of the vendor and equipment selection process and receipt inspection and/or testing as appropriate.

In summary, those procedures require that new equipment be tested with an appropriate standard or standards to ensure they function according to intended use. QC sample results from initial field use of equipment and supplies will be reviewed by the Field Manager, Laboratory Manager or his designee to identify potential causes for concern regarding new equipment and supplies received. Corrective actions will be implemented and documented according to the provisions of Section 10.0 as required.

Instrument maintenance, both routine and preventive, will be performed according to manufacturers' instructions. A preventive maintenance plan allows for periodic instrumentation checks for problems that occur frequently. The objective of a preventive maintenance plan is to rectify equipment problems before they become serious. Preventive maintenance also brings attention to those areas of the instrument susceptible to degradation from aging, toxic/corrosive attack, and clogging due to environmental factors.

Procedures for preventive maintenance are contained in each instruments associated manual under the maintenance/troubleshooting sections. Logbooks, such as those described in SOP 10.1 in Attachment A, will be maintained for each instrument used in the laboratory. Maintenance, calibration, and performance data will be entered by the operator and will be periodically reviewed by the Field/Laboratory Manager.

An inventory of critical spare parts will be maintained on-site during field activities. Critical spare parts are defined as those that upon failure would cause a delay in field or laboratory activities of greater than 4 hours. The specific needs of the program will be established at the discretion of the Field/Laboratory Manager.

8.3 Inspection/Acceptance for Supplies and Consumables

The Field/Laboratory Manager and/or his representative will inspect materials and consumables against the purchase order specifications to verify their fitness for use. Materials received will be properly labeled and recorded on the inventory log for accuracy. An expiration date will be assigned immediately to standards, reagents, and solvents. Documentation concerning the quality of materials used on-site will be retained in the central files.

8.4 Field Equipment Calibration and Maintenance

The proper calibration, maintenance, and documentation of field equipment are designed to assure that the field equipment is functioning optimally. Calibration and maintenance will follow manufacturer's specifications. The frequency of calibration is discussed in the APP. Documentation will be kept in equipment logbooks, which are required to record usage, maintenance, calibration, and repair.

8.4.1 Water Quality Parameters

Equipment used for analyzing water quality parameters (e.g., pH, conductivity, temperature, dissolved oxygen, oxidation/reduction potential, turbidity) will be calibrated at the site daily or more frequently as conditions dictate. The calibration for each type of parameter monitored will include a daily initial measurement prior to calibration, a measurement after calibration, and measurement at the end of the day. Measurements will be documented in the field logbooks (SOPs 10.1 and 10.2 in Attachment A) by the field personnel performing the calibration.

8.4.2 Air Quality Parameters

Equipment for analyzing air quality parameters (e.g., organic vapors, lower explosive limit, and percent oxygen) will be calibrated at the site daily. The calibration will include a daily initial measurement prior to calibration, a measurement after calibration, and a measurement at the end of the day. Measurements will be documented in the field logbook forms for meter calibration (SOP 10.2 in Attachment A) by the field personnel performing the calibration. Specific SOPs for air quality instruments are given in SOP Series 90.

8.4.3 Screening

Screening kits, if used, will be calibrated upon arrival according to the manufacturer's instructions.

SECTION 9. INTERNAL QUALITY CONTROL CHECKS

9.1 Laboratory Quality Control Elements

Method quality objectives (MQOs) will be specified in the IMWP. These MQOs provide a basis for project data review and should be evaluated during project planning for data use applicability.

9.2 Special Training Requirements and Certification

In addition to health and safety training as required for hazardous site workers by the Occupational Safety and Health Administration, field and laboratory personnel will receive technical training in the techniques they are expected to carry out. Training will consist of, at a minimum, on the job training by a senior staff member in the SOPs they are expected to implement, documented by virtue of a signed copy of the SOP or cover sheet for the field sampling plan. The QA Manager will retain this documentation on file.

Analysts will receive appropriate training in procedures, safety, and waste disposal. The Laboratory QA Manager, or his designee, will train analysts on analytical methods and operation of laboratory instrumentation. Analysts will be required to prove the ability to execute methods they perform with acceptable precision and accuracy through analysis of performance evaluation samples in quadruplicate, which meet the applicable QC standards of the method. Training completed by the analyst will be documented by the Laboratory QA Manager and maintained on file. These records will serve the additional purpose of providing for validation of non-standard methods of analysis.

9.3 Field Quality Control Samples

Field investigations at RFAAP will require the collection of several types of field QC samples including duplicate samples, rinse blanks, temperature blanks, trip blanks, and source water samples, as outlined in Table 9-1. If a target analyte is detected in a QC blank, data will be evaluated to establish if corrective action measures will be taken. Field QC elements of a QA program for field investigations at RFAAP are summarized in Table 9-2.

Table 9-1
Types of Field Quality Control Samples
Radford Army Ammunition Plant, Radford, VA

Type of Control	Purpose of Sample	Collection Frequency
Duplicate Sample	To ensure precision in sample homogeneity during collection and analysis	10% of field samples per matrix
Rinse Blank	To ensure the decontamination of sampling equipment has been adequately performed; to assess cross contamination and/or incidental contamination to the sample container	One per 20 samples or one per day
Temperature Blank	To verify sample cooler temperature during transport	One temperature blank per cooler
Trip Blank	To evaluate if cross contamination occurs during shipment or storage with volatile organic analyses (VOA) samples	One trip blank per cooler of VOA samples
Source Water	To characterize decontaminated water	One per source

Table 9-2 Field QC Elements of a QA Program Radford Army Ammunition Plant, Radford, VA				
Item	**DQO**	**Parameter**	**Frequency of Association**	**Criteria Requirement**
Source Water	R	Target list of parameters	Per project	Less than USACE reporting limit or if detected approved by USACE
Field Duplicates	P	Target list of parameters	One per ten samples	RPD ≤25% aqueous; ≤35% solid
Trip Blank	A,R	Volatiles in water	One per cooler with volatiles	No target analytes
Rinse Blank	A,R	Target list of parameters	One per 20 samples per matrix per equipment type	No target analytes
Field Logbook	A,C	Target list of parameters	Daily	Filled out and representative of investigation activities
Chain of Custody	R	Target list of parameters	Every sample	Filled out correctly to include signatures; no missing or incorrect info
Chemical Parameter Forms	R	Target list of parameters	Every sample	Filled out correctly to include analytical parameters; and applicable coding info
Field Instrument Calibration Logs	A	Target list of parameters	Every measurement	Measurements must have associated calibration reference

Legend:
A = Accuracy
C = Completeness
P = Precision
R = Representativeness

Table 9-3 QC Guidelines for PAHs Soil Samples					
Sampling Procedure	**Analytical Method**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
SOP 30.1 Soil Sampling	8270	Accuracy/Bias /Contamination	<LOQ	Field Blanks	S&A
		Precision	TBD	Field Duplicate	S&A
		Accuracy/Bias /Contamination	<LOQ	Method Blank	A
		Accuracy/Bias	See Table 10-1	LCS	A
		Accuracy/Bias	See Table 10-1	MS/MSD	A
		Precision	See Table 10-1	MS/MSD	A
		Precision	See Table 10-1	Surrogates	A
		Precision	See Table 10-1	Internal Standards	A

[1]If information varies within an analytical group, separate by individual analyte.

Table 9-4 QC Guidelines for PCB Soil Samples					
Sampling Procedure	**Analytical Method**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
SOP 30.1 Soil Sampling	8082	Accuracy/Bias /Contamination	<LOQ	Field Blanks	S&A
		Precision	TBD	Field Duplicate	S&A
		Accuracy/Bias /Contamination	<LOQ	Method Blank	A
		Accuracy/Bias	See Table 10-1	LCS	A
		Accuracy/Bias	See Table 10-1	MS/MSD	A
		Precision	See Table 10-1	MS/MSD	A
		Precision	See Table 10-1	Surrogates	A

[1]If information varies within an analytical group, separate by individual analyte.

Table 9-5 QC Guidelines for Metals Soil Samples					
Sampling Procedure	**Analytical Method**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
SOP 30.1 Soil Sampling	6010B/6020 & 7471A	Accuracy/Bias /Contamination	<LOQ	Field Blanks	S&A
		Precision	TBD	Field Duplicate	S&A
		Accuracy/Bias /Contamination	See Table 10-1	Preparation Blank	A
		Accuracy/Bias /Contamination	See Table 10-1	Calibration Blanks	A
		Accuracy/Bias	See Table 10-1	LCS	A
		Accuracy/Bias	See Table 10-1	MS	A
		Precision	See Table 10-1	Laboratory Duplicate	A
		Accuracy/Bias	See Table 10-1	Serial Dilution	A

[1]If information varies within an analytical group, separate by individual analyte.

Table 9-6 QC Guidelines for Pesticides (8081A) Soil Samples			
Procedure	**Frequency**	**Acceptance Criteria**	**Corrective Action**
Initial calibration curve (ICAL)	Set-up, major maintenance	See Table 10-1	Must meet criteria prior to sample analysis
Continuing calibration verification (calibration check)(CCV)	Daily before sample analysis, and after every 10 samples and at the end of the analysis sequence	See Table 10-1	If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, initial calibration must be repeated.
Independent reference standard (LCS)	1 per matrix/batch: Maximum of 20 samples per batch	See Table 10-1	Qualify associated data biased high or biased low as appropriate.
Method blanks	1 per batch	See Table 10-1	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank Document source of contamination.
Surrogate spikes	Every sample, standard, and quality control sample	See Table 10-1	If any surrogate compounds do not meet criteria, there should be a re-analysis to confirm that the non-compliance is due to the sample matrix effects rather than laboratory deficiencies.
Matrix spike and matrix spike duplicate	1 per matrix/batch; maximum of 20 samples per batch	See Table 10-1	Data reviewer may use the MS and MSD results in conjunction with other QC sample results to determine the need for some qualification of the data.

Table 9-7
QC Guidelines for VOCs Water Samples

Sampling Procedure	Analytical Method	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
12-GWS-00 SOP for Groundwater Sampling	8260B	Accuracy/Bias /Contamination	<LOQ	Field Blanks	S&A
		Precision	TBD	Field Duplicate	S&A
		Accuracy/Bias /Contamination	See Table 10-1	Method Blank	A
		Accuracy/Bias	See Table 10-1	LCS	A
		Accuracy/Bias	See Table 10-1	MS/MSD	A
		Precision	See Table 10-1	MS/MSD	A
		Precision	See Table 10-1	Surrogates	A
		Precision	See Table 10-1	Internal Standards	A

[1]If information varies within an analytical group, separate by individual analyte.

Table 9-8 QC Guidelines for SVOCs Water Samples					
Sampling Procedure	**Analytical Method**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
12-GWS-00 SOP for Groundwater Sampling	8270C	Accuracy/Bias /Contamination	<LOQ	Field Blanks	S&A
		Precision	TBD	Field Duplicate	S&A
		Accuracy/Bias /Contamination	See Table 10-1	Method Blank	A
		Accuracy/Bias	See Table 10-1	LCS	A
		Accuracy/Bias	See Table 10-1	MS/MSD	A
		Precision	See Table 10-1	MS/MSD	A
		Precision	See Table 10-1	Surrogates	A
		Precision	See Table 10-1	Internal Standards	A

[1]If information varies within an analytical group, separate by individual analyte.

Table 9-9 QC Guidelines for Metals Water Samples					
Sampling Procedure	**Analytical Method**	**Data Quality Indicators (DQIs)**	**Measurement Performance Criteria**	**QC Sample and/or Activity Used to Assess Measurement Performance**	**QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)**
12-GWS-00 SOP for Groundwater Sampling	6010B, 6020 & 7470A	Accuracy/Bias /Contamination	<LOQ	Field Blanks	S&A
		Precision	TBD	Field Duplicate	S&A
		Accuracy/Bias /Contamination	See Table 10-1	Preparation Blank	A
		Accuracy/Bias /Contamination	See Table 10-1	Calibration Blanks	A
		Accuracy/Bias	See Table 10-1	LCS	A
		Accuracy/Bias	See Table 10-1	MS	A
		Precision	See Table 10-1	Laboratory Duplicate	A
		Accuracy/Bias	See Table 10-1	Serial Dilution	A

[1]If information varies within an analytical group, separate by individual analyte.

Table 9-10 QC Guidelines for Perchlorate (6850) Water Samples			
Procedure	**Frequency**	**Acceptance Criteria**	**Corrective Action**
Initial calibration	Set-up, major maintenance	See Table 10-1	Must meet criteria prior to sample analysis
Continuing calibration verification (calibration check)(CCV)	Daily before sample analysis, and after every 10 samples and at the end of the analysis sequence	See Table 10-1	If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, initial calibration must be repeated.
Independent reference standard (LCS)	1 per matrix/batch: Maximum of 20 samples per batch	See Table 10-1	Correct problem then reprep and analyze LCS
Method blanks	1 per batch	See Table 10-1	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank Document source of contamination.
Matrix spike and matrix spike duplicate (MS/MSD)	1 per matrix/batch	See Table 10-1	Data reviewer may use the MS and MSD results in conjunction with other QC sample results to determine the need for some qualification of the data.

Table 9-11 Secondary Data Criteria and Limitations Radford Army Ammunition Plant, Radford, Virginia					
Secondary Data - Title	**Data Source**	**Date**	**Data Generator(s) Originating Org., Data Types, Data Generation / Collection Dates)**	**How Data Will be Used**	**Limitations of Data Use**
SWMU 40					
	Final RFI/CMS	4/2009	URS	Determine location of new monitoring well. Determine waste disposal characterization. Determine soil and groundwater properties. Evaluate distribution of contaminants of concern and define actions required to achieve CMOs.	None.

SECTION 10. DATA REDUCTION, VALIDATION, REPORTING, AND MANAGEMENT

The intended use of the data and the associated acceptance criteria for data quality will be established prior to initiation of the data collection. Reported data will include when appropriate, statements of precision, accuracy, representativeness, completeness, and comparability. Data processing procedures will be documented, reviewed, and revised by the QA Officer, as required to meet project-specific DQOs. The laboratory QA Officer will be responsible for data processing at the contract laboratory.

10.1 Method Detection Limit and Reporting Limits

MDL and RL will be included in the IMWP. In general, solid sample results will be reported in micrograms per kilogram (µg/kg) or milligrams per kilogram (mg/kg) depending on the method used for analysis. Aqueous sample results will in general be reported in units of micrograms per liter (µg/L) or milligrams per liter (mg/L) depending on the methods used. The IMWP for site-specific investigations will specify the reporting units for samples along with the associated MDLs and RLs.

The reported data will contain no more than three significant digits and will be rounded to the appropriate number of significant digits, based on certification class and dilution, after calculations have been completed.

10.2 Rounding Rules

The following rules will be used in data validation and reporting for rounding:

- If the figure following those to be retained is less than five, the figure is dropped, and the retained figures are left unchanged;

- If the figure following those to be retained is greater than five, the figure is dropped and the last figure is raised by one. For example, 1.26 is rounded off to 1.3; and

- If the figure following those to be retained is five, and if there are no figures other than the zeros beyond the five, the figure five is dropped, and the last-place figure is increased by one if it is an odd number or it is kept if it is an even number. For example, 1.45 is rounded off to 1.4, while 1.56 is rounded off to 1.6.

10.3 Collection

Collection of analytical data will begin when samples arrive at the laboratory. The Microbac Laboratory in its entirety is a secure area, and all samples received and logged into the laboratory remain in the custody of the Sample Custodian, supervisor or analyst until time of disposal. Refrigerators, freezers and other designated sample storage areas will be securely maintained or locked. Only the designated Sample Custodian or supervisory personnel will have keys to locked sample storage units until removed for sample preparation or analysis. The following minimum custody procedures will be followed:

- All samples are received and inspected.
- The Sample Custodian signs and dates the chain-of-custody form provided by the Field Team.
- The samples are stored in the appropriate storage unit.

- Several laboratory documents are used to document which laboratory personnel handled the samples, including bench sheets, sample preparation logbooks, and instrument run logbooks.
- The original copy of the chain-of-custody form is included in the laboratory report and a copy is maintained in the laboratory files.

10.3.1 Sample Receipt & Inspection

The Sample Custodian will receive all incoming samples and will sign for the container. The Custodian will open the shipping containers and note the presence/absence of chain-of-custody forms and seals, airbills, or bills-of-lading. The sample temperature is then read.
The Custodian will examine the shipping container to verify the integrity of the sample(s) and examine the sample documentation and identification to assure it is correct and the proper preservative has been used. The preservatives are checked by the Sample Custodian. If inspection indicates samples were damaged in transit, the shipping container will be moved to the hood in Log-in, assessments of the damage will be made and the appropriated Technical Services Representative will be notified. The Site Manager will be immediately contacted and determination of the degree of hazard will be made. If damage is minimal and the Remediation Manager requests it, an attempt to salvage the sample(s) will be made if can be done safely. In the event of damaged hazardous samples, Laboratory Spill Response Team will be notified per the laboratory's Chemical Hygiene Plan.

The Sample Custodian will log in the into the LIMS system and will indicate the actual date and time received and the original receipt documentation will be included with the chain-of-custody form.

The Sample Custodian will compare the chain-of-custody forms and labels to verify agreement of information contained therein. If major discrepancies are found, they will be documented on the Cooler Inspection Checklist and the Project Chemist will be immediately notified. Written documentation of all problem resolutions will be placed in the project/case file. If there are no problems with the samples received, the Sample Custodian files the signed chain-of-custody form and Cooler Inspection Checklist in the project/case file. After the sample is logged in, it will be immediately stored under the proper conditions.

Sample labels or other sample documents that appear to be contaminated due to sample breakage or other problems will be dried under a fume hood and be separately sealed in plastic bags, if necessary, prior to being placed in case files. The Project Chemist must also be notified.

10.3.2 Sample Storage

Samples and extracts will be stored in uniquely identified refrigerators that are in secure areas of the laboratory. The Sample Custodian or designated assistant will check the temperature of each refrigerator in the log-in area, twice daily, (once on weekends and holidays) and maintain a record book. This record book will be reviewed on a monthly basis by the Support Services Supervisor to note any trends or inconsistencies. The acceptable range for sample storage is 0 - 6°C, as long as freezing does not occur. The Sample Custodian will notify the Support Services Supervisor of any refrigerator temperature problem that cannot be corrected by simple thermostat adjustment. A list of emergency repair numbers for the refrigeration units is attached to the walk-in refrigerator's exterior.

10.3.3 Sample Distribution and Tracking

Both the preparation and the analysis of samples will be documented using special forms (logbooks). Once analysis is complete, the analyst will return the unused sample to the Sample Custodian area for return to the main cooler or to the Sample Archive Room whichever is appropriate. Samples will be returned to their original storage units after completion of analyses. Samples that have exceeded their regulated holding period will be placed in the Sample Archive Room. They are routinely stored in this area for a minimum of 14 days after the due date for the analytical report. They are then disposed per appropriate protocol listed. Extended archive beyond 14 days with refrigeration is available for specific projects or as required by contract.
It is important to note that samples received for analysis of volatile organic compounds (VOCs) are segregated from other samples. Standards are also segregated from all samples in designated storage units.

10.3.4 Sample Security

All sample storage refrigerators are equipped with a lock. The units are monitored by the Sample Custodian during business hours. After business hours, the unit is kept locked and only selected personnel have access (by key) to the sample storage unit. All samples, extracts and digests will be stored in segregated areas

10.3.5 Electronic Data Security

Data integrity is insured through LIMS multi-level security. Access to the specific user privileges can be individually controlled. Each user has his/her own user name and password which allows certain privileges. Several pieces of hard copy documentation are generated for verification, but are unsigned. Signatures on the final report indicate that all of these forms have been reviewed. Reports are automatically screened for errors by LIMS at the time of printing. Any case numbers that produce errors at the time of printing are routed to the appropriate person or section for correction. If no errors are produced at the time of printing, the finished report is stamped with the laboratory manager's signature stamp. All level four data undergoes a chemist review before it is available for printing or reporting. Hard copy data, which contains all of the data regarding a group of samples, are kept in a master file, labeled with the login numbers.

10.4 Data Reduction

Data reduction frequently includes computation of analytical results from raw instrument data and summary statistics, including standard errors, confidence intervals, test of hypotheses relative to the parameters, and model validation. Data reduction procedures address the reliability of computations and the overall accuracy of the data reduction. The numerical transformation algorithms used for data reduction will be verified against a known problem set to ensure that the reduction methods are correct. The equations and the typical calculation sequence that should be followed to reduce the data to the acceptable format are instrument and method-specific. Where standard methods are modified, data reduction techniques will be described in a report accompanying the data.

10.4.1 Gas Chromatography/Mass Spectrometry Results

Qualitative identification will be established by obtaining extracted ion current profiles (EICPs) for the primary ion mass to charge ratio (m/z) and the secondary masses for each compound. Positive identification will be based on the following criteria:

- The intensity of the three characteristic masses of each compound must maximize in the same ratio (± 20 percent (%)), within one scan of each other;
- The relative retention time must fall within 30 seconds of the retention time of the authentic compound; and
- The relative peak heights of the three characteristic masses in the EICPs must fall within 20% of the relative intensities of these masses in a reference mass spectrum (e.g., standard analysis or reference library).

Structural isomers to be listed as separate compounds must have acceptable resolution. Acceptable resolution is achieved if, in a standard mix, the baseline to valley height between the isomers is less than 25% of the sum of the two peak heights. Otherwise, structural isomers will be identified as isomeric pairs.

The calculation for the concentration for the suspect peak will be made using the average response factor (RF) for each compound, which was obtained from the daily calibration.

Water

Equation 5

$$C_s = \frac{(A_s)(C_{is})(V_t)(D)}{(A_{is})(RF)(V_o)}$$

Where:

C*w* = Compound concentration (µg/L);

A*s* = Peak area of characteristic in m/z for the compound to be measured;

A*is* = Peak area of characteristic in m/z for the internal standard;

C*is* = Concentration of the internal standard (µg);

V*t* = Final volume of total extract (µL) used in semi-volatile organic compound (SVOC) analyses;

V*o* = Volume of water (L) extracted or purged;

V*i* = Volume of extract injected; SVOC analyses (µL);

D = Dilution factor; and

RF = Compound response factor calculated from Equation 6.

Equation 6

$$C_s = \frac{(A_s)(C_{is})}{(A_{is})(C_s)}$$

Where:

A_s = Area of the characteristic ion for the compound being measured;

A_i = Area of the characteristic ion for the specific internal standard;

C_{is} = Concentration of the specific internal standard; and

C_s = Concentration of the compound being measured.

Soil

Equation 7

$$C_s = \frac{(A_s)(C_{is})(V_t)(D)}{(A_{is})(RF)(V_i)(W_s)(M)}$$

Where:

C_s = Compound concentration in the soil sample (μg/g);

A_s = Area of the characteristic ion for the compound being measured;

C_{is} = Internal standard concentration (μg);

A_{is} = Area of characteristic ion for the specific internal standard;

V_t = Volume of total extract (μL);

V_i = Volume of extract injected (μL);

W_s = Mass of sample extracted or purged (g);

D = Dilution factor;

M = Percent dry weight of sample/100; and

RF = Compound response factor calculated from the calibration curve using the same equation as that used for water samples.

10.4.2 Gas Chromatographic Results

Calculations will be performed for each compound after it is identified. Identification will be based on the relative retention time (RRT) ratio of the suspect peak compared to the internal standard as compared to the RRT calculated from the calibration curve. The concentration of the compound will be calculated by comparing the relative RFs calculated from the calibration curve and the peak area of the compound using the following equation:

Water

Equation 8

$$C_s = \frac{(A_s)(C_s)(D)}{(A_{is})(RF)(V_s)}$$

Where:

Cw = Concentration of the compound in the sample (µg/L);

As = Compound peak area;

Cs = Standard (µg);

Ais = Internal standard peak area;

Vs = Volume of water extracted (L);

D = Dilution factor; and

RF = Compound response factor calculated from the following equation:

Equation 9

$$RF = \frac{(A_s)(C_i)}{(A_i)(C_s)}$$

Where:

A*s* = Compound response measured in area counts from the calibration curve;

A*i* = Internal standard response measured in area counts from the calibration curve;

C*i* = Internal standard concentration; and

C*s* = Compound concentration from the calibration curve.

Soil

Equation 10

$$C_s = \frac{(A_s)(C_s)(D)}{(Ai)(RF)(W_s)(M)}$$

Where:
C*s* = Compound concentration in the soil sample (µg/g);

A*s* = Compound response measured in area counts;
C*s* = Standard concentration (µg);

A*i* = Standard response measured in area counts;

W*s* = Mass of sample extracted (g);
D = Dilution factor;

M = Percent dry weight of sample/100; and

RF = Compound response factor calculated from the calibration curve using the same equation as that used for water samples.

Atomic Absorption Spectrophotometry Results—Photometric absorbance is governed by the relationship presented in Equation 11.

Equation 11

$$\text{Absorbance} = \log 100/\%T = 2 - \log\%T$$

Where:
%T = 100 - % absorption.

Percent absorption is based on the amount of light of a particular wavelength absorbed by a specific metal. Its calculation is based on the loss of light after a beam of light of a particular wavelength is passed through a flame into which a solution containing metals of interest has been aspirated.

Calibration curves establishing the absorbance relationship with concentration will be generated at various concentrations. From these curves, a comparison will be made with absorbance from sample measurement. Since absorbance is directly related to concentration, a plot of the two parameters will be linear within operable ranges and will allow for determination of unknown concentrations in solutions (direct samples or extracts) after measurement of absorbance.

Concentrations of contaminants in extracts will be calculated from instrumental responses of the extracts applied to the instrument calibration curve. The resultant concentration will then be modified by applying the appropriate dilution/concentration and sample weight or volume to obtain a final reportable concentration in the original matrix. In general, solid samples will be reported in units of µg/kg or mg/kg and aqueous results will be reported in units of µg/L or mg/L. The units used for a specific project will depend on the methods of analysis, etc.

When samples are diluted into a performance-demonstrated range, the reported concentration will contain one less significant digit than an undiluted sample. Values less than the certified RL will be reported as “less than” the RL. If a sample is diluted, the non-detected results will be reported as “less than” the RL multiplied by the dilution factor to reflect more accurately the observable limit. The dilution factor will be reported with the data.

10.5 Data Validation

10.5.1 Data Review, Validation, and Verification Requirements

The QA Officer will ensure all data are reviewed and verified, and decision-making data are validated in accordance with this section. Upon completion of the data collection activities, the QA Officer will ensure all data are assessed regarding the following, and provide a report to the PM:

- Sampling design – What deviations were observed from the project controlling document (PCDs) in terms of numbers of samples collected, locations of sample collection points, and unexpected events or observations in the field. An assessment will be provided of the impact of such deviations on the usability or interpretation of the results;

- Sampling procedures – What deviations were observed from the PCDs in terms of the method of work applied in the collection of the samples. An assessment will be provided of the impact of such deviations on the usability or interpretation of the results;

- Sample handling – What deviations were observed from the PCDs in terms of the handling and custody of the samples, including containers, preservation, storage, etc. This will include an assessment of potential sample alias problems. An assessment will be provided of the impact of such deviations on the usability or interpretation of the results;

- Analytical procedures – What deviations were observed from the PCDs in terms of the method of work applied in the analysis of the samples. An assessment will be provided of the impact of such deviations on the usability or interpretation of the results;

- QC and calibration – What deviations were observed from the PCDs in terms of conformance to QC and calibration criteria. An assessment will be provided of the impact of such deviations on the usability or interpretation of the results. This assessment will be provided in the form of data validation reports as defined in Section 9.5.2; and

- Data Reduction and processing – What deviations were observed from the PCDs in terms of data reduction and processing specifications. An assessment will be provided of the impact of such deviations on the usability or interpretation of the results.

10.5.2 Validation and Verification Methods

Definitive data will be validated in accordance with USEPA *Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analysis*, April 1993, and USEPA *Region III Modifications to the USEPA National Functional Guidelines (NFGs) for Organic Data Review Multi-media, Multi-concentration* (OLM01.0-OLM01.9), September 1994, or the appropriate guidance in effect at the time of investigation as modified for the methods of analysis employed. An independent third party will provide data validation services. Ms. Jeanne Peterson, Senior Chemist, AQA will manage data validation and verification for this project. Verification for organic data will be performed at Manual Level M3 and the verification for inorganic data will be performed at Manual Level IM2. Particular emphasis will be placed on holding time compliance, equipment calibration, spike recoveries, and blank results, although each required element of the verification process will be considered. Table 10-1 provides the acceptance criteria which will be applied as applicable to decision making data validation for each method.

The AQA independent reviewer as part of the validation process will fill out a checklist based on the method/protocol. This checklist will document the checks performed and the observations of the reviewer. To the fullest extent possible, the validator will work with the laboratory to resolve anomalies encountered. The validator will then apply data qualifying flags to the data summaries provided by the laboratory and compile a report on each laboratory report. These reports will consist of a summary of the findings, copies of data summaries with data qualifying flags applied (as necessary), a copy of the data validation checklist, and supporting documentation. The reports will be included in the project documentation submitted following completion of the Interim Measures.

Laboratory deliverable packages for definitive data will be equivalent to USEPA CLP deliverable packages, containing complete QC summary reports, QA documentation, and a complete raw data package.

For first round analytical data and for screening data, an independent review of data packages will be performed to ensure compliance with specified analytical, QC, and data reduction procedures; data reporting requirements; and required accuracy, precision, and completeness measures. At a minimum, the following items will be reviewed to validate the data when applicable:

- Sample custody documents;
- QC data summaries; and
- Reasonableness of analytical results.

10.5.3 Reconciliation with Data Quality Objectives

The QA Officer in association with the PM will provide an assessment of the conformance of data gathered in the course of these activities to objectives of the work. Data found during the verification and validation processes to be unsuitable for use (i.e., data impacted by unacceptable deviations from plans and protocols and data found to be qualified as unreliable during the validation process) will be clearly identified and excluded from use in downstream decision-making. If, in the judgment of the PM and the technical data users, insufficient data remain for purposes of the work, additional sample collection and analysis may be performed. Data description and assessment tools as described in USEPA QA/G-9, *Guidance for Data Quality Assessment* (USEPA 1996), may be employed in the course of this reconciliation.

10.6 Blank Contamination Assessment

Blank contamination assessment will be performed to evaluate the impact of field sampling and laboratory analysis environments on data quality. Field and laboratory QC blanks will be collected and processed at the frequency specified in Tables 8-1 and 8-2.

Field and laboratory QC blank data will be reviewed in accordance with the NFGs for Organic and Inorganic Data Review (USEPA 1994a), USEPA Region III modifications to the NFGs (USEPA 1993c; 1994b), and USEPA Region III Innovative Approaches to Data Validation (USEPA 1995).

10.6.1 Field Blanks

Equipment Rinse Blanks - The integrity of decontamination events and sample cross-contamination will be evaluated by the rinse blank. The rinse blank will be collected at the beginning of the project when equipment is first decontaminated, and thereafter at a frequency of 5%.

Trip Blanks - Potential contamination during sample collection and shipment, and in the laboratory, will be assessed through the evaluation of trip blanks for volatile contamination. Volatile contaminants detected in a trip blank and the associated samples (associated during collection and shipping) will be flagged.

10.6.2 Laboratory Blanks

Method Blanks - Method blanks will be used to evaluate for potential contamination from the laboratory environment and analytical method used to process the sample. Method blanks will be processed at the beginning and at a frequency of 10% for each analytical run by the laboratory. The blanks will be used to evaluate whether the internal laboratory environment, reagents used during analyses, analytical techniques, or the instrumentation system is sources of contamination that could affect the integrity of the sample.

The criterion for the evaluation of blank contamination applies to blanks associated with the samples, and states that no contamination should be in the blank. If contamination is detected, data associated with the blank will be carefully evaluated to identify if there is an inherent variability in the data for the lot, or if the problem is an isolated occurrence not affecting each sample in the lot.

Examples of USEPA criteria by which the blanks will be reviewed include:

Inorganic:

- Analytes detected in the environmental sample at less than five times the concentration in the associated blank will be qualified “B.”

Organic:

- The sample result is qualified “B,” when the compound concentration is greater than the RL but less than ten times the amount detected in the associated blank for common laboratory contaminants, (i.e., methylene chloride, acetone, 2-butanone, and common phthalate esters); and
- The sample result for other contaminants are qualified “B,” when the sample concentration is greater than the RL but less than five times the amount detected in the associated blank.

In cases where more than one blank is associated with a given sample, qualification will be based upon a comparison with the associated blank having the highest concentration of the contaminant. The mean concentrations and standard deviation will be provided as a reference point. Blank qualification will be added to the data validation and the contractor PM will assess data usefulness based on the project DQOs. The PM will make project decisions (use qualified data, re-sample, re-analyze) based upon the analytical limitations of the data. Contamination assessment results will be presented in the Site Investigation Report.

10.7 Reporting

Data for entry into the project data set will consist of field data and sampling/analytical data. In general, field data will consist of location, well construction and field measurement data generated from field logbooks, boring logs, and field parameter forms used by the UXB-KEMRON team. The original records/data will be retained in the project record, and will be summarized in project reports.

Sampling and analytical data will consist of dates, times and laboratory sample and QC results taken from chain-of-custody records and the laboratory deliverable verified against hardcopy laboratory reports. Laboratory data will be submitted in summary form in project reports, and electronic versions of the complete laboratory analytical report will be included in the reports as well. The chemical data also will be retained by the Army in its ERIS electronic data system.

10.7.1 Field Data Deliverables

Raw data from field measurements and sample collection will be reviewed by UXB-KEMRON and retained in project files. Data relevant to the site-specific objectives will be tabulated and included in reports submitted for regulatory review. Field data from sampling events will be included in reports submitted for regulatory review. These data will be recorded on field data sheets that are submitted with the sample chain of custody. The field data will be entered into the laboratory information management system and included in the electronic data deliverable.

Field sample records (SRs) will be completed by field personnel, and copies of these SRs will be included in the project reports as applicable. Typical categories of information in the SRs include, but are not necessarily limited to: sampling location, date, time, interval/depth sampled, and field measurements. Any significant problems encountered in the field, resolution of those problems, deviations from planned procedures, or other matters that could impact field sampling execution and analytical results will be discussed in project reports.

10.8 Documentation and Records

Bound logbooks will be used for record keeping purposes both in the field and in the laboratory with the exception of certain standard forms, which will be maintained in three ring binders. Logbooks and binders will contain a unique document control number. Pages, including loose-leaf forms, will be numbered.

Field and laboratory personnel will transmit the bound logbooks to the Field Supervisor or Laboratory QA Manager (or their designees) on a routine basis. The Field or Laboratory QA Manager, as applicable, will review original logbooks at a frequency of at least once every week, and will sign the logbook as proof of said review.

To ease data review, the person making an entry must sign and date the entry. Entries must be recorded in ink or other permanent-marking device. Drawing a line through the incorrect entry, recording the correct information, and initialing and dating the corrected entry will make correction to entries. If the reason for making the change is not immediately evident, an explanation is required. Unused portions of logbook pages must be lined out.

If computerized information is used, a hard copy that has been permanently affixed to the logbook will be acceptable as an original record of sampling and/or laboratory logging.

10.8.1 Field Records

Field records, including sample collection records, chain-of-custody records, etc. will be maintained according to the SOPs applicable to the program. At a minimum, field personnel will keep a personal log of activities, noting conditions that in their judgment may bear on the on the use or interpretation of the data they acquire.

10.8.2 Laboratory Records

For the Laboratory, each sample delivery group is assigned a unique login number when initially logged into the LIMS system. The report master files are stored in order of the login number and can be easily retrieved using this system.
Computer records from the Microbac LIMS are maintained on the system for one year and are then archived on magnetic tape. Two backup copies of the system are maintained on magnetic tape at all times. The backup and archive tapes are stored in a fireproof safe at the laboratory indefinitely. Extraction lab logbooks and bench sheets are maintained chronologically and stored in the laboratory for five years. Inorganics raw data, including analyst notebooks, bench sheets, computer printouts and instrument logs, are stored by parameter in the individual laboratories or in the archive area for a period of five years. Gas Chromatography (GC) data is stored as hardcopy in the individual master files. GC/MS data is stored as hardcopy for three years in the work order files, and on magnetic tape for at least one year. GC/MS data stored on magnetic tape can be retrieved by the file numbers assigned to them at the time of analysis.

UXB-KEMRON will provide electronic (CD-ROM) copies of Level 4 reports generated as part of the site-specific scope of work within the final reports submitted to the Administrative Record.

10.8.3 Laboratory Deliverables

Microbac provides four levels of laboratory reports in order to match the documentation level required by specific projects. The laboratory will provide Level 4 CLP-like data packages for all decision making data for the RFAAP sites. The data packages scanned to CD and delivered as hard copy will include the normal components of a CLP-like deliverable, including case narrative, sample summary report (Form 1), QA/QC summary forms (CLP-like forms), laboratory chronicle, chain-of-custody forms, data qualifiers, raw data; and, run logs. The following list of specific elements defines the items that will be included in all data packages prepared for project sample analyses:

- Case Narrative, including: laboratory analytical batch number; matrix and number of samples included; analyses performed and analytical methods used; description of any problems or exceedence of QC criteria and corrective action taken. The laboratory manager or his/her designee will sign the case narrative.
- Copy of chain of custody forms for all samples included in the analytical batch;
- Tabulated sample analytical results with units, LODs and LOQs, data tags/qualifiers, percent solids, sample weight or volume, dilution factor, laboratory batch and sample number, UXB-KEMRON field sample number, and dates sampled, received, extracted and analyzed all clearly specified. Surrogate percent recoveries will be included for organic analyses.
- Surrogate spike recoveries reported in all organic reports where appropriate. The reports will specify the control limits for surrogate spike results, as well as the spiking concentration. Any out-of-control recoveries will be reported immediately to the Project

QA Officer. Any out-of-control recoveries (as defined by the applicable method) will result in the sample being rerun (with both sets of data to be reported).

- All calibration, quality control, run logs and sample raw data including chromatograms, quantitation reports and other instrument output data.
- Blank summary results indicating samples associated with each blank.
- Matrix spike/matrix spike duplicate result summaries with calculated percent recovery and relative percent differences.
- Laboratory control sample results, when applicable, with calculated percent recovery.
- Electronically formatted data deliverable results, in a format specified by the Project Manager.

Table 10-2 summarizes the content of a Level 4 data package. The complete Level 4 analytical package, including raw data, will be provided electronically (scanned onto a CD) as a .pdf file. The Microbac Laboratory Information Management System (LIMS) will use the project-specific data qualifiers established by this QAPP.

Reporting level requirements are logged into the LIMS system with the sample set. Level 1 and 2 data packages are assembled upon printout of the final report by the data entry staff. Copies of the raw analytical data for level 3 and 4 data packages are turned in by the analysts upon completion of analysis. Data summary forms are printed from specialized software packages by the analysts in each laboratory. The forms are reviewed by the department supervisor before insertion into the final data package.

Table 10–1
Scheduled QC Samples, Criteria, and Corrective Action

Procedure	Frequency	Acceptance Criteria			Corrective Action
VOCs by SW-846 8260B					
Initial Calibration 5-pt curve	Prior to sample analysis Set-up, major maintenance, and quarterly	RRF > 0.05 RSD ≤ 30% (up to two compounds may be >30% if ≤40%). Lab may use first or higher order regression fit (r ≥ 0.995) if %RSD > 15%.			If RSD of the average RRF for calibration check compounds > 30%, the initial calibration must be repeated. Data reviewer should review and judge all of the target compounds against the acceptance criteria.
Continuing calibration check	Daily before sample analysis, and every 12 hours	%Difference for RF all continuing calibration compounds ±25% from initial calibration average. RRF > 0.05. For first or higher order regressions, %D for recovered concentration must be ±25% of true concentration.			Samples cannot begin until this criterion is met. Data reviewer should review and judge all of the target compounds against the acceptance criteria.
Method blanks	Every 12 hours	No analytes detected ≥ RL.			Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank. Document source of contamination.
Tuning BFB	Prior to calibration	Must meet tuning criteria provided in Innovative Approaches to Data Validation (EPA Region III, June 1995).			Re-tune, re-calibrate.
LCS	Every batch	Specified QC limits provided in Innovative Approaches to Data Validation (EPA Region III, June 1995); lab limits derived per method SW846 8000 for compounds not listed.			Qualify associated data biased high or biased low as appropriate.
Internal Standards	Every sample	<u>Standards</u> Fluorobenzene Chlorobenzene-D5 1,4-Dichlorobenzene-D	Retention time ±30 seconds of last CC Area changes by a factor of two (-50% to +100%)		Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples with standards outside criteria.
Surrogate	Every Sample	<u>Standards</u> Dibromofluoromethane Toluene-D8 4-Bromofluorobenzene 1,2-DCA-D4	<u>Solid</u> ** 84-138 59-113 70-121	<u>Aqueous</u> ** 88-110 86-115 76-114	If any surrogate compounds do not meet criteria, there should be a re-analysis to confirm that the non-compliance is due to the sample matrix effects rather than laboratory deficiencies.
Matrix Spike and Duplicate	1 per 20 per matrix	Specified QC limits provided in Innovative Approaches to Data Validation (EPA Region III, June 1995); lab limits derived per method SW846 8000 for compounds not listed.			If MS/MSD results do not meet criteria, the reviewer should review the data in conjunction with other QC results to determine if the problem is specific to the QC samples or systematic.

**lab limits derived per method SW846 8000 for compounds not listed.

Table 10–1
Scheduled QC Samples, Criteria, and Corrective Action

Procedure	Frequency	Acceptance Criteria			Corrective Action
SVOCs by SW8270C					
Initial calibration curve (5-pt curve)	Set-up, major maintenance	RRF > 0.05 RSD ≤ 30% (up to two compounds may be >30% if ≤40%). Lab may use first or higher order regression fit (r ≥ 0.995) if %RSD > 15%.			Must meet criteria prior to sample analysis. Data review evaluates target compounds against the acceptance criteria.
Continuing calibration standard	12 hours	%Difference for RF all continuing calibration compounds ±25% from initial calibration average. RRF > 0.05. For first or higher order regressions, %D for recovered concentration must be ±25% of true concentration.			If criteria not met, reanalyze the daily standard. If daily standard fails a second time, repeat calibration. Review target compounds against the acceptance criteria.
Internal standards	Every sample	1,4-Dichlorobenzene-D4, Naphthalene-D8, Acenapthene-D10, Phenanthrene-D10 Chrysene-D12, Perylene-D12; Retention time ±30 seconds of last CC Area changes by a factor of two (-50% to +100%)			Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples with standards outside criteria.
Tuning DFTPP	12 hours	Must meet tuning criteria provided in Innovative Approaches to Data Validation (EPA Region III, June 1995).			Re-tune, re-calibrate.
Method blanks	Per extraction batch	No analytes detected ≥ RL			Document source of contamination.
LCS	Every batch	Specified QC limits provided in Innovative Approaches to Data Validation (EPA Region III, June 1995); lab limits derived per method SW846 8000 for compounds not listed.			Correct problem then reanalyze. If still out, reprep and reanalyze the LCS and all samples in the affected analytical batch. Qualify associated data biased high or biased low.
Surrogate spikes	Every Sample	Standards 2,4,6-Tribromophenol 2-Fluorobiphenyl 2-Fluorophenol Nitrobenzene-D5 Phenol-D5 Terphenyl-D14	Aqueous (%Rec.) 10-123 43-116 21-110 35-114 10-110 33-141	Solid (%Rec.) 19-122 30-115 25-121 23-120 24-113 18-137	If any two base/neutral or acid surrogates are out of specification, or if any one base/neutral or acid extractable surrogate has a recovery of less than 10%, then there should be a re-analysis to confirm that the non-compliance is due to sample matrix effects rather than laboratory deficiencies.
Matrix spike and duplicate	1 per 20 samples per matrix	Specified QC limits provided in Innovative Approaches to Data Validation (EPA Region III, June 1995); lab limits derived per method SW846 8000 for compounds not listed.			If MS/MSD results do not meet criteria, the reviewer should review the data in conjunction with other QC results to determine if the problem is specific to the QC samples or systematic.

Table 10–1
Scheduled QC Samples, Criteria, and Corrective Action

Procedure	Frequency	Acceptance Criteria			Corrective Action
PAHs by SW8270C SIM					
Initial calibration curve (5-pt curve)	Set-up, major maintenance	RRF > 0.05 RSD ≤ 30% (up to two compounds may be >30% if ≤40%). Lab may use first or higher order regression fit (r ≥ 0.995) if %RSD > 15%. The peak for each ion must not be cut off when switching ions.			Must meet criteria prior to sample analysis. Data review evaluates target compounds against the acceptance criteria.
Continuing calibration standard	12 hours	%Difference for RF all continuing calibration compounds ±25% from initial calibration average. RRF > 0.05. For first or higher order regressions, %D for recovered concentration must be ±25% of true concentration.			If criteria not met, reanalyze the daily standard. If daily standard fails a second time, repeat calibration. Review target compounds against the acceptance criteria.
Internal standards	Every sample	1,4-Dichlorobenzene-D4, Naphthalene-D8, Acenapthene-D10, Phenanthrene-D10 Chrysene-D12, Perylene-D12; Retention time ±30 seconds of last CC Area changes by a factor of two (-50% to +100%)			Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples with standards outside criteria.
Tuning DFTPP	12 hours	Must meet tuning criteria provided in Innovative Approaches to Data Validation (EPA Region III, June 1995); tailing factors and breakdown not required.			Re-tune, re-calibrate.
Method blanks	Per extraction batch	No analytes detected ≥ RL			Document source of contamination.
LCS	Every batch	Specified QC limits provided in Innovative Approaches to Data Validation (EPA Region III, June 1995); lab limits derived per method SW846 8000 for compounds not listed.			Correct problem then reanalyze. If still out, reprep and reanalyze the LCS and all samples in the affected analytical batch. Qualify associated data biased high or biased low.
Surrogate spikes	Every Sample	<u>Standards</u> 2-Fluorobiphenyl Nitrobenzene-D5 Terphenyl-D14	<u>Aqueous (%Rec.)</u> 43-116 35-114 33-141	<u>Solid (%Rec.)</u> 30-115 23-120 18-137	If any two base/neutral are out of specification, or if any one base/neutral extractable surrogate has a recovery of less than 10%, then there should be a re-analysis to confirm that the non-compliance is due to sample matrix effects rather than laboratory deficiencies.
Matrix spike and duplicate	1 per 20 samples per matrix	All target analytes spiked. Specified QC limits provided in Innovative Approaches to Data Validation (EPA Region III, June 1995); lab limits derived per method SW846 8000 for compounds not listed.			If MS/MSD results do not meet criteria, the reviewer should review the data in conjunction with other QC results to determine if the problem is specific to the QC samples or systematic.

**lab limits derived per method SW846 8000

Table 10–1
Scheduled QC Samples, Criteria, and Corrective Action

Procedure	Frequency	Acceptance Criteria	Corrective Action
Dioxins/Furans by SW-846 8290			
Mass Spectrometer Tune (pfk)	At the beginning of each 12-hour period prior to analysis of standards and samples and at the end of each analytical sequence or every 12-hours, whichever comes first.	Resolving power must be >10,000 at m/z 304.9824; cycle time must be ≤1 second; drift of m/z 304.9824 must be within 5ppm of the required value.	Re-tune, re-calibrate.
Column Performance Check	At beginning of each 12-hour period prior to sample analysis (may be run as part of CCV, but not as part of ICAL)	Cycle time must be ≤1 second;separation between TCDD and its isomers must be ≤25%; the peak for each ion must not be cut off when switching ions; must contain 1,2,8,9-TCDD and 1,3,4,6,8-PeCDF; lock mass must be used; each compound must be labeled.	Correct problem; reanalyze.
Initial Calibration 5-pt curve	Prior to sample analysis Set-up, major maintenance, and quarterly; CCV failure; and when a new lot of standard is used	Five standard levels in Table 5 must be used. Ion abundance ratios must meet those in Table 8 of method. Signal to noise ratios must be ≥10. RSD ≤ 20% for 17 unlabeled compounds (≤30% for labeled compounds).	If RSD of the average RRF for calibration check compounds > 20% (30%), the initial calibration must be repeated. Data reviewer should review and judge all of the target compounds against the acceptance criteria.
Continuing calibration check	At beginning of each 12-hour period after tune and column performance check; and at the end of each 12-hour period (or end of sample analysis, whichever comes first)	Ion abundance ratios must meet those in Table 8 of method. %Difference between RF and average RF must be within ±20% for unlabeled compounds (±30% for labeled compounds).	If %D is between 20% and 25% (30% and 35%), then an average of the beginning and ending CCVs can be used. Samples cannot begin until this criterion is met. Data reviewer should review and judge all of the target compounds against the acceptance criteria.

Table 10–1
Scheduled QC Samples, Criteria, and Corrective Action

Procedure	Frequency	Acceptance Criteria	Corrective Action
Dioxins/Furans by SW-846 8290			
Calibration blank	Between standards and samples	No analytes detected; IS recovery must be between 25% and 150%. Method blank may be used as this blank.	If a target analyte is present at a concentration > RL, re-calibrate, and reanalyze all samples analyzed since the last acceptable CCB.
Method blanks	1 per 20 per matrix	No analytes detected.	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank. Document source of contamination.
LCS	1 per 20 per matrix	Lab limits derived per method SW846 8000.	Qualify associated data biased high or biased low as appropriate.
Internal Standards	Every sample	Percent recovery between 40% and 135%.	Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples with standards outside criteria.
Matrix Spike and Matrix Spike Duplicate	1 per 20 per matrix	Lab recovery limits derived per method SW846 8000. MS/MSD RPD ≤20%.	If MS/MSD results do not meet criteria, the reviewer should review the data in conjunction with other QC results to determine if the problem is specific to the QC samples or systematic.
Laboratory Duplicate	1 per 20 per matrix	RPD ≤25%	If laboratory duplicate results do not meet criteria, the reviewer should review the data in conjunction with other QC results to determine if the problem is specific to the QC samples or systematic.
Target Compound Identification	Every sample	If labeled compound is present, target compound RT must be within -1 to +3 seconds of the labeled compound RT. If no labeled compound is present, target compound RRT must be within 0.005 RRT units of the CCV RRT. OCDF is based on the 13C-OCDD CCV RRT. Ion current responses for both ions must reach maximum simultaneously (±2 seconds). Ion abundance ratios must meet Table 8 of method. Signal to noise must be ≥2.5. In addition to the above criteria, the identification of a GC peak as a PCDF can only made if no signal having a signal to noise ratio ≥2.5 is detected at the same RT in the polychlorinated diphenyl ether (PCDPE) channel (see Table 6). Target compounds must be within the linear range. If signal to noise meets, but none of the other criteria meet, calculate the EMPC (see section 7.9.5.2 of the method). Concentrations are calculated from the total of the two ion responses.	Qualify associated data as appropriate.

Table 10–1
Scheduled QC Samples, Criteria, and Corrective Action

Procedure	Frequency	Acceptance Criteria	Corrective Action
Perchlorate by SW-846 6850			
Initial calibration curve 5-pt curve Initial calibration verification standard (ICV)	Prior to sample analysis. Set-up, major maintenance After initial calibration, analysis of a second source std at midpoint of the calibration.	%RSD≤20% of the response factor from the initial curve or r ≥0.995 (not forced through origin). %difference ≤15% relative to true value.	Must meet criteria prior to sample analysis Correct problem and repeat initial calibration. Flagging criteria are not appropriate. No samples may be run until calibration has been verified.
Continuing calibration (calibration check)	Daily before sample analysis, and after every 10 samples and at the end of analysis	All analytes within ±15% of expected value	If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, initial calibration must be repeated.
CRDL	CRI at 2X CRDL every 10 samples or 2 per 8 hr and end of run, whichever is more frequent. CRA at CRDL at beginning of run.	70-130% of true values.	Perform maintenance; reanalyze. Samples must be bracketed by successful CRDL analyses.
Interference Check Sample (ICS)	One ICS is prepared with every batch of 20 samples and must undergo the same preparation and pretreatment steps as the samples in the batch. At least one ICS must be analyzed daily.	80-120% of true values.	Correct problem and then reanalyze all samples in that batch. If poor recovery from the cleanup filters is suspected, a different lot of filters must be used to reextract all samples in the batch. If column degradation is suspected, a new column must be calibrated before the samples can be reanalyzed.
Independent reference standard (LCS)	One LCS is prepared with every batch of 20 samples and must undergo the same preparation and pretreatment steps as the samples in the batch. The LCS must be spiked at the RL.	80-120% or specified QC Limits derived per method SW846 8000, whichever is more stringent.	Correct problem, then reanalyze. If still out, reprep and reanalyze the LCS and all samples in the affected analytical batch.. Qualify associated data biased high or biased low as appropriate.
Method blanks	1 per batch	Perchlorate concentration < ½ RL	Correct problem then reprep and reanalyze method blank and all samples processed with the contaminated blank. Document source of contamination.

Table 10–1
Scheduled QC Samples, Criteria, and Corrective Action

Surrogate spikes	Every sample	Aqueous %R		Solid %R 30–125		If any surrogate compounds do not meet criteria, there should be a re-analysis to confirm that the non-compliance is due to the sample matrix effects rather than laboratory deficiencies.
Matrix spike and duplicate (laboratory duplicate may be analyzed in place of an MSD)	1 per 20 samples per matrix and must undergo the same preparation and pretreatment steps as the samples in the batch	Aqueous %R 75-125%	RPD ≤30 for all	Solid %R 75-125%	RPD ≤30 (may go up to 40 based on prof. judgment.	Data reviewer may use the MS and MSD results in conjunction with other QC sample results to determine the need for some qualification of the data.
Laboratory Reagent Blank	Analyzed prior to calibration and after samples with overrange concentration of perchlorate and after each batch is analyzed	Perchlorate concentration < ½ RL				Reanalyze reagent blank (until no carryover is observed) and all samples processed since the contaminated blank.
Mass Tuning	Optimize setting of the mass spectrometer after mass calibration, after any maintenance is performed, and prior to analyzing a new calibration curve.	Tuning standards must contain the analytes of interest and meet acceptance criteria outlined in the laboratory SOP				Retune instrument. If the tuning will not meet acceptance criteria, an instrument mass calibration must be performed and the tuning redone.
Mass Calibration	Instrument must have a valid mass calibration prior to any sample analysis.	The mass calibration is updated on an as-needed basis (e.g., QC failures, ion masses show large deviations from known masses, major instrument maintenance is performed, or the instrument is moved)				If the mass calibration fails, recalibrate. If it still fails, consult manufacturer instructions on corrective maintenance.

Table 10–1
Scheduled QC Samples, Criteria, and Corrective Action

Isotope Ratio $_{35}Cl/_{37}Cl$	Every sample, batch QC sample, and standard. Monitor for either the parent ion at masses 99/101 or the daughter ion at masses 83/85 depending on which ions are quantitated. Theoretical ratio ~ 3.06.	Must fall within 2.3 to 3.8.	If criteria are not met, the sample must be rerun. If the sample was not pretreated, the sample should be reextracted using cleanup procedures. If, after cleanup, the ratio still fails, use alternative techniques to confirm presence of perchlorate (i.e., a post spike sample, dilution to reduce any interference, etc.).
Internal Standard (IS)	Addition of $_{18}O$-labeled perchlorate to every sample, batch QC sample, standard, instrument blank, and method blank. Measured $_{18}O$ IS area within ±50% of the value from the average of the internal standard area counts of the initial calibration standards.	RRT of the perchlorate ion in a sample is the retention time of the perchlorate ion divided by the retention time of the internal standard. The RRT must be 1.0 ±2% (0.98 – 1.02).	Rerun the sample at increasing dilutions until the ±50% acceptance criteria are met. If criteria cannot be met with dilution, the interference are suspected and the sample must be re-prepped using additional pretreatment steps.

Table 10–1
Scheduled QC Samples, Criteria, and Corrective Action

Procedure	Frequency	Acceptance Criteria			Corrective Action
Organochlorine Pesticides by SW-846 8081A					
Initial calibration curve 5-pt curve	Set-up, major maintenance	%RSD≤20% of the response factor from the initial curve (surrogates ≤30%), (up to two %RSDs may exceed 20% if they are ≤30%).			Must meet criteria prior to sample analysis
Continuing calibration verification (calibration check)	Daily before sample analysis, and after every 10 samples and at the end of the analysis sequence	All analytes within ±25% of expected value			If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, initial calibration must be repeated.
Resolution Check Mixture	Daily prior to analysis of samples	Contains gamma-chlordane; endosulfan I; 4,4'-DDE; dieldrin; endosulfan sulfate; endrin ketone; methoxychlor; tetrachloro;m;xylene; decachlorobiphenyl. The depth of the valley between two adjacent peaks must be ≥60%.			Perform maintenance; repeat resolution check mixture
Breakdown check (Endrin and DDT)	Daily prior to analysis of samples	Contains gamma-BHC; alpha-BHC; 4,4'-DDT; beta-BHC; endrin; methoxychlor; tetrachloro;m;xylene; decachlorobiphenyl. DDT and endrin degradation ≤20% each for both columns; ≤30% combined for both columns. The depth of the valley between two adjacent peaks must be ≥60%. Absolute RTs must be within RT windows. RPDs between true values and calculated values must be ≤25%.			Repeat breakdown check
Independent reference standard (LCS)	1 per batch	Specified QC limits provided in Innovative Approaches to Data Validation (EPA Region III, June 1995); lab limits derived per method SW846 8000 for compounds not listed.			Qualify associated data biased high or biased low as appropriate.
Method blanks	1 per batch	No target analytes detected ≥ Reporting Limits			Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank Document source of contamination.
Surrogate spikes	Every sample	<u>Standards</u> TCMX DCB	<u>Aqueous</u> <u>%R</u> 60-150 60-150	<u>Solid</u> <u>%R</u> 60-150 60-150	If any surrogate compounds do not meet criteria, there should be a re-analysis to confirm that the non-compliance is due to the sample matrix effects rather than laboratory deficiencies.
Matrix spike and matrix spike duplicate	1 per 20 samples per matrix	Specified QC limits provided in Innovative Approaches to Data Validation (EPA Region III, June 1995); lab limits derived per method SW846 8000 for compounds not listed.			Data reviewer may use the MS and MSD results in conjunction with other QC sample results to determine the need for some qualification of the data.

Table 10–1
Scheduled QC Samples, Criteria, and Corrective Action

Procedure	Frequency of QC Procedure	Acceptance Criteria			Corrective Action
PCBs by SW-846 8082					
Initial calibration curve 5-pt curve	Prior to sample analysis Set-up, major maintenance	%RSD≤20% of the response factor from the initial curve (surrogates ≤30%), (up to two %RSDs may exceed 20% if they are ≤30%).			Must meet criteria prior to sample analysis
Continuing calibration (calibration check)	Daily before sample analysis, and After every 10 samples and at the end of the analysis sequence	All analytes within ±25% of expected value			If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, initial calibration must be repeated.
Independent reference standard (LCS)	1 per batch	Specified QC limits provided in Innovative Approaches to Data Validation (EPA Region III, June 1995); lab limits derived per method SW846 8000 for compounds not listed.			Qualify associated data biased high or biased low as appropriate.
Method blanks	1 per batch	No target analytes detected ≥ Reporting Limits			Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank. Document source of contamination.
Surrogate spikes	Every sample	Standards TCMX DCB	Aqueous %R 60-150 60-150	Solid %R 60-150 60-150	If any surrogate compounds do not meet criteria, there should be a re-analysis to confirm that the non-compliance is due to the sample matrix effects rather than laboratory deficiencies.
Matrix spike and matrix spike duplicate (1016/1260 mix)	1 per 20 samples per matrix	Specified QC limits provided in Innovative Approaches to Data Validation (EPA Region III, June 1995); lab limits derived per method SW846 8000 for compounds not listed.			Data reviewer may use the MS and MSD results in conjunction with other QC sample results to determine the need for some qualification of the data.

Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action
Metals by SW-846 6010B/6020/7470A/7471A			
Initial calibration curve (blank and at least four stds for Hg) (blank and at least one std for ICP)	Daily or major maintenance, instrument modification, replacement of the torch, replacement of the mirror	r > 0.995 for all elements r: linear correlation coefficient	If r < 0.995 for any element, the standards for that element must be prepared again and/or the lower/upper range standard must be used.

Table 10–1
Scheduled QC Samples, Criteria, and Corrective Action

Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action
Continuing calibration verification (CCV)	Every 10 samples or 2 per 8 hr and end of run.	Recovery ±10% of true value for ICP Recovery ±20% of true value for Hg	Reanalyze CCV. If the CCV fails second time, the terminate analysis, correct problem, re-calibrate instrument, and re-verify calibration prior to continuing sample analyses.
CRDL (CRI for ICP and CRA for Hg)	CRI at 2X CRDL every 10 samples or 2 per 8 hr and end of run, whichever is more frequent. CRA at CRDL at beginning of run.	90-110% of true values.	Perform maintenance; reanalyze.
Interference check	Beginning and end of each sample analytical run or 2 per 8 hr, whichever is more frequent.	Recovery ±20% of true value. For non-spiked analytes, absolute value <IDL.	Terminate the analysis, correct the problem, re-calibrate, re-verify the calibration, and reanalyze the samples.
Continuing calibration blank (CCB)	Every 10 samples, end of analytical run	No target analytes >RL.	If a target analyte is present at a concentration > RL, re-calibrate, and reanalyze all samples analyzed since the last acceptable CCB.
Serial Dilution (ICP)	1 per 20 samples per matrix for samples > 50x IDL	Difference between diluted and undiluted sample <10%.	Chemical or physical interference should be suspected. Investigate to determine cause.
Preparation blank	1 per batch per matrix	No target analytes.	Documented source of contamination.
Laboratory Control Sample	1 per analytical batch	80%≤%Rec.≤120% (aqueous) EPA control limits (solid)	Qualify associated data biased high or biased low as appropriate.
Duplicate Sample	1 per batch per matrix	RPD within ±20% (35% for soil) for sample values >5X the CRDL. ±CRDL (2X CRDL for soil) for sample values <5X the CRDL.	
Matrix spike and duplicate and sample duplicate	1 per analytical batch	75%≤%Rec.≤125%; %RPD<20%; If spike(s) outside of limits, analyze PDS. Spike limits do not apply if sample concentration is >4X the spike amount.	If matrix spike recovery does not meet criteria (except Ag), a post digestion spike is required for all methods except GFAA. Qualify results in accordance with Regional criteria.

Waste characterization data do not require Level 4 analytical reports.

Table 10-2 Laboratory Report Levels Radford Army Ammunition Plant, Radford, Virginia					
	ICP/6010/6020 Deliverables	**Level 1**	**Level 2**	**Level 3**	**Level 4**
1	Cover Page	x	x	x	x
2	Summary data sheet	x	x	x	x
3	Initial Calibration			x	x
4	ICV/CCV form			x	x
5	CRQL Check Standard			x	x
6	Blanks - ICB/CCB			x	x
7	Prep Blank		x	x	x
8	ICP Interference check			x	x
9	ICP/MS Interference check			x	x
10	Matrix Spike Recovery		x	x	x
11	Post Digestion Spike			x[1]	x[1]
12	Duplicates		x	x	x
13	Laboratory Control Sample		x	x	x
14	Holding Times			x	x
15	ICP Serial Dilutions			x[1]	x[1]
16	Method Detection Limits			x	x
17	ICP-AES Interelement Corr. Fac.			x	x
18	ICP-AES Interelement Corr. Fac.			x	x
19	ICP Linear Ranges			x	x
20	Preparation Log			x	x
21	Analysis Run Log			x	x
22	ICP-MS Tune			x	x
23	ICP-MS Internal Standards			x	x
24	Raw Data Package				x
	AA/7000 Deliverables	**Level 1**	**Level 2**	**Level 3**	**Level 4**
1	Cover Page	x	x	x	X
2	Summary data sheet	x	x	x	X
3	Initial Calibration			x	X
4	ICV/CCV form			x	X
5	CRQL Check Standard			x	X
6	Blanks - ICB/CCB			x	X
7	Prep Blank		x	x	X
8	Matrix Spike Recovery		x	x	X
9	Post Digestion Spike			x[1]	x[1]
10	Duplicates		x	x	X
11	Laboratory Control Sample		x	x	X
12	Holding Times			x	X
13	Method Detection Limits			x	X
14	Preparation Log			x	X
15	Analysis Run Log			x	X
16	Raw Data Package				x
	GC/MS Deliverables	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	8260,8270				

Table 10-2 Laboratory Report Levels Radford Army Ammunition Plant, Radford, Virginia					
	ICP/6010/6020 Deliverables	**Level 1**	**Level 2**	**Level 3**	**Level 4**
1	Cover Page	x	x	x	x
2	Analysis Data Sheet - Form 1	x	x	x	x
3	Tentatively Identified Compounds	x^2	x^2	x^2	x^2
4	Surrogate Recovery			x	x
5	Internal Standard Areas			x	x
6	Method Blank Summary		x	x	x
7	Method Blank Results		x	x	x
8	Laboratory Control Sample		x	x	x
9	MS/MSD Summary		x	x	x
10	Instrument Tune Summary			x	x
11	Initial Calibration Data			x	x
12	Second Source Calibration			x	x
13	Continuing Calibration Data			x	x
14	Holding Times			x	x
15	Instrument Run Log			x	x
16	Raw Data Package				x
	GC - With Data Download	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	8021, 8081, etc.				
1	Cover Page	x	x	x	x
2	Analysis Data Sheet - Form 1	x	x	x	x
3	Surrogate Recovery			x	x
4	Method Blank Summary		x	x	x
5	Method Blank Results		x	x	x
6	Laboratory Control Sample		x	x	x
7	MS/MSD Summary		x	x	x
8	Initial Calibration Data			x	x
9	Second Source Calibration			x	x
10	Continuing Calibration Data			x	x
11	Holding Times			x	x
12	Instrument Run Log			x	x
13	Raw Data Package				x
	No Data Download	**Level 1**	**Level 2**	**Level 3**	**Level 4**
	RSK, HPLC, IC, etc.				
1	Cover Page	x	x	x	x
2	Analysis Data Sheet - Form 1	x	x	x	x
3	Surrogate Recovery			x	x
4	Method Blank Summary		x	x	x
5	Method Blank Results		x	x	x
6	Laboratory Control Sample		x	x	x
7	MS/MSD Summary		x	x	x
8	Initial Calibration Data			x	x
	GC/MS Deliverables	**Level 1**	**Level 2**	**Level 3**	**Level 4**
1	Second Source Calibration			x	x
2	Continuing Calibration Data			x	x

Table 10-2 Laboratory Report Levels Radford Army Ammunition Plant, Radford, Virginia					
	ICP/6010/6020 Deliverables	**Level 1**	**Level 2**	**Level 3**	**Level 4**
1	Holding Times			x	x
2	Instrument Run Log			x	x
3	Raw Data Package				x

X item provided at that laboratory report level.

1 Item to be provided if method requires that this step be performed. ICP Serial Dilutions and Post Digestion Spikes are performed on an as needed basis.

2 Item provided only when specified in remedial action or IMWP; TICs do not apply to this project.

10.8.4 Record Storage and Handling

Records will be designated as "lifetime" or "nonpermanent" prior to temporary or final storage. Nonpermanent records will be retained for three years after the completion of the fieldwork, or three years after the date the record was generated, whichever is longer. A lifetime record will be delivered to the client for retention.

Records of either type will be catalogued prior to shipment to either the client or a storage facility. The storage facility will confirm that the received parcels contain the catalogued records and convey a receipt for the records to the originating office. The records will be made available to the originating office upon request and according to the procedures of the storage facility.

All data generated by the project are the property of the Army and will be delivered for project closeout as specified by the COR. Data, reports and other relevant records are submitted by UXB-KEMRON to the Army for permanent retention by the Army if/as necessary.

10.9 Data Management

Data management will begin when the contractor transmits a request for analytical services to the laboratory, stating the number, type, sample numbers, methods for analysis, and other information necessary for the laboratory to plan a particular job. Data fields of initial input information, including map location files, a certification status check, sample identification number, parameters, dates, etc., will be established as sample containers and chain of custody documentation are prepared for shipment to the sampling team.

While in the process of collecting, documenting, packaging, and shipping samples to the laboratory, the field sampling team will transfer sample data from their notebooks to field parameter forms. Once the samples arrive at the laboratory, this information will be used to create data fields for submission to the data management staff. Status information (e.g., date sampled, date received, data extraction/analysis due) will form a part of the record.

Each step in the analytical process will result in updates to the data files. The operation performed (e.g., preparation, extraction, analysis, data review, data package prepared), the data obtained and the data that each step was completed will be entered into the system and made available for status checks. The laboratory will validate the data, perform error checking and correction, and transmit the files to the contractor, who will also perform the checks. Hard-copy documentation will also be transferred from the laboratory to the contractor.

The laboratory will archive copies of the analytical data, including original instrument magnetic tapes, for a period specified by the contract. Records will also be maintained so that historical summaries of the analyses may be generated by site, by client, or by sample type. ERIS EDDs of chemical data will be uploaded by UXB-KEMRON into ERIS for future Army access and Army record retention. Report will be submitted in Army READ format as well.

SECTION 11. CORRECTIVE ACTION

Corrective or preventive action is required when potential or existing conditions are identified that may adversely impact data quantity or quality. Corrective action could be immediate or long term.

While the specific activities in Table 11-1 may identify a need for corrective action, any member of the project team who identifies a condition adversely affecting quality is responsible for initiating corrective action by notifying his/her supervisor, PM, and the Project QA Officer. Whether informally or formally identified, notification of issues resulting in the potential for corrective action will specify the condition and explain how it may affect data quality or quantity.

Table 11-1
Assessment Type and Corrective Action Responses
Radford Army Ammunition Plant, Radford, Virginia

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation[1]	Individual(s) Receiving Corrective Action Response (Name, Title, Organization)	Timeframe for Response
Readiness Review	Written Summary of Findings	FS, QA Manager, PM, UXB-KEMRON	Within 24 hours after review	Memorandum	FS,Officer, PM, UXB-KEMRON	Within 24 hours after notification of deficiency requiring CA
Field Sampling Technical Systems Audit	Written Audit Report	FS, QA Manager, PM, UXB-KEMRON	5 business days after audit	Memorandum	FS, QA Officer, PM UXB-KEMRON	Within 24 hours after notification of significant deficiencies
Data Review and Validation	Data Validation Report and Usability Assessment	Data Validator, AQA	Within 15 business days from receipt of analytical report	CA Report from Analytical Laboratory	AQA Data Validator; FS, QA Officer UXB-KEMRON	3 business days from identification of deficiency affecting data

Immediate corrective action is applied to spontaneous, nonrecurring problems (e.g., instrument malfunction). The individual who detects or suspects nonconformance to established criteria or protocol in equipment, instruments, data, or methods, will immediately notify his/her supervisor. The supervisor and/or the Field Supervisor will investigate the extent of the problem and take necessary corrective action. If a large quantity of data is affected, the Field Supervisor will prepare a memorandum to the Project Manager and Project QA Officer. These individuals will collectively decide how to proceed to correct the problem(s). If the problem is limited in scope, the Task Manager will decide on the corrective action measure and document the solution in memorandum form to the PM and QA Officer.

Long-term corrective action procedures are devised and implemented to prevent the recurrence of a potentially serious problem. The Project QA Officer will be notified of the problem and will conduct an investigation to determine the severity and extent of the problem. He will notify the Field Supervisor and Project Manager of the need for corrective action. If the corrective action will adversely impact project schedule, the Project Manager will notify and coordinate with the Army and regulatory personnel.

The development and implementation of preventive and corrective actions will be timed, to the extent possible, so as to not adversely impact project schedules or subsequent data generation/processing activities. Examples of long-term corrective actions include but are not limited to staff training/retraining in technical skills or in implementing the QA Program, rescheduling of laboratory routine to ensure analysis within allowed holding times, revision of UXB-KEMRON QA Program, or replacement of project personnel.

Corrective actions will be categorized as either routine or non-routine and will require short-term or long-term action. Both types will require administrative coordination between the person initiating the corrective action and the QA staff. Examples of UXB-KEMRON and analytical laboratory corrective action forms are provided in Figures 13-1, 13-2, and 13-3..

11.1 Corrective Action Documentation

The UXB-KEMRON QA Officer will ensure that incidents requiring corrective action are fully documented. Reports will be addressed to the Project Manager as well as the Field Supervisor. The summary of findings will be factual, concise, and complete. Any required supporting information will be appended to the report or cross-referenced to readily available project documents. Depending on the nature of the problem, the corrective action employed may be formal or informal.

Corrective actions reports applicable to the analytical laboratory will be documented in corrective action reports provided within 3 business days, as described in Table 11-1.

Whether requiring formal or informal corrective action, documentation will include the occurrence of the problem, corrective action employed, and verification that the problem has been eliminated. Final resolution of a problem will be documented by the signature of the Project QA Officer, or his/her designee. The QA Officer or his/her designee will sign completed corrective action documentation, verifying that the problem has been resolved.

Significant QC issues are those which require a change to an approved document or procedure, including either field or laboratory procedures, and/or which affect data usability. In cases of significant QC issues, a corrective action report will be completed by the Project QA Officer, reviewed by the Project Manager, and coordinated through the Army and regulatory personnel and/or proposed in an addendum or revision to the FSP/QAPP. For items which are not significant, reports will be issued from the Project Manager to the Project QA Officer and maintained in project records.

11.2 Stop Work Protocols

The contractor Program Manager, PM, and QA Officer have the authority to issue a stop work order. A stop work order will be issued under conditions such that the quality of work jeopardizes the attainment of the project objectives. A stop work order must not create an operational, safety, public health, or environmental hazard.

Under a stop work order, work may not be conducted within affected activities until the responsible manager acknowledges the implementation of a corrective action in accordance with the resolution criteria of the order. Immediate notification of work stoppage will be made to the USACE COR and RFAAP.

SECTION 12. QUALITY ASSESSMENTS

This section discusses the inspection program used to monitor the total measurement system and to evaluate the quality of operation in the field and at the on-site laboratory. A performance inspection is a planned independent check of the operation of a system to obtain a quantitative measure of the quality of data generated, and involves the use of standard reference samples or materials which are certified as to their chemical composition or physical characteristics. Systems inspection is of a qualitative nature and consists of on-site review of a system's quality assurance system and physical facilities for sampling/analysis, calibration, and measurement.

12.1 Document Review

Project plans will be reviewed and approved prior to implementation. The contractor PM and QA Manager will provide a qualitative self-evaluation for establishing whether the prevailing management structure, polices, practices, and procedures are adequate to ensuring that the results needed are obtained. The PM will provide an independent qualitative evaluation of a particular program operation and/or organization to establish whether the prevailing management structure, policies, practices, and procedures are adequate for ensuring that the results needed are obtained.

12.1.1 Document Control

The goal of a Document Control Program is to ensure that the project documents issued or generated will be accounted for upon completion of the project. The program includes a numerical document inventory procedure and a central filing system with a designated person(s) responsible for its maintenance. Documents used or generated during the course of the project are accounted for and become a part of the project files upon completion of the task. These may include, but are not limited to, the following:

- Project deliverables;
- LTM requirements;
- Reports and correspondence material; and
- Contract documents.

For example, QAPP will contain a control footer that includes:

- Document title;
- Document version; and
- Effective date (month year).

A distribution list of controlled documents will be maintained within the document control system. This system will ensure that revisions are distributed to the addressees. After technical work on a task has been completed, the accountable documents generated or used for the task work will be assembled and placed in a secure storage location. The QA Officer or his/her designee will inventory accountable task documentation.

12.2 Readiness Reviews

Documented readiness reviews may be performed by the contracting QA Officer at the beginning of the work schedule start date and in the event of a quality-related stop work order. The readiness review will be performed to verify the following elements:

1. Work plans are approved;

2. Personnel have been suitably trained and qualified; and

3. The proper resources are available.

Work prerequisites for investigation activities include ensuring that necessary permits and licenses have been obtained. The contractor will be responsible for site approvals and preparation, coordinating with RFAAP for the extension of utilities to the study site if determined necessary, and regulatory compliance (i.e., obtaining necessary permits to install monitoring wells). Once site preparation is complete and permits are obtained, the contractor will be responsible for monitoring these facilities and determining compliance with permit requirements.

During the readiness review, actions will be taken as necessary by the contracting QA Officer to ensure that field activities are conducted in accordance with the QAPP. The QA Officer will document deficiencies encountered during the readiness review and actions taken in the field to correct potential problems. Results of readiness reviews and corrective actions will be presented as a memorandum issued to the contracting PM. The memorandum will define deficiencies noted during the inspection and will note the actions taken to meet the QA requirements as defined by this QAPP.

12.3 Field Performance Audits

The contractor's technical audit team will perform a field audit of site activities. During this audit, current field practices will be compared to procedures outlined in the project work plans (i.e., WP, QAP, and other pertinent, industry acceptable, RFAAP-approved standards). The following elements will be evaluated during field activities at RFAAP:

- The overall level of organization and professionalism;
- Project activities;
- Document control and management;
- Level of QC conducted per each field team; and
- Task specific activities.

After audit completion, deficiencies will be discussed with the PM, and corrections will be identified. Corrective action procedures are outlined in Section 11.0.

12.4 Laboratory Performance Audits

Microbac actively participates in several Federal and State performance evaluation testing programs and system audits. External systems audits of the Microbac facility occur on a regular basis. These include audits by the West Virginia Department of Natural Resources (WVDNR), the Ohio Environmental Protection Agency (OEPA), and the Florida Department of Health (FLDOH) (NELAC Primary Accreditor). Additionally, audits are conducted every 2 - 3 years by the California Department of Health Services, and the US Army Corps of Engineers. UXB-

KEMRON's QA Officer will be provided copies of the Microbac external audit results during the term of this contract.

Additionally, both Microbac OVD and Columbia Analytical Services have been accredited by the DoD Environmental Laboratory Accreditation Program (DoD ELAP). This program was established by the Assistant Deputy Under Secretary of Defense, and became effective October 01, 2009. Laboratories seeking the DoD ELAP certification undergo stringent audits and reviews. The program is a means for laboratories to demonstrate conformance to the *DoD Quality Systems Manual for Environmental Laboratories* (DoD QSM). The DoD QSM is based on the National Environmental Laboratory Accreditation Conference Quality Systems standard, which provides guidelines for implementing ISO/IEC 17025, the international standard entitled *General Requirements for the Competence of Testing and Calibration Laboratories*. The DoD QSM is periodically revised, and laboratories are required to achieve conformance with new standards as revisions are issued and become effective. Use of laboratories that have achieved the stringent DoD ELAP certification provides additional assurance that project data will be of The highest quality.

SECTION 13. REFERENCES

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FIGURES

FIGURE 10.4-a
EXAMPLE CHAIN-OF-CUSTODY FORM

Project Number	Project Name				Matrix	A	N	A	L	Y	S	E	S		LAB :
Project Contact (Name and Phone Number)															AIRBILL No:
Samplers:															Courier:
Field Sample No.	Date (MM-DD-YY)	Time	Comp	Grab										Subtotal	REMARKS
				TOTAL											

Relinquished by:	Date/time	Received by:	Relinquished by:	Date/Time	Received by:
Relinquished by:	Date/time	Received by: (for lab)	Date/Time	Remarks	

Figure 13-1
GENERAL CORRECTIVE ACTION REPORT

KEMRON Environmental Services
General Corrective Action Report

Date:____________ **Department:**________ **Employee:**______________________________________

I. Description of Non-Conformance:

____
____
____
____
____

II. Action Taken:

____
____
____
____
____
____
____

III. Return to Control?:	Not Applicable _____	Yes _____	No _____

IV. Further Action Required?: (required if no checked in III.)

____
____
____
____
____

Approvals:
Department Supervisor: __________________________ Date: ________________
QA/QC Supervisor: ______________________________ Date: ________________
Director/Manager: ______________________________ Date: ________________

Form NC01

Figure 13-2
ANALYTICAL CORRECTIVE ACTION REPORT

KEMRON Environmental Services
Analytical Corrective Action Report

Date:_____________ **Department:**________ **Employee:**______________________________

Prep WG#_____________ **Preparation Date:**______________ **Parameter:**__________________

I. Description of Non-Conformance:

Sample ID(s) ____

☐ Surrogate(s) <10% ____

☐ Multiple Surrogate(s) ____

☐ Method Blank ____

☐ LCS Failures _______analytes out ____

☐ CCV Failures ____

☐ Other ____

____

____

II. Action Taken:

☐ Reprep affected samples only ____

☐ Reprep entire workgroup ____

☐ Reanalyze affected samples only ____

☐ Report data with qualifiers ____

☐ Other ____

____

____

III. Return to Control?:	Not Applicable	Yes _____	No _____

IV. Further Action Required?: (required if no checked in III.)

____

____

____

____

Approvals:
Department Supervisor: ______________________ Date: ______________
QA/QC Supervisor: ______________________ Date: ______________
Director/Manager: ______________________ Date: ______________

Figure 13-3
KEMRON PERFORMANCE AUDIT CORRECTIVE ACTION FORM

KEMRON PERFORMANCE AUDIT CORRECTIVE ACTION FORM

PE PROGRAM: ____________ Login Number: ____________

Analyte: ____________ Method: ____________

Analyst: ____________ Instrument: ____________

Acceptable Range

Result (Level 1): ____________ ____________

Result (Level 2): ____________ ____________

Reason for Error: ____________

Corrective Action: ____________

Supervisor Approval: ____________ Date: ____________

QAO Approval: ____________ Date: ____________

ATTACHMENT A

SWMU-40 Field Standard Operating Procedures

10.1 - Field Log Book

10.2 – Surface Water, Groundwater and Soil/Sediment Field Log Books

10.3 – Boring Logs

10.4 – Chain-of-Custody Form

20.1 – Monitoring Well Installation

20.2 – Monitoring Well Development

20.11 – Drilling Methods and Procedures

30.1 – Soil Sampling

30.2 – Groundwater Sampling

50.1 – Sample Labels

50.2 – Sample Packaging

70.1 – Investigation Derived Materials

80.1 – Decontamination

90.1 – Photo-ionization Detector (HNu Model PI-101 and HW-101)

STANDARD OPERATING PROCEDURE 10.1
FIELD LOGBOOK

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for recording daily site investigation activities.

Records should contain sufficient information so that anyone can reconstruct the sampling activity without relying on the collector's memory.

2.0 MATERIALS

- Field Logbook;
- Indelible ink pen; and
- Clear tape.

3.0 PROCEDURE

Information pertinent to site investigations will be recorded in a bound logbook. Each page/form will be consecutively numbered, dated, and signed. All entries will be made in indelible ink, and all corrections will consist of line out deletions that are initialed and dated. If only part of a page is used, the remainder of the page should have an "X" drawn across it. At a minimum, entries in the logbook will include but not be limited to the following:

- Project name (cover);
- Name and affiliation of personnel on site;
- Weather conditions;
- General description of the field activity;
- Sample location;
- Sample identification number;
- Time and date of sample collection;
- Specific sample attributes (e.g., sample collection depth flow conditions or matrix);
- Sampling methodology (grab or composite sample);
- Sample preservation, as applicable;
- Analytical request/methods;
- Associated quality assurance/quality control (QA/QC) samples;

- Field measurements/observations, as applicable; and
- Signature and date of personnel responsible for documentation.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

None.

6.0 REFERENCES

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STANDARD OPERATING PROCEDURE 10.2
SURFACE WATER, GROUNDWATER, AND SOIL/SEDIMENT FIELD LOGBOOKS

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for recording surface water, groundwater, and soil/sediment sampling information, as well as instrument calibration data in field logbooks.

2.0 MATERIAL

- Applicable field logbook (see attached forms); and
- Indelible ink pen.

3.0 PROCEDURE

All information pertinent to surface water, groundwater, or soil/sediment sampling will be recorded in the appropriate logbook. Each page/form of the logbook will be consecutively numbered. All entries will be made with an indelible ink pen. All corrections will consist of line out deletions that are initialed and dated.

3.1 SOIL/SEDIMENT

3.1.1 Field Parameters/Logbook (Form 10.2-a)

1. HIGH CONCENTRATION EXPECTED?: Answer "Yes" or "No.";
2. HIGH HAZARD?: Answer "Yes" or "No.";
3. INSTALLATION/SITE: Record the complete name of the installation or site;
4. AREA: Record the area designation of the sample site;
5. INST. NAME: Record the two-letter installation name for Radford Army Ammunition Plant – "RD";
6. SAMPLE MATRIX CODE: Record the appropriate sample matrix code. Common codes are "SD" for solid - sediment, "SI" for soil - gas, "SL for solid sludge, "SO" for surface other, "SS" for solid – soil, "SW" for surface wipe, "WD" for water – potable, "WG" for water – ground, "WS" water – surface, "WT" – water treated and "WW" water -waste;
7. SITE ID: Record a code up to 20 characters or numbers that is unique to the site;
8. ENV. FIELD SAMPLE IDENTIFIER: Record a code up to 20 characters specific for the sample;
9. DATE: Enter the date the sample was taken;
10. TIME: Enter the time (12-hour or 24-hour clock acceptable as long as internally consistent) the sample was taken;

11. AM PM: Circle "AM" or "PM" to designate morning or afternoon (12-hour clock);
12. SAMPLE PROG: Record "RFI" (RCRA Facility Investigation) or other appropriate sample program;
13. DEPTH (TOP): Record the total depth sampled;
14. DEPTH INTERVAL: Record the intervals at which the plug will be sampled;
15. UNITS: Record the units of depth (feet, meters);
16. SAMPLE MEASUREMENTS: Check the appropriate sampling method;
17. CHK: Check off each container released to a laboratory;
18. ANALYSIS: Record the type of analysis to be performed on each sample container;
19. SAMPLE CONTAINER: Record the sample container type and size;
20. NO.: Record the number of containers;
21. REMARKS: Record any remarks about the sample;
22. TOTAL NUMBER OF CONTAINERS FOR SAMPLE: Record the total number of containers;
23. SITE DESCRIPTION: Describe the location where the sample was collected;
24. SAMPLE FORM: Record the form of the sample (i.e., clay, loam, etc.) using The Unified Soil Classification System (USCS);
25. COLOR: Record the color of the sample as determined from standard Munsell Color Charts;
26. ODOR: Record the odor of the sample or "none";
27. PID: Record the measured PID values or other similar measurement instrument value;
28. UNUSUAL FEATURES: Record anything unusual about the site or sample;
29. WEATHER/TEMPERATURE: Record the weather and temperature; and
30. SAMPLER: Record your name.

3.1.2 Map File Form (refer to form 10.2-c)

1. SITE ID: Record the Site ID from the field parameter form;
2. POINTER: Record the field sample number for the sample being pointed to;
3. DESCRIPTION/MEASUREMENTS: Describe the location where the sample was taken, along with distances to landmarks;
4. SKETCH/DIMENSIONS: Diagram the surroundings and record the distances to landmarks;
5. MAP REFERENCE: Record which U.S.G.S. Quad Map references the site;
6. COORDINATE DEFINITION: Write the compass directions and the X- and Y-coordinates of the map run;
7. COORDINATE SYSTEM: Write "UTM" (Universal Transverse Mercator);
8. SOURCE: Record the 1-digit code representing the Map Reference;
9. ACCURACY: Give units (e.g., write "1-M" for 1 meter);
10. X-COORDINATE: Record the X-coordinate of the sample site location;
11. Y-COORDINATE: Record the Y-coordinate of the sample site location;

12. UNITS: Record the units used to measure the map sections;
13. ELEVATION REFERENCE: Record whether topography was determined from a map or a topographical survey;
14. ELEVATION SOURCE: Record the 1-digit code representing the elevation reference;
15. ACCURACY: Record the accuracy of the map or survey providing the topographical information;
16. ELEVATION: Record the elevation of the sampling site;
17. UNITS: Write the units in which the elevation is recorded; and
18. SAMPLER: Write your name.

3.2 SURFACE WATER

3.2.1 Field Parameter Logbook (Forms 10.2-b and 10.2-c)

1. CAL REF: Record the calibration reference for the pH meter;
2. pH: Record the pH of the sample;
3. TEMP: Record the temperature of the sample in degrees Celsius;
4. COND: Record the conductivity of the water;
5. Description of site and sample conditions (refer to 10.2-b);
6. Map File Form (refer to Section 3.1.2).

3.3 GROUNDWATER (FORMS 10.2- D)

3.3.1 Field Parameter Logbook (Form 10.2.b)

Refer to Section 3.2.1.

3.3.2 Map File and Purging Forms

1. WELL NO. OR ID: Record the abbreviation appropriate for where the sample was taken. Correct abbreviations can be found on pages 18-21 of the IRDMIS User's Guide for chemical data entry;
2. SAMPLE NO.: Record the reference number of the sample;
3. WELL/SITE DESCRIPTION: Describe the location where the sample was taken, along with distances to landmarks;
4. X-COORD AND Y-COORD: Record the survey coordinates for the sampling site;
5. ELEV: Record the elevation where the sample was taken;
6. UNITS: Record the units the elevation was recorded in;
7. DATE: Record the date in the form MM/DD/YY;
8. TIME: Record the time, including a designation of AM or PM;
9. AIR TEMP.: Record the air temperature, including a designation of C or F (Celsius or Fahrenheit);
10. WELL DEPTH: Record the depth of the well in feet and inches;
11. CASING HEIGHT: Record the height of the casing in feet and inches;
12. WATER DEPTH: Record the depth (underground) of the water in feet and inches;

13. WELL DIAMETER: Record the diameter of the well in inches;
14. WATER COLUMN HEIGHT: Record the height of the water column in feet and inches;
15. SANDPACK DIAM.: Record the diameter of the sandpack. Generally, this will be the same as the bore diameter;
16. EQUIVALENT VOLUME OF STANDING WATER: Use one of the following equations to determine one equivalent volume (EV);

    1 EV = volume in casing + volume in saturated sandpack. Or:

    $1\ EV = [\pi R_w^2 h_w + 0.30p(R_s^2 - R_w^2)h_s] * (0.0043)$

Where:

R_s = radius of sandpack in inches
R_w = radius of well casing in inches
h_s = height of sandpack in inches
h_w = water depth in inches

$0.0043 = gal/in^3$
and filter pack porosity is assumed as 30%, or

Volume in casing =
$(0.0043\ gal/in^3)(p)(12\ in/ft)(R_c^2)(W_h)$

Where:

R_c = radius of casing in inches, and
W_h = water column height in feet

Vol. in sandpack =
(0.0043 gal/in3)(p)(12 in/ft)(Rb2 - Rc2)(Wh)(0.30)

(if Wh is less than the length of the sandpack), or

Vol. in sandpack =
(0.0043 gal/in3)(p)(12 in/ft)(Rb2 - Rc2)(Sh)(0.30)

(if Wh is greater than the length of the sandpack).

where:

Rb = radius of the borehole, and
Sh = length of the sandpack.

Show this calculation in the comments section.

1. PUMP RATE: Record pump rate;
2. TOTAL PUMP TIME: Record total purge time and volume;

3. WELL WENT DRY? Write "YES" or "NO";
4. PUMP TIME: Record pump time that made the well go dry;
5. VOLUME REMOVED: Record the volume of water (gal) removed before the well went dry;
6. RECOVERY TIME: Record the time required for the well to refill;
7. PURGE AGAIN?: Answer "YES" or "NO";
8. TOTAL VOL. REMOVED: Record the total volume of water (in gallons) removed from the well;
9. CAL REF.: Record the calibration reference for the pH meter;
10. TIME: Record time started (INITIAL T(0)), 2 times DURING the sampling and the time sampling ended (FINAL);
11. pH: Record the pH at start of sampling (INITIAL), twice DURING the sampling, and at the end of sampling (FINAL);
12. TEMP: Record the water temperature (Celsius) at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL);
13. COND: Record the conductivity of the water at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL);
14. D.O.: Record the dissolved oxygen level in the water at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL);
15. TURBIDITY: Record the readings from the turbidity meter (nephelometer) and units at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL);
16. ORD: Record the oxidation/reduction (RedOx) potential of the water sample at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL);
17. HEAD SPACE: Record any positive readings from organic vapor meter reading taken in well headspace before sampling;
18. NAPL: Record the presence and thickness of any non-aqueous phase liquids (LNAPL and DNAPL)
19. COMMENTS: Record any pertinent information not already covered in the form; and
20. SIGNATURE: Sign the form.

3.4 FIELD CALIBRATION FORMS (REFER TO FORM 10.2-E)

1. Record time and date of calibration;
2. Record calibration standard reference number;
3. Record meter ID number;
4. Record initial instrument reading, recalibration reading (if necessary), and final calibration reading on appropriate line;
5. Record value of reference standard (as required);
6. COMMENTS: Record any pertinent information not already covered on form; and
7. SIGNATURE: Sign form.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

None.

6.0 REFERENCE

USEPA. 1991. *User's Guide to the Contract Laboratory Program.* EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response, January.

FIELD PARAMETER/LOGBOOK FORM 10.2-a
SOIL AND SEDIMENT SAMPLES

HIGH CONCENTRATION EXPECTED? ________________ HIGH HAZARD?

INSTALLATION/SITE ____________________________________ AREA ________________

INST NAME _________ FILE NAME _____________________________________

SAMPLE MATRIX CODE ___________ SITE ID ____________
ENV. FIELD SAMPLE IDENTIFIER ________________

DATE (MM/DD/YY) __/__/__ TIME _________ AM PM SAMPLE PROGRAM

DEPTH (TOP) ______ DEPTH INTERVAL ____________ UNIT ___________

SAMPLING METHOD:

SPLIT SPOON __ AUGER __ SHELBY TUBE __ SCOOP __ OTHER

CHK	ANALYSIS	SAMPLE CONTAINER	NO.	REMARKS

TOTAL NUMBER OF CONTAINERS FOR SAMPLE_____

DESCRIPTION OF SITE AND SAMPLE CONDITIONS

SITE DESCRIPTION:____

SAMPLE FORM ____________________ COLOR _____________ ODOR ____________

PID (HNu)____________________ UNUSUAL FEATURES_____________________

WEATHER/TEMPERATURE

SAMPLER ________________

FIELD PARAMETER/LOGBOOK FORM 10.2-b
GROUNDWATER AND SURFACE WATER SAMPLES

HIGH CONCENTRATION EXPECTED? _______________ HIGH HAZARD?

INSTALLATION/SITE ____________________ AREA

INST CODE _________ FILE NAME ___________________ SITE TYPE

SITE ID __________________ FIELD SAMPLE NUMBER

DATE (MM/DD/YY) __/__/__ TIME _________ AM PM SAMPLE PROG.

DEPTH (TOP) _________ DEPTH INTERVAL __________ UNITS

SAMPLING MEASUREMENTS

CAL REF. ____ pH _____ TEMPERATURE °C _____ CONDUCTIVITY _____ REDOX _____

DISSOLVED OXYGEN ____ TURBIDITY ____ OTHER

CHK ANALYSIS SAMPLE CONTAINER NO. REMARKS

TOTAL NUMBER OF CONTAINERS FOR SAMPLE_____

DESCRIPTION OF SITE AND SAMPLE CONDITIONS

SITE DESCRIPTION____

SAMPLING METHOD_________________________________

SAMPLE FORM ________________ COLOR ________ ODOR ________

PID (HNu)_____________________________________

UNUSUAL FEATURES__________________________

WEATHER/TEMPERATURE______________________________________ SAMPLER _______________

EXAMPLE MAP FILE LOGBOOK FORM 10.2-c
SURFACE WATER, SOIL, AND SEDIMENT SAMPLES

SITE ID________________________ POINTER___________________

DESCRIPTION/MEASUREMENTS____

SKETCH/DIMENSIONS :

MAP REFERENCE_______________________________________

COORDINATE DEFINITION (X is _______________ Y is ___________)

COORDINATE SYSTEM _______________ SOURCE _______________ ACCURACY___________________

X-COORDINATE ___________ Y-COORDINATE ___________ UNITS_________

ELEVATION REFERENCE________________________________

ELEVATION SOURCE ________________ ACCURACY _____________ELEVATION_________________

UNITS_______________

SAMPLER_________

EXAMPLE MAP FILE AND PURGING LOGBOOK FORM 10.2-d
GROUNDWATER SAMPLES

WELL COORD. OR ID ______________________ SAMPLE NO.______________

WELL/SITE DESCRIPTION____

____

X-COORD. _______ Y-COORD. ______________ ELEV. _________ UNITS

DATE ____/___/____ TIME ________________ AIR TEMP.

WELL DEPTH ____________ FT. ______ IN. CASING HT. _____ FT. ____ IN.

WATER DEPTH ______ FT. ______ IN. WELL DIAMETER _________ IN.

WATER COLUMN HEIGHT _______ FT. ______ IN. SANDPACK DIAM. _____ IN.

EQUIVALENT VOLUME OF STANDING WATER _______________ (GAL) (L)

VOLUME OF BAILER _______ (GAL) (L) or PUMP RATE _________ (GPM) (LPM)

TOTAL NO. OF BAILERS (5 EV) _________ or PUMP TIME ________ MIN.

WELL WENT DRY? [Yes] [No] NUM. OF BAILERS ________ or PUMP TIME

VOL. REMOVED _____________ (GAL) (L) RECOVERY TIME

PURGE AGAIN? [Yes] [No] TOTAL VOL. REMOVED __________ (GAL) (L)

DATE & TIME	QUANTITY REMOVED	TIME REQ'D	pH	Cond	Temp	ORD	Turb	DO	Character of water (color / clarity / odor / partic.)
(before)									
(during)									
(during)									
(during									
(after)									

COMMENTS____

SIGNATURE_____________________________________

EXAMPLE FIELD CALIBRATION FORM 10.2-e
FOR pH, CONDUCTIVITY, TEMPERATURE, TURBIDITY,
ORD, AND DISSOLVED OXYGEN METERS

INITIAL CALIBRATION	FINAL CALIBRATION
DATE:	DATE:
TIME:	TIME:

pH METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO:________________

METER ID___________________

pH STANDARD	INITIAL READING	RECALIB. READING	FINAL READING
7.0			
10.0			
4.0			

CONDUCTIVITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO:________________

METER ID___________________

COND. STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

TEMPERATURE METER CALIBRATION

METER ID___________________

TEMP. STANDARD	INITIAL READING	RECALIB. READING	FINAL READING
ICE WATER			
BOILING WATER			
OTHER ________			

EXAMPLE FIELD CALIBRATION FORM 10.2-e
FOR pH, CONDUCTIVITY, TEMPERATURE, TURBIDITY,
ORD, AND DISSOLVED OXYGEN METERS

TURBIDITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO:_______________

METER ID__________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

ORD METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO:_______________

METER ID__________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

DISSOLVED OXYGEN METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO:_______________

METER ID__________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

COMMENTS____

SIGNATURE__________________________________

STANDARD OPERATING PROCEDURE 10.3
BORING LOGS

1.0 INTRODUCTION

The purpose of this standard operating procedure (SOP) is to describe the methods to be followed for classifying soil and rock, as well as preparing borehole logs and other types of soil reports.

2.0 MATERIALS

The following equipment is required for borehole logging:

- HTRW ENG Form 5056-R and 5056A-R boring log forms;
- Daily inspection report forms;
- Chain-of-custody forms;
- Request for analysis forms;
- ASTM D 2488 classification flow chart;
- Soil and/or Rock color chart (i.e., Munsell®);
- Grain size and roundness chart;
- Graph paper;
- Engineer's scale;
- Previous reports and boring logs;
- Pocketknife or putty knife;
- Hand lens;
- Dilute hydrochloric acid (10% volume);
- Gloves;
- Personal protective clothing and equipment, as described in work plan addenda health and safety plan;
- Photoionization detector or other appropriate monitoring equipment per site-specific health and safety plan; and
- Decontamination supplies (SOP 80.1).

3.0 PROCEDURE

Each boring log should fully describe the subsurface environment and the procedures used to obtain this description.

Boring logs should be prepared in the field on USACE Engineer Form 5056-R and 5056-R. Logs should be recorded in the field directly on the boring log form and not transcribed from a field book.

A "site geologist" should conduct borehole logging and soil/rock identification and description or other professional trained in the identification and description of soil/rock.

3.1 BORING LOG INFORMATION

As appropriate, the following information should be recorded on the boring log during the course of drilling and sampling activities:

- Project information including name, location, and project number;
- Each boring and well should be uniquely numbered and located on a sketch map as part of the log;
- Type of exploration;
- Weather conditions including events that could affect subsurface conditions;
- Dates and times for the start and completion of borings, with notations by depth for crew shifts and individual days;
- Depths/heights in feet and in decimal fractions of feet;
- Descriptions of the drilling equipment including rod size, bit type, pump type, rig manufacturer and model, and drilling personnel;
- Drilling sequence and descriptions of casing and method of installation;
- Description and identification of soils in accordance with ASTM Standard D 2488;
- Descriptions of each intact soil sample for the parameters identified in Section 3.2;
- Descriptions and classification of each non-intact sample (e.g., wash samples, cuttings, auger flight samples) to the extent practicable;
- Description and identification of rock;
- Description of rock (core(s)) for the parameters identified in Section 3.7;
- Scaled graphic sketch of the rock core (included or attached to log) according to the requirements identified in Section 3.7;
- Lithologic boundaries, with notations for estimated boundaries;
- Depth of water first encountered in drilling, with the method of first determination (any distinct water level(s) below the first zone will also be noted);
- Interval by depth for each sample taken, classified, and/or retained, with length of sample recovery and sample type and size (diameter and length);
- Blow counts, hammer weight, and length of fall for driven samplers;

- Rate of rock coring and associated rock quality designation (RQD) for intervals cored;
- Drilling fluid pressures, with driller's comments;
- Total depth of drilling and sampling;
- Drilling fluid losses and gains should be recorded;
- Significant color changes in the drilling fluid returned;
- Soil gas or vapor readings with the interval sampled, with information on instrument used and calibration;
- Depth and description of any in-situ test performed; and
- Description of other field tests conducted on soil and rock samples.

3.2 SOIL PARAMETERS FOR LOGGING

In general, the following soil parameters should be included on the boring log when appropriate:

- Identification per ASTM D 2488 with group symbol;
- Secondary components with estimated percentages per ASTM D 2488;
- Color;
- Plasticity per ASTM D 2488;
- Density of non-cohesive soil or consistency of cohesive soil;
- Moisture condition per ASTM D 2488 (dry, moist, or wet);
- Presence of organic material;
- Cementation and HCL reaction testing per ASTM D 2488;
- Coarse-grained particle description per ASTM D 2488 including angularity, shapes, and color;
- Structure per ASTM D 2488 and orientation;
- Odor; and
- Depositional environment and formation, if known.

ASTM D 2488 categorizes soils into 13 basic groups with distinct geologic and engineering properties based on visual-manual identification procedures. The following steps are required to classify a soil sample:

1. Observe basic properties and characteristics of the soil. These include grain size grading and distribution, and influence of moisture on fine-grained soil.
2. Assign the soil an ASTM D 2488 classification and denote it by the standard group name and symbol.
3. Provide a written description to differentiate between soils in the same group if necessary.

Many soils have characteristics that are not clearly associated with a specific soil group. These soils might be near the borderline between groups, based on particle distribution or plasticity characteristics. In such a case, assigning dual group names and symbols (e.g., GW/GC or ML/CL) might be an appropriate method of describing the soil. The two general types of soils, for which classification is performed, coarse- and fine-grained soils, are discussed in the following sections.

3.3 COURSE-GRAINED SOIL IDENTIFICATION

For soils in the coarse-grained soils group, more than half of the material in the soil matrix will be retained by a No. 200 sieve (75-μm).

1. Coarse-grained soils are identified on the basis of the following:
   a) Grain size and distribution;
   b) Quantity of fine-grained material (i.e., silt and clay as a percentage); and
   c) Character of fine-grained material.
2. The following symbols are used for classification:

Basic Symbols	Modifying Symbols
G = gravel	W = well graded
S = sand	P = poorly graded
	M = with silty fines
	C = with clayey fines

3. The following basic facts apply to coarse-grained soil classification.

- The basic symbol G is used if the estimated percentage of gravel is greater than that for sand. In contrast, the symbol S is used when the estimated percentage of sand is greater than the percentage of gravel.
- Gravel ranges in size from 3-inch to 1/4-inch (No. 4 sieve) diameter. Sand ranges in size from the No. 4 sieve to No. 200 sieve. The Grain Size Scale used by Engineers (ASTM Standards D 422-63 and D 643-78) is the appropriate method to further classify grain size as specified by ASTM D 2488.
- Modifying symbol W indicates good representation of all particle sizes.
- Modifying symbol P indicates that there is an excess or absence of particular sizes.
- The symbol W or P is used only when there are less than 15% fines in a sample.
- Modifying symbol M is used if fines have little or no plasticity (silty).
- Modifying symbol C is used if fines have low to high plasticity (clayey).

Figure 10.03a is a flowchart for identifying coarse-grained soils by ASTM D 2488.

3.4 FINED-GRAINED SOIL IDENTIFICATON

If one-half or more of the material will pass a No. 200 sieve (75 μm), the soil is identified as fine-grained.

1. Fine-grained soils are classified based on dry strength, dilatancy, toughness, and plasticity.
2. Classification of fine-grained soils uses the following symbols:

Basic Symbols			Modifying Symbols		
M	=	silt (non plastic)	L	=	low liquid limit (lean)
C	=	clay (plastic)	H	=	high liquid limit (fat)
O	=	organic			
Pt	=	peat			

3. The following basic facts apply to fine-grained soil classification:
   - The basic symbol M is used if the soil is mostly silt, while the symbol C applies if it consists mostly of clay.
4. Use of symbol O (group name OL/OH) indicates that organic matter is present in an amount sufficient to influence soil properties. The symbol Pt indicates soil that consists mostly of organic material.

- Modifying symbols (L and H) are based on the following hand tests conducted on a soil sample:
  - — Dry strength (crushing resistance).
  - — Dilatancy (reaction to shaking).
  - — Toughness (consistency near plastic limit).
- Soil designated ML has little or no plasticity and can be recognized by slight dry strength, quick dilatency, and slight toughness.
- CL indicates soil with slight to medium plasticity, which can be recognized by medium to high dry strength, very slow dilatancy, and medium toughness.

Criteria for describing dry strength per ASTM D 2488 are as follows:

Description	Criteria
None	Dry sample crumbles into powder with pressure of handling
Low	Dry specimen crumbles into powder with some finger pressure
Medium	Dry specimen breaks into pieces or crumbles with considerable finger pressure
High	Dry specimen cannot be broken with finger pressure but will break into pieces between thumb and a hard surface
Very high	Dry specimen cannot be broken between the thumb and a hard surface stiffness

Criteria for describing dilatancy per ASTM D 2488 are as follows:

None	No visible change in the sample
Slow	Water appears slow on the surface of the sample during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the sample during shaking and disappears quickly upon squeezing

Criteria for describing toughness per ASTM D 2488 are as follows:

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit and the thread and lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit and the thread and lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit and the thread and lump have very high stiffness

Figure 10.03b is a flowchart for identifying fine-grained soils by ASTM D 2488.

3.5 DENSITY AND CONSISTENCY

Relative density for coarse-grained soils and consistency for fine-grained soils can be estimated using standard penetration test blow count data (ASTM D 1586). The number of blows required for each 6 inches of penetration or fraction thereof is recorded. If the sampler is driven less than 18 inches, the number of blows per each complete 6-inch interval and per partial interval is recorded.

For partial increments, the depth of penetration should be recorded to the nearest 1 inch. If the sampler advances below the bottom of the boring under the weight of rods (static) and/or hammer, then this information should be recorded on the log.

The following are some "rule-of-thumb" guidelines for describing the relative density of coarse-grained soils:

Blow Count	Relative Density for Sand
0–4	Very loose
4–10	Loose
10–30	Medium dense
30–50	Dense
>50	Very Dense

The following are some "rule-of-thumb" guidelines for describing the consistency of fine-grained soils:

Blow Count	Consistency for Clays	Description
0–2	Very Soft	Sample sags or slumps under its own weight
2–4	Soft	Sample can be pinched in two between the thumb and forefinger
4–8	Medium Stiff	Sample can be easily imprinted with fingers
8–16	Stiff	Sample can be imprinted only with considerable pressure of fingers
16–32	Very Stiff	Sample can be imprinted very slightly with fingers
>32	Hard	Sample cannot be imprinted with fingers; can be pierced with pencil

3.6 OTHER DESCRIPTIVE INFORMATION

The approximate percentage of gravel, sand, and fines (use a percentage estimation chart) should be recorded per ASTM D 2488 as follows:

Modifiers	Descriptions
Trace	Less than 5%
Few	5%–10%
Little	15%–25%
Some	30%–45%
Mostly	50%–100%

Color/discoloration should be recorded and described using a soil color chart, such as the Munsell® Soil Color Charts. A narrative and numerical description should be given from the color chart, such as Brown 10 YR, 5/3 (Munsell®). Odor should be described if organic or unusual.

Plasticity should be described as follows:

Description	Criteria
Non-plastic	A 1/8-inch thread cannot be rolled at any water content
Low	Thread can barely be rolled and lump cannot be formed when drier than plastic limit.
Medium	Thread is easy to roll; plastic limit can be reached with little effort and lump crumbles when drier than plastic limit.
High	Considerable time is required to reach the plastic limit and lump can be formed without crumbling when drier than plastic limit

Moisture condition should be recorded as dry (absence of moisture), moist (damp but no visible water) or wet (visible free water).

Cementation should be recorded (carbonates or silicates) along with the results of HCL reaction testing. The reaction with HCL should be described as none (no visible reaction), weak (some reaction with slowly forming bubbles) or strong (violent reaction with bubbles forming immediately).

Particle description information for coarse-grained soil should be recorded where appropriate per ASTM D 2488 including maximum particle size, angularity (angular, subangular, subrounded, or rounded), shape (flat, elongated or flat and elongated), and color.

Structure (along with orientation) should be reported using the following ASTM D 2488 descriptions:

Description	Criteria
Stratified	Alternating layers of varying material or color with layers greater than 6 millimeters thick
Laminated	Alternating layers of varying material or color with layers less than 6 millimeters thick
Fissured	Breaks along definite planes of fracture with little resistance
Slickensided	Fracture planes that appear polished or glossy, can be striated
Blocky	Inclusion of small pockets of different soils
Homogeneous	Same color and appearance throughout

3.7 ROCK CORE PARAMETERS FOR LOGGING

In general, the following parameters should be included on the boring log when rock coring is conducted:

- Rock type;
- Formation;
- Modifier denoting variety;
- Bedding/banding characteristics;
- Color;
- Hardness;
- Degree of cementation;
- Texture;
- Structure and orientation;
- Degree of weathering;
- Solution or void conditions;
- Primary and secondary permeability including estimates and rationale; and
- Lost core interval and reason for loss.

A scaled graphic sketch of the core should provided on or attached to the log, denoting by depth, location, orientation, and nature (natural, coring-induced, or for fitting into core box) of all core breaks. Where fractures are too numerous to be shown individually, their location may be drawn as a zone.

The RQD values for each core interval (run) should be calculated and included on the boring log. The method of calculating the RQD is as follows per ASTM D 6032:

RQD = [Σ length of intact core pieces > 100 mm (4-inches)] x 100%/total core length.

3.8 PROCEDURES FOR ROCK CLASSIFICATION

For rock classification record mineralogy, texture, and structural features (e.g., biotite and quartz fine grains, foliated parallel to relict bedding oriented 15 to 20 degrees to core axis, joints coated with iron oxide). Describe the physical characteristics of the rock that are important for engineering considerations such as fracturing (including minimum, maximum, and most common and degree of spacing), hardness, and weathering.

1. The following is to be used as a guide for assessing fracturing:

AEG Fracturing	Spacing
Crushed	up to 0.1 foot
Intense	0.1–0.5 foot
Moderate	0.5 foot–10 feet
Slight	1.0 foot–3.0 feet
Massive	>3.0 feet

2. Record hardness using the following guidelines:

Hardness	Criteria
Soft	Reserved for plastic material
Friable	Easily crumbled by finger pressure
Low	Deeply gouged or carved with pocketknife
Moderate	Readily scratched with knife; scratch leaves heavy trace of dust
Hard	Difficult to scratch with knife; scratch produces little powder and is often faintly visible
Very Hard	Cannot be scratched with knife

3. Describe weathering using the following guidelines:

Weathering	Decomposition	Discoloration	Fracture Condition
Deep	Moderate to complete alteration of minerals feldspars altered to clay, etc.	Deep and thorough	All fractures extensively coated with oxides, carbonates, or clay
Moderate	Slight alteration of minerals, cleavage surface lusterless and stained	Moderate or localized and intense	Thin coatings or stains
Weak	No megascopic alteration of minerals	Slight and intermittent and localized	Few strains on fracture surfaces
Fresh	Unaltered, cleavage, surface glistening		

3.9 PROCEDURE FOR LOGGING REFUSE

The following procedure applies to the logging of subsurface samples composed of various materials in addition to soil as may be collected from a landfill or other waste disposal site.

1. Observe refuse as it is brought up by the hollow stem auger, bucket auger, or backhoe.

2. If necessary, place the refuse in a plastic bag to examine the sample.

3. Record observations according to the following criteria:

   - Composition (by relative volume), e.g., paper, wood, plastic, cloth, cement, or construction debris. Use such terms as "mostly" or "at least half." Do not use percentages;
   - Moisture condition: dry, moist, or wet;
   - State of decomposition: highly decomposed, moderately decomposed, slightly decomposed, etc.;
   - Color: obvious mottling and/or degree of mottling;
   - Texture: spongy, plastic (cohesive), friable;
   - Odor;

- Combustible gas readings (measure down hole and at surface); and
- Miscellaneous: dates of periodicals and newspapers, ability to read printed materials, degree of drilling effort (easy, difficult, and very difficult).

3.10 SUBMITTAL REQUIREMENTS

Each original boring log should be submitted to the Contracting Officer Representative (CRO) after completion of the boring. When a monitoring well will be installed in a boring, the boring log and well installation diagram should be submitted together.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

Not applicable.

6.0 REFERENCES

ASTM Standard D 1586–84 (1992). 1992. *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.*

ASTM Standard D 2488-93. 1993. *Standard Practice for Description and Identification of Soils Visual-Manual Procedure).*

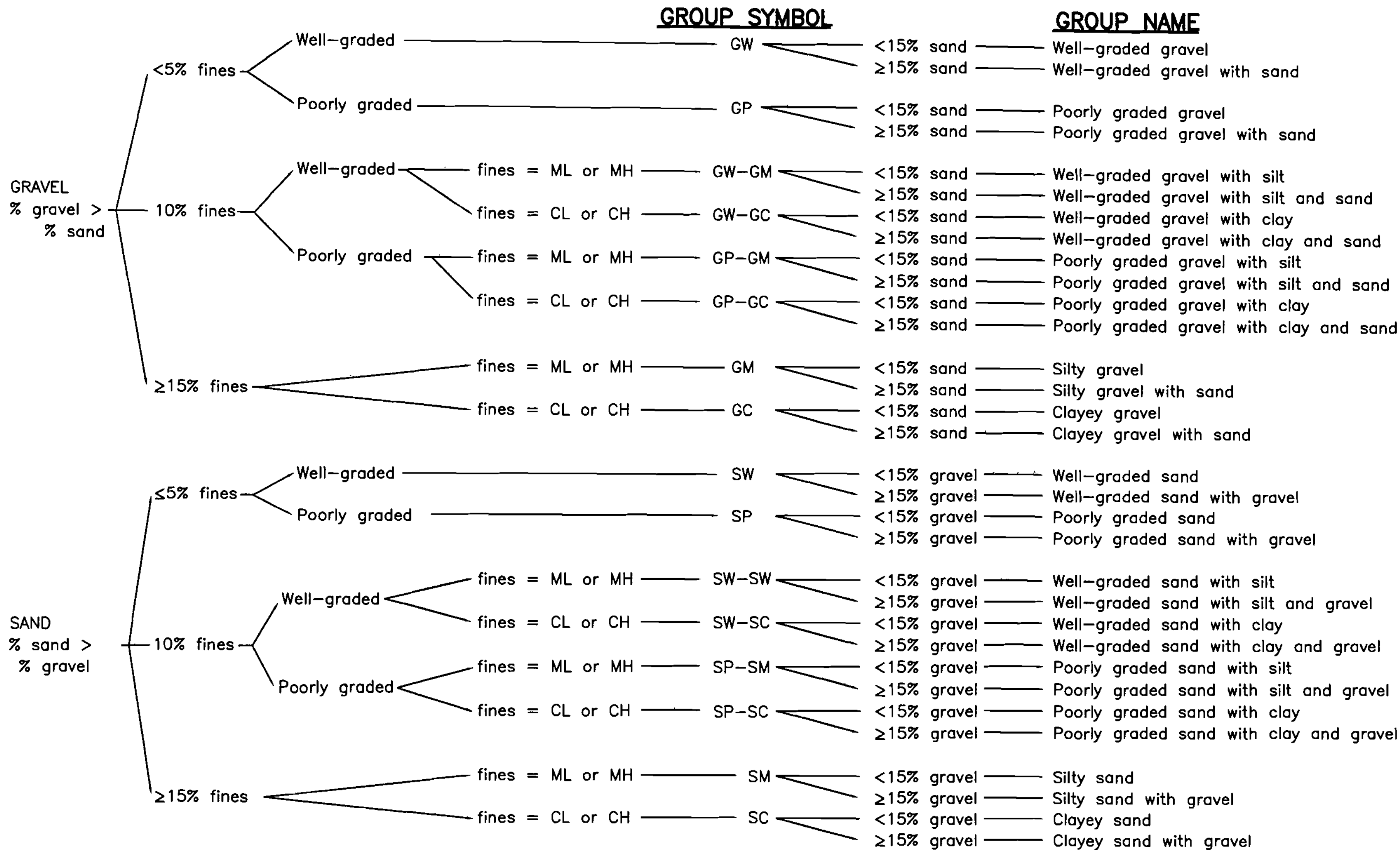
ASTM Standard D 5434-93. 1993. *Guide for Field Logging of Subsurface Explorations of Soil and Rock.*

ASTM Standard D 6032-96. 1996. *Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core.*

Compton, R. R. 1962. *Manual of Field Geology.* John Wiley & Sons, Inc., New York.

USACE. 1998. *Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites.* EM 1110-1-4000, 1, November.

U.S. Department of the Interior. 1989. *Earth Manual.* Water and Power Resources Service, Washington, DC.



NOTE: PERCENTAGES ARE BASED ON ESTIMATING AMOUNTS OF FINES, SAND, AND GRAVEL TO THE NEAREST 5%.

SOURCE: ASTM D 2488

RFAAP MASTER WORK PLAN		FIGURE 10.03a
Date: 06/13/01	Prepared By: URS Corp./DRT	FLOW CHART FOR IDENTIFYING COARSE-GRAINED SOILS
Scale: NO SCALE	File Name: P:\...\Figure XXX.x..	

GROUP SYMBOL				GROUP NAME
CL	<30% plus No. 200	<15% plus No. 200		Lean clay
		15 – 25% plus No. 200	% sand ≥ % gravel	Lean clay with sand
			% sand < % gravel	Lean clay with gravel
	≥30% plus No. 200	% sand ≥ % of gravel	<15% gravel	Sandy lean clay
			≥15% gravel	Sandy lean clay with gravel
		% sand < % of gravel	<15% sand	Gravelly lean clay
			≥15% sand	Gravelly lean clay with sand
ML	<30% plus No. 200	<15% plus No. 200		Silt
		15 – 25% plus No. 200	% sand ≥ % gravel	Silt with sand
			% sand < % gravel	Silt with gravel
	≥30% plus No. 200	% sand ≥ % of gravel	< 15% gravel	Sandy silt
			≥ 15% gravel	Sandy silt with gravel
		% sand < % of gravel	< 15% sand	Gravelly silt
			≥ 15% sand	Gravelly silt with sand
CH	<30% plus No. 200	<15% plus No. 200		Fat clay
		15 – 25% plus No. 200	% sand ≥ % gravel	Fat clay with sand
			% sand < % gravel	Fat clay with gravel
	≥30% plus No. 200	% sand ≥ % of gravel	<15% gravel	Sandy fat clay
			≥15% gravel	Sandy fat clay with gravel
		% sand < % of gravel	<15% sand	Gravelly fat clay
			≥15% sand	Gravelly fat clay with sand
MH	<30% plus No. 200	<15% plus No. 200		Elastic silt
		15 – 25% plus No. 200	% sand ≥ % gravel	Elastic silt with sand
			% sand < % gravel	Elastic silt with gravel
	≥30% plus No. 200	% sand ≥ % of gravel	<15% gravel	Sandy elastic silt
			≥15% gravel	Sandy elastic silt with gravel
		% sand < % of gravel	<15% sand	Gravelly elastic silt
			≥15% sand	Gravelly elastic silt with sand
OL/OH	<30% plus No. 200	<15% plus No. 200		Organic soil
		15 – 25% plus No. 200	% sand ≥ % gravel	Organic soil with sand
			% sand < % gravel	Organic soil with gravel
	≥30% plus No. 200	% sand ≥ % of gravel	<15% gravel	Sandy organic soil
			≥15% gravel	Sandy organic soil with gravel
		% sand < % of gravel	<15% sand	Gravelly organic soil
			≥15% sand	Gravelly organic soil with sand

NOTE: PERCENTAGES ARE BASED ON ESTIMATING AMOUNTS OF FINES, SAND, AND GRAVEL TO THE NEAREST 5%.

SOURCE: ASTM D 2488

RFAAP
MASTER WORK PLAN

Date: 06/13/01	Prepared By: URS Corp./DRT
Scale: NO SCALE	File Name: P:\...\Figure XXX.x..

FIGURE 10.03b

FLOW CHART FOR IDENTIFYING FINE-GRAINED SOILS

STANDARD OPERATING PROCEDURE 10.4
CHAIN-OF-CUSTODY FORM

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for use of the chain-of-custody form. An example is provided as part of this SOP. Other formats with similar levels of detail are acceptable.

2.0 MATERIALS

- Chain-of-custody form; and
- Indelible ink pen.

3.0 PROCEDURE

1. Record the project name and number.
2. Record the project contact's name and phone number.
3. Print sampler's names in "Samplers" block.
4. Enter the Field Sample No.
5. Record the sampling dates for all samples.
6. List the sampling times (military format) for all samples.
7. Indicate, "grab" or "composite" sample with an "X."
8. Record matrix (e.g., aqueous, soil).
9. List the analyses/container volume across top.
10. Enter the total number of containers per Field Sample No. in the "Subtotal" column.
11. Enter total number of containers submitted per analysis requested.
12. State the carrier service and airbill number, analytical laboratory, and custody seal numbers.
13. List any comments or special requests in the "Remarks" section.
14. Sign, date, and time the "Relinquished By" section when the cooler is relinquished to the next party.
15. Upon completion of the form, retain the shipper copy and place the forms and the other copies in a zip seal bag to protect from moisture. Affix the zip seal bag to the inside lid of the sample cooler to be sent to the designated laboratory.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

None.

6.0 REFERENCES

USEPA. 1990. *Sampler's Guide to the Contract Laboratory Program.* EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, DC, December 1990.

USEPA. 1991. *User's Guide to the Contract Laboratory Program..* EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response, January 1991.

USEPA. 1998. *EPA Requirements for Quality Assurance Project Plans.* EPA/600/R-98/018, QA/R5, Final, Office of Research and Development, Washington, D.C.

FIGURE 10.4-a
EXAMPLE CHAIN-OF-CUSTODY FORM

Project Number	Project Name				Matrix	A	N	A	L	Y	S	E	S		LAB :
Project Contact (Name and Phone Number)															AIRBILL No:
Samplers:															Courier:
Field Sample No.	Date (MM-DD-YY)	Time	Comp	Grab										Subtotal	REMARKS
				TOTAL											

Relinquished by:	Date/time	Received by:	Relinquished by:	Date/Time	Received by:
Relinquished by:	Date/time	Received by: (for lab)	Date/Time	Remarks	

STANDARD OPERATING PROCEDURE 20.1
MONITORING WELL INSTALLATION

1.0 SCOPE AND APPLICATION

The installation of monitoring wells is contingent upon the existing conditions at the project site. The purpose of this standard operating procedure (SOP) is to delineate the quality control measures required to ensure the accurate installation of monitoring wells. For a particular site investigation, the associated work plan addenda should be consulted for specific installation instructions. The term "monitoring wells", as used herein is defined to denote any environmental sampling well.

2.0 MATERIALS

2.1 DRILLING EQUIPMENT

- Appropriately sized drill rig adequately equipped with augers, bits, drill stem, etc;
- Steam cleaner and approved source water for decontamination of drilling equipment, etc.;
- Source of approved water;
- Photoionization detector or other appropriate monitoring instrument per the site-specific Health and Safety plan;
- Water level indicator (electrical);
- Weighted steel tape measure;
- Steel drums and other appropriate containers for investigation-derived materials (drill cuttings, contaminated PPE, decontamination solutions, etc.);
- Absorbent pads and/or logs;
- Personal protective equipment and clothing (PPE) per site-specific health and safety plan; and
- Decontamination supplies, pad with heavy plastic sheeting (SOP 80.1).

2.2 WELL INSTALLATION MATERIALS

Technical information on all installed materials (screens, riser pipe, filter pack, bentonite, cement, etc.) and representative samples of the proposed filter pack will be supplied to the Contracting Officer's Representative (COR) before initiating well installation.

Well screen slot size and filter pack gradation will be determined based on existing site geology before initiating site-specific investigations.

- Well screen :

  Polyvinyl Chloride (PVC): JOHNSON (or equivalent); PVC commercially slotted continuous slot, wire wrapped screen; 4-in. diameter.; SCH 40; SCH 80; flush-threaded (leak-proof) joints; PVC should conform to National Sanitation Foundation (NSF) Standard 14 for potable water usage or ASTM

Standard Specification F 480 and bear the appropriate rating logo. PVC should be free of ink markings, cleaned, and prepackaged by manufacturer;

Stainless Steel: JOHNSON (or equivalent); stainless steel Vee-Wire continuous slot, wire wrapped screen; 304 stainless steel (unless the sum concentration of Cl^-, F^-, and Br^- is <1000 ppm, case type 316 should be used); ASTM F 480 flush threads; cleaned, wrapped, and heat-sealed by manufacturer;

- Riser pipe:
  - PVC: JOHNSON (or equivalent); STD. PVC; 4-in. diameter.; SCH 40; SCH 80; flush-threaded (leak-proof) joints; PVC should conform to NSF Standard 14 or F 480; free of ink markings; cleaned and prepackaged by manufacturer;
  - Stainless Steel: JOHNSON (or equivalent); SCH 5; 304 stainless steel; ASTM type A312 material; 4-in. diameter.; cleaned, wrapped and heat-sealed by manufacturer;
- Plugs/Caps: JOHNSON (or equivalent); standard PVC or stainless steel;
- Filter pack: MORIE, clean sorted gravel (or equivalent);
- Bentonite seal: BAROID, bentonite pellets (3/8-in. diameter.);
- Cement: Type II Portland Cement; if sulfate concentrations are higher than 1500 ppm, Type IV Portland Cement will be used;
- Bentonite powder: BAROID, Aquagel Gold Seal;
- Steel Protective Casing: BRAINARD-KILMAN (or equivalent) zinc-plated steel, lockable, painted;
- Containers for purged water, as required;
- Submersible pump or bailer of appropriate capacity, and surge block sized to fit well;
- Hach DREL 2000 portable laboratory (or equivalent);
- Multiprobe Electronic Water Quality Recorder (Hydrolab);
- Electric well sounder and measuring tape;
- Portland Type II cement (see footnote); and
- Steel Posts (pickets), painted (see footnote).

2.3 DOCUMENTATION

- Copy of work plans and health and safety plan;
- Copy of USACE EM 110-1-4000 Monitoring Well Requirements.;
- Copies of permits (area entry, hot work, well, and utility clearance);
- Boring log forms;
- Well completion diagram form; and
- Field logbook.

2.4 GEOLOGIST'S PERSONAL EQUIPMENT

- Boring log materials per SOP 10.3; and
- Personal protective equipment and clothing (PPE) as required by the site-specific health and safety plan.

3.0 PROCEDURE

3.1 MATERIALS APPROVAL

3.1.1 Source Water

Water sources for drilling, grouting, sealing, filter pack placement, well installation, and equipment decontamination must be approved by the COR before arrival of the drilling equipment. Information required for the water source includes:

- Water source;
- Manufacturer/owner and their address and telephone number;
- Type of treatment and filtration prior to tap;
- Time of access;
- Cost per gallon (if applicable); and
- Dates and results associated with all available chemical analyses over the past 2 years, and the name and address of the analytical laboratory (if applicable).

3.1.2 Bentonite

Pure sodium bentonite with no additives (bentonite) will be the only drilling fluid additive allowed, and its use must be approved by the COR before the arrival of the drilling equipment. The information required for evaluation includes brand name, manufacturer, manufacturer's address and telephone number, product description, and intended use for the product, and potential effects on chemical analysis of water samples.

3.1.3 Granular Filter Pack

Granular filter pack material must be approved by the COR before drilling. A one-pint representative sample must be supplied to the COR. Information required includes lithology, grain size distribution, brand name, source, processing method, and size of intended screen.

3.1.4 Cement

Portland Type II cement will be used for grout (or Type IV, as noted in Section 2.2).

3.2 DRILLING

The objective of the selected drilling technique used at given site is to ensure that the drilling method provides representative data while minimizing subsurface contamination, cross contamination, and drilling costs.

Drilling methods that are appropriate for boring or monitoring well installation will depend on the subsurface geology most likely to be encountered in the boring. The geology for each site should be determined by reviewing previous investigation data (boring data, geophysics, etc.) from the site or nearby areas. Specific drilling methods that will be used to support site activities will be incorporated into work plan addenda.

Section 5.2.2 of the Master Work Plan discusses the different drilling methods that may be appropriate for installation of monitoring wells at the Radford Army Ammunition Plant (RFAAP) based on the different types of conditions encountered. The different drilling methods discussed in this section of the Master Work Plan including:

- Hollow Stem Auger (for soil);
- Air Rotary (soil and rock);
- Water Rotary and wire-line casing advancement (soil and rock);
- Drill-Through-Casing Driver (soil and rock); and
- Sonic (soil and rock).

3.2.1 Responsibilities of the Site Geologist

A Site Geologist will be present during all well drilling and installation activities and will fully characterize all tasks performed in support of these activities in the monitoring well logbook. The Site Geologist will be responsible for the logging samples, monitoring drilling operations, recording water losses/gains and groundwater data, preparing the boring logs and well diagrams, and recording the well installation procedures for one operating rig. The Site Geologist will have sufficient equipment in operable condition on-site to perform efficiently his/her duties.

3.2.2 Additives

No lubricants will be used on down hole drilling equipment. Additives containing either lead or copper will not be allowed. In addition, polychlorinated biphenyls will not be permitted in hydraulic fluids or other fluids used in the drilling rig, pumps, or other field equipment and vehicles.

Surface runoff or other fluids will not be allowed to enter any boring or well during or after drilling/construction.

Antifreeze used to keep equipment from freezing will not contain rust inhibitors and sealants. Antifreeze is prohibited in any areas in contact with drilling fluid. Absorbent pillows will be placed to catch any obvious leaks from the drill rig.

3.2.3 Boring Logs and Field Notes

Borings for monitoring wells will be logged by a geologist as described in SOP 10.3. Logs will be recorded on USACE HTRW ENG Form 5056-R and 5056A-R boring log forms.

Daily investigation activities at the site related to drilling should be recorded in field logbooks as described in SOPs 10.1 and 10.2.

3.3 WELL CONSTRUCTION AND INSTALLATION

Specifications for monitoring well construction and installation for a given site being investigated are to be included in work plan addenda. In case the previously defined criteria have not been met before the depth range for a given hole is reached, the geologist will stop the drilling and confer with the supervisor. The current boring conditions (depth, nature of the stratigraphic unit, and water-table depth) will be compared to those of other wells nearby to decide whether to continue drilling or to terminate and complete the well.

3.3.1 Overburden Wells

Overburden wells at the RFAAP are typically designed as a 4-inch diameter, single cased well (see Figure 20-1a) installed into a surficial aquifer, which is present above bedrock. For this type of well, the well boring would be terminated before penetrating any underlying confining unit and/or bedrock.

Section 5.2.2 of the Master Work Plan discusses the different drilling methods that may be appropriate for installation of overburden wells.

If dense, non-aqueous liquid (DNAPL) is encountered during drilling, the well boring will be terminated and completed at the base of the overburden aquifer being monitored.

3.3.2 Bedrock Wells

Multi-cased wells or wells with an outer casing installed into competent bedrock should be specified for wells that are designed to monitor groundwater within bedrock (see Figure 20-1c). The installation of a multi-cased well or outer casing will isolate the zone(s) monitored from overburden and will minimize the potential for cross-contamination during and after drilling.

The general procedure to be followed for installation of a multi-cased well is as follows. This procedure assumes the installation of a 4-inch diameter monitoring well. Specific procedures, drilling techniques and design of monitoring wells will be presented in work plan addenda for site-specific investigations.

1. If soil sampling is required within overburden, use appropriate drilling techniques to advance the boring and collect the soil samples.

2. A minimum 10-inch drill bit should be advanced from the surface into competent bedrock a distance not less than 2 feet. A drilling technique appropriate for penetrating overburden and bedrock should be used such as air rotary.

3. After the borehole has been advanced to the target depth within competent bedrock, a 6-inch diameter steel or Schedule 80 PVC outer casing should be lowered to the bottom of the boring.

4. Once the outer casing has been lowered to the bottom of the boring, the casing should be grouted in-place using a decontaminated tremie pipe equipped with a side discharge. The annulus between the outer casing and borehole wall will be injected with grout until undiluted grout reaches the surface.

5. The grouting mixture, specification, and placement should be consistent with the requirements identified in Section 3.3.8.

6. The grout should be allowed to cure a minimum of 24 hours before further drilling.

7. After adequate curing time for outer casing, drilling with a 5-5/8-inch bit until the desired total depth is reached should complete the well boring.

8. Once the well boring is completed, an appropriate bedrock well will be constructed based on site-specific conditions. The types of wells that may be installed may include a constructed well with screen, casing, filter pack, seal, and grout; an open-bedrock well; or a lined open bedrock well (see Section 3.3.3).

3.3.3 Well Screen Usage

Well screen usage for a given site should be specified in work plan addenda based on expected site conditions.

In general, wells installed within overburden will be installed with a screen as per Figure 20.01-a or 20.01-b. Bedrock wells may be installed with or without a screen depending on site specific conditions such as the depth of water bearing zones, stability of bedrock, occurrence of karst zones, and construction of existing wells at the site being investigated.

In general, bedrock wells installed within karst zones will be completed as open-hole construction (see Figure 20.01c). If evidence of potential or severe borehole collapse (unstable bedrock) is indicated during drilling, casing and screen will be installed in the borehole as a removable lining. If desired, multiple flow zones may be monitored in an open bedrock well by installing a multiport well, which has monitoring/sampling intervals sealed off from the rest of the boring and from each other by packers.

3.3.4 Beginning Well Installation

Schedule

Monitoring well installation should begin within 12 hours of boring completion for holes that are uncased or partially cased with temporary drill casing. In the case where a partially cased hole into bedrock is to be partially developed prior to well insertion, the well installation should begin within 12 hours of this initial development. For holes that are fully cased, installation should begin within 48 hours. Once begun, well installation should not be interrupted.

Placement of Materials

Temporary casing and hollow stem augers may be removed from the boring prior to well installation if the potential for cross contamination is low and if the borehole will remain stable during the time required for installation.

Where borehole conditions are unstable, some or all of the well materials may need to be installed prior to removal of the temporary casing or hollow stem augers. The casing or hollow stem augers should have an inside diameter sufficient to allow the installation of the screen and casing plus annular space for a pipe through which to place filter pack and grout.

Any materials blocking the bottom of the drill casing or hollow stem auger should be dislodged and removed from the casing prior to well insertion.

3.3.5 Screens, Casing, and Fittings

Borehole Specifications

The borehole for each well should be of sufficient diameter to provide for at least 2 inches of annular space between the borehole wall and all sides of the casing.

Well Screens

Material specifications for well screens, casings, and fittings are discussed in Section 2.2.
Screen bottoms should be securely fitted with a threaded cap or plug of the same composition as the screen. The cap/plug should be within 0.5 feet of the open portion of the screen. A sediment trap/sump will not be used.

Screen slot size will be appropriately sized to retain 90%–100% of the filter pack material, the size of which will be determined by sieve analysis of formation material.

Well screen lengths should be specified in work plan addenda and will be based on various site-specific factors such as environmental setting, subsurface conditions, analytes of concern, regulatory considerations, etc.

Assembly and Placement of Well Screen and Casing

Personnel should take precautions to assure that grease, oil, or other contaminants do not contact any portion of the well screen and casing assembly. Clean latex or nitrile gloves should be worn when handling the screen and casing assembly. Flush, threaded joints usually can be tightened by hand. If necessary, steam cleaned wrenches may be used to tighten joints.

In general, each section of the well assembly is lowered into the borehole, one section at a time, screwing each section securely into the section below it. No grease, lubricant, polytetrafluoroethylene (PTFE) tape, or glue may be used in joining the sections of screen and casing.

The assembly should be lowered to its predetermined level and held in position for placement of the filter pack. It is essential that the assembly be installed straight (with centralizers as appropriate) to allow for appropriate sampling. Buoyant forces associated with fluids in the borehole may require that the assembly be installed with the aid of hydraulic rams of the drill rig. When the well assembly is placed to predetermined level, a temporary cap should be place on the well to prevent foreign material from entering the well.

The bottoms of well screens should be placed no more than 3 feet above the bottom of the drilled borehole. If significant overdrilling is required, a pilot boring should be used. Sufficient filter pack should be placed at the bottom of the borehole

The well casing should be pre-cut (square) to extend 2 to 2.5 feet above the ground surface. Before placement of the last piece of well casing, a notch or other permanent reference point will be cut, filed, or scribed into the top edge of the casing.

The tops of all well casing will be capped with covers composed of materials compatible with the products used in the well installation. Caps will be loose fitting, constructed to preclude binding to the well casing caused by tightness of fit, unclean surfaces, or weather conditions. In either case, it should be secure enough to preclude the introduction of foreign material into the well, yet allow pressure equalization between the well and the atmosphere.

The top of each well casing should be level so that the maximum difference in elevation between the highest and lowest points of the casing is less than or equal to 0.02 ft.

3.3.6 Filter Pack

The volume of filter pack that is required to fill the annular between the well screen/casing and borehole should be computed, measured, and recorded.
Granular filter packs will be chemically and texturally clean, inert, and siliceous. The gradation of filter packs will be selected based on the screen size used and will be specified in the work plan addenda for the site being investigated.

Primary Filter Pack

Filter pack material should be placed in the borehole using a decontaminated tremie pipe. An appropriate amount of primary filter pack should be placed in the borehole prior to final positioning of the well screen to provide an appropriate barrier between the bottom of the borehole and the bottom of the screen. Once the initial filter pack has been placed and the well assembly is appropriately positioned and centered in the borehole, the remaining primary filter pack should be placed in increments (and tamped) as the tremie pipe is gradually raised.

As the primary filter pack is placed, approved source water may need to be added to help move the filter pack. A weighted tape should be used to measure the top of the filter pack as it is being placed. If bridging of the filter pack occurs, then this bridging should be broken mechanically prior to adding additional filter pack.

When temporary casing or hollow stem augers are used, the casing or augers should be removed in increments such that lifting of the well assembly is minimal. After removal of each increment, it should be confirmed by direct measurement that the primary filter pack has not been displaced during the removal.
The primary filter pack should extend from the bottom of the borehole to 3 to 5 ft above the top of the screen.

Secondary Filter Pack

The primary filter pack may be capped with 1 to 2 feet of feet of secondary filter pack to prevent the intrusion of the bentonite seal into the primary filter pack. The need for this filter pack (and specifications) should be addressed in work plan addenda for the site being investigated. Such factors as the gradation of the primary filter pack, the potential for grout extrusion, and site hydrogeology should be considered when evaluating the need for this filter pack.

3.3.7 Bentonite Seal

A bentonite seal, consisting of hydrated 3/8-inch diameter. bentonite pellets, will be installed immediately above the filter pack. The seal may be installed with a tremie pipe, which is lowered to the top of the filter pack and slowly raised as the pellets fill the annular space. In deep wells, the pellets may bridge and block the tremie pipe; in this case, pellets may be placed by free fall into the borehole. A weighted tape should be used to measure the top of seal as it is installed.

When cement grout is to be used above the bentonite seal, a minimum of 3 to 4 hours should be allowed for hydration of the pellets.

When installing a seal above the water table, water should be added to the bentonite for proper hydration. In this case, the seal should be placed in lifts of 0.5 to 1 foot with each lift hydrated for a period of 30 minutes.
If the bentonite seal is to be installed far below the water table, a bentonite slurry seal will be installed. Cement-bentonite grout will not be used below the water table. The slurry will be mechanically blended aboveground to ensure a lump-free mixture. The slurry will consist of bentonite powder and approved water mixed to a minimum 20 percent solids by weight of pumpable slurry with a density of 9.4 pounds per gallon or greater. The slurry will be pumped into place through a tremie pipe and measured as installed.
Bentonite seals should be 3 to 5 ft thick as measured immediately after placement. The final depth to the top of the bentonite seal will be measured and recorded before grouting.

3.3.8 Grout

Cement grout used in construction will be composed of the following:

- Type II Portland Cement (or Type IV as noted in Section 2.2);
- Bentonite (2 to 5% dry bentonite per 94-lb sack of dry cement); and
- A maximum of 6 to 7-gallons of approved water per 94-lb sack of cement

Neither additives nor borehole cuttings will be mixed with the grout. Bentonite will be added after the required amount of cement is mixed with the water.

All grout material will be combined in an aboveground container and mechanically blended to produce a thick, lump-free mixture. The mixed grout will be recirculated through the grout pump before placement. Grout placement should be performed as follows:

1. Grout should be placed from a rigid tremie pipe located just over the top of the bentonite seal. The tremie pipe should be decontaminated prior to use.
2. The tremie pipe should be kept full of grout from start to finish with the discharge end of the pipe completely submerged as it is slowly and continuously lifted.
3. The annulus between the drill casing and well casing should be filled with sufficient grout to allow for the planned drill casing removal. Grout should not penetrate the well screen or filter pack.

- For incremental removal of drill casing, grout should be pumped to maintain at least 10 ft of grout in the drill casing remaining in the borehole after removing the selected length of casing. After each section of casing is removed, the tremie pipe may be reinserted to the base of the casing not yet removed.
- In the case where drill casing will be removed all at once, grout should be pumped from the tremie pipe until undiluted grout flows from the annulus at the ground surface.

4. If the un-grouted portion of a borehole is less than 15 feet and without fluids after drill casing removal, then the un-grouted portion may be filled by pouring grout from the surface.
5. If drill casing was not used for well installation, grouting should proceed to the surface in one continuous operation.
6. For grout placement in a dry and open hole less than 15 ft deep, grout may be manually mixed and poured in from the surface providing that integrity of the bentonite seal is maintained.
7. Protective casing should be installed immediately after completion of grouting.
8. Grout settlement should be checked within 24 hours of the initial grout placement. Additional grout should be added grout should be added to fill any observed depressions.

The following will be noted in the boring logs: (1) exact amounts of cement, bentonite, and water used in mixing grout and (2) actual volume of grout placed in the hole.

3.3.9 Well Protection

The major elements of well protection will include:

- A protective casing;

- Protective concrete pad around the well; and
- Protective steel posts set around the well outside of the concrete pad.

Well Protective Casing

Well protective casings will be installed around all monitoring wells immediately after grouting. The protective casing should consist of a minimum 5-ft long, steel pipe (protective casing) installed over the well casing and into the grout. The protective casing should be installed to a depth of approximately 2.5-feet below ground surface (extending approximately 2.5 feet above ground surface). The internal well casing (riser) and protective casing will not be separated by more than 0.2 feet of height.

An internal mortar collar will be placed within the protective steel casing and outside the well casing to a height of 0.5 above ground surface.

After placement and curing of the mortar collar, an internal drainage hole will be drilled through the protective casing, which is centered no more 1/8 inch above the grout filled annulus between the well riser and the protective casing.

Any annulus formed between the outside of the protective casing and the borehole will be filled to ground surface with cement.

Concrete Pad

After the grout has thoroughly set and the well protective casing has been installed, a protective concrete pad will be installed around the well. This pad will be at least 4 inches thick and 4 feet square and sloped away from the well to provide for adequate drainage.

Protective Posts

Additional protection will be provided at each well location by the installation of four steel posts outside of each corner of the concrete pad. The installation of protective posts should occur before the well is sampled.
The posts should have a minimum diameter of 3 inches, be placed 2 to 3 feet below ground surface, and extend at least 3 feet above ground surface. Posts should be painted orange using a brush.

Posts should be set in post holes, which are backfilled with concrete. For additional protection, the posts can be filled with concrete.

3.3.10 Well Construction Diagram and Field Notes

The construction of each well will be depicted as built in a well construction diagram (see Figure 20.1a). The diagram will be attached to the boring log and the following will be graphically denoted:

- Bottom of boring;
- Screen location, length, and size;
- Coupling locations;
- Granular filter pack;
- Seal;
- Grout;

- Cave-in;
- Centralizers;
- Height of riser;
- Protective casing detail;
- Water level 24 hours after completion with date and time of measurement;
- Quantity and composition of materials used; and
- Material between bottom of boring and bottom of screen.

Daily activities at the site related to monitoring well installation should be recorded in the field logbooks as described in SOPs 10.1 and 10.2.

3.4 GENERAL SEQUENCE OF MONITORING WELL COMPLETION

The following is a general sequence of monitoring well completion with reference to the specific details included in Section 3.3.

1. Completion of borehole;
2. Assembly and placement of well assembly as described in Section 3.3.5;
3. Placement of the appropriate filter pack(s) as discussed in Section 3.3.6;
4. Installation of an appropriate bentonite seal as discussed in Section 3.3.7;
5. Grouting the remaining annular space of the borehole as discussed in Section 3.3.8;
6. Set the protective casing for the well as discussed in Section 3.3.9;
7. Complete the protective concrete pad as discussed in Section 3.3.9; and
8. Install the protective posts as discussed in Section 3.3.9.

3.5 INVESTIGATION-DERIVED MATERIAL

Investigation-derived material will be managed in accordance with procedures defined in the work plan addenda for the site being investigated and SOP 70.1.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

Refer to the site-specific health and safety plan.

6.0 REFERENCES

ASTM Standard D 5092-90. 1990. *Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers.*

ASTM Standard D 5717-95. 1995. *Standard Guide for Design of Ground-Water Monitoring Systems in Karst and Fractured Rock Aquifers.*

USACE. 1998. *Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites.* EM 1110-1-4000, 1, November.

EXAMPLE WELL DEVELOPMENT FORM

WELL DESIGNATION:________________ DATE(S) OF INSTALLATION:____/____/____

SITE GEOLOGIST:____________________ DEVELOPMENT DATE(S):____/____/____

STATIC WATER LEVELS BEFORE AND AFTER DEVELOPMENT * :

BEFORE ____________ DATE ___________ 24 HR. AFTER __________ DATE___________

DEPTH TO SEDIMENT BEFORE AND AFTER DEVELOPMENT * :

BEFORE ____________ DATE ___________ 24 HR. AFTER __________ DATE___________

DEPTH TO WELL BOTTOM *: ________________ SCREEN LENGTH _____________

HEIGHT OF WELL CASING ABOVE GROUND SURFACE: __________________

QUANTITY OF MUD/WATER:

LOST DURING DRILLING	(+)__________________	gallons
REMOVED PRIOR TO WELL INSERTION	(-)__________________	gallons
LOST DURING THICK FLUID DISPLACEMENT	(+)__________________	gallons
ADDED DURING FILTER PACK PLACEMENT	(+)__________________	gallons
TOTAL LOSSES	__________________	gallons

(a) Water column ht. (ft.) ____________ (b) Well radius (in.)___________

(c) Screen length (ft.) ____________ (d) Borehole radius (in.)___________

(e) QUANTITY OF FLUID STANDING IN WELL
Install Equation Editor and double-click here to view equation. 1 _________ gallons
(Show Calculation)

(f) QUANTITY OF FLUID IN ANNULUS Install Equation Editor and double-click here to view equation. 1_________gallons
(Show Calculation)

DEVELOPMENT VOLUME = (5 * TOTAL LOSSES) + [5 * (e + f)] = ____________ gallons
(Show Calculation)

* ALL DEPTHS MEASURED FROM TOP OF WELL CASING

EXAMPLE WELL DEVELOPMENT RECORD

WELL DESIGNATION ____________ DATE(S) OF DEVELOPMENT: ____/____/____

TYPE AND SIZE OF PUMP:____

TYPE AND SIZE OF BAILER:____

DESCRIPTION OF SURGE TECHNIQUE:____

____

____

RECORD OF DEVELOPMENT

DATE & TIME	QUANTITY REMOVED	TIME REQ'D	pH	Cond	Temp	ORD	Turb	DO	Character of water (color/clarity/ odor/partic.)
(before)									
(during)									
(during)									
(during									
(after)									

TYPICAL PUMPING RATE_______ GAL./HR. EST. RECHARGE RATE____________________

TOTAL QUANTITY OF WATER REMOVED________ TIME REQUIRED_____________

REMARKS____

____

____

SIGNATURE OF SITE GEOLOGIST______________________________

Facility/Project Name	Local Grid Location of Well ____ m. ☐N. ☐S. ____ m. ☐E. ☐W.	Well Number
Facility License, Permit or Monitoring Number	Grid Origin Location Lat. ____ ____ ____ Long ____ ____ ____ or St. Plane ______ m. N. ______ m. E.	Date Well Installed (Start)
Type of Protective Cover: Above–Ground ☐ Flush–To–Ground ☐	Section Location of Waste/Source	Date Well Installed (Completed)
Well Distance From Waste/Source Boundary	____1/4 of ____1/4 of Sec. ____ T. ____ N.R. ____ ☐E. ☐W.	Well Installed By: (Person's Name & Firm) ______________
Maximum Depth of Frost Penetration (estimated)	Location of Well Relative to Waste/Source u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known	______________

Note: Use top of casing (TOC) for all depth measurments.

A. Protective casing, top elevation ________ m. MSL

B. Well casing, Top elevation ________ m. MSL

C. Land surface elevation ________ m. MSL

D. Surface seal, bottom ______ m. TOC or ______ m. MSL

16. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

17. Sieve analysis attached? ☐ Yes ☐ No

18. Drilling method used: Rotary ☐ Hollow Stem Auger ☐ ________ Other ☐

19. Drilling fluid used Water ☐ Air ☐ Drilling mud ☐ None ☐

20. Drilling additives used? ☐ Yes ☐ No
Describe ____________

21. Source of water (attach analysis):
____

E. Secondary filter, top ______ m. TOC or ______ m. MSL

F. Bentonite seal, top ______ m. TOC or ______ m. MSL

G. Secondary filter, top ______ m. TOC or ______ m. MSL

H. Primary filter, top ______ m. TOC or ______ m. MSL

I. Screen joint ______ m. TOC or ______ m. MSL

J. Well bottom ______ m. TOC or ______ m. MSL

K. Filter pack, bottom ______ m. TOC ____ m. MSL

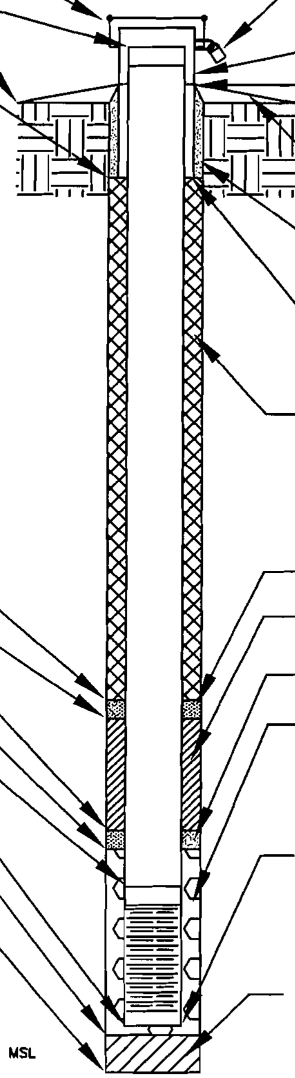
L. Borehole, bottom ____ m. TOC or ____ m. MSL

M. Borehole, diameter ________ mm.

N. O.D. well casing ________ mm.

O. I.D. well casing ________ mm.

P. 24–hr water level after completion ______ m. TOC or ______ m. MSL



1. Cap and Lock? ☐ Yes ☐ No

2. Protective posts? ☐ Yes ☐ No

3. Protective casing:
a. Inside diameter: ________ mm.
b. Length: ________ m.

4. Drainage port(s) ☐ Yes ☐ No

5. Surface seal: Gravel blanket ☐ Bentonite ☐ Concrete ☐ ________ Other ☐
a. Cap
b. Annular space seal: Bentonite ☐ Cement ☐ ________ Other ☐

6. Material between well casing and protective casing: Bentonite ☐ Cement ☐ ________ Other ☐

7. Annular space seal: A. Granular Bentonite ☐
b. ____ Lbs/gal mud weight........Bentonite–sand slurry ☐
c. ____ Lbs/gal mud weight................Bentonite slurry ☐
d. ____ x Bentonite................Bentonite–cement grout ☐
e. ________ m^3 volume added for any of the above
f. How installed: Tremie ☐ Tremie pumped ☐ Gravity ☐

8. Centralizers ☐ Yes ☐ No

9. Secondary Filter ☐ Yes ☐ No
a. Volume added ______ m^3 ________ Bags/Size

10. Bentonite seal: a. Bentonite granules ☐
b. 1/4in. 3/6in. 1/2in. Bentonite pellets ☐
c. ________ Other ☐

11 Secondary Filter ☐ Yes ☐ No
a. Volume added ______ m^3 ________ Bags/Size

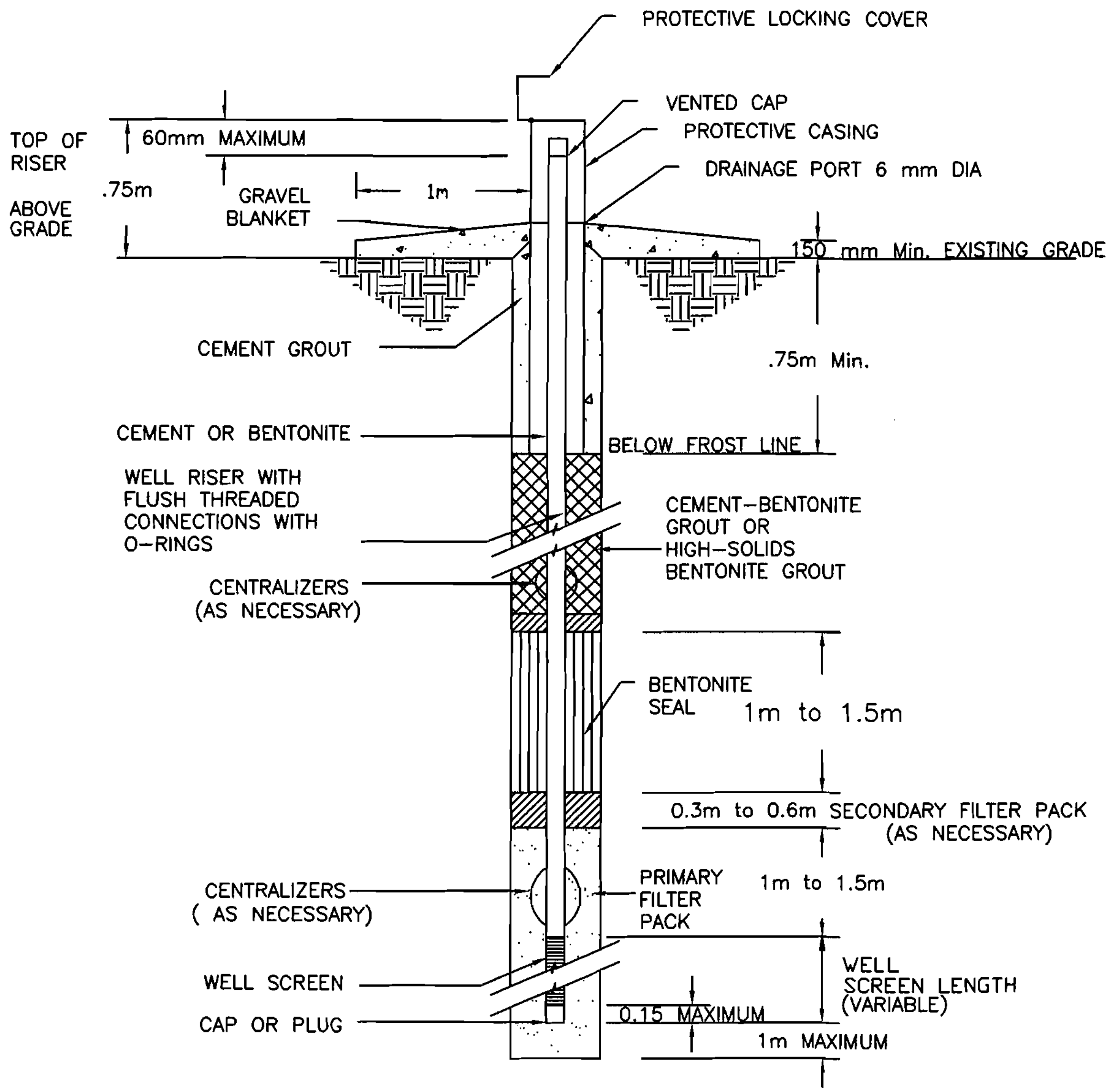
12. Filter pack material: Manufacturer, product name & mesh size
a.
b. Volume added ______ m^3 ________ Bags/Size

13. Well casing: Flush threaded PVC schedule 40 ☐ Flush threaded PVC schedule 80 ☐ ________ Other ☐

14. Screen material:
a. Screen type: Factory cut ☐ Continous slot ☐ ________ Other ☐
b. Manufacturer
c. Slot size: 0. ________ in.
d. Slotted length: ________ in.

15. Backfill material (below filter pack): None ☐ ________ Other ☐

RFAAP **MASTER WORK PLAN**	**FIGURE 20-1a**
Date: 06/27/01 **Prepared By:** URS Corp./TAC	**SCHEMATIC CONSTRUCTION DIAGRAM OF MONITORING WELL**
Scale: NO SCALE **File Name:** P:\...\Figure XXX.x..	



RFAAP MASTER WORK PLAN		FIGURE 20-1b
Date: 06/29/01	**Prepared By:** URS Corp./TAC	**SCHEMATIC CONSTRUCTION OF SINGLE-CASED WELL WITH GRAVEL BLANKET**
Scale: NO SCALE	**File Name:** P:\...\Figure 20-1b	

STANDARD OPERATING PROCEDURE 20.2
MONITORING WELL DEVELOPMENT

1.0 SCOPE AND APPLICATION

Well development is the process by which drilling fluids, solids, and other mobile particulates within the vicinity of the newly installed monitoring well are removed, while ensuring proper hydraulic connection to the aquifer. Development stabilizes the formation and filter pack sands around the well screen to ensure aquifer water moves freely to the well.

Well development will be initiated not less than 48 consecutive hours but no longer than 7 calendar days following grouting and/or placement of surface protection.

2.0 MATERIALS

- Work Plans;
- Well Development Form;
- Field Logbook;
- Boring Log and Well Completion Diagram for the well;
- Submersible pump, control box, associated equipment, etc;
- Photoionization detector or other appropriate monitoring instrument as specified in site-specific health and safety plan;
- Personal protective equipment and clothing (PPE) as specified in site-specific health and safety plan;
- Flow-through-cell and probes measuring specific conductance, pH, temperature, oxidation/reduction potential, dissolved oxygen, and turbidity;
- Decontamination supplies (SOP 80.1);
- Electric well level indicator and measuring tape;
- Appropriate containers for purged water and other investigation-derived material, as required; and
- Drilling tools for reverse-air circulation development, as appropriate.

3.0 PROCEDURE

3.1 SELECTING METHOD OF DEVELOPMENT

The type of subsurface conditions encountered should determine the method of well development used at a particular site at the Radford Army Ammunition Plant (RFAAP).

When monitoring wells are installed within overburden material, fractured bedrock or karst aquifers producing little sediment, a combination of mechanical surging and pumping (over pumping) or bailing is generally appropriate for well development. In general, over-pumping is the method of pumping the well at a rate higher than recharge occurs. Moving a tight-fitting surge block along the inside of the well screen to create a vacuum completes surging.

When monitoring wells are installed with solution features containing excessive amounts of sediment, reverse-circulation airlifting should be used as the initial step of development. Because reverse-circulation tools airlift methods avoid forcibly exposing the annular space to air, reverse-circulation tools can be run throughout the entire water column in the wells being developed.

After the excessive sediment has been removed by reverse-circulation airlifting, conventional pumping techniques may be used as appropriate to complete the well development.

3.2 DEVELOPMENT AND SAMPLING TIMING

Final development of monitoring wells should not be initiated any sooner than 48 hours after or more than 7 days beyond the final grouting of the well. Pre-development or preliminary development may be initiated before this 48-hour minimum period. Preliminary development may be conducted for open wells or for screened wells after installation of the well screen, casing, and filter pack but before installation of the annular seal. Pre-development is recommended when the natural formation will be used as a filter pack. Well development should be completed at least 14 days prior to sampling.

3.3 SUMMARY OF PROCEDURES

In general, the following procedure should be followed when developing a well using the pump and surge technique:

1. Prepare the work area outside the well by placing plastic sheeting on the ground to avoid cross-contamination.
2. Calibrate water quality meters (refer to SOP 40.1).
3. Determine the depth to water and total depth of well (refer to SOP 40.2).
4. Calculate the equivalent volume (EV) of water in well to be developed (refer to SOP 30.2).
5. Pump or bail the well to ensure that water flows into it and to remove some of the fine materials from the well. Removal of a minimum of one EV is recommended at this point. The rate of removal should be high enough to stress the well by lowering the water level to approximately one-half its original level.
6. Remove pump or bailer, slowly lower a close-fitting surge block into the well until it rests below the static water level but above the screened interval. (NOTE: The latter is not required in the case of an LNAPL well.)
7. Begin a gentle surging motion along top on-third length of the screen, which will allow any material blocking the screen to break up, go into suspension, and move into the well. Note that development should always begin above or at the top of the screen and move progressively downward to prevent the surge block from becoming sand locked in the well casing. Continue surging for 5-10 minutes, remove surge block, and pump or bail the well, rapidly removing at least one EV.
8. Repeat previous step at successively lower levels within the well screen, until the bottom of the well is reached. As development progresses, successive surging can be more vigorous and of longer duration as long as the amount of sediment in the screen is kept to a minimum.
9. Development should continue until the well development criteria listed in Section 3.1.3 have been achieved.

10. All water removed must be managed as directed by the site investigation plan.

3.3.1 Well Development Criteria

In general, well development should proceed until the following criteria are met:

1. At a minimum, removal of three EV of water from the well.
2. Removal of three times of the amount of fluid (mud and/or water) lost during drilling.
3. Removal of three times the fluid used for well installation.
4. The following indicator parameters should be stabilized as indicated by three successive readings within:
   - ± 0.2 for pH;
   - ±3% for specific conductance;
   - ±10 mV for oxidation/reduction potential;
   - ± 1 degree Celsius for temperature; and
   - ±10% for turbidity and dissolved oxygen (except for wells installed in karst aquifers).
5. Well water is clear to the unaided eye (except for wells installed in karst aquifers).
6. The sediment thickness remaining within the well is less than one percent of the screen length or less than 0.1 ft for screens equal to or less than 10 feet.
7. Site specific factors should be evaluated to determine appropriate well development criteria have been if:
   - Well recharge is so slow that the required volume of water cannot be removed during 48 consecutive hours of development;
   - Water discoloration persists after the required volumetric development; and
   - Excessive sediment remains after the required volumetric development.

3.4 WELL DEVELOPMENT RECORD

Record all data as required on a Well Development Record Form (see example), which becomes a part of the complete Well Record. These data include the following:

- Project name, location;
- Well designation, location;
- Date(s) and time(s) of well installation;
- Static water level from top of well casing before and 24 hours after development;
- Depths and dimensions of the well, the casing, and the screen, obtained from the Well Diagram;
- Water losses and uses during drilling, obtained from the boring log for the well;
- Water contained in the well, obtained from calculations using the depth of the water column and the well radius, plus the radius and height of the filter pack and an assumed 30% porosity;
- Measurements of the following indicator parameters: pH, conductivity, oxidation/reduction potential, temperature, and turbidity before and after development and once during each EV;

- Notes on characteristics of the development water;
- Data on the equipment and technique used for development; and
- Estimated recharge rate and rate/quantity of water removal during development.

Well development records shall be submitted to the COR after the development has been completed.

3.5 INVESTIGATION-DERIVED MATERIAL

Investigation-derived material will be managed in accordance with procedures defined in the work plan addendum for the site being investigated and SOP 70.1.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

Refer to the site-specific health and safety plan.

6.0 REFERENCES

Aller, Linda, et al. 1989. *Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells.* National Water Well Association.

EPA Groundwater Handbook. 1989.

Nielsen, David M. 1993. *Correct Well Design Improves Monitoring,* in "Environmental Protection," Vol. 4, No.7, July, 1993.

USACE. 1998. *Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites.* EM 1110-1-4000, 1 November.

ASTM Standard D 5092-90. 1990. *Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers.*

ASTM Standard D 5717-95. 1995. *Standard Guide for Design of Ground-Water Monitoring Systems in Karst and Fractured Rock Aquifers.*

EXAMPLE WELL DEVELOPMENT FORM

WELL DESIGNATION:________________ DATE(S) OF INSTALLATION:____/____/____

SITE GEOLOGIST:____________________ DEVELOPMENT DATE(S):____/____/____

STATIC WATER LEVELS BEFORE AND AFTER DEVELOPMENT :

BEFORE ____________ DATE __________ 24 HR. AFTER __________ DATE__________

DEPTH TO SEDIMENT BEFORE AND AFTER DEVELOPMENT * :

BEFORE ____________ DATE __________ 24 HR. AFTER __________ DATE__________

DEPTH TO WELL BOTTOM *: _______________ SCREEN LENGTH _____________

HEIGHT OF WELL CASING ABOVE GROUND SURFACE: __________________

QUANTITY OF MUD/WATER:

LOST DURING DRILLING	(+)__________________	gallons
REMOVED PRIOR TO WELL INSERTION	(-)__________________	gallons
LOST DURING THICK FLUID DISPLACEMENT	(+)__________________	gallons
ADDED DURING FILTER PACK PLACEMENT	(+)__________________	gallons
TOTAL LOSSES	__________________	gallons

(a) Water column ht. (ft.) ____________ (b) Well radius (in.)___________

(c) Screen length (ft.) ____________ (d) Borehole radius (in.)___________

(e) QUANTITY OF FLUID STANDING IN WELL

Install Equation Editor and double-click here to view equation. 1 ________ gallons
(Show Calculation)

(f) QUANTITY OF FLUID IN ANNULUS Install Equation Editor and double-click here to view equation. 1________gallons
(Show Calculation)

DEVELOPMENT VOLUME = (3 * TOTAL LOSSES) + [5 * (e + f)] = ____________ gallons
(Show Calculation)

* **ALL DEPTHS MEASURED FROM TOP OF WELL CASING**

EXAMPLE WELL DEVELOPMENT RECORD

WELL DESIGNATION ______________ DATE(S) OF DEVELOPMENT: _____/_____/_____

TYPE AND SIZE OF PUMP:______________________________

TYPE AND SIZE OF BAILER:______________________________

DESCRIPTION OF SURGE TECHNIQUE:______________________________

____

____

RECORD OF DEVELOPMENT

DATE & TIME	QUANTITY REMOVED	TIME REQ'D	pH	Cond	Temp	ORD	Turb	DO	Character of water (color/clarity/ odor/partic.)
(before)									
(during)									
(during)									
(during									
(after)									

TYPICAL PUMPING RATE________ GAL./HR. EST. RECHARGE RATE______________________

TOTAL QUANTITY OF WATER REMOVED_________ TIME REQUIRED_______________

REMARKS______________________________

____

____

SIGNATURE OF SITE GEOLOGIST______________________________

STANDARD OPERATING PROCEDURE 20.11
DRILLING METHODS AND PROCEDURES

1.0 SCOPE AND APPLICATION

The use of an appropriate drilling procedure is contingent upon the existing conditions at the project site. The purpose of this standard operating procedure (SOP) is to outline procedures for the various methods of soil and rock drilling identified in the Master Work Plan. In addition it provides procedures for using sampling devices commonly used during soil and rock drilling such as split-barrel sampling, thin walled tube sampling, direct push samplers, and rock coring. For a particular site investigation, the associated work plan addendum will identify the appropriate drilling method and method of sampling, along with proposed sampling depths and intervals and any special procedures or methods.

2.0 MATERIALS

The following types of materials are generally appropriate for drilling:

2.1 SPLIT-BARREL SAMPLING

- Split barrel sampler;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.2 THIN WALLED TUBE SAMPLING

- Thin walled tubes;
- Sealing materials for sample such as sealing wax, metal disks, wood disks, tape, cheesecloth, caps, etc;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.3 DIRECT PUSH SAMPLING

- Direct push unit with hydraulic ram, hammer, etc;
- Sample collection devices, associated equipment and expendable supplies such as sample liners, sample retainers, appropriate lubricants, etc;
- Hollow extension rods;
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;

- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.4 HOLLOW-STEM AUGER DRILLING

- Drill rig and associated equipment;
- Hollow stem auger assemblies for drilling to appropriate depth including auger heads, drive assembly, pilot assembly, and hollow-stem auger sections;
- Auxiliary devices such as wrenches, auger forks, hoisting hooks, swivels, and adaptors;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.5 DIRECT AIR ROTARY DRILLING

- Drill rig with rotary table and Kelly or top-head drive unit;
- Drill rods, bits, and core barrels (as appropriate);
- Casing;
- Sampling devices and equipment, as appropriate;
- Air compressor and filters, pressure lines, discharge hose, swivel, dust collector, and air-cleaning device (cyclone separator);
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.6 DRILL-THROUGH CASING DRIVER

- Drill rig equipped with a mast-mounted, percussion driver;
- Casing, drill rods, and drill bits or hammers;
- Air compressor and filters, pressure lines, discharge hose, swivel, dust collector, and air-cleaning device (cyclone separator);
- Sampling devices and equipment, as appropriate;
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;
- Welding equipment and materials for installation of casing;

- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.7 DIRECT WATER-BASED ROTARY DRILLING

- Drill rig with derrick, rotary table and Kelly or top-head drive unit;
- Drill rods, bits, and core barrels (as appropriate);
- Casing;
- Water based drilling fluid, with approved additives as appropriate;
- Mud tub, suction hose, cyclone de-sander(s), drilling fluid circulation pump, pressure hose, and swivel;
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1.
- Decontamination supplies and equipment per SOP 80.1.

2.8 DIRECT ROTARY WIRELINE-CASING ADVANCEMENT DRILLING

- Drill rig with either hollow spindle or top-head drive;
- Drill rods, coring or casing bits, overshot assembly, pilot bit, and core barrel;
- Water based drilling fluid, with approved additives as appropriate;
- Mud tub, suction hose, drilling fluid circulation pump, pressure hose, and swivel;
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.9 DIAMOND CORE DRILLING

- Direct rotary drill rig and associated equipment (see Sections 2.4, 2.5 or 2.6);
- Core barrels and core bits;
- Core lifters;
- Core boxes, engineers scale, permanent marking pen, and camera for photographing cores;
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;

- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

3.0 PROCEDURES

3.1 PENETRATION TEST AND SPLIT-BARREL SAMPLING OF SOILS

The following general procedure may be followed as outlined in ASTM Standard Test Method D 1586-84.

1. Advance the boring to the desired sampling depth using an appropriate drilling method (see sections below) and remove excessive cuttings from the borehole.
2. Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.
3. Position the hammer above and attach the anvil to the top of the drilling rods.
4. Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the borehole, remove the sampler and rods from borehole and remove the cuttings.
5. Mark the drill rods in three successive 6-inch increments so that the advance of the sampler can be observed.
6. Drive the sampler with blow from the 140 pound hammer and count the number of blows applied in each 6-inch increment until:
    a. Fifty (50) blows have been applied during one of the three 6-inch increments.
    b. A total of 100 blows have been applied.
    c. There is no observed advance of the sampler during the application of 10 successive blows of the hammer.
7. The sampler is advanced the complete 18-inches without the limiting blow counts occurring as described above.
8. Record the number of blows that is required to achieve each 6-inch increment of penetration or fraction of this increment on the boring.
    a. The first 6 inches is considered the seating driver.
    b. The sum of the second and third 6-inch penetration intervals is termed the "standard penetration resistance" or "N-value."
    c. If the sampler is driven less than 18 inches as discussed in No. 6, then the number of blow for each partial increment will be recorded.
    d. For partial increments, the depth of penetration should be recorded to the nearest 1-inch on the boring log.
    e. If the sampler advances below the bottom of the boring under the weight of rods (static) and/or hammer, then this information will be recorded on the boring log.
9. The raising and dropping of the 140 pound hammer may be accomplished by:
    a. Using a trip, automatic, or semi-automatic hammer drop system that lifts the hammer and allows it to drop 30± 1 inches.

b. Using a cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 inches. The cathead should be operated at a minimum speed of rotation of 100 revolutions per minute. No more than 2-1/4 rope turns on the cathead may be used when conducting the penetration test.

10. For each hammer blow, a 30-inch lift and drop shall be used.
11. After completing the penetration test, retrieve the sampler and open. Record the percent recovery or the length of sample recovered. Following the procedures outlined in SOP 30.1 when collecting environmental soil samples.
12. Borehole logging should be completed per SOP 10.3.
13. Split-barrel samples must be decontaminated before and after each use per the requirements of SOP 80.1.

3.2 THIN WALLED TUBE SAMPLING

The following general procedure may be followed for collection of relatively undisturbed, thin walled tube samples (e.g., Shelby tube) as outlined in ASTM Standard Practice D 1587-94.

1. Clean out the borehole to targeted sampling depth using most appropriate method, which avoids disturbing the material to be sampled. If groundwater is encountered, maintain the liquid level in the borehole at or above the groundwater level during sampling.
2. Place the sample tub so that its bottom rests on the bottom of the borehole.
3. Advance the sampler without rotation by a continuous relatively rapid motion.
4. Determine the length of the advance by the resistance and condition of the formation, the length of the advance should never exceed 5 to 10 diameters of the tube in sands and 10 to 15 diameters of the tube in clay.
5. When the formation is too hard for push type of sampling, the tube may be driven or the practice used for ring-lined barrel sampling may be used per ASTM Standard D 3550-84 (1995). When a sample is driven, the weight and fall of the hammer must be recorded along with the penetration achieved.
6. The maximum length of sample advance will be no longer than the sample-tube length minus an allowance for the sample head and a minimum of 3-inches for sludge-end cuttings.
7. Upon removal of the tube, measure the length of the sample in the tube. Remove the disturbed material in the upper end of the tube and re-measure the sample length.
8. Remove at least one-inch of material from the lower end of the tube for soil description and identification per SOP 10.3. Measure the overall sample length. Seal the lower end of the tube. If directed, the material from the end of the tube will not be removed for soil identification and description; in this case the tube will be sealed promptly.
9. Prepare sample labels and affix (or markings) on the tube.

3.3 DIRECT PUSH SOIL BORING

The following general procedures outlined in this section may be followed as described in ASTM Standard Test Method D 6282-98.

General considerations for this method include the following:

- A variety of direct push drive systems may be used to advance soil borings based on the intended sampling depths and subsurface conditions and include the following:

  Shallower Depths and Less Difficult Conditions

  - Percussive driving systems – use hydraulically operated hammers and mechanically operated hammers.
  - Static push drive systems – use hydraulic rams to apply pressure and exert static pull (e.g., cone penetrometer systems).
  - Vibratory/sonic systems – use a vibratory device, which is attached to the top of the sampler extension rods.

  Greater Depths and More Difficult Conditions

  - Sonic or resonance drilling systems – use a high power vibratory system to advance larger diameter single or dual tube systems.
  - Rotary drilling equipment – use hydraulic system of drill rig for direct push.

- The equipment used for direct push must be capable of apply sufficient static force, or dynamic force, or both, to advance the sampler to the required depth of collection. Additionally, this equipment must have adequate retraction force to remove the sampler and extension/drive rods once the sample has been collected.
- Avoid using excessive down pressure when advancing the drilling tools/sampler. Excessive pressure may cause the direct push unit to offset from the boring location and may damage drilling tools and samplers.
- Sample liners should be compatible with the material being sampled and the type of analysis to be conducted on the sample. Sealing of liners for submittal to the laboratory for physical testing should be accomplished according to ASTM Standard D 4220-95 (Standard Practice for Preserving and Transporting Soil Samples).
- The general procedure for completing direct push soil borings is the following:

1. Stabilize direct push unit and raise mast at desired location.
2. Attach the hammer assembly to the drill head if not permanently attached. Attach the anvil assembly in the prescribed manner, slide the direct push unit the position over the borehole, and ready the tools for insertion.
3. Inspect the direct push tools before and after use. Decontaminate all down hole tools before and after use per SOP 80.1.
4. Inspect drive shoes for damaged cutting edges, dents or thread failures and these conditions could cause loss of sample recovery and slow the rate of advancement.
5. Assemble samplers and install where required, install sample retainers where needed, and install and secure sampler pistons to ensure proper operation where needed (see Steps 14 through 20 for the various sampler assembly procedures, etc.).
6. After sampler has been appropriately installed (see Steps 14 through 20 for installation procedures, etc.) advance the boring to the target sampling depth using an appropriate direct push technique, as identified above under general considerations.
7. Collect the soil sample from the target sampling depth using one of the methods identified in Steps 14 through 20.

8. Retrieve the sampler and appropriately process the soil sample as identified in Steps 14 through 20 below and in SOP 30.1.
9. Log the borehole per the requirements of SOP 10.3.
10. If collecting another soil sample, decontaminate the sampler for reuse per the requirements of SOP 80.1 or use another decontaminated sampler.
11. Appropriately manage investigation-derived material (discarded samples, decontamination fluids, etc.) per SOP 70.1.
12. Upon completion of the boring and collection of the desired soil samples, abandon the boring per the requirements of SOP 20.2.
13. The following single tube sampling systems (generally piston rod) may be used to collect soil samples (see Steps 14 through 16 below):
    a. Open Solid Barrel Sampler;
    b. Closed Solid Barrel Sampler (e.g. Geoprobe Macro-Core® Piston Rod Sampler); and
    c. Standard Split Barrel Sampler (see Section 3.1).
14. The following two tube sampling systems may be used to collect soil samples (see Steps 17 through 20 below):
    a. Split Barrel Sampler;
    b. Thin Wall Tubes;
    c. Thin Wall Tube Piston Sampler; and
    d. Open Solid Barrel Samplers.
15. Sampling with the single tube, open solid barrel sampler:
    a. Attach the required liner to the cutting shoe by insertion into the machined receptacle are or by sliding over the machined tube.
    b. Insert the liner and shoe into the solid barrel and attach the shoe.
    c. Attach the sampler head to the sampler barrel.
    d. Attach the sampler assembly to the drive rod and the drive head to the drive rod.
    e. Position the sampler assembly under the hammer anvil and advance the sampler assembly into the soil at a steady rate slow enough to allow the soil to be cut by the shoe and move up into the sample barrel.
    f. At the completion of the sampling interval, removal the sampler from the borehole. Remove the filled sampler liner from the barrel by unscrewing the shoe. Cap the liner for laboratory testing or split open for field processing (see SOP 30.1).
    g. Log the borehole per the requirements of SOP 10.3.
16. Sampling with the closed, solid barrel sampler (e.g., Macro-Core® sampler).
    a. Insert or attach the sample liner to the shoe and insert the assembly into the solid barrel sampler. Install the sample, retaining basket, if desired.
    b. Attach the latch coupling or sampler head to the sampler barrel, and attach the piston assembly with point and "O" rings if free water is present, to the latching mechanism.
    c. Insert the piston or packer into the liner to its proper position so that the point leads the sampler shoe. Set latch, charge packer, or install locking pin, and attach assembled sampler to drive rod.
    d. Add drive head and position under the hammer anvil. Apply down pressure, and hammer if needed, to penetrate the soil strata above the targeted sampling interval.

e. When the sampling interval is reached, insert the piston latch release and recovery tool, removing the piston, or insert the locking pin removal/extension rods through the drive rods, turn counter clockwise, and remove the piston locking pin so the piston can float on top of the sample, or release any other piston holding device.

f. Direct push or activate the hammer to advance the sampler the desired interval.

g. Retrieve the sampler from the borehole by removing the extension/drive rods. Remove the shoe, and withdraw the sample line with sample for processing (see SOP 30.1).

h. Clean and decontaminate the sampler, reload as described above and repeat the same procedure for collection of addition samples.

i. Log the borehole per the requirements of SOP 10.3.

17. Sampling with standard split barrel (split spoon) sampler generally consists of the following:

a. Attach the split barrel sampler to an extension rod or drill rod.

b. Using a mechanical or hydraulic hammer drive the ampler into the soil the desired interval. The maximum interval that should be driven is equal to the sample chamber length of the split barrel sampler, which is either 18-inches or 24-inches.

c. Retrieve the sampler from the borehole by removing the extension/drive rods.

d. Split the sampler open for field processing (see SOP 30.1).

e. Clean and decontaminate the sampler (SOP 80.1), re-attach and repeat the same procedure for collection of additional samples.

f. Log the borehole per the requirements of SOP 10.3.

18. Sampling with a two tube, split barrel sampler generally consists of the following:

a. Assemble the outer casing with the drive shoe on the bottom, attach the drive head to the top of the outer casing, and attach the sampler to the extension rods.

b. Connect the drive head to the top of the sampler extension rods, and insert the sampler assembly into the outer casing.

c. The cutting shoe of the sampler should contact the soil ahead of the outer casing to minimize sample disturbance.

d. The sample barrel should extend a minimum of 0.25 inches ahead of the outer casing.

e. Mark the outer casing to identify the required drive length, position the outer casing and sampler assembly under the drill head.

f. Move the drill head downward to apply pressure on the tool string. Advance the casing assembly into the soil at a steady rate, which is slow enough to allow the soil to be cut by the shoe and move up inside the sample barrel.

g. Occasional hammer action during the push may assist recovery.

h. If smooth push advancement is not possible because of subsurface conditions, use the hammer to advance the sampler.

i. Stop the application of pressure or hammering when target interval has been sampled. Move the drill head off the drive head. Attach a pulling device to the extension rods or position the hammer bail and retrieve the sampler from the borehole.

j. At the surface, remove the sampler from the extension rods and process the sample per Section 3.01 and SOP 30.1.

k. Log the borehole per the requirements of SOP 10.3.

19. Sampling with a two tube, thin wall tube sampler generally consists of the following:
    a. Attach the tube to the tube head using removable screws.
    b. Attach the tube assembly to the extension rods and position at the base of the outer casing shoe protruding a minimum of 0.25 inches to contact the soil ahead of the outer casing.
    c. Advance the tube with or without the outer casing at a steady rate.
    d. After completing the sampling interval, let the tube remain stationary for one minute. Rotate the tube slowly two revolutions to shear off the sample.
    e. Remove the tube from the borehole and measure the recovery, and log the borehole per the requirements of SOP 10.3.
    f. For field processing, extrude the sample from the tube sampler and process per SOP 30.1. Alternatively, the tube may be sealed and shipped to the laboratory.
20. Sampling with two tube, thin wall tube, piston sampler generally consists of the following:
    a. Check the fixed piston sampling equipment for proper operation of the cone clamping assembly and the condition of the "O" rings.
    b. Slide the thin wall tube over the piston, and attach it to the tube head. Position the piston at the sharpened end of the thin wall tube just above the sample relief bend.
    c. Attach the tube assembly to the extension rods and lower the sampler into position through the outer casing. Install the actuator rods through the extension rod, and attach to the actuator rod in the sampler assembly.
    d. Attach a holding ring to the to top of the actuator rod string and hook the winch cable or other hook to the holding ring to hold the actuator rods in a fixed position.
    e. Attach the pushing fork to the drill head/probe hammer and slowly apply downward pressure to the extension rods advancing the thin wall tube over the fixed piston into the soil for the length of the sampling interval.
    f. After completing the sampling interval, let the tube remain stationary for one minute. Rotate the tube slowly one revolution to shear off the sample.
    g. Remove the tube sampler from the borehole and measure the recovery, and log the borehole per the requirements of SOP 10.3.
    h. For field processing, extrude the sample from the tube sampler and process per SOP 30.1.
21. Sampling with an two tube, open solid barrel sampler generally consists of the following:
    a. This sampling technique may be used when soil conditions prevent advancement of a split barrel sampler or advancement of an outer casing.
    b. The solid, single, or segmented barrel sampler requires the use of a liner.
    c. Use sampler in advance of outer casing when this casing cannot be advanced.
    d. Follow the procedures outlined for two tube, split barrel sampling.

3.4 HOLLOW-STEM AUGER DRILLING

The following general procedure may be followed as outlined in ASTM Standard Guide D 5784.

1. Stabilize drill rig and raise mast at desired location.
2. Attach an initial assembly of hollow-stem auger components (hollow stem auger, hollow auger head, center rod and pilot assembly, as appropriate) to the rotary drive of the drill rig.
3. Push the auger assembly below the ground surface and initiate rotation at a low velocity.

4. Decontamination of auger head may be necessary after this initial penetration if this surface soil is contaminated.
5. Continue drilling from the surface, usually at a rotary velocity of 50 to 100 rotations per minute to the depth where sampling or in-situ testing is required or until the drive assembly is within approximately 6- to 18 inches of the ground surface.
6. As appropriate, collect a soil sample from the required depth interval. The sample may be conducted by
   a. Removing the pilot assembly, if used, and inserting and driving a sampler through the hollow stem auger of the auger column; or
   b. Using a continuous sampling device within the lead auger section, where the sampler barrel fills with material as the auger is advanced.
7. Additional sections of hollow stems augers may be added to drill to a greater depth. After these auger sections are added, rotation of the hollow-stem auger assembly may be resumed.
8. When drilling through material suspected of being contaminated, the installation of single or multiple (nested) outer casings may be required to isolate zones suspected contamination (see SOP 20.1). Outer casings may be installed in a pre-drilled borehole or using a method in which casing is advanced at the same of drilling.

   Monitoring wells or piezometers may be installed using hollow-stem augers by:
   a. Drilling with or without sampling to the target depth.
   b. Removal of the pilot assembly, if used, and insertion of the monitoring well (or piezometer) assembly.
   c. The hollow stem auger column should be removed incrementally as the monitoring well (or piezometer) completion materials are placed (see SOP 20.1 for grouting).
9. If materials enter the bottom of the auger hollow stem during the removal of the pilot assembly, it should be removed with a drive sampler or other appropriate device.
10. If sampling or *in-situ* testing is not required during completion of the boring, the boring may be advanced with an expendable knock out plate or plug of an appropriate material instead of a pilot assembly.
11. Drill cuttings should be appropriately controlled and contained as IDM per SOP 70.1. It may be necessary to drill through a hole of sheet of plywood or similar material to prevent cuttings from contacting the ground surface.
12. The hollow-auger assembly and sampling devices must be decontaminated before and after each use per the methods specified in SOP 80.1.
13. Borehole logging should be completed per SOP 10.3.
14. Borehole abandonment, when required, should be conducted according to SOP 20.3.

3.5 DIRECT AIR ROTARY DRILLING

The following general procedure may be followed as outlined in ASTM Standard Guide D 5784-95.

1. Stabilize drill rig and raise mast at desired location. Appropriately position the cyclone separator and seal it to the ground surface considering the prevailing wind direction (exhaust).
2. Establish point for borehole measurements.
3. Attach an initial assembly of a bit, down hole hammer, or core barrel with a single section of drill rod, below the rotary table or top-head drive unit, with the bit placed below the top of the dust collector.
4. Activate the air compressor to circulate air through system.

5. Initiate rotation of bit.
6. Continue with air circulation and rotation of the drill-rod column to the depth where sampling or in-situ testing is required or until the length of the drill rod section limits further penetration.
7. Monitor air pressure during drilling operations. Maintain low air pressure at bit to prevent fracturing of surrounding material.
8. Stop rotation and lift the bit slightly off the bottom of the hole to facilitate removal of drill cuttings and continue air circulation until the drill cuttings are removed from the borehole annulus.
9. Open reaching a desired depth of sampling, stop the air circulation and rest bit on bottom of hole to determine the depth. Record the borehole depth and any resultant caving in. If borehole caving is apparent set a decontaminated casing to protect the boring.
10. When sampling, remove the drill rod column from the borehole or leave the drill rod assembly in place if the sampling can be performed through the hollow axis of the drill rods and bit.
11. Compare the sampling depth to clean-out depth by first resting the sampler on the bottom of the hole and compare that measurement with the clean-out depth measurement.
12. If bottom-hole contamination is apparent (indicated by comparison of sample depth to clean-out depth), it is recommended that the minimum depth below the sampler/bit be 18 inches for testing. Record the depth of sampling or in-situ testing and the depth below the sampler/bit.
13. The procedure described in Steps 8 through 12 should be conducted for each sampling or testing interval.
14. Drilling to a greater depth may be accomplished by attaching an additional drill rod section to the top of the previously advanced drill-rod column and resuming drilling operations as described above.
15. When drilling through material suspected of being contaminated, the installation of single or multiple (nested) outer casings may be required to isolate zones suspected contamination (see SOP 20.1 for grouting requirements). Outer casings may be installed in a pre-drilled borehole or using a method in which casing is advanced at the same of drilling.
16. Monitoring wells or piezometers may be installed by:
    a. Drilling with or without sampling to the target depth.
    b. Removal of the drill rod assembly and insertion of the monitoring well (or piezometer) assembly.
    c. Addition of monitoring well (or piezometer) completion materials (see SOP 20.1).
17. Drill cuttings should be appropriately controlled and contained as IDM per SOP 70.1.
18. The drill rod assembly, sampling devices, and other drilling equipment contacting potentially contaminated material must be decontaminated before and after each use per the methods specified in SOP 80.1.
19. Borehole logging should be completed per SOP 10.3.
20. Borehole abandonment, when required, should be conducted according to SOP 20.3

3.6 DRILL-THROUGH CASING DRILLING

The following general procedure may be followed as outlined in ASTM Standard Guide D 5872-95.

1. Stabilize drill rig and raise mast at desired location. Appropriately position the cyclone separator and seal it to the ground surface considering the prevailing wind direction (exhaust).
2. Establish point for borehole measurements.
3. Attach an initial assembly of a bit or down hole hammer with a single section of drill rod and casing to the top-head drive unit.

4. Activate the air compressor to circulate air through system.
5. Drilling may be accomplished by
    a. Method 1- the casing will fall, or can be pushed downward behind the bit.
    b. To drill using Drive the casing first followed by drilling out the plug inside the casing.
    c. Method 2 - Advancing the casing and bit as a unit, with the drill bit or hammer, extending up to 12-inches below the casing.
6. Method 3 - Under reaming method where bit or hammer pens a hole slightly larger than the casing so that Method 1, drive the casing first and drill out the plug in the casing by moving the bit or hammer beyond the casing and then withdrawing it into the casing. Air exiting the bit will remove the cuttings up the hole. Separate cuttings from the return air with a cyclone separator or similar device.
7. To drill using Method 2, advance casing and bit as unit with the bit or hammer extending up to 12-inches beyond the casing depending on the conditions. While drilling, occasionally stop the casing advancement, retract the bit or hammer inside the casing to clear and maintain air circulation to clear cuttings.
8. To drill using Method 3, use a special down hole bit or hammer to open a hole slightly larger than the outside diameter of the casing so that the casing will fall or can be pushed downward immediately behind the bit. After advancing the casing, retract the radial dimension of the drill bit to facilitate removal of the down hole bit or hammer and drill tools inside the casing. Cuttings are removed from the borehole with the air that operates the bit or hammer and can be separated from the air with a cyclone separator or similar device.
9. Monitor air pressure during drilling operations. Maintain low air pressure at bit or hammer to prevent fracturing of surrounding material.
10. Continue air circulation and rotation of the drill rod column until drilling is completed to the target depth (for sampling, in-situ sampling, etc.) or until the length of the drill-rod section limits further penetration.
11. Stop rotation and lift bit or hammer slightly off the bottom of the hole to facilitate removal of drill cuttings and continue air circulation until the drill cuttings are removed from the borehole annulus.
12. After reaching a desired depth of sampling, stop the air circulation and rest the bit on bottom of hole to determine the depth. Record the borehole depth and any resultant caving in. If borehole caving is apparent set a decontaminated casing to protect the boring.
13. When sampling, remove the drill rod column from the borehole. Compare the sampling depth to clean-out depth by first resting the sampler on the bottom of the hole and compare that measurement with the clean-out depth measurement.
14. If bottom-hole contamination is apparent (indicated by comparison of sample depth to clean-out depth), it is recommended that the minimum depth below the sampler/bit be 18 inches for testing. Record the depth of sampling or in-situ testing and the depth below the sampler/bit.
15. The procedure described in Steps 11 through 14 should be conducted for each sampling or testing interval.
16. Drilling to a greater depth may be accomplished by attaching an additional drill rod section and casing section to the top of the previously advanced drill-rod column/casing and resuming drilling operations as described above.
17. Monitoring wells or piezometers may be installed by:
    a. Casing advancement in increments, with or without sampling to the target depth.
    b. Removal of the drill rods and the attached drill bit while the casing is temporarily left in place to support the borehole wall.

c. Insertion of the monitoring well (or piezometer) assembly.

d. Addition of monitoring well (or piezometer) completion materials (see SOP 20.1).

18. Drill cuttings should be appropriately controlled and contained as IDM per SOP 70.1.

19. The drill rod assembly, casing, sampling devices, and other drilling equipment contacting potentially contaminated material must be decontaminated before and after each use per the methods specified in SOP 80.1.

20. Borehole logging should be completed per SOP 10.3.

21. Borehole abandonment, when required, should be conducted according to SOP 20.3.

3.7 DIRECT WATER-BASED ROTARY DRILLING

The following general procedure may be followed as outlined in ASTM Standard Guide D 5783-95.

1. Stabilize drill rig and raise mast at desired location. Appropriately position the mud tub and install surface casing and seal at the ground surface.
2. Establish point for borehole measurements.
3. Attach an initial assembly of a bit or core barrel with a single section of drill rod, below the rotary table or top-head drive unit, with the bit placed with the top of the surface casing.
4. Activate the drilling-fluid circulation pump to circulate drill fluid through the system.
5. Initiate rotation of bit and apply axial force to bit.
6. Document drilling conditions and sequence (fluid loss, circulation pressures, depths of lost circulation, etc.) as described in SOP 10.3.
7. Continue with drill fluid circulation as rotation and axial force are applied to the bit until drilling to the depth
    a) Where sampling or in-situ testing is required;
    b) Until the length of the drill rod section limits further penetration; or
    c) Until core specimen has completely entered the core barrel (when coring) or blockage has occurred.
8. Stop rotation and the lift bit slightly off the bottom of the hole to facilitate removal of drill cuttings and continue fluid circulation until the drill cuttings are removed from the borehole annulus.
9. After reaching a desired depth of sampling, stop the fluid circulation and rest the bit on bottom of hole to determine the depth. Record the borehole depth and any resultant caving in. If borehole caving is apparent set a decontaminated casing to protect the boring.
10. When sampling, drill rod removal is not necessary if the sampling can be performed through the hollow axis of the drill rods and bit.
11. Compare the sampling depth to clean-out depth by first resting the sampler on the bottom of the hole and compare that measurement with the clean-out depth measurement.
12. If bottom-hole contamination is apparent (indicated by comparison of sample depth to clean-out depth), it is recommended that the minimum depth below the sampler/bit be 18 inches for testing. Record the depth of sampling or in-situ testing and the depth below the sampler/bit.
13. The procedure described in Steps 8 through 11 should be conducted for each sampling or testing interval.
14. Drilling to a greater depth may be accomplished by attaching an additional drill rod section to the top of the previously advanced drill-rod column and resuming drilling operations as described above.

15. When drilling through material suspected of being contaminated, the installation of single or multiple (nested) outer casings may be required to isolate zones suspected contamination (see SOP 20.1 for grouting requirements). Outer casings may be installed in a pre-drilled borehole or using a method in which casing is advanced at the same of drilling.
16. Monitoring wells or piezometers may be installed using hollow-stem augers by:
    a. Drilling with or without sampling to the target depth.
    b. Removal of the drill rod assembly and insertion of the monitoring well (or piezometer) assembly.
    c. Addition of monitoring well (or piezometer) completion materials (see SOP 20.1).
17. Drill cuttings and fluids should be appropriately controlled and contained as IDM per SOP 70.1.
18. The drill rod assembly, sampling devices, and other drilling equipment contacting potentially contaminated material must be decontaminated before and after each use per the methods specified in SOP 80.1.
19. Borehole logging should be completed per SOP 10.3.
20. Borehole abandonment, when required, should be conducted according to SOP 20.3.

3.8 DIRECT ROTARY WIRELINE CASING ADVANCEMENT DRILLING

The following general procedure may be followed as outlined in ASTM Standard Guide D 5876-95.

1. Stabilize drill rig and raise mast at desired location. Appropriately position the mud tub (for water based rotary) and install surface casing and seal at the ground surface.
2. Record the hole depth by knowing the length of the rod-bit assemblies and comparing its position relative to the established surface datum.
3. Attach an initial assembly of a lead drill rod and a bit or core barrel below the top-head drive unit, with the bit placed with the top of the surface casing.
4. Activate the drilling-fluid circulation pump to circulate drill fluid through the system.
5. Initiate rotation of bit and apply axial force to bit.
6. Document drilling conditions and sequence (fluid loss, circulation pressures, depths of lost circulation, down feed pressures etc.) as described in SOP 10.3.
7. In general, the pilot bit or core barrel can be inserted or removed at any time during the drilling process and the large inside diameter rods can act as a temporary casing for testing or installation of monitoring devices.
8. Continue with drill fluid circulation as rotation and axial force are applied to the bit until drilling to the depth
    a) Where sampling or in-situ testing is required;
    b) Until the length of the drill rod section limits further penetration; or
    c) Until core specimen has completely entered the core barrel (when coring) or blockage has occurred.
9. Stop rotation and lift the bit slightly off the bottom of the hole to facilitate removal of drill cuttings and continue fluid circulation until the drill cuttings are removed from the borehole annulus.
10. After reaching a desired depth of sampling, stop the fluid circulation and rest the bit on bottom of hole to determine the depth. Record the borehole depth and any resultant caving in. If borehole caving is apparent set a decontaminated casing to protect the boring.

11. When sampling, drill rod removal is not necessary if the sampling can be performed through the hollow axis of the drill rods and bit.
12. Compare the sampling depth to clean-out depth by first resting the sampler on the bottom of the hole and compare that measurement with the clean-out depth measurement.
13. If bottom-hole contamination is apparent (indicated by comparison of sample depth to clean-out depth), it may be necessary to further clean the hole by rotary recirculation.
14. Continuous sampling may be conducted with a soil core barrel or rock core barrel (see Section 1.7).
15. The pilot bit or core barrel may need to be removed during drilling such as when core barrels are full or there is evidence of core blocking. Before the drill string is reinserted, the depth of the boring should be rechecked to evaluate hole quality and determine whether casing may be required.
16. Water testing may be performed in consolidated deposits by pulling back on the drill rods and passing inflatable packer(s) with pressure fitting to test the open borehole wall (see ASTM Standards D 4630 and D 4631).
17. Drilling to a greater depth may be accomplished by attaching an additional drill rod section to the top of the previously advanced drill-rod column and resuming drilling operations as described above.
18. When drilling through material suspected of being contaminated, the installation of single or multiple (nested) outer casings might be required to isolate zones suspected contamination (see SOP 20.1 for grouting requirements). Outer casings may be installed in a pre-drilled borehole or using a method in which casing is advanced at the same of drilling.
19. Monitoring wells or piezometers may be installed by:
    a. Drilling with or without sampling to the target depth.
    b. Removal of the pilot bit or core barrel and insertion of the monitoring well (or piezometer) assembly.
    c. Addition of monitoring well (or piezometer) completion materials (see SOP 20.1).
20. Drill cuttings and fluids should be appropriately controlled and contained as IDM per SOP 70.1.
21. The drill rod assembly, sampling devices, and other drilling equipment contacting potentially contaminated material must be decontaminated before and after each use per the methods specified in SOP 80.1.
22. Borehole logging should be completed per SOP 10.3.
23. Borehole abandonment, when required, should be conducted according to SOP 20.3.

3.9 DIAMOND CORE DRILLING

The following general procedure may be followed as outlined in ASTM Standard Practice D 2113-83 (1993).

1. Use core-drilling procedures, such as the water-rotary drilling method outlined in Section 3.6.
2. Seat the casing on bedrock or firm formation to prevent raveling of the borehole and to prevent loss of drilling fluid. Level the formation that the casing will be seated on as needed.
3. Begin core drilling using an N-size double-tube, swivel-type core barrel or other approved size or type. Continue core drilling until core blockage occurs or until the net length of the core has been drilled.
4. Remove the core barrel from the borehole, and dis-assemble the core barrel as necessary to remove the core.
5. Reassemble the core barrel and return it to hole.
6. Continue core drilling.

7. Place the recovered core in the core box with the upper (surface) end of the core at the upper-left corner of the core box. Wrap soft or friable cores, etc. as needed or required. Use spacer blocks or slugs properly marked to indicate any noticeable gap in recovered core that might indicate a change or void in the formation. Fit fracture, bedded, or jointed pieces of core together as they naturally occurred.
8. The core within each completed box should be photographed after core surface has been cleaned or peeled, as appropriate, and wetted. Each photo should be in sharp focus and contain a legible scale in feet and tenths of feet (or metric if appropriate). The core should be oriented so that the top of the core is at the top of the photograph. A color chart should be included in the photograph frame as a check on photographic accuracy. The inside lid of the box should also be shown.
9. The inside of the box lid should be labeled at a minimum with the facility name, project name, boring number, box number, and core interval.
10. A preliminary field log of the core must be completed before the core box has been packed for transport (see SOP 10.3). Detailed logging may be conducted at a later time providing the core is appropriately handled and transported.
11. Four levels of sample protection may be used depending on character of the rock and the intended use of the rock core including:
    a. *Routine care* – for rock cored in 5 to 10 foot runs. Consists of placing in structurally sound boxes. Lay flat tubing may be used prior to placing the core.
    b. *Special care* – for rock samples to be tested that are potentially moisture sensitive, such as shale. This care consists of sealing with a tight fitting wrapping of plastic film and application of wax at the ends of the sample.
    c. *Critical care* – for rock samples that may be sensitive to shock and vibration and/or temperature. Protect by encasing each sample in cushioning material, such as sawdust, rubber, polystyrene, foam, etc. A minimum one-inch thick layer of cushioning material should be used. Thermally insulate samples that are potentially sensitive to changes in temperature.
    d. *Soil-Like care* – handle per ASTM Standard D 4220-95.
12. Drilling conditions and sequence (fluid loss, circulation pressures, depths of lost circulation, down feed pressures, core blockage etc.) should be documented on the boring log as described in SOP 10.3.
13. Drill cuttings and fluids should be appropriately controlled and contained as investigation-derived material per SOP 70.1.
14. The drill rod assembly, sampling devices, and other drilling equipment contacting potentially contaminated material must be decontaminated before and after each use per the methods specified in SOP 80.1.
15. Borehole logging should be completed per SOP 10.3.
16. Borehole abandonment, when required, should be conducted according to SOP 20.3.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

Refer to site-specific health and safety plan included in work plan addenda.

6.0 REFERENCES

ASTM Standard D 2113-83 (1993). 1993. *Standard Practice for Diamond Core Drilling for Site Investigation.*

ASTM Standard D 1586-84 (1992). 1992. *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.*

ASTM Standard D 1587-94. 1994. *Standard Practice for Thin-Walled Tube Geotechnical Sampling of Soils.*

ASTM Standard D 4220-95. 1995. *Standard Practices for Preserving and Transporting Soil Samples.*

ASTM Standard D 5079-90. 1995. *Standard Practices for Preserving and Transporting Rock Core Samples.*

ASTM Standard D 5782-95. 1995. *Standard Guide for Use of Direct Air-Rotary Drilling for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices.*

ASTM Standard D 5783-95. 1995. *Standard Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices.*

ASTM Standard D 5784-95. 1995. *Standard Guide for Use of Hollow-Stem Augers for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices.*

ASTM Standard D 5872-95. 1995. *Standard Guide for Use of Casing Advancement Drilling Methods for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices.*

ASTM Standard D 5876-95. 1995. *Standard Guide for Use of Direct Rotary Wireline Casing Advancement Drilling Methods for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices.*

ASTM Standard D 6282-98. 1998. *Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations.*

USACE. 1998. *Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites.* EM 1110-1-4000. 1, November.

STANDARD OPERATING PROCEDURE 30.1
SOIL SAMPLING

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for sampling surface and subsurface soils.

2.0 MATERIALS

- Stainless steel scoop, spoon, trowel, knife, spatula, (as needed);
- Split-spoon, Shelby tube, or core barrel sampler;
- Hand auger or push tube sampler;
- Drill rig and associated equipment (subsurface soil);
- Stainless steel bowls;
- Photoionization detector or other appropriate instrument as specified in site-specific health and safety plan;
- Sampling equipment for collection of volatile organic samples;
- Appropriate sample containers;
- Appropriate sample labels and packaging material.;
- Personal protective equipment and clothing (PPE) per site-specific health and safety plan; and
- Decontamination equipment and supplies (SOP 80.1).

3.0 PROCEDURE

3.1 DOCUMENTATION

Soil sampling information should be recorded in the field logbooks as described in SOPs 10.1 and 10.2.

3.2 SURFICIAL SOIL SAMPLES

The targeted depths for surficial soil samples (surface and near surface) will be specified in the work plan addenda developed for site-specific investigations.

1. All monitoring equipment should be appropriately calibrated before beginning sampling according to the requirements of the work plan addenda and SOP 90.1 or 90.2.
2. All sampling equipment should be appropriately decontaminated before and after use according to the requirements of the work plan addendum and SOP 80.1.
3. Use a spade, shovel, or trowel or other equipment (manufactured from material, which is compatible with the soil to be sampled) to remove any overburden material present (including vegetative mat) to the level specified for sampling.
4. Measure and record the depth at which the sample will be collected with an engineers scale or tape.

5. Remove the thin layer that was in contact with the overburden removal equipment using a clean stainless steel scoop or equivalent and discard it.
6. Begin sampling with the acquisition of any discrete sample(s) for analysis of volatile organic compounds (VOCs), with as little disturbance as possible. VOC samples will not be composited or homogenized.
7. When a sample will not be collected with a core type of sampler (push tube, split spoon, etc.), the sample for VOC analysis will be collected from freshly exposed soil. The method of collection will follow the procedures specified in SOP 30.8 (Methanol Preservation Method) or 30.9 (En Core® Method) based on the requirements of the work plan addenda.
8. Field screen the sample with properly calibrated photoionization detector (PID) or other appropriate instrument. Cut a cross-sectional slice from the core or center of the sample and insert the monitoring instrument(s). Based on the screening results, collect the VOC fraction, as applicable.
9. Collect a suitable volume of sample from the targeted depth with a clean stainless steel scoop (or similar equipment), push tube sampler, or bucket auger
10. For core type of samplers, rough trimming of the sampling location surface should be considered if the sampling surface is not fresh or other waste, different soil strata, or vegetation may contaminate it. Surface layers can be removed using a clean stainless steel, spatula, scoop, or knife. Samples collected with a bucket auger or core type of sampler should be logged per the requirements of SOP 10.3.
11. If homogenization or compositing of the sampling location is not appropriate for the remaining parameters, the sample should be directly placed into appropriate sample containers with a stainless steel spoon or equivalent.
12. If homogenization of the sample location is appropriate or compositing of different locations is desired, transfer the sample to a stainless steel bowl for mixing. The sample should be thoroughly mixed with a clean stainless steel spoon, scoop, trowel, or spatula and then placed in appropriate sample containers per the requirements for containers and preservation specified in work plan addenda. Secure the cap of each container tightly.
13. Appropriately, label the samples (SOP 50.1), complete the chain-of-custody (SOP 10.4), and package the samples for shipping (SOP 50.2).
14. Return any remaining unused soil to the original sample location. If necessary, add clean sand to bring the subsampling areas back to original grade. Replace the vegetative mat over the disturbed areas.

3.3 SUBSURFACE SAMPLES

All sampling equipment should be appropriately decontaminated before and after use according to the requirements of the work plan addendum and SOP 80.1.

1. All monitoring equipment should be appropriately calibrated before sampling according to the requirement of the work plan addendum and SOP 90.1 or SOP 90.2.
2. All sampling equipment should be appropriately decontaminated before and after use according to the requirements of the work plan addendum and SOP 80.1.
3. Collect split-spoon; core barrel, Shelby tube, sonic core or other similar samples during drilling.
4. Upon opening sampler or extruding sample, immediately screen soil for VOCs using a PID or appropriate instrument. If sampling for VOCs, determine the area of highest concentration; use a

stainless steel knife, trowel, or lab spatula to cut the sample; and screen for VOCs with monitoring instrument(s).

5. Log the sample on the boring log before extracting from the sampler per the requirements of SOP 10.3.
6. Any required VOC samples will be collected first followed by the other parameters. VOC samples will not be composited or homogenized and will be collected from the area exhibiting the highest screening level. The method of VOC sample collection will follow the procedures specified in SOP 30.8 (Methanol Preservation Method) or 30.9 (En Core® Method) based on the requirements of the work plan addenda.
7. Field screen the sample with properly calibrated photoionization detector (PID) or other appropriate instrument. Cut a cross-sectional slice from the core or center of the sample and insert the monitoring instrument(s). Based on the screening results, collect the VOC fraction, as applicable.
8. Rough trimming of the sampling location surface should be considered if the sampling surface is not fresh or other waste, different soil strata, or vegetation may contaminate it. Surface layers can be removed using a clean stainless steel, spatula, scoop, or knife.
9. If homogenization or compositing of the sampling location is not appropriate for other parameters, the sample should be directly placed into appropriate sample containers with a stainless steel spoon or equivalent.
10. If homogenization of the sample location is appropriate or compositing of different locations is desired, transfer the sample to a stainless steel bowl for mixing. The sample should be thoroughly mixed with a clean stainless steel spoon, scoop, trowel, or spatula and placed in appropriate sample containers per the requirements for containers and preservation specified in work plan addenda. Secure the cap of each container tightly.
15. Appropriately, label the samples (SOP 50.1), complete the chain-of-custody (SOP 10.4), and package the samples for shipping (SOP 50.2).
16. Discard any remaining sample into the drums used for collection of cuttings.
17. Abandon borings according to procedures outlined in SOP 20.2.

3.4 INVESTIGATION-DERIVED MATERIAL

Investigation-derived material will be managed in accordance with procedures defined in the work plan addenda for the site being investigated and SOP 70.1.

NOTES: If sample recoveries are poor, it may be necessary to composite samples before placing them in jars. In this case, the procedure will be the same except that two split-spoon samples (or other types of samples) will be mixed together. The boring log should clearly state that the samples have been composited, which samples were composited, and why the compositing was done. In addition, VOC fraction should be collected from the first sampling device.

When specified, samples taken for geotechnical analysis (e.g., percent moisture, density, porosity, and grain size) will be undisturbed samples, such as those collected using a thin-walled (Shelby tube) sampler, sonic core sampler, etc.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

Refer to the site-specific health and safety plan.

Soil samples will not include vegetative matter, rocks, or pebbles unless the latter are part of the overall soil matrix.

6.0 REFERENCES

ASTM Standard D 1586-84. 1984. *Penetration Test and Split-Barrel Sampling of Soils.*

ASTM Standard D 1587-83. 1983. *Thin Walled Sampling of Soils.*

ASTM Standard D 5633-94. 1994. *Standard Practice for Sampling with a Scoop.*

USACE. 2001. *Requirements for the Preparation of Sampling and Analysis Plans.* EM 200-1-3. 1 February.

STANDARD OPERATING PROCEDURE 30.2
GROUNDWATER SAMPLING

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for the collection of groundwater samples from monitoring wells.

2.0 MATERIALS

- Work Plans;
- Field logbooks and field parameter forms;
- Plastic sheeting;
- Decontamination equipment and supplies (SOP 80.1);
- Variable-speed, low-flow submersible pump with safety drop cable;
- Nylon stay-ties;
- Generator;
- Dedicated Teflon tubing or Teflon lined polyethylene tubing;
- Flow-through-cell and probes for measuring pH, temperature, specific conductance, oxidation/reduction potential, dissolved oxygen, and turbidity (SOP 40.1);
- Electronic water-level indicator;
- Appropriate sample bottles, labels, chain-of-custody forms, and sample shipping supplies etc;
- Cooler with ice;
- Silicone tubing;
- 0.45-micron disposable filters (as appropriate).
- Personal protective equipment and clothing (PPE) per site-specific health and safety plan;
- Photoionization detector (PID) or other appropriate monitoring instrument per the site-specific health and safety plan; and
- Appropriate containers for investigation-derived material.

3.0 PROCEDURE

3.1 DOCUMENTATION

Groundwater sampling information should be recorded in the field logbooks as described in SOPs 10.1 and 10.2.

The following are general rules for the field parameter logbook for groundwater, as described in SOP 10.2:

- Only information for one site or installation per logbook. The same book maybe used for more than one sampling event.
- The first five pages will be reserved for index, general notes, etc. Sign and date each entry.
- Fill in the forms.
- Duplicate copies, index pages, and calibration sheets remain intact.

3.2 OVERVIEW OF SAMPLING TECHNIQUES

In general, two different techniques may be used to sample groundwater from monitoring wells at Radford Army Ammunition Plant (RFAAP):

- Low flow purging and sampling (Type I); and
- Conventional purging and low-flow sampling (Type II).

These two sampling techniques are intended to address the different groundwater conditions that may be encountered at RFAAP.

The Type I sampling technique will be used in the following situations:

- In wells where only one discrete water-producing zone is encountered;
- In wells with no discrete water bearing zone and a low yield (generally < 0.5 liters per minute); and
- In wells sampled during seasonal low groundwater conditions with greatly reduced yield.

The Type II sampling technique will be used in the following situations:

- In a well with potential or documented multiple flow zones and where individual flow zones will not be evaluated;
- In moderately producing wells (> 0.5 liters per minute) where no discrete flow zones were documented during drilling; and
- In wells sampled during seasonal high groundwater conditions with enhanced yield (and potentially additional flow zones).

Groundwater samples should be collected no sooner than 14 days after well development. Information from the boring logs, well completion records, and well development records should be reviewed before sampling a well to determine the most appropriate sampling technique. Pertinent information for each well to be sampled includes:

- Well construction;
- Depth and nature of water producing zones;
- Sustainable pumping rate of the well to be sampled;
- Well recharge characteristics; and
- Baseline turbidity.

Because of the heterogeneous nature of the fracture and solution-enhanced fractured bedrock at RFAAP, monitoring well purging and sampling techniques will need to be flexible. This flexibility is necessary to obtain representative samples that meet the data quality objectives (DQOs) specified in site-specific work plan addenda.

In general, when using the pumps specified in the following sections, situate any gasoline-powered generator on level ground approximately 15 ft downwind from the well. All generator maintenance (oil and fueling) is to be performed off site. If the hose(s) and/or power cord of the pump is not on a reel, place the pump with its hose and power cord on the plastic sheeting downhill from the well.

3.3 TYPE I SAMPLING PROCEDURES

Type I low flow purging and sampling procedures include the following:

- The work area outside the well will be prepared by placing plastic sheeting on the ground around the well casing to avoid cross-contamination.
- All equipment used to purge and sample the wells will be thoroughly decontaminated before and after use according to the requirements of the work plan addenda and SOP 80.1.
- All equipment to be used for monitoring water quality parameters will be calibrated before beginning purging according to the requirements of the work plan addenda and SOP 40.1.
- Note the condition of the well and well head.
- Monitor the headspace of the well with a photoionization detector as the well cap is removed.
- Measure and record the depth to water with an electronic water level indicator. The measurement of well depth will not be taken until after sampling is completed so that potential re-suspension of any settled solids at the bottom of the well is avoided.
- Well depth at the time of purging will be obtained from well construction and existing data.
- Slowly lower a clean, stainless steel, adjustable flow rate, submersible pump and dedicated Teflon or Teflon-lined polyethylene tubing to the desired depth. As the pump is slowly lowered into the well, secure the safety drop cable, tubing, and electrical lines to each other using nylon stay-ties.
- For wells with very low sustainable pumping rates (≤ 0.5 liters per minute), the pump should be set in the middle of the saturated screen section of the well or middle of the water column for open wells. The pump should be set 12 hours prior to purging so that the depth to water equilibrates and sediments disturbed during pump placement have time to settle.
- For wells with sustainable pumping rates (> 0.5 liters per minute), the pumps will be set at a desired depth prior to purging, allowing for the depth to water to equilibrate before sampling. The desired depth will be specified in work plan addenda based on site-specific conditions and DQOs.
- Connect the pump tubing to an in-line flow-through cell(s) and connect the multi-parameter probe to the cell(s). The end of the tubing exiting the in-line flow-through cell should be placed to discharge into a appropriate container(s) to collect purge water.
- Immediately prior to purging, the depth to water will be measured and record. Start pumping the water at a rate of 100 to 400 milliliters per minute. Avoid surging. The pumping rate should cause minimal drawdown (less than 0.2 ft). Water level measurements should be collected continuously to document stabilization of the water level. Pumping rates should, if needed, be reduced to the minimal capabilities of the pump to avoid dewatering the screen interval and ensure stabilization of indicator parameters.

- During purging, water quality indicator parameters will be monitored at the in-line flow-through cell(s) every 3 to 5 minutes. The parameters to be monitored include pH, specific conductance, oxidation/reduction potential (Eh), dissolved oxygen, and turbidity.
- Continue purging until stabilization of indicator parameters is achieved. Stabilization is defined as three consecutive readings that are within the following criteria:
  - ± 0.1 for pH;
  - ±3% for specific conductance;
  - ±10 mV for oxidation/reduction potential (Eh); and
  - ±10% for turbidity and dissolved oxygen.
- If the parameters have stabilized, but the turbidity is not in the range of 5 to 10 NTU, then both filtered and unfiltered samples should be collected for any metals analysis. Filter metal samples should be collected with an in-line filter using a high capacity 0.45-micron particulate filter. This filter should be pre-rinsed according to the manufacturer's instructions.
- Once purging is completed, reduce the pumping rate to its lowest steady rate and disconnect the tubing from the in-line flow-though cell(s).
- Collect groundwater samples directly from the end of the tubing into clean containers provided by the laboratory. The container requirements and preservatives for groundwater samples are specified in work plan addenda. Allowing the pump discharge to flow gently down the inside of the container with minimal turbulence should fill all sample containers. Volatile organic compound (VOC) and gas sensitive parameter samples should be collected first followed by other parameters.
- In general, samples should be collected and containerized in the order of the volatilization sensitivity of the parameters. A preferred collection order for some common parameters is VOCs, extractable organics, metals, cyanide, sulfate and chloride, turbidity, and nitrate and ammonia. The parameters to be collected at any well location are site-specific and are specified in work plan addenda.
- Appropriately, label the samples (SOP 50.1), complete the chain-of-custody (SOP 10.4), and package the samples for shipping (SOP 50.2).
- After the sample collection is complete, remove the pump, tubing, and associated lines. Note: sample tubing will be dedicated to each well.
- Measure and record the total depth of the well.
- Secure the well be replacing and locking the lid.

3.4 TYPE II SAMPLING PROCEDURES

- The work area outside the well will be prepared by placing plastic sheeting on the ground around the well casing to avoid cross-contamination.
- All equipment used to purge and sample the wells will be thoroughly decontaminated before and after use according to the requirements of the work plan addenda and SOP 80.1.
- All equipment to be used for monitoring water quality parameters will be calibrated before beginning purging according to the requirements of the work plan addenda and SOP 40.1.
- Note the condition of the well and well head.
- Monitor the headspace of the well with a photoionization detector as the well cap is removed.

- Measure and record the depth to water with an electronic water level indicator. The measurement of well depth will not be taken until after sampling is completed so that potential re-suspension of any settled solids at the bottom of the well is avoided.
- Well depth at the time of purging will be obtained from well construction and existing data.
- Calculate the standing water column in the well by subtracting the depth to water from the total depth of the well as recorded during completion of the well.
- From the water depth, well diameter, sand pack length, etc., calculate the equivalent volume (1 EV) of water in the well.

  1 EV = volume in casing + volume in saturated sand pack. Therefore; if the water table lies below the top of the sand pack, use the following equation:

  $1\ EV = (pR_w^2h_w) + (0.30p(R_s^2-R_w^2)h_w) * (0.0043)$

  If the water table lies above the top of the sand pack use this equation:

  $1\ EV = [(pR_w^2h_w) + (0.30p(R_s^2-R_w^2)h_s)] * (0.0043)$

  Where: R_s = radius of sand pack in inches
  R_w = radius of well casing in inches
  h_s = height of sand pack in inches
  h_w = water depth in inches

  0.0043 gal/in^3
  Assumed filter pack porosity = 30%

Tables and graphs showing equivalent volumes for typical well constructions are available.

- Slowly lower a clean, stainless steel, adjustable flow rate, submersible pump and dedicated Teflon or Teflon-lined polyethylene tubing to the middle of the saturated screen interval or water column in an open borehole. As the pump is slowly lowered into the well, secure the safety drop cable, tubing, and electrical lines to each other using nylon stay-ties.
- Connect the pump tubing to an in-line flow-through cell(s) and connect the multi-parameter probe to the cell(s). The end of the tubing exiting the in-line flow-through cell should be placed to discharge into an appropriate container to collect purge water.
- Start purging the well at the minimally achievable pumping rate. Gradually increase the pumping rate to achieve the maximum flow rate of the pump or the maximum sustainable flow rate that does not draw down the static water level to a point below the top of the first water bearing zone, whichever is achieved first.
- During purging, water level measurements should be collected periodically to verify water levels in the well.
- During purging, water quality indicator parameters will be monitored at the in-line flow-through cell(s) every 3 to 5 minutes. The parameters to be monitored include pH, specific conductance, oxidation/reduction potential (Eh), dissolved oxygen, and turbidity.
- Note when each indicator parameter stabilizes. Stabilization is defined as three consecutive readings that are within the following criteria:
  - ± 0.1 for pH;
  - ±3% for specific conductance;

STANDARD OPERATING PROCEDURE 50.1
SAMPLE LABELS

1.0 SCOPE AND APPLICATION

Every sample will have a sample label uniquely identifying the sampling point and analysis parameters. The purpose of this standard operating procedure (SOP) is to delineate protocols for the use of sample labels. An example label is included as Figure 50.1-A. Other formats with similar levels of detail are acceptable.

2.0 MATERIALS

- Sample label; and
- Indelible marker.

3.0 PROCEDURE

The use of preprinted sample labels is encouraged and should be requested from the analytical support laboratory during planning activities.
As each sample is collected, fill out a sample label ensuring the following information has been collected:

- Project name;
- Sample ID: enter the SWMU number and other pertinent information concerning where the sample was taken. This information should be included in site-specific work plan addenda;
- Date of sample collection;
- Time of sample collection;
- Initials of sampler(s);
- Analyses to be performed (NOTE: Due to number of analytes, details of analysis should be arranged with lab *a priori*); and
- Preservatives (water samples only).

Double-check the label information to make sure it is correct. Detach the label, remove the backing and apply the label to the sample container. Cover the label with clear tape, ensuring that the tape completely encircles the container.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

None.

6.0 REFERENCES

USEPA. 1998. *EPA Requirements for Quality Assurance Project Plans.* EPA/600/R-98/018, QA/R5, Final, Office of Research and Development, Washington, D.C.

FIGURE 50.1-A
SAMPLE LABEL

PROJECT NAME ____________________	
SAMPLE ID ____________________	
DATE: ___/___/___ TIME: ____:____	
ANALYTES:	VOC SVOC P/P METALS CN
	PAH D/F HERBs ANIONS TPH
	ALK TSS
PRESERVATIVE: [HCl] [HNO_3] [NaOH] [H_2SO_4]	
SAMPLER: ______________	

STANDARD OPERATING PROCEDURE 50.2
SAMPLE PACKAGING

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for the packing and shipping of samples to the laboratory for analysis.

2.0 MATERIALS

- Waterproof coolers (hard plastic or metal);
- Metal cans with friction-seal lids (e.g., paint cans);
- Chain-of-custody forms;
- Chain-of-custody seals (optional);
- Packing material;
- Sample documentation;
- Ice;
- Plastic garbage bags;
- Clear Tape;
- Zip-top plastic bags; and
- Temperature blanks provided by laboratory for each shipment.

3.0 PROCEDURE

1. Check cap tightness and verify that clear tape covers label and encircles container.
2. Wrap sample container in bubble wrap or closed cell foam sheets. Samples may be enclosed in a secondary container consisting of a clear zip-top plastic bag. Sample containers must be positioned upright and in such a manner that they will not touch during shipment.
3. Place several layers of bubble wrap, or at least 1 in. of vermiculite on the bottom of the cooler. Line cooler with open garbage bag, place all the samples upright inside the garbage bag and tie.
4. Double bag and seal loose ice to prevent melting ice from soaking the packing material. Place the ice outside the garbage bags containing the samples.
5. Pack shipping containers with packing material (closed-cell foam, vermiculite, or bubble wrap). Place this packing material around the sample bottles or metal cans to avoid breakage during shipment.
6. A temperature blank (provided by laboratory) will be included in each shipping container to monitor the internal temperature. Samples should be cooled to 4 degrees C on ice immediately after sampling.

7. Enclose all sample documentation (i.e., Field Parameter Forms, Chain-of-Custody forms) in a waterproof plastic bag and tape the bag to the underside of the cooler lid. If more than one cooler is being used, each cooler will have its own documentation. Add the total number of shipping containers included in each shipment on the chain-of-custody form.
8. Seal the coolers with signed and dated custody seals so that if the cooler were opened, the custody seal would be broken. Place clear tape over the custody seal to prevent damage to the seal.
9. Tape the cooler shut with packing tape over the hinges and place tape over the cooler drain.
10. Ship all samples via overnight delivery on the same day they are collected if possible.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

5.1 PERMISSIBLE PACKAGING MATERIALS

- Non-absorbent
  - Bubble wrap; and
  - Closed cell foam packing sheets.
- Absorbent
  - Vermiculite.

5.2 NON-PERMISSIBLE PACKAGING MATERIALS

- Paper;
- Wood shavings (excelsior); and
- Cornstarch "peanuts".

6.0 REFERENCES

USEPA. 1990. *Sampler's Guide to the Contract Laboratory Program.* EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, D.C., December 1990.

USEPA. 1991. *User's Guide to the Contract Laboratory Program.* EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response. January 1991.

USEPA. 1998. *EPA Requirements for Quality Assurance Project Plans.* EPA/600/R-98/018, QA/R5, Final, Office of Research and Development, Washington, D.C

STANDARD OPERATING PROCEDURE 70.1
INVESTIGATION-DERIVED MATERIAL

1.0 SCOPE AND APPLICATION

Management of investigation-derived material (IDM) minimizes the potential for the spread of waste material onsite or offsite through investigation activities. The purpose of this standard operating procedure (SOP) is to provide general guidelines for appropriate management of potentially contaminated materials derived from the field investigations. Specific procedures related to the transportation and disposal of hazardous waste are beyond the scope of this SOP.

2.0 INTRODUCTION

Investigation derived material (IDM) consists of waste materials that are known or suspected to be contaminated with waste substances through the actions of sample collection or personnel and equipment decontamination. These materials include decontamination solutions, disposable equipment, drill cuttings and fluids, and water from groundwater monitoring well development and purging. To the extent possible, the site manager will attempt to minimize the generation of these materials through careful design of decontamination schemes and groundwater sampling programs. Testing conducted on soil and water investigation-derived material will show if they are also hazardous wastes as defined by RCRA. This will determine the proper handling and ultimate disposal requirements.

The criteria for designating a substance as hazardous waste according to RCRA is provided in 40 CFR 261.3. If IDM meet these criteria, RCRA requirements will be followed for packaging, labeling, transporting, storing, and record keeping as described in 40 CFR 262.34. Those materials that are judged potentially to meet the criteria for a regulated solid or hazardous waste will be placed in DOT-approved 55-gallon steel drums or another type of DOT approved container; based on waste characteristics and volume.
Investigation-derived material will be appropriately placed in containers, labeled, and tested to determine disposal options in accordance with RCRA regulations and Virginia Hazardous Waste Management Regulations.

3.0 INVESTIGATION-DERIVED MATERIAL MANAGEMENT

Procedures that minimize potential for the spread of waste material include minimizing the volume of material generated, material segregation, appropriate storage, and disposal according to RCRA requirements.

3.1 WASTE MINIMIZATION

In the development of work plan addenda, each aspect of the investigation will be reviewed to identify areas where excess waste generation can be eliminated. General procedures that will eliminate waste include avoidance of unnecessary exposure of materials to hazardous material and coordination of sampling schedules to avoid repetitious purging of wells and use of sampling equipment.

3.2 WASTE SEGREGATION

Waste accumulation and management procedures to be used depend upon the type of material generated. For this reason, IDM described below are segregated into separate 55-gallon storage drums or other appropriate DOT containers. Waste materials that are known to be free of potential hazardous waste contamination (such as broken sample bottles or equipment containers and wrappings) must be collected separately for disposal to municipal systems. Large plastic garbage or "lawn and leaf" bags are useful for collecting this trash. Even "clean" sample bottles or Tyvek should be disposed of with care. Although they are not legally a problem, if they are discovered by the public they may cause concern. Therefore, items that are known to be free from contamination but are also known to represent "hazardous or toxic waste" to the public must not be disposed of in any public trash receptacle, such as found at your hotel or park.

3.2.1 Decontamination Solutions

Solutions considered investigation-derived materials range from detergents, organic solvents, and acids used to decontaminate small hand samplers to steam-cleaning rinsate used to wash drill rigs and other large equipment. These solutions are to be placed in 55-gallon drums with bolt-sealed lids or other appropriate DOT approved containers. Residual liquid IDM from decontamination pads will be removed and appropriately placed in container(s) at the end of each field day.

3.2.2 Soil Cuttings and Drilling Muds

Soil cuttings are solid to semi-solid soils generated during trenching activities or drilling for the collection of subsurface soil samples or the installation of monitoring wells. Depending on the type of drilling, drilling fluids known as "muds" may be used to remove soil cuttings. Drilling fluids flushed from the borehole must be directed into a settling section of a mud pit. This allows reuse of the decanted fluids after removal of the settled sediments. Drill cuttings, whether generated with or without drilling fluids, are to be removed with a flat-bottomed shovel and placed in 55-gallon drums with bolt-sealed lids or other appropriate DOT containers, as conditions or volume of IDM dictate.

3.2.3 Well Development and Purge Water

Well development and purge water is removed from monitoring wells to repair damage to the aquifer following well installation, obtain characteristic aquifer groundwater samples, or measure aquifer hydraulic properties. The volume of groundwater to be generated will determine the appropriate container to be used for accumulation of IDM.

For well development and purging, 55-gallon drums are typically an efficient container for accumulation. When larger volumes of water are removed from wells, such as when pumping tests are conducted, the use of large-volume portable tanks such as "Baker Tanks" should be considered for IDM accumulation.

Analytical data for groundwater samples associated with the well development and purge water will be used to assist in characterizing IDM and evaluating disposal options.

3.2.4 Personal Protective Equipment and Disposable Sampling Equipment

Personal protective equipment and clothing (PPE) may include such items as Tyvek coveralls, gloves, booties, and APR cartridges. Disposable sampling equipment may include such items as plastic sheeting, bailers, disposable filters, disposable tubing and paper towels. PPE and disposable sampling equipment that have or may have contacted contaminated media (soil, water, etc.) will be segregated and placed in 55-gallon drums separate from soil and water IDM. Disposition of this type of IDM will be determined by the results of IDM testing of the media in which the PPE and sampling equipment contacted.

3.3 MATERIAL ACCUMULATION

The IDM in containers must be placed in an appropriate designated RCRA container accumulation area at RFAAP, where it is permissible to accumulate such waste. IDM placed into a designated 90-day accumulation area will be properly sealed, labeled and covered. All drums will be placed on pallets.

A secure and controlled waste staging area will be designated by the installation prior the commencement of field sampling activities. Per the facility's requirements as a RCRA large quantity generator, waste accumulation cannot exceed 90 days for materials presumed or shown to be RCRA-designated hazardous wastes; waste which is known not to be RCRA-designated waste should be promptly disposed to municipal waste systems or appropriate facility.

3.3.1 IDM Accumulation Containers

Containers will be DOT-approved (DOT 17H 18/16GA OH unlined) open-head steel drums or other DOT approved container, as appropriate.

Container lids should lift completely off be secured by a bolt ring (for drum). Order enough containers to accumulate all streams of expected IDM including soil, PPE and disposable sampling equipment, decontamination water, purge water, etc.

Solid and liquid waste streams will not be mixed in a container. PPE and expendable sampling equipment will be segregated from other IDM and placed in different containers than soil. Containers inside containers are not permitted. PPE must be placed directly in a drum not in a plastic bag.

Pallets are often required to allow transport of filled drums to the staging area with a forklift. Normal pallets are 3×4 ft and will hold two to three 55-gallon drums depending on the filled weight. If pallets are required for drum transport or storage, field personnel are responsible for ensuring that the empty drums are placed on pallets before they are filled and that the lids are sealed on with the bolt-tighten ring after the drums are filled. Because the weight of one drum can exceed 500 lbs, under no circumstances should personnel attempt to move the drums by hand.

3.3.2 Container Labeling

Each container that is used to accumulate IDM will be appropriately labeled at the time of accumulation and assigned a unique identification number for tracking purposes. The following information will be written in permanent marker on a drum label affixed on the exterior side at a location at least two-thirds of the way up from the bottom of the drum.

- Facility name.
- Accumulation start date and completion date.
- Site identifier information (SWMU, boring, well, etc.).
- Description of IDM.
- Drum ID No.

4.0 MATERIAL CHARACTERIZATION AND DISPOSAL

IDM will be characterized and tested to determine whether it is a hazardous waste as defined by 40 CFR Part 261 and to determine what disposal options exist in accordance with RCRA regulations and the Virginia Hazardous Waste Management Regulations (VHWMR).

In general, IDM will be considered a hazardous waste if it contains a listed hazardous waste or if the IDM exhibits a characteristic of hazardous waste.

Work plan addenda will identify the appropriate characterization and testing program for IDM based on the following:

- Site-specific conditions related to chemicals of concern, etc.
- The nature and quantity of expected IDM to be generated during site-specific investigations.
- Applicable Federal, State, and local regulations, such as RCRA, VHWMR regulations and policies and procedures, and Army Regulation 200-1.
- RFAAP specific requirements and policies for IDM characterization and disposal at the time of the investigation.

In general, appropriate USEPA SW 846 Test Methods for Evaluating Solid Waste will be used for testing IDM and will be specified in work plan addenda. Other appropriate test methods may be specified by RFAAP in addition to SW 846 Methods that are specific to installation operations, the site of interest (percent explosive content, reactivity, etc.), or requirements for disposal at RFAAP water treatment facilities or publicly owned treatment works.

Responsibility for the final disposal of IDM will be determined before field activities are begun and will be described in work plan addenda. Off-site disposal of IDM will be coordinated with RFAAP (generator) to ensure appropriate disposition. The contractor will coordinate IDM transportation and disposal activities for RFAAP (generator).

At the direction of RFAAP, appropriate waste manifests will be prepared by the USACE contractor or Alliant Techsystems subcontractor for transportation and disposal. Alliant Techsystems or other appropriate RFAAP entity will be listed as the generator and an appointed representative from RFAAP will review and sign the manifest for offsite disposal.

RFAAP will make the final decision on the selection of the transporter, storage, and disposal facility (TSDFs) or recycling facility. RFAAP will provide the contractor a listing of previously used TSDFs for priority consideration. Proposed facilities that are not included on the listing are required to provide a copy of the TSDFs most recent state or federal inspection to the installation. Waste characterization and testing results will be submitted to RFAAP (generator) for review and approval before final disposition of the material.

Hazardous waste: Prior to final disposition, a hazardous waste manifest will be furnished by the TSDF to accompany transport to the disposal facility. Following final disposition, a certificate of disposal will be furnished by the disposal facility. Copies of the manifests and certificates of disposal are to be provided to RFAAP and retained on file by the contractor or subcontractor.

4.0 PRECAUTIONS

- Because the weight of one drum can exceed 500 lbs, under no circumstances should personnel attempt to move drums by hand.
- Refer to the site-specific health and safety plan when managing IDM.

5.0 REFERENCES

Safety Rules for Contractors and Subcontractors, 1995. Alliant Techsystems, Incorporated, Radford Army Ammunition Plant.

STANDARD OPERATING PROCEDURE 80.1
DECONTAMINATION

1.0 SCOPE AND APPLICATION

Before leaving the site, all personnel or equipment involved in intrusive sampling or having entered a hazardous waste site during intrusive sampling must be thoroughly decontaminated to prevent adverse health effects and minimize the spread of contamination. Equipment must be decontaminated between sites to preclude cross-contamination. Decontamination water will be free of contaminants as evidenced through either chemical analyses or certificates of analysis. This standard operating procedure (SOP) describes general decontamination requirements for site personnel and sampling equipment. Decontamination procedures for contaminants requiring a more stringent procedure, e.g., dioxins/furans, will be included in site-specific addenda.

2.0 MATERIALS

- Plastic sheeting, buckets or tubs, pressure sprayer, rinse bottles, and brushes;
- U.S. Army Corps of Engineers or installation approved decontamination water source;
- Deionized ultra-filtered, HPLC-grade organic free water (DIUF);
- Non-phosphate laboratory detergent;
- Nitric Acid, 0.1 Normal (N) solution;
- Pesticide-grade solvent, Methanol;
- Aluminum foil;
- Paper towels;
- Plastic garbage bags; and
- Appropriate containers for management of investigation-derived material (IDM).

3.0 PROCEDURE

3.1 SAMPLE BOTTLES

At the completion of each sampling activity the exterior surfaces of the sample bottles must be decontaminated as follows:

- Be sure that the bottle lids are on tight.
- Wipe the outside of the bottle with a paper towel to remove gross contamination.

3.2 PERSONNEL DECONTAMINATION

Review the site-specific health and safety plan for the appropriate decontamination procedures.

3.3 EQUIPMENT DECONTAMINATION

3.3.1 Drilling Rigs

Drilling rigs and associated equipment, such as augers, drill casing, rods, samplers, tools, recirculation tank, and water tank (inside and out), will be decontaminated before site entry, after over-the-road mobilization and immediately upon departure from a site after drilling a hole. Supplementary cleaning will be performed before site entry. There is a likelihood that contamination has accumulated on tires and as spatter or dust en route from one site to the next.

1. Place contaminated equipment in an enclosure designed to contain all decontamination residues (water, sludge, etc.).
2. Steam-clean equipment until all dirt, mud, grease, asphaltic, bituminous, or other encrusting coating materials (with the exception of manufacturer-applied paint) has been removed.
3. Water used will be taken from an approved source.
4. When cross-contamination from metals is a concern, rinse sampling components such as split spoons, geo-punch stems, and augers with nitric acid, 0.1N.
5. Rinse with DIUF water.
6. When semi-volatile and non-volatile organics may be present, rinse the sampling components with pesticide-grade solvent methanol.
7. Double rinse the sampling components with DIUF water.
8. Decontamination residues and fluids will be appropriately managed as IDM per work plan addenda and SOP 80.1.

3.3.2 Well Casing and Screen

Prior to use, well casing and screen materials will be decontaminated. This activity will be performed in the leak proof, decontamination pad, which will be constructed prior to commencement of the field investigation. The decontamination process will include:

- Steam cleaning with approved source water.
- Rinse with DUIF water.
- Air-dry on plastic sheeting.
- Wrap in plastic sheeting to prevent contamination during storage/transit.

3.3.3 Non Dedicated Submersible Pumps Used for Purging and Sampling

1. Scrub the exterior of the pump to remove gross (visible) contamination using appropriate brushes, approved water, and non-phosphate detergent (steam cleaning may be substituted for detergent scrub).
2. Pump an appropriate amount of laboratory detergent solution (minimum 10 gallons) to purge and clean the interior of the pump.
3. Rinse by pumping no less than 10 gallons of approved water to rinse.
4. Rinse the pump exterior with approved decontamination water.
5. When cross-contamination from metals is a concern, rinse the pump exterior with approved nitric acid 0.1N solution.
6. Rinse the pump exterior with DIUF water.

7. When semi-volatile and non-volatile organics may be present, rinse the pump exterior with pesticide-grade solvent methanol.
8. Double rinse the pump exterior with DIUF water.
9. Air-dry on aluminum foil or clean plastic sheeting.
10. Wrap pump in aluminum foil or clean plastic sheeting, or store in a clean, dedicated PVC or PTFE storage container.
11. Solutions and residuals generated from decontamination activities will be managed appropriately as IDM per work plan addenda and SOP 80.1.

3.3.4 Sample Equipment and Measuring Water Level Devices

1. Scrub the equipment to remove gross (visible) contamination using appropriate brush (es), approved water, and non-phosphate detergent.
2. Rinse with approved source water.
3. When cross-contamination from metals is a concern, rinse the sampling equipment with approved nitric acid 0.1N solution.
4. Rinse equipment with DIUF water.
5. When semi-volatile and non-volatile organics may be present, rinse the sampling equipment with pesticide-grade solvent methanol.
6. Double rinse the sampling equipment with DIUF water.
7. Air-dry on aluminum foil or clean plastic sheeting.
8. Wrap in aluminum foil, clean plastic sheeting, or zip top bag or store in a clean, dedicated PVC or PTFE storage container.
9. Solutions and residuals generated from decontamination activities will be managed appropriately as IDM per work plan addenda and SOP 80.1.

3.3.5 Other Sampling and Measurement Probes

Temperature, pH, conductivity, Redox, and dissolved oxygen probes will be decontaminated according to manufacturer's specifications. If no such specifications exist, remove gross contamination and triple-rinse probe with DIUF water.

4.0 PRECAUTIONS

- Manage IDM appropriately according to the requirements specified in work plan addenda.
- Follow appropriate procedures as specified in the site-specific health and safety plan.

5.0 REFERENCES

USACE. 2001. Requirements for the Preparation of Sampling and Analysis Plans. EM 200-1-3. 1 February.

STANDARD OPERATING PROCEDURE 90.1
PHOTOIONIZATION DETECTOR (HNu Model PI–101 and HW–101)

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for field operations with a photoionization detector (HNu Systems Model PI–101 or HW–101). The photoionization detector (PID) detects total ionizables; hence it is used to monitor both organic and inorganic vapors and gases to determine relative concentrations of air contaminants. This information is used to establish level of protection and other control measures such as action levels. The PID cannot effectively detect compounds having ionization potentials above the photon energy level of the lamp used; therefore, methane, which has an ionization potential of 12.98 eV, is undetectable by PIDs because the lamps produce 9.5, 10.2, or 11.7 eV.

Use of brand names in this SOP is in not intended as an endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc., are acceptable. If alternate equipment is to be used, the contractor shall provide applicable and comparable SOPs for its maintenance and calibration.

2.0 MATERIALS

- HNu Systems Model PI–101 or HW–101 survey probe with 9.5, 10.2, or 11.7 eV lamp;
- Lead-acid gel-cell battery;
- Calibration gas (e.g., isobutylene, 101 ppm) with regulator;
- Tygon tubing;
- Tedlar bag (optional);
- Instrument logbook; and
- Field logbook.

3.0 PROCEDURE

These procedures are to be followed when using the HNu in the field.

3.1 STARTUP

1. Before attaching the probe, check the function switch on the control panel to ensure that it is in the off position. Attach the probe by plugging it into the interface on the top of the readout module.
2. Turn the function switch to the battery check position. The needle on the meter should read within or above the green battery arc on the scale; if not, recharge the battery. If the red indicator light comes on, the battery needs recharging or service may be indicated.
3. Turn the function switch to any range setting. Listen for the hum of the fan motor. Check meter function by holding a solvent-based marker pen near the sample intake. If there is no needle deflection, look briefly into the end of the probe (no more than 1 or 2 sec) to see if the lamp is on; if it is on, it will give a purple glow. Do not stare into the probe any longer than 2 sec. Long-term exposure to UV light can damage the eyes. (See further information in Section 5.)

4. To zero the instrument, turn the function switch to the standby position and rotate the zero adjustment until the meter reads zero. A calibration gas is not needed since this is an electronic zero adjustment. If the span adjustment setting is changed after the zero is set, the zero should be rechecked and adjusted if necessary. Allow the instrument to warm up for 3–5 min to ensure that the zero reading is stable. If necessary, readjust the zero.

3.2 OPERATIONAL CHECK

Follow the startup procedure in Section 3.1.
With the instrument set on the 0–20 range, hold a solvent-based marker near the probe tip. If the meter deflects upscale, the instrument is working.

3.3 FIELD CALIBRATION PROCEDURE

1. Follow the startup procedures in Section 3.1 and the operational check in Section 3.2.
2. Set the function switch to the range setting for the concentration of the calibration gas.
3. Attach a regulator HNu P/N 101-351 or equivalent (flow = 200 to 300 ml/min) to a disposable cylinder of isobutylene (HNu 101-351 or equivalent). Connect the regulator to the probe of the HNu with a piece of clean Tygon tubing. Turn on the valve of the regulator.
4. After 5 sec, adjust the span dial until the meter reading equals the benzene concentration of the calibration gas used, corrected to its equivalence, which should be marked on the canister (Isobutylene ~0.7X benzene).
5. Record in the field log the instrument ID No., serial No., initial and final span settings, date, time, location, concentration and type of calibration gas used, and the signature of the person who calibrated the instrument.
6. If the HNu does not function or calibrate properly, the project equipment manager is to be notified as soon as possible. Under no circumstances is work requiring monitoring with a PI–101 or HW–101 to be done with a malfunctioning instrument.

3.4 CALIBRATION TO A GAS OTHER THAN ISOBUTYLENE

The HNu may be calibrated to any certified calibration gas. However, after calibration, all subsequent instrument readings will be relative to the calibration gas used. General procedures include the following:

1. Calibrate according to procedure 3.3.
2. Partially fill and flush one-to-two times a gas bag (Tedlar recommended) with the certified National Institute of Standards and Technology (NIST) (formerly NBS) traceable calibration gas. Then fill the bag with 1–3 L of the calibration gas. If the gas is toxic, this must be done in a fume hood.
3. Feed the calibration gas into the probe with the range set for the value of the gas. After 5 sec, adjust the span control until the meter reads the value of the calibration gas.
4. Record the results of the calibration on the calibration/maintenance log and attach a new calibration sticker (if available) or correct the existing sticker to reflect the new calibration data. All subsequent readings will be relative to the new calibration gas.

3.5 OPERATION

1. Follow the startup procedure, operational check, and calibration check (refer to Section 3.1).

2. Set the function switch to the appropriate range. If the concentration of gas vapors is unknown, set the function switch to 0-20 ppm range. Adjust if necessary.
3. Prevent exposing the HNu to excessive moisture, dirt, or contaminant while monitoring the work activity as specified in the Site Health and Safety Plan.
4. When the activity is completed, or at the end of the day, carefully clean the outside of the HNu with a damp disposable towel to remove all visible dirt. Return the HNu to a secure area and place on charge. Charge after each use; the lead acid batteries cannot be ruined by over charging.
5. With the exception of the probe's inlet and exhaust, the HNu can be wrapped in clear plastic to prevent it from becoming contaminated and to prevent water from getting inside in the event of precipitation. If the instrument becomes contaminated, make sure to take necessary steps to decontaminate it. Call the Equipment Administrator if necessary; under no circumstances should an instrument be returned from the field in a contaminated condition.

4.0 MAINTENANCE

Calibration/maintenance logs are to be filled in completely whenever a PI-101 or HW-101 receives servicing. This is true of both contractor-owned and rental instruments.

The equipment manager should be called to arrange for a fresh instrument when necessary. The contractor's equipment facility is responsible for arranging all repairs that cannot be performed by the project equipment manager.

4.1 ROUTINE SERVICE

The PID's performance is affected by a number of factors. These include but are not limited to the decay of the UV lamp output over time and the accumulation of dust and other particulate material and contaminates on the lamp and in the ion chamber. Because of these factors, the PID should not be left in the field for a period of more than 2 weeks before being replaced with a fresh instrument. If a site is going to be inactive for a period of more than a week, all monitoring instruments are to be returned to the project equipment manager or his trained designee for servicing and/or reassignment. The following procedures are to be performed at the designated intervals for routine service.

Procedure	Frequency
Operational check	Before use and at instrument return
Field calibration	Before use and at instrument return
Full calibration	Bi-weekly (return instrument to equipment manager for replacement with a fresh unit)
Clean UV lamp and	Bi-weekly or as needed ion chamber
Replace UV Lamp	As needed

4.1.1 UV Lamp and Ion Chamber Cleaning

During periods of analyzer operation, dust and other foreign materials are drawn into the probe forming deposits on the surface of the UV lamp and in the ion chamber. This condition is indicated by meter readings that are low, erratic, unstable, non-repeatable, or drifting and show apparent moisture sensitivity. These deposits interfere with the ionization process and cause erroneous readings. Check for this condition regularly to ensure that the HNu is functioning properly. If the instrument is malfunctioning, call your equipment manager to arrange to have a fresh replacement.

4.1.2 Lamp eV Change

If different applications for the analyzer would require different eV lamps, separate probes, each with its own eV lamp, must be used. A single readout assembly will serve for any of the probes (9.5, 10.2, and 11.7 eV). A change in probe will require resetting of the zero control and recalibrating the instrument. The 11.7 eV lamp will detect more compounds than either of the two lower eV lamps. However, the 11.7 eV probe needs more frequent calibration; it burns out much faster than the lower eV lamps.

5.0 PRECAUTIONS

- The HNu PI–101 and HW–101 are designed to sample air or vapors only. *Do not allow any liquids or low boiling vapors to get into the probe or meter assembly.*
- High concentrations of any gas can cause erroneous readings. High humidity can also cause the instrument readings to vary significantly from the actual concentration of gases or vapors present. This is true even through the HNu cannot react to water vapor.
- High humidity, dust, and exposure to concentrations of low boiling vapors will contaminate the ion chamber, causing a steady decrease in sensitivity.
- Continued exposure to ultraviolet light generated by the light source can be harmful to eyesight. If a visual check of the UV lamp is performed *do not look at the light source from a distance closer than 6 inches with unprotected eyes.* Use eye protection (UV-blocking sunglasses or safety glasses). Only look briefly—never more than about 2 sec.

  Place the instrument on charge after each use; the lead batteries cannot be ruined by over charging.
- If at any time the instrument does not check out or calibrate properly in the field, the equipment manager is to be notified immediately and a replacement obtained for the malfunctioning instrument. Under no circumstances should fieldwork requiring continuous air monitoring for organic vapors and/or gases be done with a malfunctioning Hnu or without a HNu or an approved comparable instrument.

6.0 REFERENCES

Manufacturer's Equipment Manual.

ATTACHMENT B

Laboratory QC Limits

6010-Solid

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
Aluminum	7429-90-5	REG	mg/kg	10	20	80	120	20
Zirconium	7440-67-7	REG	mg/kg	12.5	25	80	120	20
Arsenic	7440-38-2	REG	mg/kg	0.5	5	80	120	20
Barium	7440-39-3	REG	mg/kg	0.1	0.5	80	120	20
Beryllium	7440-41-7	REG	mg/kg	0.0125	0.5	80	120	20
Boron	7440-42-8	REG	mg/kg	2.5	5	80	120	20
Cadmium	7440-43-9	REG	mg/kg	0.05	0.5	80	120	20
Calcium	7440-70-2	REG	mg/kg	5	10	80	120	20
Chromium	7440-47-3	REG	mg/kg	0.125	1	80	120	20
Cobalt	7440-48-4	REG	mg/kg	0.125	1	80	120	20
Copper	7440-50-8	REG	mg/kg	0.5	1	80	120	20
Iron	7439-89-6	REG	mg/kg	1	3	80	120	20
Lead	7439-92-1	REG	mg/kg	0.5	5	80	120	20
Lithium	7439-93-2	REG	mg/kg	2.5	5	80	120	20
Magnesium	7439-95-4	REG	mg/kg	12	25	80	120	20
Manganese	7439-96-5	REG	mg/kg	0.1	0.5	80	120	20
Molybdenum	7439-98-7	REG	mg/kg	1.5	5	80	120	20
Nickel	7440-02-0	REG	mg/kg	0.5	2	80	120	20
Potassium	7440-09-7	REG	mg/kg	25	50	80	120	20
Selenium	7782-49-2	REG	mg/kg	0.5	5	80	120	20
Silver	7440-22-4	REG	mg/kg	0.25	2	80	120	20
Sodium	7440-23-5	REG	mg/kg	5	25	80	120	20
Strontium	7440-24-6	REG	mg/kg	0.25	0.5	80	120	20
Thallium	7440-28-0	REG	mg/kg	1	25	80	120	20
Tin	7440-31-5	REG	mg/kg	5	25	80	120	20
Titanium	7440-32-6	REG	mg/kg	0.5	2	80	120	20
Vanadium	7440-62-2	REG	mg/kg	0.25	0.5	80	120	20
Zinc	7440-66-6	REG	mg/kg	0.5	1	80	120	20
Phosphorus	7723-14-0	REG	mg/kg	25	50	80	120	20
Antimony	7440-36-0	REG	mg/kg	0.5	10	80	120	20

6010-Water

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
Calcium	7440-70-2	REG	mg/L	0.1	0.2	85	115	20
Vanadium	7440-62-2	REG	mg/L	0.005	0.01	85	115	20
Cobalt	7440-48-4	REG	mg/L	0.0025	0.02	85	115	20
Copper	7440-50-8	REG	mg/L	0.005	0.02	85	115	20
Iron	7439-89-6	REG	mg/L	0.025	0.1	85	115	20
Lead	7439-92-1	REG	mg/L	0.01	0.1	85	115	20
Lithium	7439-93-2	REG	mg/L	0.05	0.1	85	115	20
Magnesium	7439-95-4	REG	mg/L	0.25	0.5	85	115	20
Manganese	7439-96-5	REG	mg/L	0.005	0.01	85	115	20
Molybdenum	7439-98-7	REG	mg/L	0.005	0.1	85	115	20
Nickel	7440-02-0	REG	mg/L	0.005	0.04	85	115	20
Potassium	7440-09-7	REG	mg/L	0.25	1	85	115	20
Selenium	7782-49-2	REG	mg/L	0.04	0.08	85	115	20
Silicon	7440-21-3	REG	mg/L	0.25	1	85	115	20
Silver	7440-22-4	REG	mg/L	0.005	0.01	85	115	20
Sodium	7440-23-5	REG	mg/L	0.25	0.5	85	115	20
Strontium	7440-24-6	REG	mg/L	0.005	0.01	85	115	20
Thallium	7440-28-0	REG	mg/L	0.1	1	85	115	20
Zinc	7440-66-6	REG	mg/L	0.005	0.02	85	115	20
Aluminum	7429-90-5	REG	mg/L	0.05	0.1	85	115	20
Antimony	7440-36-0	REG	mg/L	0.05	0.2	85	115	20
Arsenic	7440-38-2	REG	mg/L	0.01	0.1	85	115	20
Barium	7440-39-3	REG	mg/L	0.0025	0.01	85	115	20
Beryllium	7440-41-7	REG	mg/L	0.0005	0.01	85	115	20
Boron	7440-42-8	REG	mg/L	0.05	0.1	85	115	20
Cadmium	7440-43-9	REG	mg/L	0.0025	0.01	85	115	20
Silica, Calculated as SiO2		REG	mg/L	0.25	1	85	115	20
Phosphorus	7723-14-0	REG	mg/L	0.5	1	85	115	20
Zirconium	7440-67-7	REG	mg/L	0.25	0.5	85	115	20
Tin	7440-31-5	REG	mg/L	0.05	0.5	85	115	20
Titanium	7440-32-6	REG	mg/L	0.005	0.03	85	115	20
Chromium	7440-47-3	REG	mg/L	0.0025	0.02	85	115	20

6020-Solid

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
Arsenic, Total	7440-38-2	REG	mg/kg	0.075	0.3	80	120	20
Uranium, Total	7440-61-1	REG	mg/kg	0.1	0.4	80	120	20
Antimony, Total	7440-36-0	REG	mg/kg	0.05	0.1	80	120	20
Selenium, Total	7782-49-2	REG	mg/kg	0.1	0.2	80	120	20
Thallium, Total	7440-28-0	REG	mg/kg	0.01	0.02	80	120	20
Silver, Total	7440-22-4	REG	mg/kg	0.05	0.2	80	120	20
Barium, Total	7440-39-3	REG	mg/kg	0.075	0.3	80	120	20
Cadmium, Total	7440-43-9	REG	mg/kg	0.025	0.1	80	120	20
Cobalt, Total	7440-48-4	REG	mg/kg	0.125	0.5	80	120	20
Chromium, Total	7440-47-3	REG	mg/kg	0.1	0.4	80	120	20
Copper, Total	7440-50-8	REG	mg/kg	0.15	0.6	80	120	20
Manganese, Total	7439-96-5	REG	mg/kg	0.05	0.2	80	120	20
Nickel, Total	7440-02-0	REG	mg/kg	0.2	0.8	80	120	20
Vanadium, Total	7440-62-2	REG	mg/kg	0.125	0.5	80	120	20
Zinc, Total	7440-66-6	REG	mg/kg	0.625	2.5	80	120	20
Lead, Total	7439-92-1	REG	mg/kg	0.1	0.2	80	120	20

6020-Water

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
Arsenic	7440-38-2	REG	mg/L	0.00025	0.001	80	120	20
Uranium	7440-61-1	REG	mg/L	0.00025	0.001	80	120	20
Selenium	7782-49-2	REG	mg/L	0.0005	0.001	80	120	20
Silver	7440-22-4	REG	mg/L	0.00025	0.001	80	120	20
Thallium	7440-28-0	REG	mg/L	0.00005	0.0002	80	120	20
Barium	7440-39-3	REG	mg/L	0.0005	0.003	80	120	20
Cadmium	7440-43-9	REG	mg/L	0.000125	0.0005	80	120	20
Cobalt	7440-48-4	REG	mg/L	0.00025	0.001	80	120	20
Chromium	7440-47-3	REG	mg/L	0.0005	0.002	80	120	20
Copper	7440-50-8	REG	mg/L	0.0005	0.002	80	120	20
Manganese	7439-96-5	REG	mg/L	0.0005	0.002	80	120	20
Nickel	7440-02-0	REG	mg/L	0.001	0.004	80	120	20
Vanadium	7440-62-2	REG	mg/L	0.00025	0.001	80	120	20
Zinc	7440-66-6	REG	mg/L	0.005	0.025	80	120	20
Antimony	7440-36-0	REG	mg/L	0.00025	0.001	80	120	20
Lead	7439-92-1	REG	mg/L	0.00025	0.001	80	120	20

Microbac Laboratories Inc.
List Definitions Report

AUGUST 23, 2010 12:08

List Type: 6850
List Function: ALL
List Matrix Class: WATER
List Join ID: LJ56434
Methodref: 6850
PKey: STD Description: STD

Compound	CAS #	Parm Type	Units	MDL	RL	QCKEY	L_LCS	U_LCS
Perchlorate	14797-73-0	REG	ug/L	.1	.2	STD	80	120
O18LP		STD	ug/L			STD	0	0

Microbac Laboratories Inc.
List Definitions Report

AUGUST 27, 2010 13:24

List Type: 8081
List Function: ALL
List Matrix Class: SOLID
List Join ID: LJ65199
Methodref: 8081
PKey: 2415.034 Description:

Compound	CAS #	Parm Type	Units	MDL	RL	QCKEY	L_LCS	U_LCS
4,4'-DDD	72-54-8	REG	ug/kg	.33	1.65	DOD4	30	135
4,4'-DDE	72-55-9	REG	ug/kg	.33	1.65	DOD4	70	125
4,4'-DDT	50-29-3	REG	ug/kg	.33	1.65	DOD4	45	140
Aldrin	309-00-2	REG	ug/kg	.33	1.65	DOD4	45	140
alpha Chlordane	5103-71-9	REG	ug/kg	.33	1.65	DOD4	65	120
alpha-BHC	319-84-6	REG	ug/kg	.33	1.65	DOD4	60	125
beta-BHC	319-85-7	REG	ug/kg	.33	1.65	DOD4	60	125
delta-BHC	319-86-8	REG	ug/kg	.33	1.65	DOD4	55	130
Dieldrin	60-57-1	REG	ug/kg	.33	1.65	DOD4	65	125
Endosulfan I	959-98-8	REG	ug/kg	.33	1.65	DOD4	15	135
Endosulfan II	33213-65-9	REG	ug/kg	.33	1.65	DOD4	35	140
Endosulfan sulfate	1031-07-8	REG	ug/kg	.33	1.65	DOD4	60	135
Endrin	72-20-8	REG	ug/kg	.33	1.65	DOD4	60	135
Endrin aldehyde	7421-93-4	REG	ug/kg	.33	1.65	DOD4	35	145
Endrin ketone	53494-70-5	REG	ug/kg	.33	1.65	DOD4	65	135
gamma Chlordane	5103-74-2	REG	ug/kg	.33	1.65	DOD4	65	125
gamma-BHC (Lindane)	58-89-9	REG	ug/kg	.33	1.65	DOD4	60	125
Heptachlor	76-44-8	REG	ug/kg	.33	1.65	DOD4	50	140
Heptachlor epoxide	1024-57-3	REG	ug/kg	.33	1.65	DOD4	65	130
Methoxychlor	72-43-5	REG	ug/kg	.33	1.65	DOD4	55	145
Toxaphene	8001-35-2	REG	ug/kg	16.7	33	DOD4	25	138
2,4,5,6-Tetrachloro-m-xylene	877-09-8	SURR	% Recovery			DOD4	70	125
Decachlorobiphenyl	2051-24-3	SURR	% Recovery			DOD4	55	130

Microbac Laboratories Inc.
List Definitions Report

AUGUST 27, 2010 13:25

List Type: 8081
List Function: ALL
List Matrix Class: WATER
List Join ID: LJ65200
Methodref: 8081
PKey: 2415.034 Description:

Compound	CAS #	Parm Type	Units	MDL	RL	QCKEY	L_LCS	U_LCS
4,4'-DDD	72-54-8	REG	ug/L	.01	.05	DOD4	25	150
4,4'-DDE	72-55-9	REG	ug/L	.01	.05	DOD4	35	140
4,4'-DDT	50-29-3	REG	ug/L	.01	.05	DOD4	45	140
Aldrin	309-00-2	REG	ug/L	.01	.05	DOD4	25	140
alpha Chlordane	5103-71-9	REG	ug/L	.01	.05	DOD4	65	125
alpha-BHC	319-84-6	REG	ug/L	.01	.05	DOD4	60	130
beta-BHC	319-85-7	REG	ug/L	.01	.05	DOD4	65	125
delta-BHC	319-86-8	REG	ug/L	.01	.05	DOD4	45	135
Dieldrin	60-57-1	REG	ug/L	.01	.05	DOD4	60	130
Endosulfan I	959-98-8	REG	ug/L	.01	.05	DOD4	50	110
Endosulfan II	33213-65-9	REG	ug/L	.01	.05	DOD4	30	130
Endosulfan sulfate	1031-07-8	REG	ug/L	.01	.05	DOD4	55	135
Endrin	72-20-8	REG	ug/L	.01	.05	DOD4	55	135
Endrin aldehyde	7421-93-4	REG	ug/L	.01	.05	DOD4	55	135
Endrin ketone	53494-70-5	REG	ug/L	.01	.05	DOD4	75	125
gamma Chlordane	5103-74-2	REG	ug/L	.01	.05	DOD4	60	125
gamma-BHC (Lindane)	58-89-9	REG	ug/L	.01	.05	DOD4	25	135
Heptachlor	76-44-8	REG	ug/L	.01	.05	DOD4	40	130
Heptachlor epoxide	1024-57-3	REG	ug/L	.01	.05	DOD4	60	130
Methoxychlor	72-43-5	REG	ug/L	.01	.05	DOD4	55	150
Toxaphene	8001-35-2	REG	ug/L	.3	1	DOD4	41	126
2,4,5,6-Tetrachloro-m-xylene	877-09-8	SURR	% Recovery			DOD4	25	140
Decachlorobiphenyl	2051-24-3	SURR	% Recovery			DOD4	30	135

Microbac

Compound	CAS Number	Parm Type	Units	LOD	LOQ	LCL	UCL	RPD
4,4'-DDD	72-54-8	REG	ug/L	0.01	0.05	25	150	30
Methoxychlor	72-43-5	REG	ug/L	0.01	0.05	55	150	30
Toxaphene	8001-35-2	REG	ug/L	0.3	1	41	126	30
4,4'-DDE	72-55-9	REG	ug/L	0.01	0.05	35	140	30
4,4'-DDT	50-29-3	REG	ug/L	0.01	0.05	45	140	30
Aldrin	309-00-2	REG	ug/L	0.01	0.05	25	140	30
alpha-BHC	319-84-6	REG	ug/L	0.01	0.05	60	130	30
alpha Chlordane	5103-71-9	REG	ug/L	0.01	0.05	65	125	30
beta-BHC	319-85-7	REG	ug/L	0.01	0.05	65	125	30
delta-BHC	319-86-8	REG	ug/L	0.01	0.05	45	135	30
Dieldrin	60-57-1	REG	ug/L	0.01	0.05	60	130	30
Endosulfan I	959-98-8	REG	ug/L	0.01	0.05	50	110	30
Endosulfan II	33213-65-9	REG	ug/L	0.01	0.05	30	130	30
Endosulfan sulfate	1031-07-8	REG	ug/L	0.01	0.05	55	135	30
Endrin	72-20-8	REG	ug/L	0.01	0.05	55	135	30
Endrin aldehyde	7421-93-4	REG	ug/L	0.01	0.05	55	135	30
Endrin ketone	53494-70-5	REG	ug/L	0.01	0.05	75	125	30
gamma-BHC (Lindane)	58-89-9	REG	ug/L	0.01	0.05	25	135	30
gamma Chlordane	5103-74-2	REG	ug/L	0.01	0.05	60	125	30
Heptachlor	76-44-8	REG	ug/L	0.01	0.05	40	130	30
Heptachlor epoxide	1024-57-3	REG	ug/L	0.01	0.05	60	130	30
Decachlorobiphenyl	2051-24-3	SURR	% Recovery			30	135	
2,4,5,6-Tetrachloro-m-xylene	877-09-8	SURR	% Recovery			25	140	

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
Aroclor-1254	11097-69-1	REG	ug/kg	8.3	16.5	60	130	40
Aroclor-1260	11096-82-5	REG	ug/kg	8.3	16.5	60	130	40
Aroclor-1016	12674-11-2	REG	ug/kg	8.3	16.5	40	140	40
Aroclor-1242	53469-21-9	REG	ug/kg	8.3	16.5	64	136	40
Aroclor-1248	12672-29-6	REG	ug/kg	8.3	16.5	64	136	40
Aroclor-1221	11104-28-2	REG	ug/kg	8.3	16.5	64	136	40
Aroclor-1232	11141-16-5	REG	ug/kg	8.3	16.5	64	136	40
2,4,5,6-Tetrachloro-m-Xylene	877-09-8	SURR	% Recovery			29	133	
Decachlorobiphenyl	2051-24-3	SURR	% Recovery			30	173	

8082-Solid

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
Aroclor-1254	11097-69-1	REG	ug/kg	8.25	16.5	60	130	40
Aroclor-1260	11096-82-5	REG	ug/kg	8.25	16.5	60	130	40
Aroclor-1016	12674-11-2	REG	ug/kg	8.25	16.5	40	140	40
Aroclor-1242	53469-21-9	REG	ug/kg	8.25	16.5	64	136	40
Aroclor-1248	12672-29-6	REG	ug/kg	8.25	16.5	64	136	40
Aroclor-1221	11104-28-2	REG	ug/kg	8.25	16.5	64	136	40
Aroclor-1232	11141-16-5	REG	ug/kg	8.25	16.5	64	136	40
2,4,5,6-Tetrachloro-m-Xylene	877-09-8	SURR	% Recovery			29	133	
Decachlorobiphenyl	2051-24-3	SURR	% Recovery			30	173	

8082-Water

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
Aroclor-1242	53469-21-9	REG	ug/L	0.25	0.5	32	137	40
Aroclor-1260	11096-82-5	REG	ug/L	0.25	0.5	40	140	40
Aroclor-1016	12674-11-2	REG	ug/L	0.25	0.5	40	140	40
Aroclor-1221	11104-28-2	REG	ug/L	0.25	0.5	32	137	40
Aroclor-1232	11141-16-5	REG	ug/L	0.25	0.5	32	137	40
Aroclor-1248	12672-29-6	REG	ug/L	0.25	0.5	32	137	40
Aroclor-1254	11097-69-1	REG	ug/L	0.25	0.5	60	130	30
Decachlorobiphenyl	2051-24-3	SURR	% Recovery			36	144	
2,4,5,6-Tetrachloro-m-xylene	877-09-8	SURR	% Recovery			30	132	

8260-Solid

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
1,1,1,2-Tetrachloroethane	630-20-6	REG	ug/kg	0.5	5	71	137	30
1,1,1-Trichloroethane	71-55-6	REG	ug/kg	0.5	5	70	135	30
1,1,2,2-Tetrachloroethane	79-34-5	REG	ug/kg	0.5	5	55	130	30
1,1,2-Trichloroethane	79-00-5	REG	ug/kg	0.5	5	60	125	30
1,1-Dichloroethane	75-34-3	REG	ug/kg	1	5	75	125	30
1,1-Dichloroethene	75-35-4	REG	ug/kg	0.5	5	65	135	30
1,1-Dichloropropene	563-58-6	REG	ug/kg	0.5	5	57	138	30
1,2,3-Trichlorobenzene	87-61-6	REG	ug/kg	0.5	5	60	135	30
1,2,3-Trichloropropane	96-18-4	REG	ug/kg	1	5	65	130	30
1,2,4-Trichlorobenzene	120-82-1	REG	ug/kg	0.5	5	65	130	30
1,2,4-Trimethylbenzene	95-63-6	REG	ug/kg	0.5	5	75	132	30
1,2-Dibromo-3-chloropropane	96-12-8	REG	ug/kg	2	5	40	135	30
1,2-Dibromoethane	106-93-4	REG	ug/kg	0.5	5	69	130	30
1,2-Dichlorobenzene	95-50-1	REG	ug/kg	0.5	5	70	130	30
1,2-Dichloroethane	107-06-2	REG	ug/kg	0.5	5	63	133	30
1,2-Dichloropropane	78-87-5	REG	ug/kg	0.5	5	72	130	30
1,3,5-Trimethylbenzene	108-67-8	REG	ug/kg	0.5	5	74	133	30
1,3-Dichlorobenzene	541-73-1	REG	ug/kg	0.5	5	70	130	30
1,3-Dichloropropane	142-28-9	REG	ug/kg	0.5	5	65	128	30
1,4-Dichlorobenzene	106-46-7	REG	ug/kg	0.5	5	70	130	30
2,2-Dichloropropane	594-20-7	REG	ug/kg	0.5	5	66	135	30
2-Butanone	78-93-3	REG	ug/kg	2.5	10	37	180	30
2-Chloroethyl vinyl ether	110-75-8	REG	ug/kg	2	10	35	154	30
2-Chlorotoluene	95-49-8	REG	ug/kg	0.5	5	63	147	30
2-Hexanone	591-78-6	REG	ug/kg	2.5	10	45	145	30
4-Chlorotoluene	106-43-4	REG	ug/kg	0.5	5	70	138	30
4-Methyl-2-pentanone	108-10-1	REG	ug/kg	2.5	10	47	146	30
Acetone	67-64-1	REG	ug/kg	5	10	20	160	30
Benzene	71-43-2	REG	ug/kg	0.5	5	70	130	30
Bromobenzene	108-86-1	REG	ug/kg	0.5	5	72	131	30
Bromochloromethane	74-97-5	REG	ug/kg	0.5	5	70	130	30
Bromodichloromethane	75-27-4	REG	ug/kg	0.5	5	72	137	30
Bromoform	75-25-2	REG	ug/kg	0.5	5	49	136	30
Bromomethane	74-83-9	REG	ug/kg	1	10	37	143	30
Carbon disulfide	75-15-0	REG	ug/kg	0.5	5	39	139	30
Carbon tetrachloride	56-23-5	REG	ug/kg	0.5	5	59	136	30
Chlorobenzene	108-90-7	REG	ug/kg	0.5	5	70	130	30
Chloroethane	75-00-3	REG	ug/kg	1	10	52	135	30
Chloroform	67-66-3	REG	ug/kg	0.5	5	74	129	30
Chloromethane	74-87-3	REG	ug/kg	2	10	30	131	30
cis-1,2-Dichloroethene	156-59-2	REG	ug/kg	0.5	5	70	130	30
cis-1,3-Dichloropropene	10061-01-5	REG	ug/kg	0.5	5	70	142	30
Chlorodibromomethane	124-48-1	REG	ug/kg	0.5	5	59	136	30
Dibromomethane	74-95-3	REG	ug/kg	0.5	5	69	130	30
Dichlorodifluoromethane	75-71-8	REG	ug/kg	1	10	25	130	30
Ethylbenzene	100-41-4	REG	ug/kg	0.5	5	70	130	30
Hexachlorobutadiene	87-68-3	REG	ug/kg	0.5	5	65	135	30
Isopropylbenzene	98-82-8	REG	ug/kg	0.5	5	68	129	30

8260-Solid

m-,p-Xylene	179601-23-1	REG	ug/kg	0.5	5	70	130	30
Methylene chloride	75-09-2	REG	ug/kg	1	5	74	128	30
n-Butylbenzene	104-51-8	REG	ug/kg	0.5	5	70	136	30
n-Propylbenzene	103-65-1	REG	ug/kg	0.5	5	72	136	30
Naphthalene	91-20-3	REG	ug/kg	0.5	10	50	146	30
o-Xylene	95-47-6	REG	ug/kg	0.5	5	70	130	30
p-Isopropyltoluene	99-87-6	REG	ug/kg	0.5	5	72	128	30
sec-Butylbenzene	135-98-8	REG	ug/kg	0.5	5	71	132	30
Styrene	100-42-5	REG	ug/kg	0.5	5	74	130	30
tert-Butylbenzene	98-06-6	REG	ug/kg	0.5	5	72	130	30
Tetrachloroethene	127-18-4	REG	ug/kg	0.5	5	72	130	30
Toluene	108-88-3	REG	ug/kg	0.5	5	77	126	30
trans-1,2-Dichloroethene	156-60-5	REG	ug/kg	0.5	5	72	127	30
trans-1,3-Dichloropropene	10061-02-6	REG	ug/kg	0.5	5	65	139	30
Trichloroethene	79-01-6	REG	ug/kg	0.5	5	72	126	30
Trichlorofluoromethane	75-69-4	REG	ug/kg	1	10	48	154	30
Vinyl acetate	108-05-4	REG	ug/kg	1	10	10	150	30
Vinyl chloride	75-01-4	REG	ug/kg	1	10	45	140	30
Chlorobenzene-d5	3114-55-4	STD	ug/kg			0	0	0
Fluorobenzene	462-06-6	STD	ug/kg			0	0	0
1,4-Dichlorobenzene-d4	3855-82-1	STD	ug/kg			0	0	0
4-Bromofluorobenzene	460-00-4	SURR	% Recovery			74	121	
Toluene-d8	2037-26-5	SURR	% Recovery			81	117	
1,2-Dichloroethane-d4	17060-07-0	SURR	% Recovery			80	120	
Dibromofluoromethane	1868-53-7	SURR	% Recovery			80	120	

8260 Water

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
1,1,1,2-Tetrachloroethane	630-20-6	REG	ug/L	0.25	1	80	130	20
1,1,1-Trichloroethane	71-55-6	REG	ug/L	0.25	1	80	134	20
1,1,2,2-Tetrachloroethane	79-34-5	REG	ug/L	0.2	1	79	125	20
1,1,2-Trichloroethane	79-00-5	REG	ug/L	0.25	1	80	125	20
1,1-Dichloroethane	75-34-3	REG	ug/L	0.125	1	80	125	20
1,1-Dichloroethene	75-35-4	REG	ug/L	0.5	1	80	132	20
1,1-Dichloropropene	563-58-6	REG	ug/L	0.25	1	75	130	20
1,2,3-Trichlorobenzene	87-61-6	REG	ug/L	0.15	1	55	140	20
1,2,3-Trichloropropane	96-18-4	REG	ug/L	0.5	1	75	125	20
1,2,4-Trichlorobenzene	120-82-1	REG	ug/L	0.2	1	65	135	20
1,2,4-Trimethylbenzene	95-63-6	REG	ug/L	0.25	1	80	125	20
1,2-Dibromo-3-chloropropane	96-12-8	REG	ug/L	1	5	50	130	20
1,2-Dibromoethane	106-93-4	REG	ug/L	0.25	1	80	129	20
1,2-Dichlorobenzene	95-50-1	REG	ug/L	0.125	1	80	125	20
1,2-Dichloroethane	107-06-2	REG	ug/L	0.25	1	80	129	20
1,2-Dichloropropane	78-87-5	REG	ug/L	0.2	1	80	120	20
1,3,5-Trimethylbenzene	108-67-8	REG	ug/L	0.25	1	80	127	20
1,3-Dichlorobenzene	541-73-1	REG	ug/L	0.25	1	80	120	20
1,3-Dichloropropane	142-28-9	REG	ug/L	0.2	1	80	120	20
1,4-Dichlorobenzene	106-46-7	REG	ug/L	0.125	1	80	120	20
2,2-Dichloropropane	594-20-7	REG	ug/L	0.25	1	80	133	20
2-Butanone	78-93-3	REG	ug/L	2.5	10	10	170	20
2-Chloroethyl vinyl ether	110-75-8	REG	ug/L	2	10	45	160	20
2-Chlorotoluene	95-49-8	REG	ug/L	0.125	1	80	127	20
2-Hexanone	591-78-6	REG	ug/L	2.5	10	55	130	20
4-Chlorotoluene	106-43-4	REG	ug/L	0.25	1	80	126	20
4-Methyl-2-pentanone	108-10-1	REG	ug/L	2.5	10	64	140	20
Acetone	67-64-1	REG	ug/L	2.5	10	40	180	20
Benzene	71-43-2	REG	ug/L	0.125	1	80	121	20
Bromobenzene	108-86-1	REG	ug/L	0.125	1	80	120	20
Bromochloromethane	74-97-5	REG	ug/L	0.2	1	65	130	20
Bromodichloromethane	75-27-4	REG	ug/L	0.25	1	80	131	20
Bromoform	75-25-2	REG	ug/L	0.5	1	70	130	20
Bromomethane	74-83-9	REG	ug/L	0.5	1	30	145	20
Carbon disulfide	75-15-0	REG	ug/L	0.5	1	58	128	20
Carbon tetrachloride	56-23-5	REG	ug/L	0.25	1	65	140	20
Chlorobenzene	108-90-7	REG	ug/L	0.125	1	80	120	20
Chloroethane	75-00-3	REG	ug/L	0.5	1	60	135	20
Chloroform	67-66-3	REG	ug/L	0.125	1	80	125	20
Chloromethane	74-87-3	REG	ug/L	0.5	1	40	125	20
cis-1,2-Dichloroethene	156-59-2	REG	ug/L	0.25	1	70	125	20
cis-1,3-Dichloropropene	10061-01-5	REG	ug/L	0.25	1	70	130	20
Chlorodibromomethane	124-48-1	REG	ug/L	0.25	1	60	135	20
Dibromomethane	74-95-3	REG	ug/L	0.25	1	75	125	20
Dichlorodifluoromethane	75-71-8	REG	ug/L	0.25	1	40	160	20
Ethylbenzene	100-41-4	REG	ug/L	0.25	1	80	122	20
Hexachlorobutadiene	87-68-3	REG	ug/L	0.25	1	72	132	20
Isopropylbenzene	98-82-8	REG	ug/L	0.25	1	80	122	20

8260 Water

m-,p-Xylene	179601-23-1	REG	ug/L	0.5	1	80	122	20
Methylene chloride	75-09-2	REG	ug/L	0.25	5	80	123	20
n-Butylbenzene	104-51-8	REG	ug/L	0.25	1	80	131	20
n-Propylbenzene	103-65-1	REG	ug/L	0.125	1	80	129	20
Naphthalene	91-20-3	REG	ug/L	0.2	1	59	149	20
o-Xylene	95-47-6	REG	ug/L	0.25	1	80	122	20
p-Isopropyltoluene	99-87-6	REG	ug/L	0.25	1	80	122	20
sec-Butylbenzene	135-98-8	REG	ug/L	0.25	1	80	127	20
Styrene	100-42-5	REG	ug/L	0.125	1	80	123	20
tert-Butylbenzene	98-06-6	REG	ug/L	0.25	1	80	126	20
Tetrachloroethene	127-18-4	REG	ug/L	0.25	1	80	124	20
Toluene	108-88-3	REG	ug/L	0.25	1	80	124	20
trans-1,2-Dichloroethene	156-60-5	REG	ug/L	0.25	1	80	127	20
trans-1,3-Dichloropropene	10061-02-6	REG	ug/L	0.5	1	80	130	20
Trichloroethene	79-01-6	REG	ug/L	0.25	1	80	122	20
Trichlorofluoromethane	75-69-4	REG	ug/L	0.25	1	62	151	20
Vinyl acetate	108-05-4	REG	ug/L	2.5	10	10	190	20
Vinyl chloride	75-01-4	REG	ug/L	0.25	1	50	170	20
Chlorobenzene-d5	3114-55-4	STD				0	0	0
Fluorobenzene	462-06-6	STD				0	0	0
1,4-Dichlorobenzene-d4	3855-82-1	STD				0	0	0
4-Bromofluorobenzene	460-00-4	SURR	% Recovery			86	115	
Toluene-d8	2037-26-5	SURR	% Recovery			88	110	
1,2-Dichloroethane-d4	17060-07-0	SURR	% Recovery			80	120	
Dibromofluoromethane	1868-53-7	SURR	% Recovery			86	118	

8270-Solid

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
1,2,4-Trichlorobenzene	120-82-1	REG	ug/kg	82.5	165	35	100	40
1,2-Dichlorobenzene	95-50-1	REG	ug/kg	82.5	165	35	95	40
1,3-Dichlorobenzene	541-73-1	REG	ug/kg	82.5	165	35	100	40
1,4-Dichlorobenzene	106-46-7	REG	ug/kg	82.5	165	35	105	40
2,4,5-Trichlorophenol	95-95-4	REG	ug/kg	82.5	165	40	110	40
2,4,6-Trichlorophenol	88-06-2	REG	ug/kg	82.5	165	40	110	40
2,4-Dichlorophenol	120-83-2	REG	ug/kg	82.5	165	35	110	40
2,4-Dimethylphenol	105-67-9	REG	ug/kg	82.5	165	30	105	40
2,4-Dinitrophenol	51-28-5	REG	ug/kg	330	825	40	130	40
2,4-Dinitrotoluene	121-14-2	REG	ug/kg	82.5	165	50	130	40
2,6-Dinitrotoluene	606-20-2	REG	ug/kg	82.5	165	50	125	40
2-Chloronaphthalene	91-58-7	REG	ug/kg	82.5	165	40	105	40
2-Chlorophenol	95-57-8	REG	ug/kg	82.5	165	35	105	40
2-Methylnaphthalene	91-57-6	REG	ug/kg	82.5	165	35	115	40
Phenol	108-95-2	REG	ug/kg	82.5	165	35	100	40
Pyrene	129-00-0	REG	ug/kg	82.5	165	35	140	40
2-Methylphenol	95-48-7	REG	ug/kg	82.5	165	35	100	40
2-Nitroaniline	88-74-4	REG	ug/kg	330	825	45	120	40
2-Nitrophenol	88-75-5	REG	ug/kg	82.5	165	35	100	40
3,3'-Dichlorobenzidine	91-94-1	REG	ug/kg	165	330	40	140	40
3-,4-Methylphenol	106-44-5	REG	ug/kg	82.5	165	35	105	40
3-Nitroaniline	99-09-2	REG	ug/kg	330	825	50	130	40
4,6-Dinitro-2-methylphenol	534-52-1	REG	ug/kg	330	825	45	130	40
4-Bromophenyl-phenylether	101-55-3	REG	ug/kg	82.5	165	40	115	40
4-Chloro-3-methylphenol	59-50-7	REG	ug/kg	82.5	165	40	100	40
4-Chloroaniline	106-47-8	REG	ug/kg	82.5	165	35	100	40
4-Chlorophenyl-phenyl ether	7005-72-3	REG	ug/kg	82.5	165	40	110	40
4-Nitroaniline	100-01-6	REG	ug/kg	330	825	35	140	40
4-Nitrophenol	100-02-7	REG	ug/kg	330	825	45	140	40
Acenaphthene	83-32-9	REG	ug/kg	82.5	165	40	110	40
Acenaphthylene	208-96-8	REG	ug/kg	82.5	165	40	110	40
Anthracene	120-12-7	REG	ug/kg	82.5	165	55	130	40
Benzo(a)anthracene	56-55-3	REG	ug/kg	82.5	165	50	130	40
Benzo(a)pyrene	50-32-8	REG	ug/kg	82.5	165	50	130	40
Benzo(b)fluoranthene	205-99-2	REG	ug/kg	82.5	165	45	125	40
Benzo(g,h,i)Perylene	191-24-2	REG	ug/kg	82.5	165	40	140	40
Benzo(k)fluoranthene	207-08-9	REG	ug/kg	82.5	165	45	135	40
Benzoic acid	65-85-0	REG	ug/kg	330	5000	20	110	40
Benzyl alcohol	100-51-6	REG	ug/kg	82.5	165	30	100	40
Bis(2-Chloroethoxy)Methane	111-91-1	REG	ug/kg	82.5	165	30	100	40
Bis(2-Chloroethyl)ether	111-44-4	REG	ug/kg	82.5	165	30	100	40
bis(2-Chloroisopropyl)ether	108-60-1	REG	ug/kg	82.5	165	20	115	40
bis(2-Ethylhexyl)phthalate	117-81-7	REG	ug/kg	82.5	165	50	150	40
Butylbenzylphthalate	85-68-7	REG	ug/kg	82.5	165	50	150	40
Chrysene	218-01-9	REG	ug/kg	82.5	165	55	140	40
Di-N-Butylphthalate	84-74-2	REG	ug/kg	82.5	165	55	140	40
Di-n-octylphthalate	117-84-0	REG	ug/kg	82.5	165	40	145	40
Dibenzo(a,h)Anthracene	53-70-3	REG	ug/kg	82.5	165	40	140	40

8270-Solid

Dibenzofuran	132-64-9	REG	ug/kg	82.5	165	35	110	40
Diethylphthalate	84-66-2	REG	ug/kg	82.5	165	50	130	40
Dimethylphthalate	131-11-3	REG	ug/kg	82.5	165	45	115	40
Fluoranthene	206-44-0	REG	ug/kg	82.5	165	55	140	40
Fluorene	86-73-7	REG	ug/kg	82.5	165	45	115	40
Hexachlorobenzene	118-74-1	REG	ug/kg	82.5	165	45	120	40
Hexachlorobutadiene	87-68-3	REG	ug/kg	82.5	165	30	100	40
Hexachlorocyclopentadiene	77-47-4	REG	ug/kg	82.5	165	30	110	40
Hexachloroethane	67-72-1	REG	ug/kg	82.5	165	30	100	40
Indeno(1,2,3-cd)pyrene	193-39-5	REG	ug/kg	82.5	165	50	135	40
Isophorone	78-59-1	REG	ug/kg	82.5	165	35	100	40
N-Nitrosodiphenylamine	86-30-6	REG	ug/kg	82.5	165	50	130	40
N-Nitrosodipropylamine	621-64-7	REG	ug/kg	82.5	165	35	110	40
Naphthalene	91-20-3	REG	ug/kg	82.5	165	35	100	40
Nitrobenzene	98-95-3	REG	ug/kg	82.5	165	35	100	40
Pentachlorophenol	87-86-5	REG	ug/kg	330	825	50	150	40
Phenanthrene	85-01-8	REG	ug/kg	82.5	165	50	130	40
1,4-Dichlorobenzene-d4	3855-82-1	STD				0	0	0
Acenaphthene-d10	15067-26-2	STD				0	0	0
Perylene-d12	1520-96-3	STD				0	0	0
Naphthalene-D8	1146-65-2	STD				0	0	0
Chrysene-d12	1719-03-5	STD				0	0	0
Phenanthrene-d10	1517-22-2	STD				0	0	0
Nitrobenzene-d5	4165-60-0	SURR	% Recovery			23	120	
p-Terphenyl-d14	1718-51-0	SURR	% Recovery			18	137	
Phenol-d5	4165-62-2	SURR	% Recovery			24	113	
2-Fluorophenol	367-12-4	SURR	% Recovery			25	121	
2-Fluorobiphenyl	321-60-8	SURR	% Recovery			30	115	
2,4,6-Tribromophenol	118-79-6	SURR	% Recovery			19	122	

8270-Water

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
1,2,4-Trichlorobenzene	120-82-1	REG	ug/L	2.5	5	25	105	30
1,2-Dichlorobenzene	95-50-1	REG	ug/L	2.5	5	25	110	30
1,3-Dichlorobenzene	541-73-1	REG	ug/L	2.5	5	25	110	30
1,4-Dichlorobenzene	106-46-7	REG	ug/L	2.5	5	25	110	30
2,4,5-Trichlorophenol	95-95-4	REG	ug/L	2.5	5	35	120	30
2,4,6-Trichlorophenol	88-06-2	REG	ug/L	2.5	5	30	120	30
2,4-Dichlorophenol	120-83-2	REG	ug/L	2.5	5	20	110	30
2,4-Dimethylphenol	105-67-9	REG	ug/L	2.5	5	20	120	30
2,4-Dinitrophenol	51-28-5	REG	ug/L	12.5	25	20	140	30
2,4-Dinitrotoluene	121-14-2	REG	ug/L	2.5	5	50	139	30
2,6-Dinitrotoluene	606-20-2	REG	ug/L	2.5	5	50	120	30
2-Chloronaphthalene	91-58-7	REG	ug/L	2.5	5	25	120	30
2-Chlorophenol	95-57-8	REG	ug/L	2.5	5	25	110	30
2-Methylnaphthalene	91-57-6	REG	ug/L	2.5	5	25	120	30
2-Methylphenol	95-48-7	REG	ug/L	2.5	5	20	110	30
2-Nitroaniline	88-74-4	REG	ug/L	12.5	25	45	115	30
2-Nitrophenol	88-75-5	REG	ug/L	2.5	5	20	115	30
3,3'-Dichlorobenzidine	91-94-1	REG	ug/L	2.5	10	30	140	30
3-,4-Methylphenol	106-44-5	REG	ug/L	2.5	5	20	110	30
3-Nitroaniline	99-09-2	REG	ug/L	12.5	25	40	120	30
4,6-Dinitro-2-methylphenol	534-52-1	REG	ug/L	12.5	25	40	145	30
4-Bromophenyl-phenylether	101-55-3	REG	ug/L	2.5	5	40	115	30
4-Chloro-3-methylphenol	59-50-7	REG	ug/L	2.5	5	25	110	30
4-Chloroaniline	106-47-8	REG	ug/L	2.5	5	25	120	30
4-Chlorophenyl-phenyl ether	7005-72-3	REG	ug/L	2.5	5	35	120	30
4-Nitroaniline	100-01-6	REG	ug/L	12.5	25	53	135	30
4-Nitrophenol	100-02-7	REG	ug/L	12.5	25	10	132	30
Acenaphthene	83-32-9	REG	ug/L	2.5	5	30	120	30
Acenaphthylene	208-96-8	REG	ug/L	2.5	5	30	120	30
Anthracene	120-12-7	REG	ug/L	2.5	5	55	130	30
Benzo(a)anthracene	56-55-3	REG	ug/L	2.5	5	60	130	30
Benzo(a)pyrene	50-32-8	REG	ug/L	2.5	5	55	135	30
Benzo(b)fluoranthene	205-99-2	REG	ug/L	2.5	5	45	125	30
Benzo(g,h,i)Perylene	191-24-2	REG	ug/L	2.5	5	45	140	30
Benzo(k)fluoranthene	207-08-9	REG	ug/L	2.5	5	55	140	30
Benzoic acid	65-85-0	REG	ug/L	12.5	25	10	100	30
Benzyl alcohol	100-51-6	REG	ug/L	2.5	5	20	110	30
Bis(2-Chloroethoxy)Methane	111-91-1	REG	ug/L	2.5	5	20	105	30
Bis(2-Chloroethyl)ether	111-44-4	REG	ug/L	2.5	5	25	110	30
bis(2-Chloroisopropyl)ether	108-60-1	REG	ug/L	2.5	5	20	110	30
bis(2-Ethylhexyl)phthalate	117-81-7	REG	ug/L	3	10	50	150	30
Butylbenzylphthalate	85-68-7	REG	ug/L	2.5	5	55	150	30
Chrysene	218-01-9	REG	ug/L	2.5	5	55	130	30
Di-N-Butylphthalate	84-74-2	REG	ug/L	2.5	5	55	118	30
Di-n-octylphthalate	117-84-0	REG	ug/L	2.5	5	40	146	30
Dibenzo(a,h)Anthracene	53-70-3	REG	ug/L	2.5	5	45	125	30
Dibenzofuran	132-64-9	REG	ug/L	2.5	5	35	115	30
Diethylphthalate	84-66-2	REG	ug/L	2.5	5	45	120	30

8270-Water

Dimethylphthalate	131-11-3	REG	ug/L	2.5	5	25	112	30
Fluoranthene	206-44-0	REG	ug/L	2.5	5	50	137	30
Fluorene	86-73-7	REG	ug/L	2.5	5	40	120	30
Hexachlorobenzene	118-74-1	REG	ug/L	2.5	5	50	130	30
Hexachlorobutadiene	87-68-3	REG	ug/L	2.5	5	24	105	30
Hexachlorocyclopentadiene	77-47-4	REG	ug/L	2.5	5	20	143	30
Hexachloroethane	67-72-1	REG	ug/L	2.5	5	25	95	30
Indeno(1,2,3-cd)pyrene	193-39-5	REG	ug/L	2.5	5	50	135	30
Isophorone	78-59-1	REG	ug/L	2.5	5	30	110	30
N-Nitrosodiphenylamine	86-30-6	REG	ug/L	2.5	5	40	110	30
N-Nitrosodipropylamine	621-64-7	REG	ug/L	2.5	5	28	120	30
Naphthalene	91-20-3	REG	ug/L	2.5	5	25	110	30
Nitrobenzene	98-95-3	REG	ug/L	2.5	5	30	110	30
Pentachlorophenol	87-86-5	REG	ug/L	12.5	25	40	140	30
Phenanthrene	85-01-8	REG	ug/L	2.5	5	55	120	30
Phenol	108-95-2	REG	ug/L	2.5	5	10	120	30
Pyrene	129-00-0	REG	ug/L	2.5	5	55	130	30
1,4-Dichlorobenzene-d4	3855-82-1	STD						
Chrysene-d12	1719-03-5	STD						
Phenanthrene-d10	1517-22-2	STD						
Perylene-d12	1520-96-3	STD						
Naphthalene-D8	1146-65-2	STD						
Acenaphthene-d10	15067-26-2	STD						
p-Terphenyl-d14	1718-51-0	SURR	% Recovery			33	141	
Phenol-d5	4165-62-2	SURR	% Recovery			10	94	
Nitrobenzene-d5	4165-60-0	SURR	% Recovery			35	114	
2-Fluorophenol	367-12-4	SURR	% Recovery			21	100	
2-Fluorobiphenyl	321-60-8	SURR	% Recovery			43	116	
2,4,6-Tribromophenol	118-79-6	SURR	% Recovery			10	123	

827 PAHL-Solid

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
Phenanthrene	85-01-8	REG	ug/kg	1.25	2.5	35	92	40
Indeno(1,2,3-cd)pyrene	193-39-5	REG	ug/kg	1.25	2.5	42	132	40
Naphthalene	91-20-3	REG	ug/kg	1.25	2.5	37	87	40
Acenaphthene	83-32-9	REG	ug/kg	1.25	2.5	30	87	40
1-Methylnaphthalene	90-12-0	REG	ug/kg	1.25	2.5	35	89	40
Acenaphthylene	208-96-8	REG	ug/kg	1.25	2.5	31	87	40
Anthracene	120-12-7	REG	ug/kg	1.25	2.5	37	94	40
Benzo(a)anthracene	56-55-3	REG	ug/kg	1.25	2.5	43	136	40
Benzo(a)pyrene	50-32-8	REG	ug/kg	1.25	2.5	45	136	40
Benzo(b)fluoranthene	205-99-2	REG	ug/kg	1.25	2.5	39	130	40
Benzo(g,h,i)perylene	191-24-2	REG	ug/kg	1.25	2.5	42	132	40
Benzo(k)fluoranthene	207-08-9	REG	ug/kg	1.25	2.5	40	133	40
Chrysene	218-01-9	REG	ug/kg	1.25	2.5	43	131	40
Pyrene	129-00-0	REG	ug/kg	1.25	2.5	47	118	40
Dibenzo(a,h)anthracene	53-70-3	REG	ug/kg	1.25	2.5	40	135	40
Fluoranthene	206-44-0	REG	ug/kg	1.25	2.5	41	123	40
Fluorene	86-73-7	REG	ug/kg	1.25	2.5	31	86	40
2-Methylnaphthalene	91-57-6	REG	ug/kg	1.25	2.5	35	92	40
Naphthalene-d8	1146-65-2	STD				0	0	0
Chrysene-d12	1719-03-5	STD				0	0	0
Acenaphthene-d10	15067-26-2	STD				0	0	0
Phenanthrene-d10	1517-22-2	STD				0	0	0
Perylene-d12	1520-96-3	STD				0	0	0
Nitrobenzene-d5	4165-60-0	SURR	% Recovery			23	120	
2-Fluorobiphenyl	321-60-8	SURR	% Recovery			30	115	
p-Terphenyl-d14	1718-51-0	SURR	% Recovery			18	137	

827-PAHL-Water

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
Phenanthrene	85-01-8	REG	ug/L	0.025	0.05	33	122	40
Indeno(1,2,3-cd)pyrene	193-39-5	REG	ug/L	0.025	0.05	42	147	40
Naphthalene	91-20-3	REG	ug/L	0.025	0.05	33	112	40
Acenaphthene	83-32-9	REG	ug/L	0.025	0.05	22	116	40
1-Methylnaphthalene	90-12-0	REG	ug/L	0.025	0.05	31	111	40
Acenaphthylene	208-96-8	REG	ug/L	0.025	0.05	21	116	40
Anthracene	120-12-7	REG	ug/L	0.025	0.05	34	121	40
Benzo(a)anthracene	56-55-3	REG	ug/L	0.025	0.05	55	150	40
Benzo(a)pyrene	50-32-8	REG	ug/L	0.025	0.05	55	150	40
Benzo(b)fluoranthene	205-99-2	REG	ug/L	0.025	0.05	51	148	40
Benzo(g,h,i)perylene	191-24-2	REG	ug/L	0.025	0.05	29	149	40
Benzo(k)fluoranthene	207-08-9	REG	ug/L	0.025	0.05	42	157	40
Chrysene	218-01-9	REG	ug/L	0.025	0.05	50	155	40
Pyrene	129-00-0	REG	ug/L	0.025	0.05	55	138	40
Dibenzo(a,h)anthracene	53-70-3	REG	ug/L	0.025	0.05	23	150	40
Fluoranthene	206-44-0	REG	ug/L	0.025	0.05	51	141	40
Fluorene	86-73-7	REG	ug/L	0.025	0.05	23	118	40
2-Methylnaphthalene	91-57-6	REG	ug/L	0.025	0.05	32	115	40
Naphthalene-d8	1146-65-2	STD				0	0	0
Chrysene-d12	1719-03-5	STD				0	0	0
Acenaphthene-d10	15067-26-2	STD				0	0	0
Phenanthrene-d10	1517-22-2	STD				0	0	0
Perylene-d12	1520-96-3	STD				0	0	0
Nitrobenzene-d5	4165-60-0	SURR	% Recovery			35	114	
2-Fluorobiphenyl	321-60-8	SURR	% Recovery			43	116	
p-Terphenyl-d14	1718-51-0	SURR	% Recovery			33	141	

CAS/HOUSTON DATA QUALITY OBJECTIVES

METHOD	ANALYTE	CAS No.	MATRIX	EDL	MRL	DOD LOD	DOD LOQ	UNITS	Accuracy (LCS %Rec.)	Matrix Spike (%Rec.)	Precision (% RPD)	DOD QSM (LCS %Rec.)	DOD QSM (% RPD)	Precision (DUP % RPD)
8290	2378-TCDD	1746-01-6	Aqueous	0.566	10	3	10	pg/L	76-124	76-124	9	76-124	20	25
8290	12378-PeCDD	40321-76-4	Aqueous	0.877	25	7.5	25	pg/L	75-117	75-117	10	75-117	20	25
8290	123478-HxCDD	57653-85-7	Aqueous	0.740	25	7.5	25	pg/L	70-137	70-137	13	70-137	20	25
8290	123678-HxCDD	39227-28-6	Aqueous	0.669	25	7.5	25	pg/L	77-120	77-120	10	77-120	20	25
8290	123789-HxCDD	19408-74-3	Aqueous	0.714	25	7.5	25	pg/L	67-127	67-127	17	67-127	20	25
8290	1234678-HpCDD	35822-46-9	Aqueous	0.772	25	7.5	25	pg/L	74-118	74-118	14	74-118	20	25
8290	OCDD	3268-87-9	Aqueous	1.168	50	15	50	pg/L	60-151	60-151	13	60-151	20	25
8290	2378-TCDF	51207-31-9	Aqueous	0.656	10	3	10	pg/L	70-122	70-122	18	70-122	20	25
8290	12378-PeCDF	57117-41-6	Aqueous	0.635	25	7.5	25	pg/L	72-118	72-118	8	72-118	20	25
8290	23478-PeCDF	57117-31-4	Aqueous	0.623	25	7.5	25	pg/L	67-120	67-120	15	67-120	20	25
8290	123478-HxCDF	57117-44-9	Aqueous	0.568	25	7.5	25	pg/L	73-117	73-117	9	73-117	20	25
8290	123678-HxCDF	72918-21-9	Aqueous	0.551	25	7.5	25	pg/L	72-122	72-122	11	72-122	20	25
8290	123789-HxCDF	70648-26-9	Aqueous	0.707	25	7.5	25	pg/L	56-137	56-137	22	56-137	20	25
8290	234678-HxCDF	60851-34-5	Aqueous	0.611	25	7.5	25	pg/L	63-126	63-126	31	63-126	20	25
8290	1234678-HpCDF	67562-39-4	Aqueous	0.764	25	7.5	25	pg/L	69-112	69-112	14	69-112	20	25
8290	1234789-HpCDF	55673-89-7	Aqueous	1.032	25	7.5	25	pg/L	70-132	70-132	18	70-132	20	25
8290	OCDF	39001-02-0	Aqueous	1.202	50	15	50	pg/L	70-144	70-144	21	70-144	20	25

HG-Solid

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
Mercury, Total	7439-97-6	REG	mg/kg	0.01	0.25	80	120	25

HG-Water

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
Mercury	7439-97-6	REG	mg/L	0.0001	0.0002	85	115	20

TOC-Solid

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
Total Organic Carbon		REG	mg/kg	500	1000	70	140	50

TOC Water

Compound	CAS Number	Parm Type	Units	MDL	RDL	LCL	UCL	RPD
Total Organic Carbon		REG	mg/L	0.5	1	85	115	15

ATTACHMENT C

SWMU-40 Laboratory Standard Operating Procedures (on CD)

6010 6020 Soils Digest SOP
6010 6020 Water Digest SOP
6010 SOP
6020 SOP
6850 SOP
8081 SOP
8082 Extraction SOP
8082 SOP
8260 SOP
8270 Extraction SOP
8270 PAHL SOP
8270 SOP
827-PAHL Extraction SOP
HG Soil SOP
HG Water SOP
SOP-45 Validation
TOC SOP
8081-8082 Extraction SOP
8081-8082 Soil Extraction SOP
TCLP Prep SOP

APPENDIX C

Interim Measures Specifications

Interim Measures Specifications

Process / Task	Unit	Quantity	Specifications	Additional Notes
Site Preparation				
Construction entrance/exit and staging area	CY	60	VDOT #1 coarse aggregate (2- to 3-inch stone) or equivalent	6 inch thick
Silt fence	LF	200	To comply with Virginia Erosion and Sediment Control Std and Spec 3.05	
Solid Waste Dumpster	EA	1	10 yard dumpster	
Portable Toilet	EA	1		
Landfill Cap Repair				
Dozer	EA	1	Dozer D-5	
Compactor/Roller	EA	1	IR/SD-100D	
Dump Trucks	EA	2	18 yard dump trucks	
Backfill	CY	250	Common Fill	compacted
Geotextile liner	SF	300	Mirafi woven fabric (FW 700)	
Topsoil	CY	50		
Hydroseeding	SY	2750	Fescue/Creeping/Rye mix w/ fertilizer and mulch	
rip-rap	TON	36	Riprap: Well-graded with a minimum d_{50} of 0.5 feet	
seed and straw	CY	TBD	Slopes require Erosion Control Mat	
Monitoring Well Installation				
Minor clearing and grubbing	EA	1		
Truck mounted air rotary drill rig	EA	1		
sand	EA	8		
PVC riser pipe	LF	20		
2" diameter PVC 0.10 slot screen	LF	20		
Bentonite Pellets	LB	TBD	minimun thickness of bentonite seal will be achieved per SOP and regulations	
Grout	GAL	TBD	Volume will be based on final well construction	
Centralizers	EA	TBD	May be used if voids in bedrock preclude standard well completions	
Decontamination				
Containment berm	EA	1	10 feet by 20 feet	
pressure washer	EA	1		
Alconox powder	LB	1		
Decontamination brush	EA	3	Rigid plastic bristles	

Notes:

When brands and model numbers are specified, equivalent equipment may be substituted.
Excavation and backfill volumes are estimated are subject to change based on field conditions and material used.

BD = To be determined
GAL= gallons
CY = cubic yard
EA = each
LB = pound
TON= ton
LF = linear feet
SF = square feet
SY = square yards

APPENDIX D

Landfill Cap Inspection Form

INSPECTION OF CLOSED WASTE MANAGEMENT FACILITIES

Name of Waste Management Facility: ____

EPA Permit No. ____
Date of Inspection _____ /_____ /_____ Time of Inspection _____: _____ AM/ PM
Reason for Inspection: Quarterly/ Major rainfall event (2" in 8 hr period)/ catastrophic event

ITEM	INSPECT FOR	**DEFICIENCIES NOTED**	**REMEDIAL ACTION REQUIRED**
Final Soil Cover	Erosion Settlement, Subsidence, or Displacement Pooling		
Vegetative Cover	Dead vegetation, or inadequate growth Presence of trees, shrubs, or deep rooted vegetation Need to fertilize, irrigate, or cut grass		
PVC Liner (if applicable)	Liner exposed		
Peripheral Drainage Swales	Erosion Subsidence Pooling		
Stormwater Drainage Areas	Erosion Subsidence Vegetation growth Accumulated sediment		
Security (if applicable)	Access road in place Sign legible and in place Fences not breached and no visible damage		
Monitoring Wells Outer protective casing Well caps and locks Concrete pad Inner cap and riser	Casing in good condition In place and functioning Cracks or settlement Intact and functioning		
Benchmarks (2) (if applicable)	Monuments present and visible Damage to monument		

Date and nature of repairs or remedial action: ____
____
____

Printed Name of Inspector: ____________________ Signature of Inspector: ___________________

Company: ____

Date remedial action completed: ________________ Remedial action approved by: ___