RADFORD ARMY AMMUNITION PLANT, VIRGINIA

SWMU 54 (RAAP-14) Monitored Natural Attenuation Interim Measures Work Plan

Prepared for:
USACE, Baltimore District
10 South. Howard St.
Baltimore, MD 21201

Prepared by:
Shaw Environmental, Inc.
2113 Emmorton Park Rd.
Edgewood, MD 21040
Contract No. W912QR-04-D-0027-DA04

Final Document **April 2011**

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

April 11, 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,VA
Solid Waste Management Unit 54
Monitored Natural Attenuation
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) April 2011 Final Monitored Natural Attenuation Interim Measures Work Plan for Solid Waste Management Unit 54, 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
Route 114, P.O. Box 1
Radford, VA 24143-0100

www.atk.com

April 11, 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, SWMU 54 (RAAP-014) Monitored Natural Attenuation, Interim Measures Work Plan, Final Document, April 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 April 7, 2011. Also enclosed is the 7 April 2011 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,

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
Roanoke, VA 24019

11-815-58
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
ATTN: CENAB-EN-HM
10 South Howard Street
Baltimore, MD 21201

11-815-58
JMcKenna

bc: Administrative File
J. McKenna, ACO Staff
Rob Davie-ACO Staff
P.W. Holt
J. J. Redder
Env. File

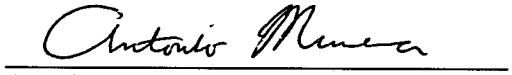
Coordination: J. McKenna M. A. Miano

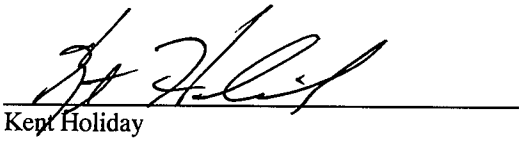
11-815-58
JMcKenna

Concerning the following:

Radford Army Ammunition Plant
SWMU 54 (RAAP-014) Monitored Natural Attenuation
Interim Measures Work Plan
Final Document, April 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: Antonio Munera
TITLE: LTC, CM
Commanding

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

11-815-58
JMcKenna

Greene, Anne

From: McKenna, Jim
Sent: Thursday, April 07, 2011 2:55 PM
To: Weissbart.Erich@epamail.epa.gov
Cc: Flint, Jeremy; Redder, Jerome; Meyer, Tom NAB02; Timothy.Leahy@shawgrp.com; Parks, Jeffrey N; Cutler,Jim; Geiger.William@epamail.epa.gov; Mendoza, Richard R Mr CIV USA IMCOM AEC
Subject: FW: Final SWMU 54 MNA WP (UNCLASSIFIED)
Attachments: SWMU54 EPA_RTCs_MNA_IMWP_rev4.pdf

Importance: High

Classification: UNCLASSIFIED
Caveats: FOUO

All:

Note the contractor will ship the subject document with a copy of this email to the POCs and tracking numbers below. Attached are the response to comments on the draft.

A certification letter will follow.

Thank you for your support of the Radford Army Ammunition Plant Installation Restoration Program.

Jim McKenna

Jim McKenna	1Z63V8840197900241
Thomas Meyer	1Z63V8840196941057
Jeffrey Leach	1Z63V8840199071527
Susan M. Ryan	1Z63V8840199347471
Erich Weissbart	1Z63V8840196267518
Jim Cutler	1Z63V8840199945084
E.A. Lohman	1Z63V8840196160294

Classification: UNCLASSIFIED
Caveats: FOUO

EPA Comments on the MNA IM Workplan for SWMU 54:
By: Erich Weissbart P.G.
Land and Chemicals Division (3LC20)
US EPA Region III

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.

Response: The purpose of each well in the monitoring network is defined in Table 2-2, which is identical to Table 10-3 in the EPA/VDEQ-approved SWMU 54 RFI/CMS (URS, September 2008). These tables use similar terminology to what is proposed above.

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.

Response: Historic groundwater data and a potentiometric surface map will be added to the work plan, as requested. This work plan, however; is meant to explain how we will implement a remedy that has already been discussed in detail in the Solid Waste Management Unit 54 RCRA Facility Investigation/Corrective Measures Study Report, Final September 2008, URS (URS September 2008) and approved by the EPA and DEQ. Thus it is based upon the reasoning described in the RFI/CMS Report (URS September 2008).

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.

Response: The footnote will be revised to state "The sampling frequency will be reduced from quarterly to annually, if detections are below RGs in four consecutive quarters." Text will be added stating "Wells will be removed from the monitoring network if all constituents are found below their respective RGs for 2 consecutive years." Additionally, the following text will be added "A constituent will be removed from the sampling program if it is consistently found below its respective RGs for 2 consecutive years."
Having agreed to modify the text as above, RFAAP still maintains per S10.3.3 of the RFI/CMS Report (URS September 2008) only three consecutive years of data

within the RGs are needed to terminate the MNA program regardless of the sampling frequency.

4. What is the contingency plan if constituents 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.

Response: **The MNA plan described in this work plan is only part of the selected remedy for the site. Source removal for contaminated soil (based on IGW SSLs) was also part of the remedy and has already been implemented. The soil IMs are described in the SWMU 54 Interim Measures Completion Report, which will be submitted concurrently with the revised MNA Work Plan. Based on the existing low groundwater concentrations (below groundwater RGs) and the source area removal, it is considered extremely unlikely that the MNA will not succeed. This topic will be re-evaluated after 2 years of monitoring, and, if necessary a contingency plan will be developed at that time. As previously noted, this topic was discussed in detail in the Solid Waste Management Unit 54 RCRA Facility Investigation/Corrective Measures Study Report, Final September 2008, URS (URS September 2008). This work plan is meant to explain how we will go about implementing a remedy that has already been approved by the EPA and VDEQ. Finally, note the September 2007 groundwater data show the concentrations are below RGs, except for 2,4,6-TNT and RDX in one well, 54MW10.**

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, chloride 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.

Response: **The work plan is intended to describe the previously approved remedy from the Solid Waste Management Unit 54 RCRA Facility Investigation/Corrective Measures Study Report, Final September 2008, URS (URS, September 2008) where the well locations, as well as the analytical parameters, were defined and discussed. See Table 10-3 in the CMS report and Table 2-2 in the work plan.**

6. What is the evidence for natural attenuation? Please include a discussion or demonstration that MNA is occurring.

Response: **As noted in the response to comment #2, historical data documenting the decrease in concentrations will be added. This work plan is meant simply to explain how we will implement a remedy that has already been approved by the EPA and VDEQ. The basis for this remedy was substantiated in the Solid Waste**

Management Unit 54 RCRA Facility Investigation/Corrective Measures Study Report, Final September 2008, URS (URS September 2008) and approved by the EPA and VDEQ.

Subsection 2.2

7. 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.

Response: The wording will be changed from stating that compliance will be "measured" to stating that it will be "achieved" in all the wells and pore water locations. MNA as a remedy for groundwater has already been substantiated within the Solid Waste Management Unit 54 RCRA Facility Investigation/Corrective Measures Study Report, Final September 2008, URS (URS 2008) and approved by the EPA and VDEQ. Please note that there have been two separate and large source removal actions that were performed at SWMU 54 as Interim Measures. The most recent one was completed in 2010 which we believe has achieved its objective per the Solid Waste Management Unit 54 RCRA Facility Investigation/Corrective Measures Study Report, Final September 2008, URS (URS September 2008) A separate IM completion report for soil has been prepared describing the soil contamination that has been removed from the site in 2010.

Subsection 2.4.1

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

Response: The work plan will be revised to state that pore water/surface water results will be included in the annual report.

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

Response: Purge water generated during the sampling of the groundwater wells for the MNA sampling will likely be disposed of in Radford's wastewater treatment plant, rather than off-site. Soil that was removed during the soil IMs was

disposed of offsite and the results (including results and transport and disposal paperwork) will be provided in a separate Interim measures completion Report.

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

Response: **The work plan will be revised to state that results will be included in the annual report.**

Subsection 2.5

11. 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.

Response: **The report will be revised to include this wording.**

Subsection 2.6.1

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

Response: **We will add wording to the report that says pore water/surface water samples will be included in the decision to terminate MNA.**

Leahy, Timothy

From: McKenna, Jim J Mr CIV USA AMC [jim.mckenna@us.army.mil]
Sent: Wednesday, February 23, 2011 9:35 AM
To: Weissbart.Erich@epamail.epa.gov
Cc: jeremy.flint@atk.com; jerome.redder@atk.com; Meyer, Tom NAB02; Richard Mendoza; Mary Lou Rochotte; Leahy, Timothy; Parks, Jeffrey; Cutler,Jim
Subject: RE: SWMU 40 & SWMU 54 comments (UNCLASSIFIED)
Attachments: Fact Sheet Unified Guidance 2009.pdf

Importance: High

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.
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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.

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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.”

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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.
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
Classification: UNCLASSIFIED
Caveats: FOUO

DEPARTMENT OF THE ARMY
ARMY INSTITUTE OF PUBLIC HEALTH
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND MARYLAND 21010-5403

MCHB-IP-REH

11 FEB 2011

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

SUBJECT: Draft Monitored Natural Attenuation Interim Measures Work Plan for the Propellant Burning Ash Disposal Area, SWMU 54 (RAAP-014), Radford Army Ammunition Plant, Virginia, January 2011

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 the work plan.

2. Having previously reviewed the internal draft, we have no additional comments to provide on this document.

3. The document was reviewed by Mr. Dennis Druck, Environmental Health Risk Assessment Program. He can be reached at DSN 584-2953, commercial (410) 436-2953 or electronic mail, dennis.druck@us.army.mil.

FOR THE DIRECTOR:

JEFFREY S. KIRKPATRICK
Portfolio Director, Health Risk Management

CF:
HQDA (DASG-PPM-NC)
IMCOM-NE (IMNE-PWD-E)
USACE (CEHNC-CX-ES)
USAEC (IMAE-CD/Mr. Rich Mendoza)

ATK Armament Systems
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January 14, 2011

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, SWMU 54 (RAAP-14) Monitored Natural Attenuation Interim Measures Work Plan, Draft Document, January 2011
EPA ID# VA1 210020730

Dear Mr. Geiger and Mr. Cutler:

Enclosed is the certification for the subject document that was sent to you on January 13, 2011. Also enclosed is the 13 January 2011 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,

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

c: Karen Sismour
Virginia Department of Environmental Quality
629 East Main Street
Richmond, VA 23219

E. A. Lohman
Virginia Department of Environmental Quality
Blue Ridge Regional Office
3019 Peters Creek Road
Roanoke, VA 24019

11-815-14
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
ATTN: CENAB-EN-HM
10 South Howard Street
Baltimore, MD 21201

11-815-14
JMcKenna

bc: J. McKenna, ACO Staff
Rob Davie-ACO Staff
P.W. Holt
J. J. Redder
Env. File

Coordination: J. McKenna M. A. Miano

11-815-14
JMcKenna

Concerning the following:

Radford Army Ammunition Plant
SWMU 54 (RAAP-14)
Monitored Natural Attenuation
Interim Measures Work Plan,
Draft Document, January 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: Antonio Munera
TITLE: LTC, CM
Commanding

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

11-815-14
JMcKenna

Greene, Anne

From: McKenna, Jim
Sent: Thursday, January 13, 2011 12:58 PM
To: Greene, Anne; Cutler,Jim; dennis.druck@us.army.mil; diane.wisbeck@arcadis-us.com; Geiger.William@epamail.epa.gov; Redder, Jerome; Lohman,Elizabeth; Mendoza, Rich; Meyer, Tom NAB02; Parks, Jeffrey N; Sismour,Karen; Timothy.Leahy@shawgrp.com
Subject: Draft SWMU 54 MNA IMWP (UNCLASSIFIED)
Importance: High

Classification: UNCLASSIFIED
Caveats: FOUO

All:

Note the contractor will ship the subject document with a copy of this email to the POCs and tracking numbers below.

A certification letter will follow.

Thank you for your support of the Radford Army Ammunition Plant Installation Restoration Program.

Jim McKenna

Jim McKenna	1Z63V8841393311925 (CD and page changes only)
Mr. Richard Mendoza	1Z63V8841390210754
Mr. Tom Meyer	1Z63V8841391440530
Mr. Dennis Druck	1Z63V8841391040141
Mr. James Cutler	1Z63V8841394664972
Ms. Elizabeth Lohman	1Z63V8841391148580
Mr. William Geiger	1Z63V8841392052369

Classification: UNCLASSIFIED
Caveats: FOUO

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LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

The Appendices are Included on a CD Located at the Back of This Report

LIST OF ACRONYMS AND ABBREVIATIONS

°C .....degrees Celsius
°F.....degrees Fahrenheit
µg/L.....micrograms per liter
ACGIH.....American Conference of Governmental Industrial Hygienists
ATK .....Alliant TechSystems, Inc.
bgs.....below ground surface
CFR.....Code of Federal Regulations
CGI/O_2 .....Combustible Gas Indicator/Oxygen
CIH.....Certified Industrial Hygienist
CMO .....Corrective Measures Objective
CMS .....Corrective Measures Study
COC .....Chain-of-Custody
COC .....Contaminant of Concern
COD .....Chemical Oxygen Demand
COI.....Contaminant of Interest
COPC .....Chemical of Potential Concern
CPR.....Cardiopulmonary Resuscitation
CQC .....Contractor Quality Control
CRZ.....Contamination Reduction Zone
CVAA .....Cold Vapor Atomic Absorption
DO.....Dissolved Oxygen
DoD.....Department of Defense
DQO.....Data Quality Objective
ELAP.....Environmental Laboratory Accreditation Program
EM.....Engineer Manual
EZ.....Exclusion Zone
FAR.....Federal Acquisition Regulation
FSP.....Field Sampling Plan
ft.....feet
ft^2.....square feet
HDPE .....High Density Polyethylene
HHRA .....Human Health Risk Assessment
ICP .....Inductively Coupled Plasma
IDLH.....Immediately Dangerous to Life or Health
IM.....Interim Measures
LMARC .....Louisville Multiple Award Remediation Contract
LQAP .....Laboratory Quality Assurance Plan
MDL.....Method Detection Limit
MedEvac .....Medical Evacuation
mg/kg .....milligrams per kilogram
mg/L.....milligrams per liter
mg/m^3.....milligrams per cubic meter
MNA .....Monitored Natural Attenuation
MRL.....Method Reporting Limit
MS.....Matrix Spike
MSD.....Matrix Spike Duplicate
MSDS.....Material Safety Data Sheet
MSE .....Millennium Science and Engineering
msl.....mean sea level
MWP.....Master Work Plan
NELAP.....National Environmental Laboratory Accreditation Program
NIOSH .....National Institute for Occupational Safety and Health
ORNL.....Oak Ridge National Laboratory
ORP.....Oxidation-Reduction Potential
OSHA.....Occupational Safety and Health Administration
OSIC .....On-Scene Incident Commander
OSWER.....Office of Solid Waste and Emergency Response
PAH.....Polynuclear Aromatic Hydrocarbon
PAN.....1-(2-Pyridylazo)-2-Naphthol

Parsons .....Parsons Engineering Science, Inc.
PCB .....Polychlorinated Biphenyl
PEL .....Permissible Exposure Limit
PID .....Photoionization Detector
POC.....Point of Compliance
PPE.....Personal Protective Equipment
QA.....Quality Assurance
QA/QC .....Quality Assurance/Quality Control
QAPP .....Quality Assurance Project Plan
QC .....Quality Control
QIP .....Quality Improvement Process
QL .....Quantitation Limit
QSM.....Quality Systems Manual
RCRA.....Resource Conservation and Recovery Act
RFAAP.....Radford Army Ammunition Plant
RFI .....RCRA Facility Investigation
RG.....Remedial Goal
RL .....Reporting Limit
RMSF.....Rocky Mountain Spotted Fever
RSL .....Regional Screening Level
Shaw.....Shaw Environmental, Inc.
SOP .....Standard Operating Procedure
SPE.....Solid-Phase Extraction
SSHO .....Site Safety and Health Officer
SSHP.....Site Safety and Health Plan
SSL.....Soil Screening Level
STEL.....Short-Term Exposure Limit
SVOC.....Semivolatile Organic Compound
SWMU .....Solid Waste Management Unit
SZ.....Support Zone
TAL.....Target Analyte List
TCL.....Target Compound List
TCLP.....Toxicity Characteristic Leaching Procedure
TLV.....Threshold Limit Value
TWA .....Time-Weighted Average
URS.....URS Corporation
USACE .....U.S. Army Corps of Engineers
USEPA.....U.S. Environmental Protection Agency
VDEQ .....Virginia Department of Environmental Quality
VI .....Verification Investigation
VOC .....Volatile Organic Compound
WP.....Work Plan

1.0 INTRODUCTION

Shaw Environmental, Inc. (Shaw) has been contracted by the U.S. Army Corps of Engineers (USACE) to perform a Monitored Natural Attenuation (MNA) Plan at Solid Waste Management Unit (SWMU) 54 (RAAP-001), the Propellant Burning Ash Disposal Area, at Radford Army Ammunition Plant (RFAAP), Radford, VA. This MNA Interim Measures (IM) Work Plan (WP) describing this action and program comprises six sections as follows: Introduction; Organization and Technical Approach Plan; Field Sampling Plan (FSP); Quality Assurance Project Plan (QAPP); Site Safety and Health Plan (SSHP); and References. This WP is presented as an addendum to, and incorporates by reference, the elements of the RFAAP Master Work Plan (MWP) (URS, 2003), including Section 5.0, which discusses entry to the Installation and security concerns and requirements.

This WP details site-specific procedures for the MNA work at SWMU 54. Specifically, this WP addresses the removal of explosives and perchlorate from groundwater in accordance with Part II(D)(11-21) IM of the RFAAP Corrective Action Permit (USEPA, 2000a). This removal action work is being performed in accordance with Contract No. W912QR-04-D-0027-DA04.

1.1 Background

1.1.1 Site Description

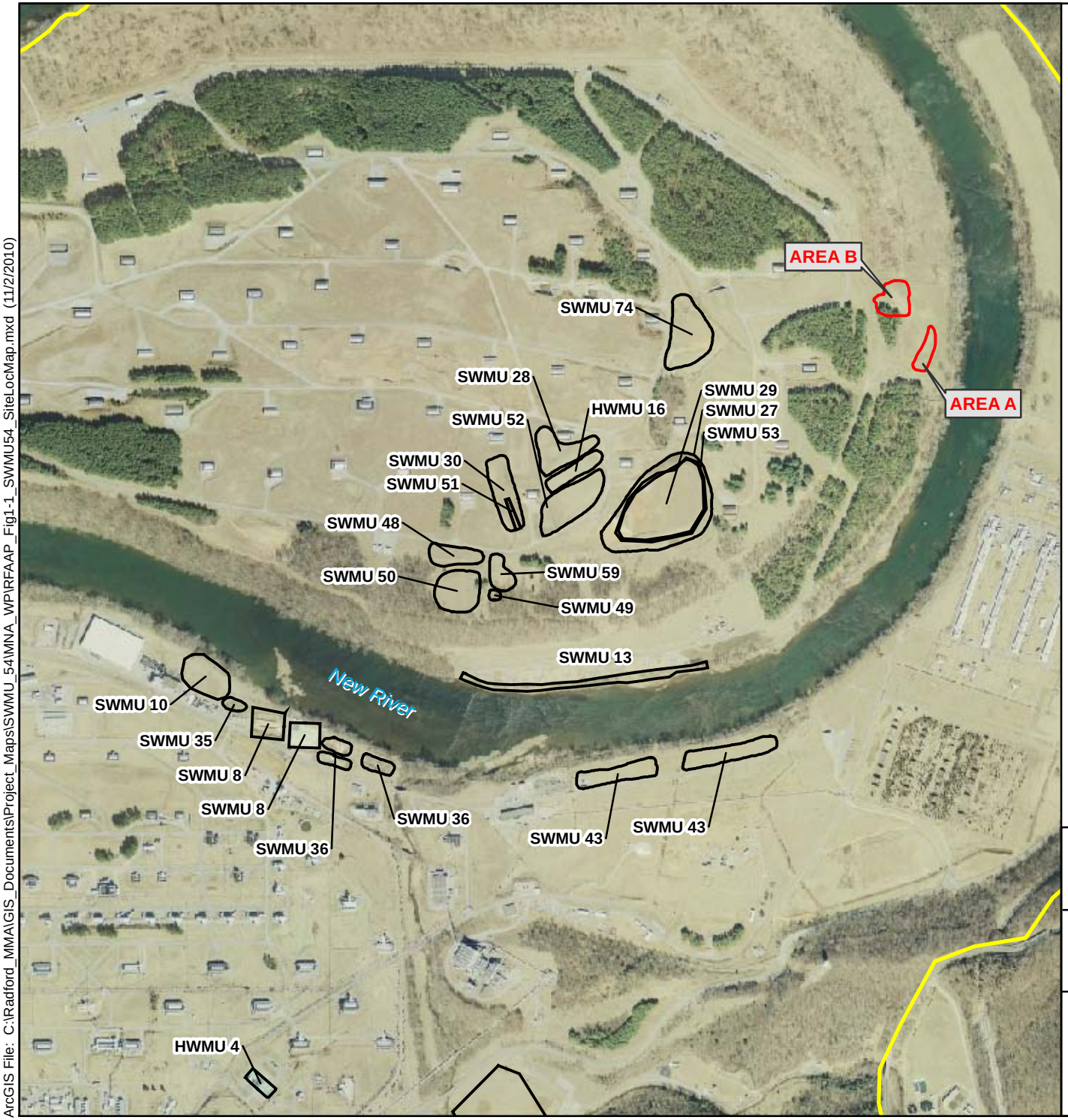
SWMU 54 is located within the easternmost portion of the Horseshoe Area at RFAAP. SWMU 54 consists of two non-contiguous disposal areas; Area A is an approximately 0.58-acre triangular shaped area in the southern portion of SWMU 54 and Area B is an approximately 1.09-acre area in the northern portion of SWMU 54 (**Figure 1-1**). SWMU 54 was reportedly used as a disposal area in the late 1970s for ash from propellant burning activities located at the Waste Propellant Burning Grounds. The site is currently undeveloped. The RFAAP Installation security fence is located along the northern and eastern boundaries of SWMU 54.

As illustrated on **Figure 1-1**, SWMU 54 is situated on a gently sloping terrace ranging from approximately 1,716 to 1,696 feet (ft) mean sea level (msl) from east to west, respectively. The SWMU is positioned within the 100-year floodplain on a terrace feature of the New River. East of the site, the ground surface slopes steeply towards the New River (approximately 1,676 ft msl).

1.1.2 Site Geology

RFAAP is located in the New River Valley, which crosses the Valley and Ridge Province approximately perpendicular to the regional strike of bedrock, and cross cuts Cambrian and Ordovician limestone or dolostone. Deep clay-rich residuum is prevalent in areas underlain by carbonate rocks. The valley is covered by river floodplain and terrace deposits; karst topography is dominant throughout the area.

Lithologic characterization of the subsurface at SWMU 54 was performed during the advancement of soil borings and monitoring well borings at the site. Two geologic cross-sections were developed based on the logging descriptions recorded during the advancement of the soil borings. A plan view of the cross-sectional lines (Line A-A' and Line B-B') is presented on **Figure 1-2**. The geologic cross-sections are presented on **Figures 1-3 and 1-4**.



LEGEND

- SWMU 54 Boundary
- Other SWMU Boundary
- Installation Boundary

Notes:
1) Aerial photo, dated 2005, was obtained from Montgomery County Planning, VA Planning & GIS Services.

N

Scale:

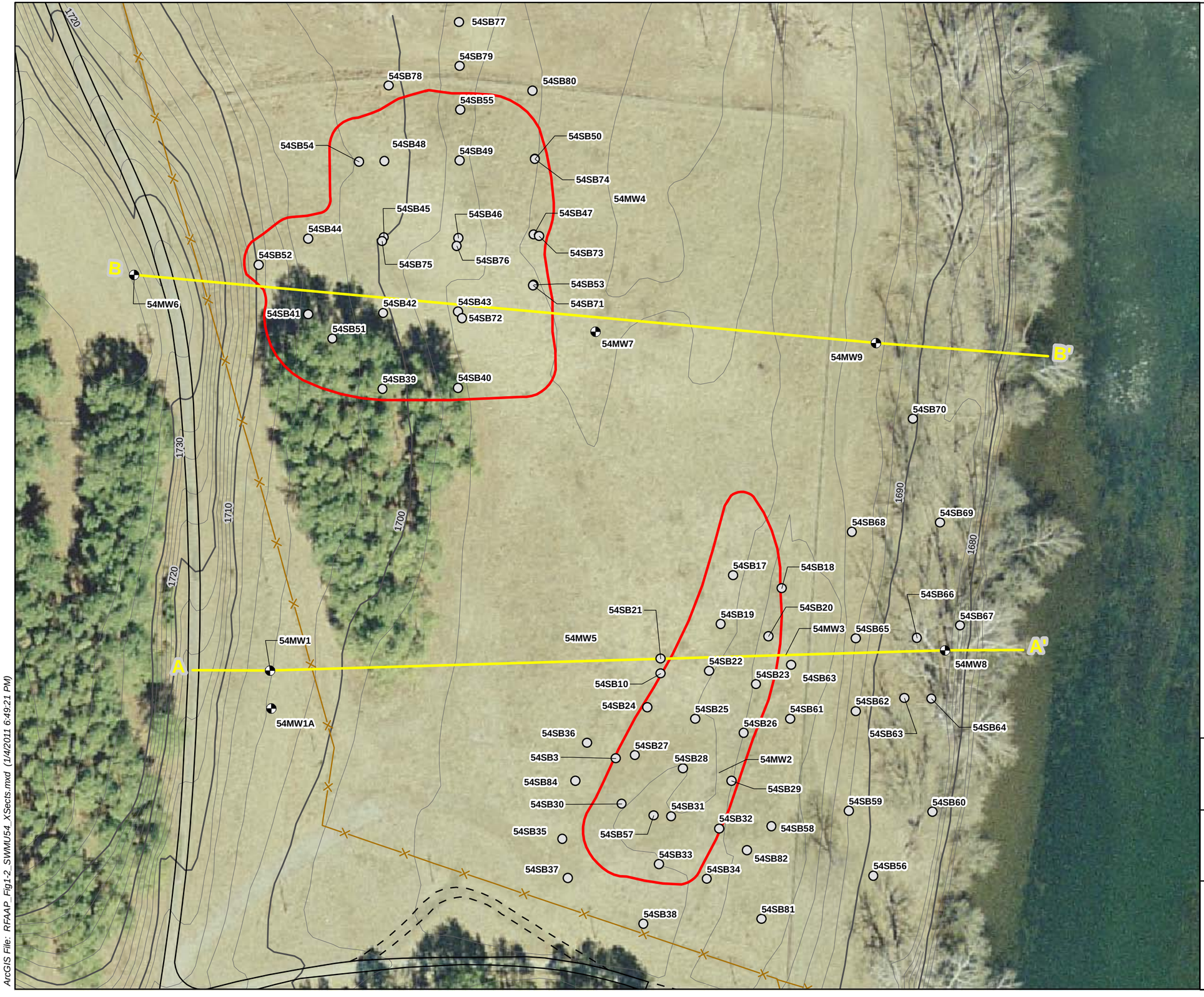
0 500 1,000 2,000 Feet

U.S. Army Corps of Engineers

Shaw® Shaw Environmental, Inc.

FIGURE 1-1
SWMU 54
Site Location Map
Radford Army Ammunition Plant,
Radford, VA

ArcGIS File: C:\Radford_MMA\GIS_Documents\Project_Maps\SWMU_54\MNA_WP\RFAAP_Fig1-1_SWMU54_SiteLocMap.mxd (11/2/2010)



LEGEND

- Soil Sample Location
- Monitoring Well
- Cross Section Line
- Dirt Road
- Paved Road
- Railroad
- Fence
- 10 ft Contour Line
- SWMU 54 Boundary
- Other SWMU Boundary

N

Scale:

0 37.5 75 150 Feet

Notes:
1) Aerial photo, dated 2005, was obtained from Montgomery County, VA Planning & GIS Services.

U.S. Army Corps of Engineers

Shaw® Shaw Environmental, Inc.

FIGURE 1-2

SWMU 54 Cross Sections

Radford Army Ammunition Plant,
Radford, VA

ArcGIS File: RFAAP_Fig1-2_SWMU54_XSects.mxd (1/4/2011 6:49:21 PM)

N

AREA B

AREA A

A

A'

54MW1

54MW1A

54MW3

54MW5

54MW8

54MW10

54SB10

54SB17

54SB18

54SB19

54SB20

54SB21

54SB22

54SB23

54SB24

54SB25

54SB26

54SB27

54SB28

54SB29

54SB30

54SB31

54SB32

54SB33

54SB34

54SB35

54SB36

54SB37

54SB38

54SB3

54SB57

54SB58

54SB59

54SB60

54SB61

54SB62

54SB63

54SB64

54SB65

54SB66

54SB67

54SB68

54SB69

54SB70

54SB81

54SB82

54SB84

1680

1690

1700

1710

1720

1730

0 37.5 75 Feet

ArcGIS File: C:\Radford_MMA\GIS_Documents\Project_Maps\SWMU_54MNA_WPInONE RFAAP_Fig1-3_SWMU54_XSect_AA.mxd (1/4/2011)

LEGEND

- Soil Sample Location
- Monitoring Well
- Dirt Road
- Paved Road
- Railroad
- Cross Section Line
- 10 ft Contour Line
- SWMU 54 Boundary

Notes:

1) Aerial photo, dated 2005, was obtained from Montgomery County, VA Planning & GIS Services.
2) Cross section A-A' profile and soil sample locations were obtained from SWMU 54 Final RCRA Facility Investigation/Corrective Measures Study Report, Volume I (September 2008, URS). Distance and elevation units are in feet. Vertical exaggeration = 5.

U.S. Army Corps of Engineers

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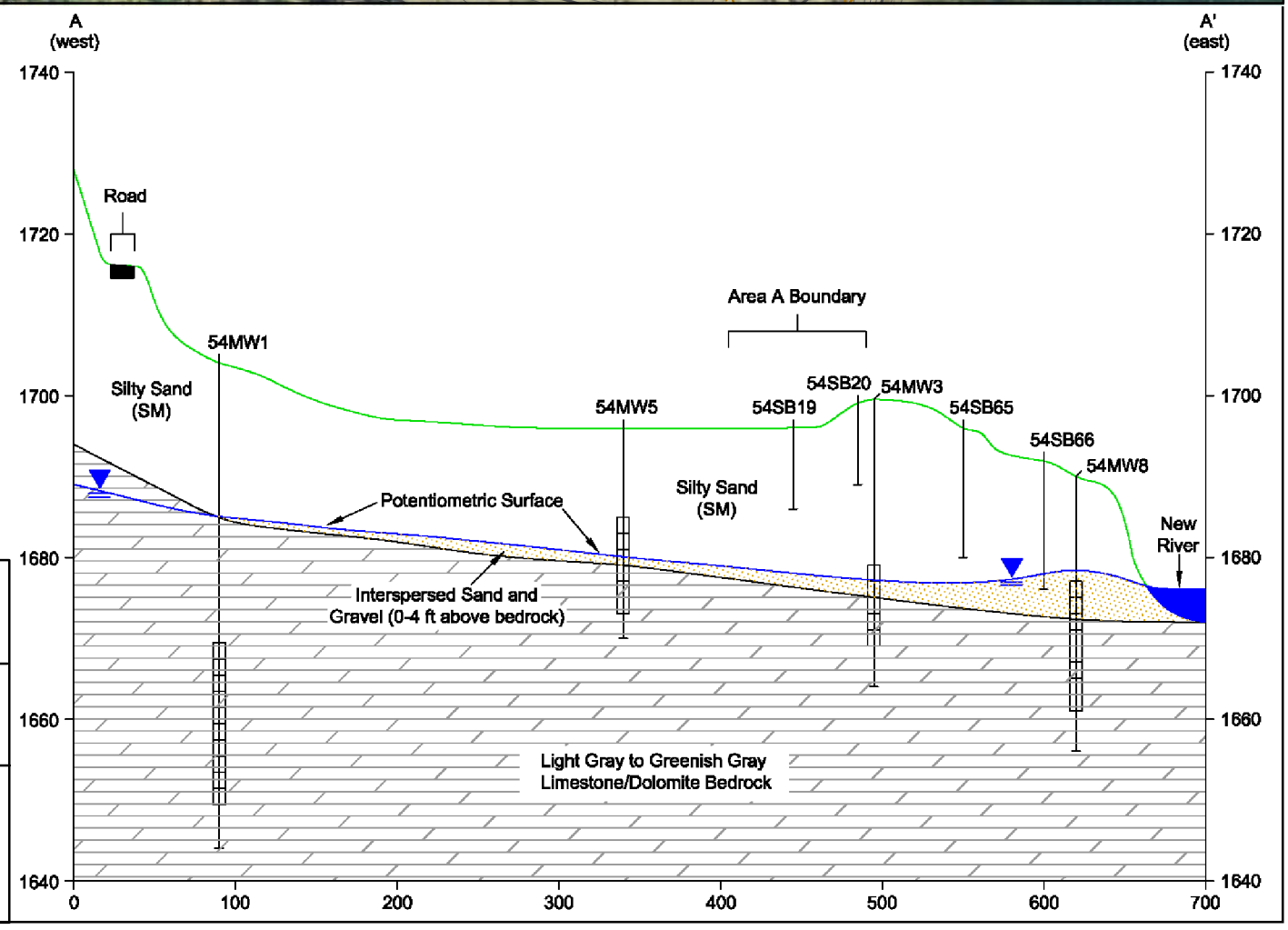
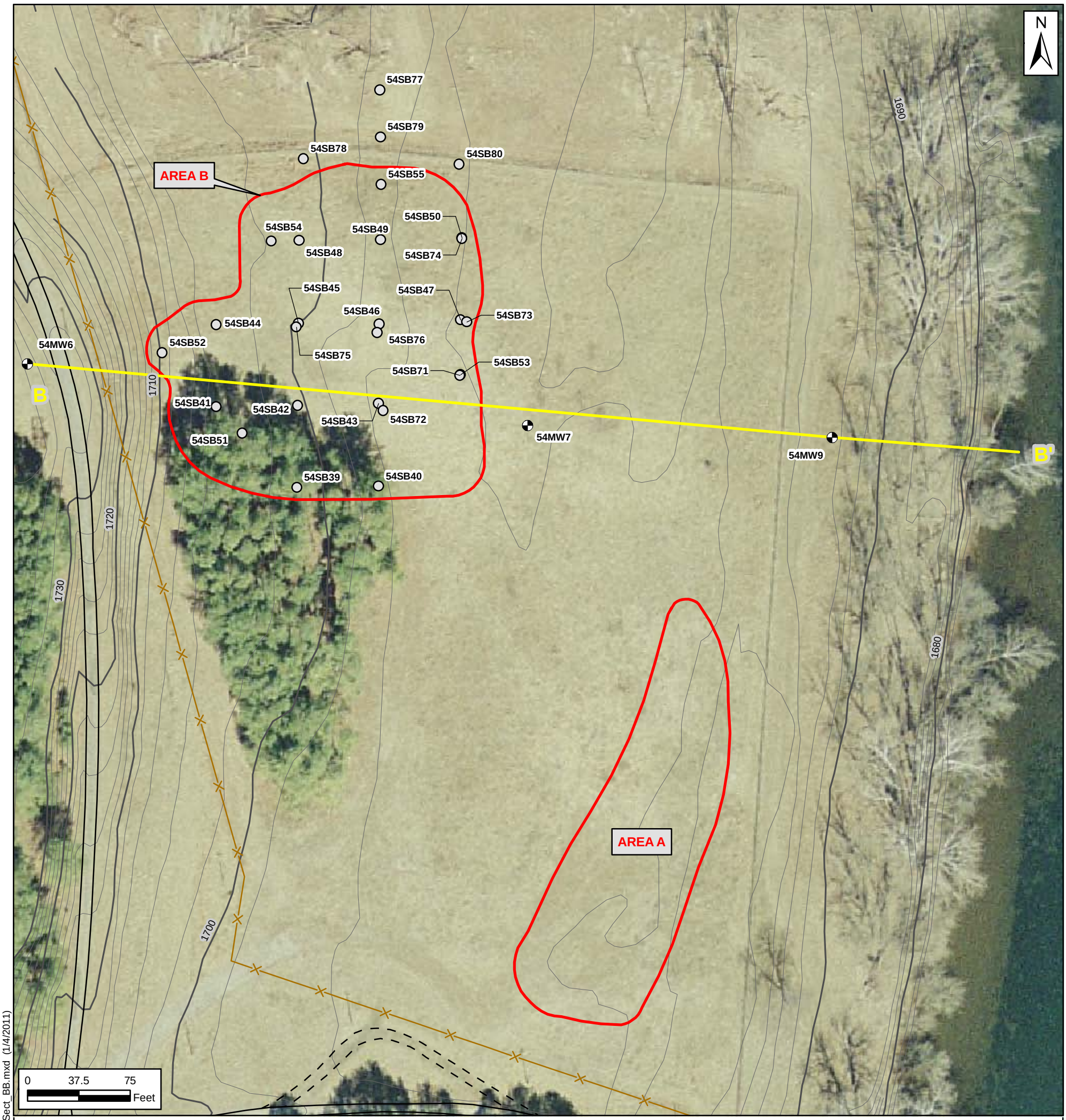
FIGURE 1-3

SWMU 54 Cross Section A-A'

Radford Army Ammunition Plant,
Radford, VA





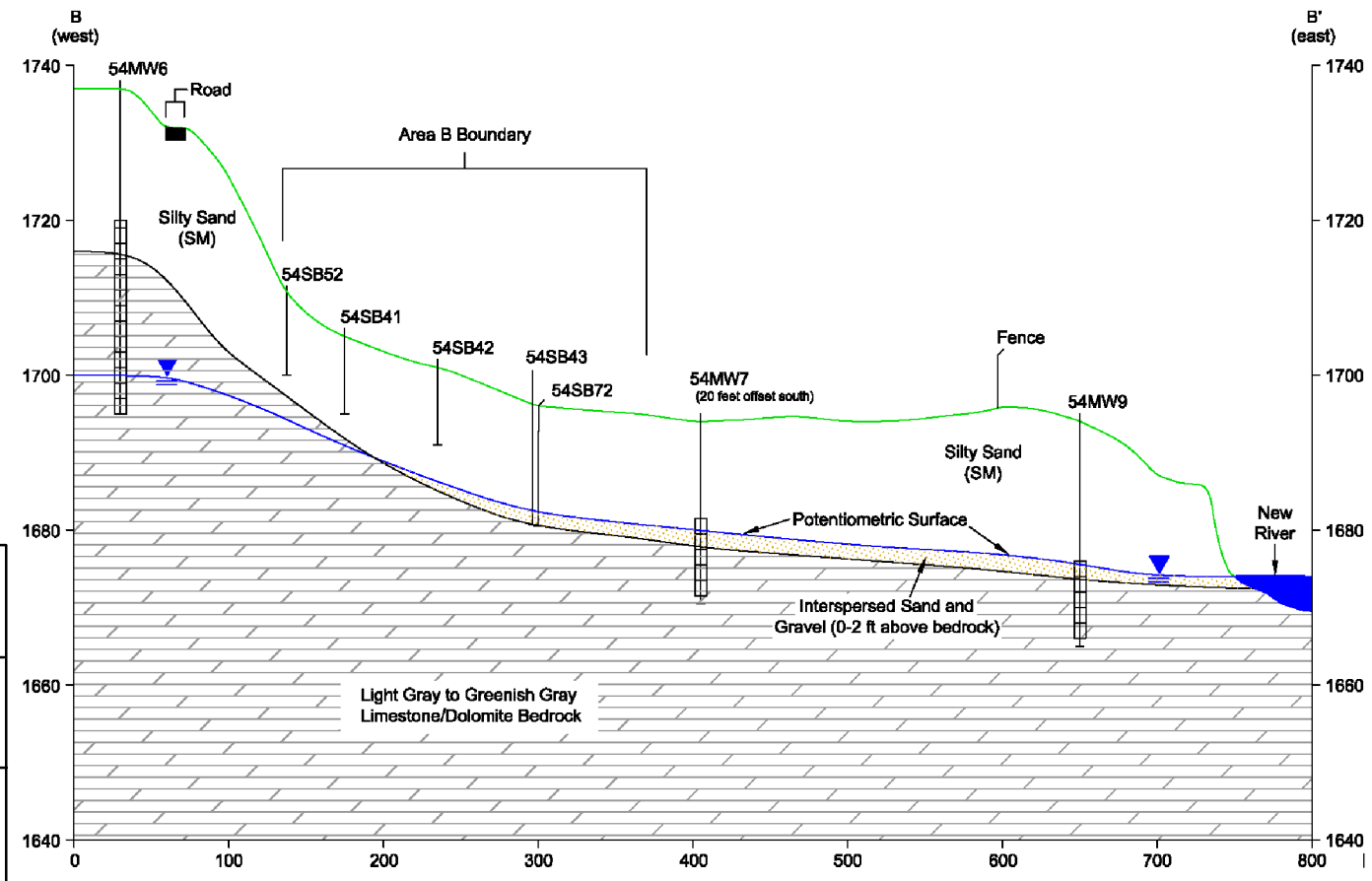
ArcGIS File: C:\Radford_MMA\GIS_Documents\Project_Maps\SWMU_54MNA_WP\nONE RFAAP_Fig1-4_SWMU54_XSect_BB.mxd (1/4/2011)

LEGEND

- Soil Sample Location
- Monitoring Well
- 10 ft Contour Line
- Dirt Road
- Paved Road
- Railroad
- Cross Section Line
- SWMU 54 Boundary

Notes:

1) Aerial photo, dated 2005, was obtained from Montgomery County, VA Planning & GIS Services.
2) Cross section B-B' profile and soil sample locations were obtained from SWMU 54 Final RCRA Facility Investigation/Corrective Measures Study Report, Volume I (September 2008, URS). Distance and elevation units are in feet. Vertical exaggeration = 5.



U.S. Army Corps of Engineers

Shaw® Shaw Environmental, Inc.

FIGURE 1-4

SWMU 54 Cross Section B-B'

Radford Army Ammunition Plant,
Radford, VA

Borings advanced at the site ranged from 10 to 60 ft in depth. Depths to bedrock were directly measured at the monitoring well borings. Bedrock elevations ranged from approximately 1,716 ft msl to 1,670 ft msl, with the bedrock surface sloping to the east.

Depth to competent bedrock at the site ranges from 17 to 24 ft. A saprolitic layer, formed from *in situ* weathering of the carbonate bedrock, immediately overlies the competent bedrock. The saprolite is up to 2.5 ft in thickness.

The bedrock under the site is the Cambrian-aged Elbrook Formation, which is a thickly-bedded, blue-gray dolostone interspersed with blue-gray to white limestone. It is locally described in nearby well borings as interbedded green and maroon shale and yellowish-brown dolostone and greenish- to grayish-brown limestone and dolostone.

The unconsolidated sediment immediately overlying the saprolite consists of alluvial deposits. Alluvial deposits, consisting primarily of silty sand overly channel deposits of fine- to coarse-grained, sand and gravel (river jack). These Paleo-channel deposits rest directly on the saprolite. Portions of the disposal areas contain fill material to depths of 9 to 10 ft below ground surface (bgs).

A more detailed discussion of the geology and soil at RFAAP is presented in Sections 3.4 through 3.7 of the *RFAAP MWP* (URS, 2003) and in the *Facility-Wide Background Study Report* (IT, 2001).

1.2 Site History

In the late 1970s, ash from propellant burning operations was reportedly disposed of at the site. The propellant ash consists of a residue resulting from the burning of waste explosives, propellants, and laboratory waste. The actual disposal practices at the site are unknown, as conflicting information describing the practices exists. The Resource Conservation and Recovery Act (RCRA) Facility Assessment (USEPA, 1987) indicated that, according to plant personnel, disposal occurred on the surface, with no routine disposal in pits or trenches. In 1998, Millennium Science and Engineering (MSE) reported that ash was buried up to 17 ft bgs in Area A and up to 7 ft bgs in Area B (MSE, 1998). The quantity of ash disposed at SWMU 54 is estimated at 10 tons (USEPA, 1987; USATHAMA, 1976). A sample of ash was collected for laboratory analysis from the site during an investigation conducted by Parsons Engineering Science, Inc. in 1996 (Parsons, 1996). Analytical results of the sample indicated a concentration of lead above the Toxicity Characteristic Leaching Procedure (TCLP) limit of 5 milligrams per liter (mg/L).

1.2.1 Previous Investigations

Four previous investigations have been conducted at this site prior to completion of an interim removal measure in 1999 by Parallax, Inc. Data obtained from previous site investigations prior to the interim measure were used to identify site boundaries and characteristics, and identify chemicals of potential concern (COPCs). In 1992, the Environmental Photographic Interpretation Center provided aerial photographic analysis of SWMU 54, under the direction of the U.S. Environmental Protection Agency (USEPA). Also in 1992, under authority of the 1984 Hazardous and Solid Waste Amendments, Dames & Moore conducted a RCRA Verification Investigation (VI) at the site to identify the ash disposal at Area A. As a follow-up to the 1992 VI, Parsons completed a RCRA Facility Investigation (RFI) in 1996, as part of a multiple site

investigation to "define the extent of ash and the limits of soil contamination." In 1998, a Supplemental RFI/Corrective Measures Study (CMS) was conducted to investigate a flat grassy area ringed by mature pine trees northwest of Area A. This area was defined as Area B within SWMU 54. The purpose of the supplemental RFI was to "characterize the nature and extent of contamination within SWMU 54." In 1999, Parallax, Inc. completed IM at Area A and Area B of SWMU 54 consisting of excavation of selected "hot spot" areas of lead and explosives in soil.

In 2008, URS Corporation (URS) conducted an RFI/CMS investigating both Area A and Area B to confirm the effectiveness of the IM as well as evaluate and assess current conditions at the sites and provide recommendations regarding potential corrective measure requirements at the sites. Direct push soil borings with chemical sampling were used to: characterize the nature and extent of constituents in soil at SWMU 54, identify the lateral and vertical extent of any waste material present, and characterize soil lithology and depth to groundwater and bedrock. Additionally, monitoring wells were installed at the site and groundwater samples were collected and analyzed. Details of these investigations are described in Section 3.0 (Field Investigation Program) of the Final *SWMU 54 RFI/CMS Report* (URS, 2008). A potentiometric map, portraying the most recent groundwater levels is provided as **Figure 1-5**. Historical data listing constituent concentrations in the existing wells on site can be found in **Tables 1-1** through **1-6.**

The nature and extent assessment indicated that the main concern at the site is the fill material and grossly-contaminated soil directly below the material. Areas A and B were evaluated separately for the soil and groundwater nature and extent assessments given the 200-ft separation between the areas, their topographic cross-gradient position, the lack of mobility of the chemicals in soil, and observed distributions of chemicals.

The main parameters of concern in Area A soil are lead, 2,4,6-TNT, DNT, RDX, amino DNTs, NG, heptachlor epoxide, and dioxins/furans. The main parameters of concern in groundwater at Area A are explosives and perchlorate. Concentrations of 2,4,6-TNT, DNT, amino DNT, RDX, and perchlorate in groundwater have decreased since RFI monitoring began in 2003 and 2004. The lateral extent of explosives and perchlorate in groundwater extends from Area A eastward to the area of the New River. Sampling of the groundwater/surface water interface (sediment pore water) and surface water of the New River did not indicate detectable impacts to sediment pore water or surface water from COPCs in groundwater.

Parameters of concern in Area B soils include lead, DNT, amino DNT, NG, RDX, dieldrin, Aroclor 1254, heptachlor epoxide, and dioxins/furans. No contaminants of interest (COIs) were identified for Area B Groundwater.

The Human Health Risk Assessment (HHRA) identified eight COIs at Area A (2,4,6-TNT, DNT, RDX, perchlorate, amino DNTs, NG, heptachlor epoxide, and 2,3,7,8-TCDD) and ten COIs at Area B (2,4,6-TNT, DNT, RDX, amino DNTs, NG, lead, Aroclor 1254, heptachlor epoxide, dieldrin, and 2,3,7,8-TCDD) under both an industrial and residential future-use scenario for total soil at SWMU 54. The HHRA determined that unacceptable risks to potential future residential and industrial receptors were associated with the COIs. Based on the results from the HHRA, it was concluded that based on the levels detected in the soil hot spot areas, COIs could potentially leach from soil to groundwater at levels of concern, although groundwater impacts at levels of concern have not yet been identified at Area B. Because the RFI demonstrated that COI contamination is present at concentrations associated with unacceptable human health concerns,

Table 1-1
2002 Area A Direct Push Groundwater Analytical Results with Remedial Goals
SWMU 54
Radford Army Ammunition Plant, Radford, Virginia

Sample ID Sample Date	CAS	C/N	RG	Units	54DPW1 12/11/2002		MDL	RL	54DPW2 12/11/2002		MDL	RL	54DPW3 12/11/2002		MDL	RL	54GP77 10/13/2004		MDL	RL	54GP78 10/11/2004		MDL	RL	54GP78-DUP(DUP-1) 10/11/2004		MDL	RL	54GP79 10/11/2004		MDL	RL	54GP80 10/13/2004		MDL	RL	54GP81 10/11/2004		MDL	RL	54GP82 10/11/2004		MDL	RL
					Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
Explosives				ug/L																																								
2,4,6-Trinitrotoluene	118-96-7	N	**7.82**	ug/L	<7.2	U,R,I	0.73	7.2	1.5	JB,B,z	0.33	3.3	<2.1	U,R,I	0.21	2.1	NT				NT				NT				NT				NT				NT				NT				NT			
DNT mixture*			**0.932**		ND				ND				ND				ND				ND				ND				ND				ND				ND				ND			
RDX	121-82-4	C	**6.1**	ug/L	<7.2	U,R,I	1	7.2	<3.3	U,R,I	0.48	3.3	<2.1	U,R,I	0.31	2.1	NT				NT				NT				NT				NT				NT				NT				NT			
Perchlorate																																												
Perchlorate	14797-73-0	N	**10.9**	ug/L	5.5		0.54	1	27.7		0.54	1	2		0.54	1	3.5		0.1	1	<1	U	0.1	1	<1	U	0.1	1	<1	U	0.1	1	<1	U	0.1	1	1		0.1	1	<1	U	0.1	1

Table 1-1
2002 Area A Direct Push Groundwater Analytical Results with Remedial Goals
SWMU 54
Radford Army Ammunition Plant, Radford, Virginia

Sample ID Sample Date	CAS	C/N	RG	Units	54GP83 10/11/2004		MDL	RL	54GP84 10/13/2004		MDL	RL	54GP85 10/14/2004		MDL	RL	54GP86 10/13/2004		MDL	RL	54GP87 10/14/2004		MDL	RL	54GW56 8/18/2004		MDL	RL	54GW57 8/17/2004		MDL	RL	54GW58 8/24/2004		MDL	RL	54GW59 8/18/2004		MDL	RL	54GW59-DUP(DUP-3) 8/18/2004		MDL	RL
					Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
Explosives				ug/L																																								
2,4,6-Trinitrotoluene	118-96-7	N	**7.82**	ug/L	NT				NT				NT				NT				NT				160		0.15	1.3	1.7	,J,g	0.0749	0.65	15		0.0749	0.65	4.2	,L,f	0.0749	0.65	11	,J,g	0.0749	0.65
DNT mixture*			**0.932**		ND				ND				ND				ND				ND				ND				ND	U			ND				ND				ND			
RDX	121-82-4	C	**6.1**	ug/L	NT				NT				NT				NT				NT				35	,J,g	0.164	0.65	0.69		0.164	0.65	3.7		0.164	0.65	1		0.164	0.65	1.7		0.164	0.65
Perchlorate																																											
Perchlorate	14797-73-0	N	**10.9**	ug/L	<1	U	0.1	1	<1	U	0.1	1	<1	U	0.1	1	<1	U	0.1	1	<1	U	0.1	1	13.5		0.1	1	2		0.1	1	25.8		0.1	1	4		0.1	1	3.6		0.1	1

Table 1-1
2002 Area A Direct Push Groundwater Analytical Results with Remedial Goals
SWMU 54
Radford Army Ammunition Plant, Radford, Virginia

Sample ID / Sample Date	CAS	C/N	RG	Units	54GW60 8/24/2004		MDL	RL	54GW61 8/24/2004		MDL	RL	54GW62 8/23/2004		MDL	RL	54GW63 8/23/2004		MDL	RL	54GW64 8/23/2004		MDL	RL	54GW64-DUP(DUP-9) 8/23/2004		MDL	RL	54GW65 8/20/2004		MDL	RL	54GW66 8/20/2004		MDL	RL	54GW66 8/23/2004		MDL	RL	54GW67 8/20/2004		MDL	RL	54G 8/23/
					Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result
Explosives				ug/L																																						
2,4,6-Trinitrotoluene	118-96-7	N	**7.82**	ug/L	9.3		0.0749	0.65	74		0.0749	0.65	9		0.0749	0.65	<0.65	U	0.0749	0.65	0.82	,J,g	0.0749	0.65	0.76	,J,g	0.0749	0.65	3		0.0749	0.65	NT				<0.65	U	0.0749	0.65	NT				<0.65
DNT mixture*			**0.932**		ND				ND				ND				ND				ND				ND				ND				ND				ND				ND				ND
RDX	121-82-4	C	**6.1**	ug/L	0.8		0.164	0.65	<0.65	U	0.164	0.65	1.6		0.164	0.65	<0.65	U	0.164	0.65	0.75	,J,g	0.164	0.65	0.73	,J,g	0.164	0.65	0.7		0.164	0.65	NT				<0.65	U	0.164	0.65	NT				<0.65
Perchlorate																																											
Perchlorate	14797-73-0	N	**10.9**	ug/L	1.7		0.1	1	3		0.1	1	5.3		0.1	1	<1	U	0.1	1	1.1		0.1	1	0.97	B	0.1	1	1.7		0.1	1	0.94	B,J,m	0.1	1	NT				0.59	B,J,m	0.1	1	NT

Notes:

µg/L = Microgram Per Liter
TAL = Target Analyte List
TCL = Target Compound List
SVOC = Semivolatile Organic Compound
TIC = Tentatively Identified Compound
MDL = Method Detection Limit
RL = Reporting Limit
LQ = Laboratory Qualifier
VQ = Validation Qualifier
r = Reason Code
NI = Not Identified
NT = Not Tested
ND = Not Detected
*The results of 2,4-DNT and 2,6-DNT were added together to get the DNT mixture result.

C = Carcinogenic per EPA RBC Table (October 2007)
N = Noncarcinogenic per EPA RBC Table (October 2007)

=Exceeds RG

B = Not detected substantially above the level reported in laboratory or field blanks.
E = Concentration exceeded the upper level of the calibration range of the instrument for that specific analysis. For TICs, compound not present in calibration standard, calculated using total peak areas ion chromatographs and response factor of 1.
J = Analyte present. Reported value may not be accurate or precise.
L = Analyte present. Reported value may be biased low. Actual value is expected to be higher.
N = Sample spike recovery is outside of control limits.
P = Greater than 40% difference for detected concentrations between the two GC or HPLC columns.
U = Not detected. The associated number indicates the approximate sample concentration necessary to be detected.
UJ = Not detected, quantitation limit may be inaccurate or imprecise.
UL = Not detected, quantitation limit is probably higher.
g = Dual column confirmation imprecision
l = LCS recovery failure
m = MS/MSD recovery failure.
o = Calibration blank contamination
p = Preparation blank contamination
s = Serial dilution failure
w = Field and/or equipment blank contamination
x = Trip blank contamination
z = Method blank and/or storage blank contamination

Table 1-1
2002 Area A Direct Push Groundwater Analytical Results with Remedial Goals
SWMU 54
Radford Army Ammunition Plant, Radford, Virginia

Sample ID Sample Date	CAS	C/N	RG	Units	W67 2004		MDL	RL	54GW68 8/20/2004		MDL	RL	54GW69 8/20/2004		MDL	RL	54GW69 8/23/2004		MDL	RL	54GW70 8/20/2004		MDL	RL
					LQ, VQ, r				Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
Explosives				ug/L																				
2,4,6-Trinitrotoluene	118-96-7	N	**7.82**	ug/L	U		0.0749	0.65	2.6	,J,g	0.0749	0.65	NT				1.4		0.0749	0.65	<0.65	U	0.0749	0.65
DNT mixture*			**0.932**						ND				ND				ND				ND			
RDX	121-82-4	C	**6.1**	ug/L	U		0.164	0.65	<0.65	U	0.164	0.65	NT				0.51	J	0.164	0.65	<0.65	U	0.164	0.65
Perchlorate																								
Perchlorate	14797-73-0	N	**10.9**	ug/L					<1	U	0.1	1	0.65	B,J,m	0.1	1	NT				0.76	B	0.1	1

Table 1-2
2003-2004 Area A Groundwater Analytical Results with Remedial Goals
SWMU 54
Radford Army Ammunition Plant, Radford, Virginia

Sample ID / Sample Date	CAS	C/N	RG	Units	54MW2 3/4/2003		MDL	RL	54MW3 3/4/2003		MDL	RL	54MW5 3/4/2003		MDL	RL	54MW-8 12/21/2004		MDL	RL	54MW-9 12/21/2004		MDL	RL	54MW-10 12/21/2004		MDL	RL	54MW10-DUP(DUP-1) 12/21/2004		MDL	RL
					Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
Explosives				ug/L																												
2,4,6-Trinitrotoluene	118-96-7	N	**7.82**	ug/L	<3.6	U	0.365	3.6	38		0.365	3.6	<4.2	U	0.43	4.2	<0.65	U	0.0749	0.65	<0.65	U	0.0749	0.65	62		0.15	1.3	65		0.15	1.3
DNT mix*			**0.932**	ug/L	ND				ND				ND				ND				ND				ND				ND			
RDX (Hexahydro-1,3,5-trinitro-1,3,5-tria	121-82-4	C	**6.1**	ug/L	<3.6	U	0.526	3.6	32		0.526	3.6	<4.2	U	0.61	4.2	0.2	J,J,g	0.164	0.65	1.1	,J,g	0.164	0.65	28		0.164	0.65	29		0.164	0.65
Perchlorate																																
Perchlorate	14797-73-0	N	**10.90**	ug/L	12		0.54	1	59.2		0.54	1	1.6		0.54	1	0.22	B	0.1	1	0.21	B	0.1	1	9.8		0.1	1	9.1		0.1	1
Field Parameters																																
Dissolved Oxygen	--	--	--	mg/L	6.97				5.18				2.88				0.25				2.56				1.25				1.25			
Oxidation Reduction Potential	--	--	--	mV	159.5				119.0				95.1				215				234				208				208			
pH	--	--	--	SU	6.37				6.65				7.00				7.20				7.53				7.06				7.06			
Conductivity	--	--	--	mS	0.191				0.341				0.310				0.627				0.706				0.760				0.760			
Temperature	--	--	--	°C	16.24				15.97				12.91				13.6				13.2				13.8				13.8			
Turbidity	--	--	--	NTU	0.80				1.93				12.0				4.17				4.13				3.52				3.52			

*DNT mixture result is the result of the adding together of 2,4-DNT and 2,6-DNT.

ND

CAS = Chemical Abstracts Service
µg/L = Microgram Per Liter
TAL = Target Analyte List
TCL = Target Compound List
SVOC = Semivolatile Organic Compound
TIC = Tentatively Identified Compound
MDL = Method Detection Limit
RL = Reporting Limit
LQ = Laboratory Qualifier
VQ = Validation Qualifier
r = Reason Code
NI = Not Identified
NT = Not Tested
mV = millivolt

SU = Standard Units
mS = milliSiemen
°C = degrees Celcius
NTU = Nephelometric Turbidity
RBC = USEPA Region III Risk-Based Concentration (RBC) values from the October 11, 2007, RBC Table and October 11, 2007, Alternate RBC Table
C = Carcinogenic per EPA RBC Table (October 2007)
N = Noncarcinogenic per EPA RBC Table (October 2007)
MCL = Maximum Contaminant Level

= detected above Remedial Goal (RG)

Data Qualifiers:
B = Not detected substantially above the level reported in laboratory or field blanks.
E = Concentration exceeded the upper level of the calibration range of the instrument for that specific analysis. For TICs, compound not present in calibration standard, calculated using total peak areas ion chromatographs and response factor of 1.
J = Analyte present. Reported value may not be accurate or precise.
L = Analyte present. Reported value may be biased low. Actual value is expected to be higher.
N = Sample spike recovery is outside of control limits.
P = Greater than 40% difference for detected concentrations between the two GC or HPLC columns.
U = Not detected. The associated number indicates the approximate sample concentration necessary to be detected.
UJ = Not detected, quantitation limit may be inaccurate or imprecise.
UL = Not detected, quantitation limit is probably higher.

g = Dual column confirmation imprecision
l = LCS recovery failure
m = MS/MSD recovery failure.
o = Calibration blank contamination
p = Preparation blank contamination
s = Serial dilution failure
w = Field and/or equipment blank contamination
x = Trip blank contamination
z = Method blank and/or storage blank contamination

Table 1-3
2006-2007 Area A Quarterly Groundwater Monitoring Results with Remedial Goals
SWMU 54
Radford Army Ammunition Plant, Radford, Virginia

First Quarter - November/December 2006

Sample ID / Sample Date	CAS	C/N	RG	54MW1 11/29/2006 Result	LQ, VQ, r	MDL	RL	54MW2 11/29/2006 Result	LQ, VQ, r	MDL	RL	54MW3 12/5/2006 Result	LQ, VQ, r	MDL	RL	54MW5 11/29/2006 Result	LQ, VQ, r	MDL	RL	54MW8 12/1/2006 Result	LQ, VQ, r	MDL	RL	54MW9 12/1/2006 Result	LQ, VQ, r	MDL	RL	54MW10 12/1/2006 Result	LQ, VQ, r	MDL	RL
Explosives (ug/L)																															
2,4,6-Trinitrotoluene	118-96-7	N	**7.82**	<5	U	0.075	5	5.6		0.075	5	0.85	J	0.075	5	0.29	J	0.075	5	<5	U	0.075	5	<5	U	0.075	5	2.1	J	0.075	5
Dinitrotoluene Mixture	--	C	**0.932**	<5				<5				<5				<5				<5				<5				<5			
RDX	121-82-4	C	**6.100**	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5	3.3	J	0.16	5
Perchlorate (ug/L)																															
Perchlorate	14797-73-0	N	**10.90**	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10
Field Parameters																															
Dissolved Oxygen (mg/L)	--	--	--	11.95				10.29				11.94				10.1				8.94				8.51				8.13			
Oxidation Reduction Potential (mV)	--	--	--	153				159				171				231				32				53				36			
pH (SU)	--	--	--	7.86				7.15				7.26				7.2				7.53				7.65				7.39			
Conductivity (mS)	--	--	--	0.44				0.533				0.580				0.557				0.605				0.790				0.733			
Temperature (°C)	--	--	--	18.6				17.7				18.3				18.5				17.1				19.1				16.3			
Turbidity (NTU)	--	--	--	4.47				1.16				0.07				16.6				11.83				23.5				10.31			

Second Quarter - March 2007

Sample ID / Sample Date	CAS	C/N	RG	54MW-1 3/28/2007 Result	LQ, VQ, r	MDL	RL	54MW-2 3/28/2007 Result	LQ, VQ, r	MDL	RL	54MW-3 3/28/2007 Result	LQ, VQ, r	MDL	RL	54MW-5 3/28/2007 Result	LQ, VQ, r	MDL	RL	54MW-8 3/27/2007 Result	LQ, VQ, r	MDL	RL	54MW-9 3/27/2007 Result	LQ, VQ, r	MDL	RL	54MW10 DUP AVG 3/27/2007 Result	LQ, VQ, r	MDL	RL
Explosives (ug/L)																															
2,4,6-Trinitrotoluene	118-96-7	N	**7.82**	<5	U	0.1	5	0.25	J,J,d	0.1	5	<5	U	0.1	5	0.84	J,J,g	0.1	5	14		0.1	5	<5	U	0.1	5	6.018		0.1	5
Dinitrotoluene Mixture	--	C	**0.932**	<5				1.146				<5				<5				<5				<5				0.898			
RDX	121-82-4	C	**6.100**	<5	U	0.092	5	<5	U	0.092	5	<5	U	0.092	5	<5	U	0.092	5	8.1		0.092	5	<5	U	0.092	5	3.87		0.092	5
Perchlorate (ug/L)																															
Perchlorate	14797-73-0	N	**10.90**	<0.2	U	0.036	0.2	3.6		0.036	0.2	<0.2	U	0.036	0.2	0.52		0.036	0.2	0.26		0.036	0.2	0.24		0.036	0.2	2.9		0.036	0.2
Field Parameters																															
Dissolved Oxygen (mg/L)	--	--	--	8.06				7.75				6.12				8.38				6.68				6.51				8			
Oxidation Reduction Potential (mV)	--	--	--	-5				44				-11				53				-17				-10				11			
pH (SU)	--	--	--	7.63				6.45				6.94				6.51				7.05				7.18				6.88			
Conductivity (mS)	--	--	--	0.199				0.183				0.311				0.167				0.267				0.960				0.334			
Temperature (°C)	--	--	--	13.44				15.8				15.22				12.73				13.92				14.43				15.95			
Turbidity (NTU)	--	--	--	1.82				0.37				2.13				1.22				13.96				7.71				3.64			

Table 1-3
2006-2007 Area A Quarterly Groundwater Monitoring Results with Remedial Goals
SWMU 54
Radford Army Ammunition Plant, Radford, Virginia

Third Quarter - June 2007

Sample ID / Sample Date	CAS	C/N	RG	54MW-1 6/5/2007		MDL	RL	54MW-2 6/5/2007		MDL	RL	54MW-3 6/5/2007		MDL	RL	54MW-5 6/5/2007		MDL	RL	54MW-8 6/5/2007		MDL	RL	54MW-9 6/5/2007		MDL	RL	54MW-10 6/5/2007		MDL	RL
				Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
Explosives (ug/L)																															
2,4,6-Trinitrotoluene	118-96-7	N	**7.82**	<5	U	0.1	5	3.9	J	0.1	5	1	J	0.1	5	0.49	J	0.1	5	<5	U	0.1	5	<5	U	0.1	5	2.4	J	0.1	5
Dinitrotoluene Mixture	--	C	**0.932**	ND				ND				ND				ND				ND				0.466				ND			
RDX	121-82-4	C	**6.100**	<5	U	0.092	5	<5	U	0.092	5	<5	U	0.092	5	<5	U	0.092	5	6.3		0.092	5	<5	U	0.092	5	1.6	J	0.092	5
Perchlorate (ug/L)																															
Perchlorate	14797-73-0	N	**10.90**	<0.2	U	0.08	0.2	2		0.08	0.2	0.88		0.08	0.2	0.58		0.08	0.2	0.7		0.08	0.2	0.23		0.08	0.2	0.37		0.08	0.2
Field Parameters																															
Dissolved Oxygen (mg/L)	--	--	--	7.57				8.46				5.06				8.44				8.82				5.21				7.35			
Oxidation Reduction Potential (mV)	--	--	--	297				268				109				236				285				94				187			
pH (SU)	--	--	--	7.33				6.78				6.2				6.24				6.9				6.25				6.87			
Conductivity (mS)	--	--	--	0.192				0.225				0.003				0.163				0.245				0.003				0.353			
Temperature (°C)	--	--	--	13.58				13.48				15.66				21.68				13.4				15.44				14.51			
Turbidity (NTU)	--	--	--	0.48				0.29				0.36				0.67				0.06				1.67				9.37			

Fourth Quarter - September 2007

Sample ID / Sample Date	CAS	C/N	RG	54MW-1 9/19/2007		MDL	RL	54MW-2 9/19/2007		MDL	RL	54MW-3 9/19/2007		MDL	RL	54MW-5 9/19/2007		MDL	RL	54MW-8 9/18/2007		MDL	RL	54MW-9 9/18/2007		MDL	RL	54MW-10 9/18/2007		MDL	RL
				Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
Explosives (ug/L)																															
2,4,6-Trinitrotoluene	118-96-7	N	**7.82**	<5	U	0.1	5	0.78	J	0.1	5	1.2	J	0.1	5	0.38	J,J,g	0.1	5	<5	U	0.1	5	<5	U	0.1	5	17		0.1	5
Dinitrotoluene Mixture	--	C	**0.932**	ND				ND				ND				ND				ND				ND				0.696			
RDX	121-82-4	C	**6.100**	<5	U	0.092	5	<5	U	0.092	5	<5	U	0.092	5	<5	U	0.092	5	<5	U	0.092	5	<5	U	0.092	5	8		0.092	5
Perchlorate (ug/L)																															
Perchlorate	14797-73-0	N	**10.90**	<0.2	U	0.08	0.2	0.57		0.08	0.2	0.31		0.08	0.2	0.34		0.08	0.2	0.37		0.08	0.2	<0.2	U	0.08	0.2	2.9		0.08	0.2
Field Parameters																															
Dissolved Oxygen (mg/L)	--	--	--	4.03				2.37				6.34				5.53				4.06				3.78				3.89			
Oxidation Reduction Potential (mV)	--	--	--	233				172				205				228				288				237				239			
pH (SU)	--	--	--	8.2				7.01				5.67				6.89				6.82				7.11				6.76			
Conductivity (mS)	--	--	--	0.487				0.637				0.57				0.647				0.711				0.833				0.844			
Temperature (°C)	--	--	--	19.79				15.91				15.6				17.36				14.41				18.05				17.27			
Turbidity (NTU)	--	--	--	0.79				2.19				2.02				1.62				0.43				2.19				7.19			

Notes:

CAS = Chemical Abstracts Service
ug/L = Microgram Per Liter
ng/L = Nanograms Per Liter
MDL = Method Detection Limit
RL = Reporting Limit
LQ = Laboratory Qualifier
VQ = Validation Qualifier
r = Reason Code

ND = Not Detected
NT = Not Tested
mV = millivolt
SU = Standard Units
mS = milliSiemen
°C = degrees Celcius
NTU = Nephelometric Turbidity

RBC = USEPA Region III Risk-Based Concentration (RBC) values from the October 11, 2007, RBC Table and October 11, 2007, Alternate RBC Table
C = Carcinogenic per EPA RBC Table (October 2007)
N = Noncarcinogenic per EPA RBC Table (October 2007)
MCL = Maximum Contaminant Level
=Exceeds RG

Data Qualifiers:
J = Analyte present. Reported value may not be accurate or precise.
U = Not

UJ = Not detected, quantitation limit may be inaccurate or imprecise.
c = Calibration failure
d = MS/MSD or LCS/LCSD RPD imprecision
g = Dual column confirmation imprecision
l = LCS recovery failure
m = MS/MSD recovery failure.

Table 1-4
2003 Area B Groundwater Analytical Results with Remedial Goals
SWMU 54
Radford Army Ammunition Plant, Radford, Virginia

Sample ID / Sample Date	RG	Units	54MW4 3/4/2003 Result	LQ, VQ, r	MDL	RL	54MW6 3/3/2003 Result	LQ, VQ, r	MDL	RL	54MW7 3/4/2003 Result	LQ, VQ, r	MDL	RL	54MW7-DUP(GW-DUP-1) 3/4/2003 Result	LQ, VQ, r	MDL	RL
Perchlorate																		
Perchlorate[1]	**10.9**	µg/L	<1	U	0.54	1	<1	U	0.54	1	<1	U	0.54	1	<1	U	0.54	1
Explosives																		
2,4,6-Trinitrotoluene	**7.82**	µg/L	<5.4	U	0.55	5.4	<4.2	U	0.43	4.2	<3.6	U	0.365	3.6	<4.8	U	0.487	4.8
DNT Mixture	**0.932**	ug/L	ND				ND				ND				ND			
RDX (Hexahydro-1,3,5-trinitro-1,3,5-tria	**6.1**	µg/L	<5.4	U	0.79	5.4	<4.2	U	0.61	4.2	<3.6	U	0.526	3.6	<4.8	U	0.701	4.8

Notes:

CAS = Chemical Abstracts Service
µg/L = Microgram Per Liter
MDL = Method Detection Limit
RL = Reporting Limit
LQ = Laboratory Qualifier
VQ = Validation Qualifier
r = Reason Code
C = Carcinogenic per EPA RBC Table (October 2007)
N = Noncarcinogenic per EPA RBC Table (October 2007)

ND = Not detected

mV = millivolt
SU = Standard Units
mS = miliSiemen
°C = degrees Celcius
NTU = Nephelometric Turbidity

=Exceeds RG

Data Qualifiers:
B = Not detected substantially above the level reported in laboratory or field blanks.
E = Concentration exceeded the upper level of the calibration range of the instrument for that specific analysis. For TICs, compound not present in calibration standard, calculated using total peak areas ion chromatographs and response factor of 1.
J = Analyte present. Reported value may not be accurate or precise.
K = Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L = Analyte present. Reported value may be biased low. Actual value is expected to be higher.
N = Sample spike recovery is outside of control limits.
U = Not detected. The associated number indicates the approximate sample concentration necessary to be detected.
UJ = Not detected, quantitation limit may be inaccurate or imprecise.
UL = Not detected, quantitation limit is probably higher.
g = Dual column confirmation imprecision
l = LCS recovery failure
m = MS/MSD recovery failure.
o = Calibration blank contamination
p = Preparation blank contamination
s = Serial dilution failure
w = Field and/or equipment blank contamination
x = Trip blank contamination
z = Method blank and/or storage blank contamination

Table 1-5
2006-2007 Area B Quarterly Groundwater Monitoring Results with Remedial Goals
SWMU 54
Radford Army Ammunition Plant, Radford, Virginia

First Quarter - November/December 2006

Sample ID / Sample Date	CAS	C/N	Adjusted Tap Water RBC	54MW4 11/30/2006		MDL	RL	54MW6 11/29/2006		MDL	RL	54MW7 12/5/2006		MDL	RL
				Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
Explosives (ug/L)															
2,4,6-Trinitrotoluene	118-96-7	N	**7.82**	<5	U	0.075	5	<5	U	0.075	5	<5	U	0.075	5
Dinitrotoluene Mixture	--	C	**0.932**	<5				<5				<5			
RDX	121-82-4	C	**6.100**	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5
Perchlorate (ug/L)															
Perchlorate	14797-73-0	N	**10.90**	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10
Field Parameters															
Dissolved Oxygen (mg/L)	--	--	--	9.9				11.63				10.46			
Oxidation Reduction Potential (mV)	--	--	--	-92				181				170			
pH (SU)	--	--	--	7.77				8				7.56			
Conductivity (mS)	--	--	--	1.13				0.297				0.729			
Temperature (°C)	--	--	--	15				16.6				15.9			
Turbidity (NTU)	--	--	--	2.66				4.87				5.91			

Table 1-5
2006-2007 Area B Quarterly Groundwater Monitoring Results with Remedial Goals
SWMU 54
Radford Army Ammunition Plant, Radford, Virginia

Second Quarter - March 2007

Sample ID / Sample Date	CAS	C/N	RG	54MW-4 3/27/2007		MDL	RL	54MW-6 3/27/2007		MDL	RL	54MW-7 3/27/2007		MDL	RL
				Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
Explosives (ug/L)															
2,4,6-Trinitrotoluene	118-96-7	N	**7.82**	<5	U	0.1	5	<5	U	0.1	5	<5	U	0.1	5
Dinitrotoluene Mixture	--	C	**0.932**	<5				<5				<5			
RDX	121-82-4	C	**6.100**	<5	U	0.092	5	<5	U	0.092	5	<5	U	0.092	5
Perchlorate (ug/L)															
Perchlorate	14797-73-0	N	**10.90**	<0.2	U	0.036	0.2	<0.2	U	0.036	0.2	<0.2	U	0.036	0.2
Field Parameters															
Dissolved Oxygen (mg/L)	--	--	--	5.97				8.8				6			
Oxidation Reduction Potential (mV)	--	--	--	-95				135				-44			
pH (SU)	--	--	--	7.16				8.21				7			
Conductivity (mS)	--	--	--	1.11				0.314				0.323			
Temperature (°C)	--	--	--	15.68				17.77				14.25			
Turbidity (NTU)	--	--	--	1.54				31.1				6.59			

Table 1-5
2006-2007 Area B Quarterly Groundwater Monitoring Results with Remedial Goals
SWMU 54
Radford Army Ammunition Plant, Radford, Virginia

Third Quarter - June 2007

Sample ID / Sample Date	CAS	C/N	RG	54MW4 DUP AVG 6/5/2007		MDL	RL	54MW-6 6/5/2007		MDL	RL	54MW-7 6/5/2007		MDL	RL
				Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
Explosives (ug/L)															
2,4,6-Trinitrotoluene	118-96-7	N	**7.82**	<5	U	0.1	5	<5	U	0.1	5	<5	U	0.1	5
Dinitrotoluene Mixture	--	C	**0.932**	<5				<5				<5			
RDX	121-82-4	C	**6.100**	<5	U	0.092	5	<5	U	0.092	5	<5	U	0.092	5
Perchlorate (ug/L)															
Perchlorate	14797-73-0	N	**10.90**	<0.2	U	0.08	0.2	<0.2	U	0.08	0.2	<0.2	U	0.08	0.2
Field Parameters															
Dissolved Oxygen (mg/L)	--	--	--	5.15				4.5				7.72			
Oxidation Reduction Potential (mV)	--	--	--	91				76				225			
pH (SU)	--	--	--	6.39				6.03				6.97			
Conductivity (mS)	--	--	--	0.003				0.003				0.302			
Temperature (°C)	--	--	--	14.54				19.28				3.03			
Turbidity (NTU)	--	--	--	0.67				9.96				0.71			

Table 1-5
2006-2007 Area B Quarterly Groundwater Monitoring Results with Remedial Goals
SWMU 54
Radford Army Ammunition Plant, Radford, Virginia

Fourth Quarter - September 2007

Sample ID / Sample Date	CAS	C/N	RG	54MW4 9/19/2007 Result	LQ, VQ, r	MDL	RL	54MW6 9/19/2007 Result	LQ, VQ, r	MDL	RL	54MW7 DUP AVG 9/19/2007 Result	LQ, VQ, r	MDL	RL
Explosives (ug/L)															
2,4,6-Trinitrotoluene	118-96-7	N	**7.82**	<5	U	0.1	5	<5	U	0.1	5	<5	U	0.1	5
Dinitrotoluene Mixture	--	C	**0.932**	ND				ND				ND			
RDX	121-82-4	C	**6.100**	<5	U	0.092	5	<5	U	0.092	5	<5	U	0.092	5
Perchlorate (ug/L)															
Perchlorate	14797-73-0	N	**10.90**	<0.2	U	0.08	0.2	0.1	J	0.08	0.2	<0.2	U	0.08	0.2
Field Parameters															
Dissolved Oxygen (mg/L)	--	--	--	4.03				7.47				4.56			
Oxidation Reduction Potential (mV)	--	--	--	-1				236				266			
pH (SU)	--	--	--	7.91				8.13				6.97			
Conductivity (mS)	--	--	--	1.1				0.267				0.766			
Temperature (°C)	--	--	--	16.08				16.69				16.83			
Turbidity (NTU)	--	--	--	0.43				4.37				0.39			

Notes:

CAS = Chemical Abstracts Service
ug/L = Microgram Per Liter
ng/L = Nanogram Per Liter
MDL = Method Detection Limit
RL = Reporting Limit
LQ = Laboratory Qualifier
VQ = Validation Qualifier
r = Reason Code
mV = millivolt
SU = Standard Units
mS = milliSiemen
°C = degrees Celcius
NTU = Nephelometric Turbidity
C/N = Carcinogenic/Noncarcinogenic per RBC Table (Oct 2007)
MCL = Maximum Contaminant Level

=Exceeds RG

See Table 6-3D (December 2006) and Table 6-3E (June 2007) for Total 2,3,7,8-TCDD TEQ Calculations

Table 1-6
2006 New River Surface Water and Sediment Pore Water Sample Results with Remedial Goals
SWMU 54
Radford Army Ammunition Plant, Radford, Virginia

Surface Water

Sample ID / Sample Date	CAS	C/N	RG	NR-SW-1 11/30/2006		MDL	RL	NR-SW-2 11/30/2006		MDL	RL	NR-SW-3 11/30/2006		MDL	RL	NR-SW-4 11/30/2006		MDL	RL	NR-SW-5 11/30/2006		MDL	RL	NR-SW-6 11/30/2006		MDL	RL	NR-S 12/1/
				Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result
Explosives (ug/L)																												
2,4,6-Trinitrotoluene	118-96-7	C	**7.82**	<5	U	0.075	5	<5	U	0.075	5	<5	U	0.075	5	<5	U	0.075	5	<5	U	0.075	5	<5	U	0.075	5	<5
2,4-Dinitrotoluene	121-14-2	N		<5	U	0.12	5	<5	U	0.12	5	<5	U	0.12	5	<5	U	0.12	5	<5	U	0.12	5	<5	U	0.12	5	<5
2,6-Dinitrotoluene	606-20-2	N		<5	U	0.27	5	<5	U	0.27	5	<5	U	0.27	5	<5	U	0.27	5	<5	U	0.27	5	<5	U	0.27	5	<5
DNT mixture*			**0.932**	<5				<5				<5				<5				<5				<5				<5
RDX	121-82-4	C	**6.100**	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5	<5
Perchlorate (ug/L)																												
Perchlorate	14797-73-0	--	**10.900**	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10	<10
Field Parameters																												
Dissolved Oxygen (mg/L)	--	--	--	17.05				15.83				14.64				12.93				14.83				15.11				13.13
Oxidation Reduction Potential (mV)	--	--	--	219				118				47				53				32				35				10
pH (SU)	--	--	--	8.9				8.1				7.96				7.81				7.67				8.3				8.11
Conductivity (mS)	--	--	--	0.116				0.113				0.118				0.174				0.117				0.155				0.140
Temperature (°C)	--	--	--	10.1				9.9				10.1				10.3				10.2				10.4				11.7
Turbidity (NTU)	--	--	--	71.3				13.7				17.48				9.94				7.66				6.21				148

Pore Water

Sample ID / Sample Date	CAS	C/N	RG	NR-PW-1 11/30/2006		MDL	RL	NR-PW-2 11/30/2006		MDL	RL	NR-PW-3 11/30/2006		MDL	RL	NR-PW-4 11/30/2006		MDL	RL	NR-PW-5 11/30/2006		MDL	RL	NR-PW-6 11/30/2006		MDL	RL	NR-PW-6-D 11/30
				Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result
Explosives (ug/L)																												
2,4,6-Trinitrotoluene	118-96-7	C	**7.82**	<5	U	0.075	5	<5	U	0.075	5	<5	U	0.075	5	<5	U	0.075	5	<5	U	0.075	5	<5	U	0.075	5	<5
2,4-Dinitrotoluene	121-14-2	N		<5	U	0.12	5	<5	U	0.12	5	<5	U	0.12	5	<5	U	0.12	5	<5	U	0.12	5	<5	U	0.12	5	<5
2,6-Dinitrotoluene	606-20-2	N		<5	U	0.27	5	<5	U	0.27	5	<5	U	0.27	5	<5	U	0.27	5	<5	U	0.27	5	<5	U	0.27	5	<5
DNT mixture*			**0.932**	<5				<5				<5				<5				<5				<5				<5
RDX	121-82-4	C	**6.100**	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5	<5
Perchlorate (ug/L)																												
Perchlorate	14797-73-0	--	**10.900**	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10	<10
Field Parameters																												
Dissolved Oxygen (mg/L)	--	--	--	10.38				10.46				12.2				9.35				10.82				11.34				11.34
Oxidation Reduction Potential (mV)	--	--	--	-109				-174				20				-182				-44				-58				-58
pH (SU)	--	--	--	7.33				7.21				7.47				7.57				7.44				7.2				7.2
Conductivity (mS)	--	--	--	0.307				0.344				0.248				0.38				0.553				0.353				0.353
Temperature (°C)	--	--	--	12.8				10.7				10.8				10.6				13.2				11.9				11.9
Turbidity (NTU)	--	--	--	16.35				37.9				22.7				4.86				3.63				11.85				11.85

Table 1-6
2006 New River Surface Water and Sediment Pore Water Sample Results with Remedial Goals
SWMU 54
Radford Army Ammunition Plant, Radford, Virginia

Surface Water

Sample ID				SW-7			NR-SW-8			NR-SW-8-DUP(DUP-4)			NR-SW-9			NR-SW-10		
Sample Date				2006			12/1/2006			12/1/2006			12/1/2006			12/1/2006		
	CAS	C/N	RG	LQ, VQ, r	MDL	RL	Result	LQ, VQ, r	MDL	RL	Result	LQ, VQ, r	MDL	RL	Result	LQ, VQ, r	MDL	RL	Result	LQ, VQ, r	MDL	RL
Explosives (ug/L)																						
2,4,6-Trinitrotoluene	118-96-7	C	**7.82**	U	0.075	5	<5	U	0.075	5	<5	U	0.075	5	<5	U	0.075	5	<5	U	0.075	5
2,4-Dinitrotoluene	121-14-2	N		U	0.12	5	<5	U	0.12	5	<5	U	0.12	5	<5	U	0.12	5	<5	U	0.12	5
2,6-Dinitrotoluene	606-20-2	N		U	0.27	5	<5	U	0.27	5	<5	U	0.27	5	<5	U	0.27	5	<5	U	0.27	5
DNT mixture*			**0.932**				<5				<5				<5				<5			
RDX	121-82-4	C	**6.100**	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5
Perchlorate (ug/L)																						
Perchlorate	14797-73-0	--	**10.900**	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10
Field Parameters																						
Dissolved Oxygen (mg/L)	--	--	--				13.27				13.27				13.76				14.69			
Oxidation Reduction Potential (mV)	--	--	--				41				41				51				52			
pH (SU)	--	--	--				7.8				7.8				7.62				7.83			
Conductivity (mS)	--	--	--				0.124				0.124				0.131				0.114			
Temperature (°C)	--	--	--				12.5				12.5				11.8				11			
Turbidity (NTU)	--	--	--				13.8				13.8				20.5				11.46			

Pore Water

Sample ID				UP(DUP-3)			NR-PW-7			NR-PW-8			NR-PW-9			NR-PW-10		
Sample Date				/2006			12/1/2006			12/1/2006			12/1/2006			12/1/2006		
	CAS	C/N	RG	LQ, VQ, r	MDL	RL	Result	LQ, VQ, r	MDL	RL	Result	LQ, VQ, r	MDL	RL	Result	LQ, VQ, r	MDL	RL	Result	LQ, VQ, r	MDL	RL
Explosives (ug/L)																						
2,4,6-Trinitrotoluene	118-96-7	C	**7.82**	U	0.075	5	<5	U	0.075	5	<5	U	0.075	5	<5	U	0.075	5	<5	U	0.075	5
2,4-Dinitrotoluene	121-14-2	N		U	0.12	5	<5	U	0.12	5	<5	U	0.12	5	<5	U	0.12	5	<5	U	0.12	5
2,6-Dinitrotoluene	606-20-2	N		U	0.27	5	<5	U	0.27	5	<5	U	0.27	5	<5	U	0.27	5	<5	U	0.27	5
DNT mixture*			**0.932**				<5				<5				<5				<5			
RDX	121-82-4	C	**6.100**	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5	<5	U	0.16	5
Perchlorate (ug/L)																						
Perchlorate	14797-73-0	--	**10.900**	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10	<10	U	1.84	10
Field Parameters																						
Dissolved Oxygen (mg/L)	--	--	--				9.25				9.74				10.55				10.18			
Oxidation Reduction Potential (mV)	--	--	--				-194				-173				-173				-157			
pH (SU)	--	--	--				7.54				7.36				7.23				7.47			
Conductivity (mS)	--	--	--				0.517				0.660				0.533				0.479			
Temperature (°C)	--	--	--				13				12.9				13.2				13.1			
Turbidity (NTU)	--	--	--				3.72				5.6				15.87				1.66			

Notes:

CAS = Chemical Abstracts Service
mg/L = Milligram Per Liter
ug/L = Microgram Per Liter
MDL = Method Detection Limit
RL = Reporting Limit
LQ = Laboratory Qualifier
VQ = Validation Qualifier
r = Reason Code

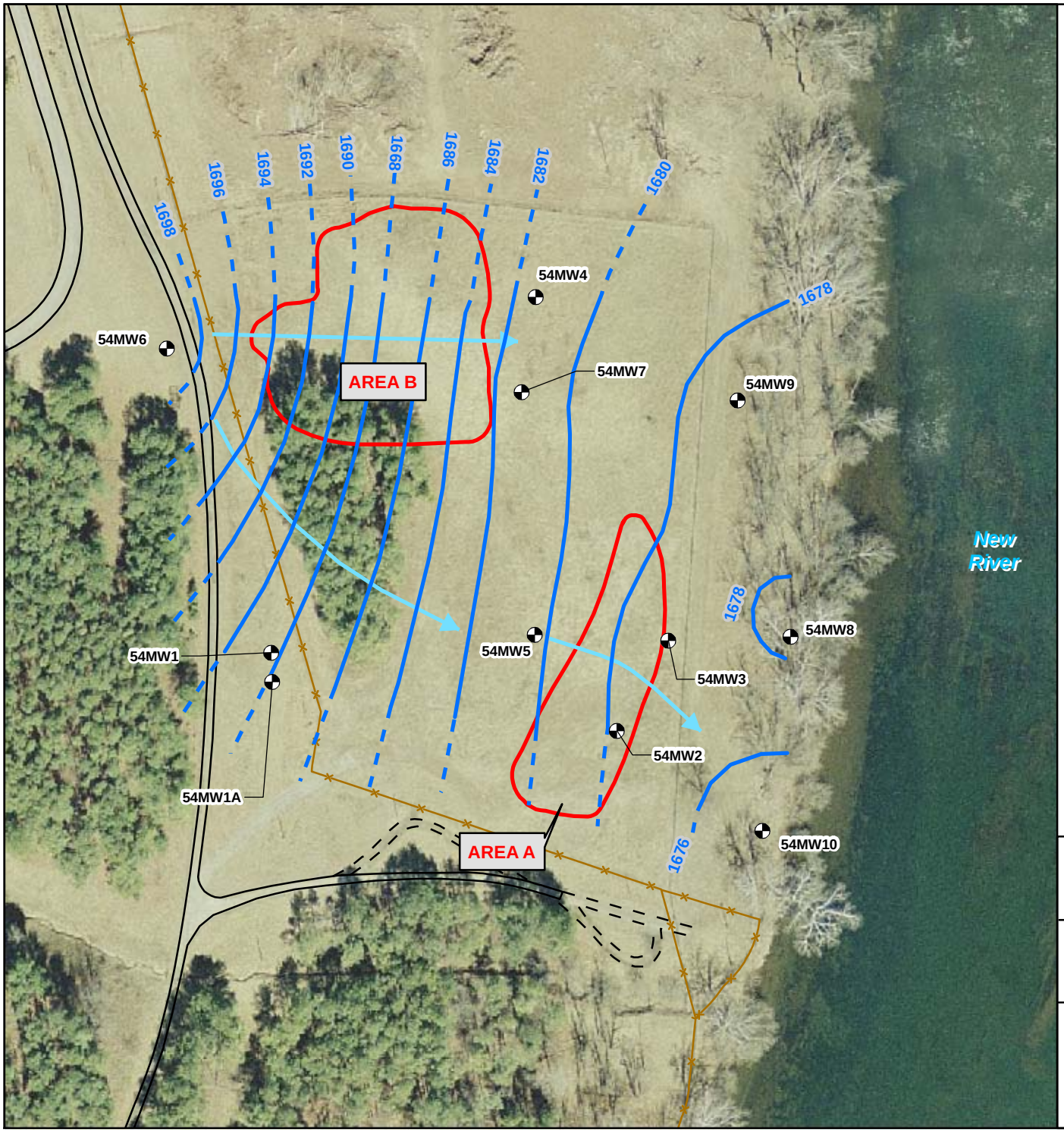
mV = millivolt
SU = Standard Units
mS = milliSiemen
°C = degrees Celcius
NTU = Nephelometric Turbidity

*DNT mixture results are obtained by adding together the results of 2,4-DNT and 2,6-

RBC = USEPA Region III Risk-Based Concentration (RBC) values from the October 11, 2007, RBC Table and October 11, 2007, Alternate RBC Table
C = Carcinogenic per EPA RBC Table (October 2007)
N = Noncarcinogenic per EPA RBC Table (October 2007)
BTAG = Biological Technical Assistance Group Water - BTAG Freshwater Screening Values, 2006a

=Exceeds Remedial Goal (RG)

Data Qualifiers:
J = Analyte present. Reported value may not be accurate or precise
U = Not detected. The associated number indicates the approximate sample concentration necessary to be detected.



LEGEND

- Monitoring Well Location
- Groundwater Contour
- Inferred Groundwater Contour
- Groundwater Flow Direction
- Dirt Road
- Paved Road
- Railroad
- Fence
- SWMU 54 Boundary

Notes:
1) Aerial photo, dated 2005, was obtained from Montgomery County Planning, VA Planning & GIS Services.

N

Scale:
0 75 150 300 Feet

U.S. Army Corps of Engineers

Shaw® Shaw Environmental, Inc.

FIGURE 1-5
SWMU 54 Groundwater Contour Map
June 5, 2007
Radford Army Ammunition Plant,
Radford, VA

ArcGIS File: C:\Radford_MMA\GIS_Documents\Project_Maps\SWMU_54\MNA_WP\RFAAP_Fig1-5_SWMU54_2007_GW_Contours.mxd (3/15/2011)

a CMS was performed to address the propellant ash material and grossly-contaminated soil under the ash material at SWMU 54. The alternatives evaluated were as follows:

- Alternative One: No Further Action.
- Alternative Two: Excavation of Soil at Area A and Area B, Off-site Disposal, and MNA of Groundwater.
- Alternative Three: Excavation of Soil at Area A and Area B, Off-site Disposal, and Enhanced *In Situ* Bioremediation of Groundwater.

These three alternatives were evaluated using the selection criteria: effectiveness, implementability, and cost. The site-specific Corrective Measures Objective (CMO) for SWMU 54 is to mitigate further leaching of explosives constituents from soil to groundwater at levels that would potentially increase observed concentrations and adversely impact future beneficial use of groundwater, and to eliminate the potential threats to human health and the environment that exist within materials found in SWMU 54. Observations from the SWMU 54 soil investigations indicate that the propellant ash material consisted of a black, ashy material that was very evident when encountered. Therefore, identification and removal of the propellant ash and grossly-contaminated soil will be partially based on visual observations during excavation.

Alternative Two, which entails excavation and off-site disposal as the primary remediation process, was found to achieve the CMO. Therefore, Alternative Two was selected as the final alternative for SWMU 54 because it is implementable and provides a greater level of protection to human health and the environment not provided by other alternatives. In addition, Alternative Two is the sole alternative that facilitates remedial goals (RGs) without potential adverse effects to groundwater (i.e., degradation of secondary water quality parameters) from remedial implementation activities, which would occur with implementation of Alternative Three. By achieving the CMOs, Alternative Two accomplishes the Army's goal for the Installation Restoration Program and its funding source the Environmental Restoration, Army account.

1.3 Corrective Measures Objectives and Remedial Goals

The CMOs and RGs were developed in the Final *SWMU 54 RFI/CMS Report* (URS, 2008). The following is a summary of the findings from that process.

The site-specific CMO for SWMU 54 Area A is to mitigate further leaching of explosives constituents from soil to groundwater at levels that would potentially increase observed concentrations and adversely impact future beneficial use of groundwater; and to the extent practicable, a goal of restoring site groundwater to the most beneficial use. The soil CMOs for Area A have been met and the purpose of this WP is to implement the groundwater IMs to meet the CMOs for groundwater.

The site-specific CMO for SWMU 54 Area B is to mitigate the potential hypothetical future risks that have been identified for exposure to soil under a future construction worker scenario; and to prevent leaching of contaminants of concern (COCs) from soil-to-groundwater at levels that would potentially adversely impact future beneficial use of groundwater. The site-specific CMOs have been met through the soil excavation and off-site disposal completed in 2010.

RGs for Area A are shown in **Table 1-7**. These RGs were used at SWMU 54 to confirm that all COIs were removed from soil to levels that are safe for human health and the environment. The groundwater RGs will be used to compare results from groundwater monitoring wells to assess the progress of the MNA.

Table 1-7
SWMU 54 Area A Remedial Goals

Chemical of Interest	Groundwater RG (mg/L)	Groundwater RG Source[(3)]	Area A - Soil RG (mg/kg)	Soil RG Source
2,4,6-TNT	0.00782	RG	1.7	SSL[4]
DNT Mixture	0.000932	RG	0.044 or Lab RL (if higher)	SSL[4]
RDX	0.0061	RG	0.161	SSL[4]
Perchlorate	0.0109	RG	--	--
Amino DNTs[(1)]	--	--	1.095	SSL[5]
Nitroglycerin[(2)]	--	--	0.069 or Lab RL (if higher)	SSL[5]
Heptachlor Epoxide[(2)]	--	--	0.0047	SSL[5]
2,3,7,8-TCDD (TEQ)[(1)]	--	--	7.89E-06	SSL[5]

Notes:
TNT = Trinitrotoluene
DNT = Dinitrotoluene
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazacyclohexane
TCDD = Tetrachlorodibenzodioxin
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
RG = Remedial Goal
RL = Reporting Limit
SSL = Soil Screening Level
(1) =Not identified as COPC in groundwater.
(2) =Not detected in groundwater.
(3) = The lowest of calculated carcinogenic and noncarcinogenic groundwater RGs used (see Appendix G.1, Table G.1-1c in URS, 2008).
Carcinogenic and noncarcinogenic RG values for groundwater COCs (2,4,6-TNT, DNT Mixture, RDX, and perchlorate) calculated using target risk 1E.-05 for the lifetime resident (see Appendix G.1 Table G.1-1c in URS, 2008) and a target hazard of 1 for the adult and child resident (see Appendix G.1 Table G.1-1b in URS, 2008).
(4) = Soil SSL RG values for soil-to-groundwater migration pathway calculated with SSL equation using groundwater RGs as target groundwater concentrations (see Tables G.1-2a - G.1-2c in URS, 2008).
(5) = Soil SSL RG values for soil-to-groundwater migration pathway calculated with SSL equation using T-RSLs as target groundwater concentrations (see Tables G.1-2d - G.1-2g in URS, 2008).

1.4 Interim Measures Scope

Based on the Final *SWMU 54 RFI/CMS Report* (URS, 2008), soil IMs were performed at SWMU 54. The IMs were conducted to mitigate the threat of a contaminant release, migration, and/or exposure to the public and the environment in accordance with Part II(D)(11-21) IM of the *RFAAP Corrective Action Permit* (USEPA, 2000a). The IMs included:

1. **Site Preparation**.
2. **Excavation**. Excavate the delineated area such that the remaining soil is below the selected RGs.
3. **Waste Characterization & Off-site Disposal**.
4. **Confirmation Sampling**. Samples were collected after removal of the soil with concentrations above the RGs to ensure that soil RGs had been met.
5. **Site Restoration**.

The soil IMs have been completed and this WP details the implementation of the groundwater MNA IMs, including:

1. Installation and development of four groundwater monitoring wells, in accordance with Standard Operating Procedures (SOPs) 20.1 and 20.2 (**Appendix A**).
2. Periodic sampling from existing and new groundwater monitoring wells and sediment pore water sample points.
3. Abandonment of wells and piezometers when RGs have been met, in accordance with the Virginia Department of Environmental Quality (VDEQ) Memorandum dated January 8, 2008 (**Appendix F**).

Specific details on the contractor organization and technical approach for the IM listed above are provided in the *Organization and Technical Approach Plan*, *Section 2.0*.

1.5 Work Plan Content

This WP is composed of an Introduction (*Section 1.0*), four sub-plans (*Sections 2.0 through 5.0*), and references (*Section 6.0*). The four sub-plans are as follows:

Section 2.0 – Organization and Technical Approach Plan

Identifies the Shaw project staff and subcontractors, their roles and responsibilities, and identifies the technical approach to be followed for the IM.

Section 3.0 – Field Sampling Plan

Describes the sampling rationale and field sampling procedures that will be used to collect field samples.

Section 4.0 – Quality Assurance Project Plan

Identifies the sample management methods, analytical methods, and quality control (QC) requirements necessary to achieve data quality objectives (DQOs) associated with chemical sampling.

Section 5.0 – Site Safety and Health Plan

Provides site-specific safety and health controls to prevent and/or minimize personal injuries, illnesses, and physical damage to equipment and property.

1.6 Work Plan Changes

Work outside the scope of this WP is not to be performed without the approval of the USACE, Baltimore District. Amendments or supplements to this WP will be submitted in writing to the USACE for approval prior to being implemented by project personnel.

2.0 ORGANIZATION AND TECHICAL APPROACH

This section describes the organization and activities to be conducted to accomplish the Groundwater MNA remedy at SWMU 54. 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 corrective action tasks.

2.1 Organization and Responsibilities

The organizational structure established for this project is depicted on **Figure 2-1** and includes the Shaw management and field staff, and subcontractors. The lines of authority and the lines of communication for the project can be determined from this organizational structure. Communication of project objectives will be provided to project staff through meetings.

Names, addresses, and phone numbers of key Shaw individuals are presented in **Table 2-1**. The duties and responsibilities of the key members of this organization are described below.

Program Manager, Mr. Bob Culbertson, has complete management authority and responsibility for all work performed under the Louisville Multiple Award Remediation Contract (LMARC) contract. The Program Manager directs the program management organization as a central resource for management, continuity, and control of all LMARC program activities. The centralized program management is organized to facilitate communication with and reporting to the USACE and to expedite and support project execution. The Program Manager has total authority, responsibility, and accountability for managing the contract. He will be involved in the decision-making process and oversight of the management of the project.

RFAAP Project Manager, Mr. Timothy Leahy, reports to the LMARC Program Manager. He is responsible for ensuring that all activities are conducted in accordance with contractual specifications and technical requirements. The Project Manager will also coordinate with the USACE Project Officer. The Project Manager will monitor the budget and schedule to ensure availability of necessary personnel, equipment, subcontractors, and services.

IM Task Manager, Ms. Robin Sims, reports to the RFAAP Project Manager. She is responsible for ensuring that all activities are conducted in accordance with the WP. The IM Task Manager is responsible for management of all operations conducted for this project. Ms. Sims will ensure that all personnel assigned to this project, including subcontractors, have reviewed the technical plans before any task associated with the project is initiated. She will participate in the development of the field program, evaluation of data, and reporting.

Project Engineer, Mr. Doug Schicho, P.E., is responsible for development and/or approval of field procedures and evaluation of applicable or relevant and appropriate requirements for the remedial activities.

Health and Safety Manager, Mr. David Mummert, Certified Industrial Hygienist (CIH), will oversee the development and implementation of the SSHP to ensure that it meets all specific needs of the project and that appropriate health and safety requirements are defined.

Figure 2-1
SWMU 54 Interim Measures Organizational Chart

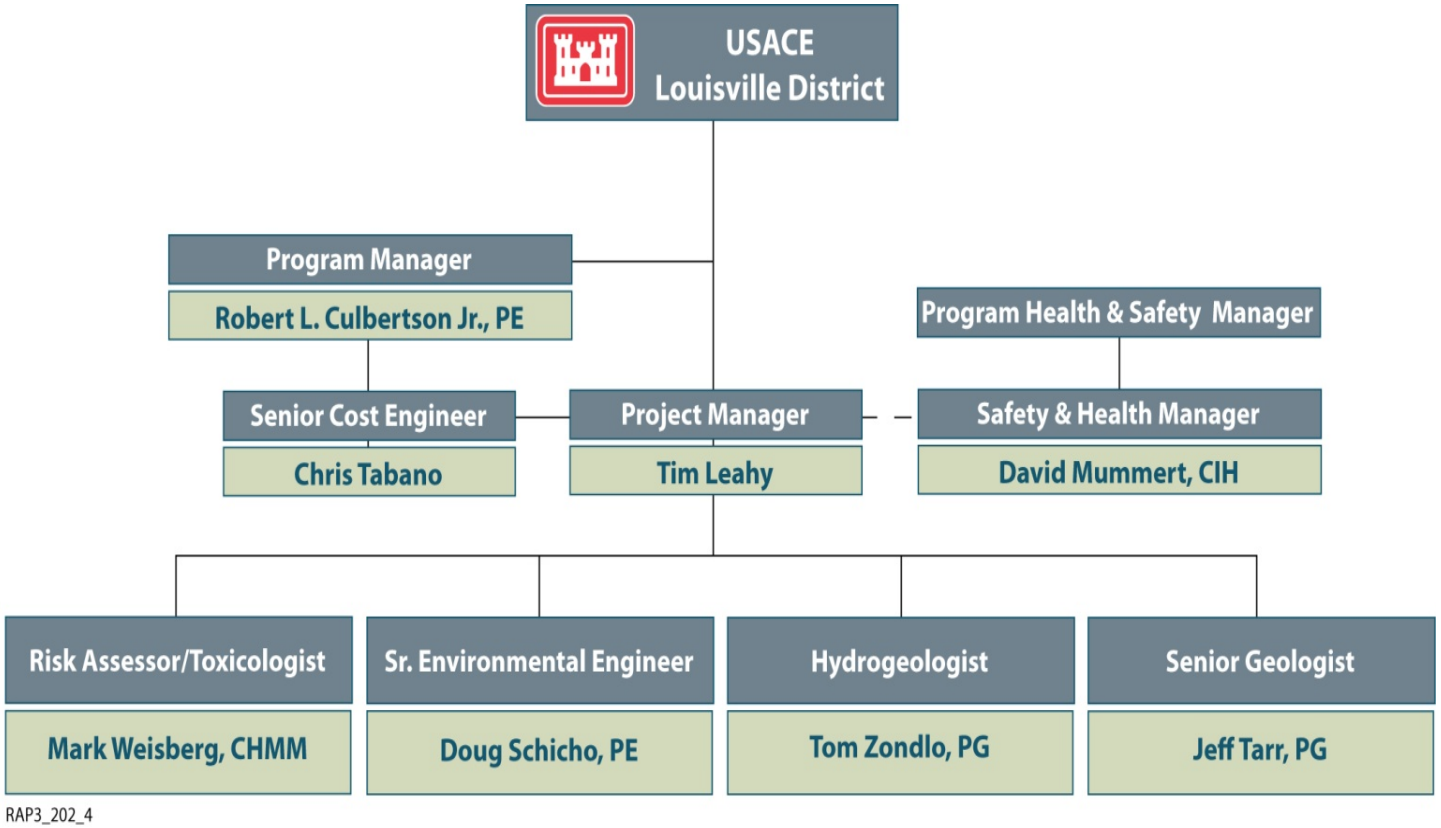


Table 2-1
Shaw Environmental, Inc. and Subcontractor Key Points of Contact

Shaw Environmental, Inc./Subcontractor Personnel	Contact Information
Bob Culbertson Shaw Environmental, Inc. LMARC Program Manager	312 Directors Drive Knoxville, TN 37923 Phone No.: (865) 694-7402 Fax No.: (865) 690-3626 E-Mail: bob.culbertson@shawgrp.com
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Analytical Laboratory Subcontractor TBD	

QC Manager, Mr. Kenneth Martinez, is responsible for ensuring that quality planning is accomplished, QC procedures are available, and a qualified Contractor Quality Control (CQC) System Manager is assigned to the project. The LMARC QC Manager will review and ensure that all project-specific QC needs are met and that all appropriate QC requirements are addressed.

Site Safety and Health Officer (SSHO), Mr. Glen Davis, will be responsible for implementing and oversight of the on-site health and safety program, and maintaining health and safety documentation. He will ensure that an adequate level of personal protection is worn by field personnel for anticipated potential hazards and will work in coordination with the IM Task Manager to ensure compliance of project activities with health and safety requirements as outlined in the SSHP. Additional details on the responsibilities of the SSHO are provided in the SSHP (*Section 5.0*).

Project Chemist, Mr. Eric Malarek, will be responsible for sample tracking, data management, laboratory coordination, and data validation activities. The Project Chemist will work with field sampling technicians and the contract laboratory to ensure that the work performed is in accordance with the QAPP (*Section 4.0*).

Field Sampling Technicians, Field sampling technicians will be responsible for collecting all samples associated with the IM. These technicians will be under the direction of the Site Superintendent. The technicians will coordinate sampling activities with the Project Chemist who in turn coordinates with the contract laboratory.

Subcontractors. Shaw will procure the following subcontractors: laboratory support.

2.2 Technical Approach

The MNA program will be conducted as specified in the EPA and VDEQ approved Final *SWMU 54 RFI/CMS Report* (URS, 2008); and this Groundwater Monitoring Plan. The following sections describe the background and technical approach to the SWMU 54 Groundwater MNA IM. The field activities to be performed include: site preparation; installation of four monitoring wells; periodic groundwater monitoring focused on evaluating the natural attenuation of the following COCs: explosives (2,4,6-TNT; DNT-mixture; and RDX) and perchlorate. Detailed safety and health requirements for this scope of work are presented in *Section 5.0*.

2.2.1 Selected Groundwater Remedy – Monitored Natural Attenuation

The goal of this MNA, through performance monitoring, is to measure and track the reduction of 2,4,6-TNT, DNT-mixture, RDX and perchlorate to levels below the RGs as defined in **Table 1-1** for the respective COCs, within a reasonable period of time. Compliance will be measured at the Point of Compliance (POC) wells in the aquifer downgradient of SWMU 54 and achieved at all the wells in the monitoring network. During natural attenuation, multiple processes such as dispersion, diffusion, dilution, sorption, volatilization, biological degradation and chemical decomposition of COCs result in an effective reduction of contaminant concentration, toxicity, mobility, or volume to levels that are protective of human health and the ecosystem. The daughter products of explosives will be monitored and evaluated to determine the progress (effectiveness and timeliness) of the degradation process.

2.2.2 Groundwater Monitoring System

The groundwater beneath SWMU 54 will be monitored with two existing upgradient groundwater monitoring wells; five existing disposal area POC wells; three existing downgradient POC wells adjacent to the New River; and five surface water/pore water sampling locations located as specified on **Figure 2-2**. Monitoring locations/purposes, types, and sampling frequency are shown in **Table 2-2**. Two monitoring wells (54MW-11 and 54MW-12) will be installed for performance monitoring between the POC wells (54MW-2 and 54MW-3) and downgradient wells (54MW-8 and 54MW-10) adjacent to the New River. An additional two wells (54MW-13 and 54MW-14) will be installed north and south of the unit.

2.2.3 Remedial Objectives

The remedial objective is to achieve and maintain the RGs for the groundwater COCs shown in **Table 1-1** for 3 years in accordance with the Final *SWMU 54 RFI/CMS Report* (URS, 2008). To accomplish this objective, data from the monitoring and compliance wells will be collected and evaluated against the chemical-specific RGs.

2.2.4 Sampling and Analysis Schedule

All of the wells listed in **Table 2-2** will be sampled in accordance with the methods and procedures specified in the EPA/VDEQ approved Final *SWMU 54 RFI/CMS Report* (URS, 2008) and this WP and the following schedule:

a. The wells specified in **Table 2-2** will be sampled for the analysis of the current IM-targeted constituents listed **Table 2-3**. In addition, groundwater samples collected during the first year of monitoring will be analyzed for MNA indicators (total organic carbon, dissolved inorganic carbon, dissolved ferrous iron, dissolved manganese, nitrate, and sulfate) for the purpose of establishing a baseline concentration of the analyses. Analyses shall be obtained using the EPA SW-846 Methods specified in *Section 4* of this WP.

b. The New River Sediment Pore water/Surface water sampling locations (NRSW-1/PW-1, NRSW-3/PW-3, NRSW-5/PW-5, NRSW-8/PW-8, and NRSW-9/PW-9, all shown on **Figure 2-2**) shall be sampled annually for the analytical parameters in **Table 2-3** using the EPA SW-846 Methods.

c. Static groundwater elevations and total depths as well as the hydrogeologic and physical parameters pH, temperature, specific conductivity, dissolved oxygen (DO), and oxidation-reduction potential (ORP) will be measured at all wells during each sampling event.

2.3 Measurement and Maintenance of Natural Attenuation Remedy

The groundwater gradient and flow direction in the uppermost aquifer will be calculated annually. Constituent migration rates will be calculated, if necessary, to demonstrate the effectiveness of the IM and the IM monitoring program. Potentiometric maps showing groundwater elevation contours and flow direction during each sampling event shall be prepared at least annually.

Natural attenuation is the reduction of COC concentrations in the environment through destructive biological processes (including, but not limited to; aerobic and anaerobic biodegradation, plant and animal uptake), non-destructive physical mechanisms (advection,

ArcGIS File: C:\Radford_MMA\GIS_Documents\Project_Maps\SWMU_54\MNA_WP\RFAAP_Fig2-2_SWMU54_Proposed_GW_Sample_Locations.mxd (1/4/2011)

LEGEND

- Proposed Monitoring Well
- Existing Monitoring Well
- Surface Water and Pore Water Sample Location Proposed for Resampling
- Dirt Road
- Paved Road
- Railroad
- Fence
- SWMU 54 Boundary

Notes:
1) Aerial photo, dated 2005, was obtained from Montgomery County Planning, VA Planning & GIS Services.

N

Scale:

0 75 150 300 Feet

U.S. Army Corps of Engineers

Shaw® Shaw Environmental, Inc.

FIGURE 2-2
SWMU 54 Proposed
Groundwater Sample Locations
Radford Army Ammunition Plant,
Radford, VA

Table 2-2
Monitored Natural Attenuation - Performance Monitoring Locations
SWMU 54 MNA Interim Measures Work Plan
Radford Army Ammunition Plant, Radford, Virginia

Monitoring Locations

Location	Monitoring Locations	Location Type	Sampling Frequency*
Upgradient	54MW1 (Area A) 54MW6 (Area B)	Existing Monitoring Wells	Quarterly
Disposal Area Point of Compliance	54MW2, 54MW3, 54MW5 (Area A) 54MW4, 54MW7 (Area B)	Existing Monitoring Wells	Quarterly
Downgradient Point of Compliance Adjacent to New River	54MW8, 54MW9, 54MW10	Existing Monitoring Wells	Quarterly
Between Disposal Area and Downgradient Wells at New River	54MW11, 54MW12 (Area A)	New Monitoring Wells	Quarterly
Between Disposal Area and Monitoring Well MW-9	54MW14	New Monitoring Well	Quarterly
Between Disposal Area and Creek South of Area A	54MW13 (Area A)	New Monitoring Well	Quarterly
Receptor Point of Compliance at New River	NRSW-1/PW-1, NRSW-3/PW-3, NRSW-5/PW-5, NRSW-8/PW-8, NRSW-9/PW-9	Existing Sediment Pore Water/Surface Water Sample Stations	Annually

Analytical Parameters

Parameters	Analytical Method	Comment
Explosives	SW-846 Method 8330/8332	Chemicals of Interest
Perchlorate	SW-846 Method 6850	
Total Organic Carbon Dissolved Inorganic Carbon	EPA Method 415.1	Water Quality Parameters
Dissolved Ferrous Iron (Fe^{+2}) Dissolved Manganese (Mn^{+2})	Field	
Nitrate (NO3)	353.2	
Sulfate ($SO4^{2+}$)	300	
pH, Temperature, Specific Conductance, Dissolved Oxygen, Oxidation-Reduction Potential, Turbidity	Field	

*The sampling frequency will be reduced from quarterly to annually, if detections are below RGs in four consecutive quarters.

Table 2-3
Monitored Natural Attenuation - Performance Monitoring Parameters
SWMU 54 MNA Interim Measures Work Plan

Parameter	Data Use
Explosives and Perchlorate	COIs - Evaluate concentration trends and attenuation with respect to RGs. Used to document achievement of CMOs and RGs. Allows for evaluation of 2,4,6-TNT transformation processes to 4ADNT and 2ADNT.
Total Organic Carbon	Allows for evaluation of immobilization potential of 2,4,6-TNT and RDX.
Dissolved Inorganic Carbon	It is a by-product of organic compound oxidation and indicates the difference in microbial oxidation processes within versus outside the plume area.
Dissolved Ferrous Iron (Fe +2)	May indicate anaerobic degradation due to depletion of oxygen, nitrate, and manganese. Also allows for evaluation of immobilization potential of 2,4,6-TNT.
Dissolved Manganese (Mn^{+2})	May indicate anaerobic degradation due to depletion of oxygen and nitrate.
Nitrate (NO3)	Substrate for microbial respiration if oxygen is depleted.
Sulfate ($SO4^{2-}$)	Substrate for anaerobic microbial respiration.
pH	Aerobic and anaerobic processes are pH sensitive. Stabilization parameter for groundwater purging and sampling.
Dissolved Oxygen	Concentrations indicate whether an aerobic or anaerobic pathway exists. Concentrations of <0.5 mg/L generally indicate an anaerobic pathway. DO contributes to the potential of biodegradation and other attenuation mechanisms.
Oxidation Reduction Potential	Reflects the relative oxidizing or reducing nature of the aquifer. ORP is influenced by the biologically mediated degradation of contaminants and ranges from 800 mV (oxygenated) to -400 mV (strongly reducing). Stabilization parameter for groundwater purging and sampling.
Specific Conductance	General parameters for water quality and stabilization parameter for groundwater purging and sampling.
Temperature and Turbidity	General parameters for water quality and stabilization parameter for groundwater purging and sampling.

Notes:

ADNT = Aminodinotrotoluene
CMO = Corrective Measures Objective
COI = Contaminant of Interest
DO = Dissolved Oxygen
mg/L = milligram per liter
mV = millivolt
ORP = Oxidation-Reduction Potential
RG = Remedial Goal
TNT = Trinitrotoluene

dispersion, diffusion, dilution, volatilization, sorption/desorption), and chemical reactions (ion exchange, complexation, decomposition, and abiotic transformation). Natural Attenuation is therefore, a passive remedial approach reliant upon natural transport and degradation processes.

Beyond the monitoring wells, there is no capital equipment requiring regular maintenance or upkeep other than as described below. The operation system for the continued maintenance of the Natural Attenuation Remedy will be maintained as follows:

a. In accordance with the approved Final *SWMU 54 RFI/CMS Report* (URS, 2008), groundwater will be sampled in accordance with *Section 2.2.4*. These monitoring results will be reported in an annual data report.

b. Water Quality Sampling Events – In addition to the water level in the well, the following field parameters shall be measured from each well during each sampling event: pH, temperature, ORP, specific conductivity, and DO. In addition, groundwater samples collected during the first year of monitoring will also be analyzed for MNA indicators (total organic carbon, dissolved inorganic carbon, dissolved ferrous iron, dissolved manganese, nitrate, and sulfate) for the purpose of establishing a baseline concentration of these analytes. The analytical laboratory shall analyze these samples in accordance with the sampling and analytical methods listed in *Section 4*.

c. Piezometers or monitoring wells designated solely for the purpose of measuring water levels (and not for water quality sampling), that are part of the Natural Attenuation Remedy, may be installed or abandoned. Abandonment will be in accordance with VDEQ Memorandum of January 8, 2008, located in **Appendix F**.

2.4 Data Analysis and Reporting

The analytical data obtained from the contract analytical laboratory will be assessed as follows:

- The concentrations/values of hazardous constituents listed in **Table 1-1**. Data will be validated within 2 weeks of return of the data from the laboratory performing the analyses.

  Estimated values between the method detection limit (MDL) and quantitation limit (QL) will be validated and qualified with the "J" flag to indicate the result that a constituent is present and detected at or above the MDL, but below the QL. The "U" flag will be used to indicate that the constituent is not detected at or above the MDL.

- The report will include at least the following information: the constituents analyzed and concentrations with qualifiers, the background values, the RGs, the SW-846 test methods, MDLs, QLs, the internal laboratory quality assurance/quality control (QA/QC), matrix spike duplicates (MSDs), percent recovery, duplicate analyses, dilution factors, any lab-specific detection limit and/or QL, the results of any screening analyses, and any other information needed to evaluate accuracy, precision, representativeness, comparability, and completeness of the groundwater quality data.

- Annually, the COI concentrations in each well will be compared to the RGs to evaluate the effectiveness of natural attenuation in this groundwater IM program.

- Annually, the data and monitoring results will be reviewed to evaluate the concentration trends, the fate and transport for the constituents and to evaluate the process and progress of natural attenuation.

2.4.1 Contents of an Annual Report

The annual report for monitoring performed in the previous calendar year shall meet all the requirements of an Annual Groundwater Monitoring Report and shall include an evaluation of the IM program. The following items shall be included, at a minimum:

a. Copies of current potentiometric surface maps and static groundwater level elevations for each event during the period.

b. Evaluation of groundwater flow directions and gradients and the calculated or measured rate of migration of hazardous constituents in the groundwater for the period.

c. Data package with the certification from the contract analytical laboratory.

d. Analytical Result/Data Summary containing the following columns: well name, sampling/analytical dates, constituents analyzed, analytical methods, detection limit, practical quantitation limit, resulting data (concentrations) with qualifiers, and RGs. Pore water/surface water results will also be included. All historic groundwater and pore water/surface water data will be included as well.

e. Long-term time concentration plots of COCs exceeding RGs for each well. When appropriate, graphic representation of groundwater impact plumes for constituents exceeding RGs.

f. An evaluation of the effectiveness of the remedial measures. The evaluation shall contain adequate information to demonstrate that the remedial measures are addressing the groundwater contamination at and downgradient of SWMU 54 and progress is being made toward the remediation objectives. The evaluation shall also contain updated compliance timeframe predictions.

2.5 Changes in MNA Program

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.

2.6 Evaluation of MNA Program

The effectiveness of the Natural Attenuation Program shall be evaluated on an annual basis. This evaluation shall be submitted as part of the Annual Monitoring Report. The evaluation shall contain information to demonstrate that natural attenuation is still functioning as designed. Continued decrease in concentrations will be considered progress toward the remedial objectives. The following shall be contained in the evaluation, if available:

a. Present sampling and analysis results collected for the Natural Attenuation Program in field and lab analysis.

b. Evaluation of the changes in concentration trends over the previous 12 months, natural attenuation rate, and resulting remedial progress.

c. Review of constituent concentrations and evaluation of natural attenuation processes/progress possibly occurring. For example, potential for biodegradation occurrence, detection of daughter products, and general water quality conditions.

d. Modifications to the Remedy proposed to correct deficiencies/malfunctions or, enhance performance.

e. Provide other recommendations regarding the IM program, as appropriate.

A constituent will be removed from the sampling program if it is consistently found below its respective RGs for 2 consecutive years. Wells will be removed from the monitoring network if all constituents of concern are found below their respective RGs for 2 consecutive years. If after 2 years of monitoring the MNA plan is not shown to be working, a contingency plan will be developed at that time, as discussed in the SWMU 54 RFI/CMS Report, Final September 2008, URS (URS, 2008).

2.6.1 Termination of IM/Remedy Program

The MNA at SWMU 54 will continue until the remedial objective specified in *Section 2.2.3* has been met. The following steps are to be taken in establishing that the MNA objective has been met:

- Termination of the use of MNA as a remedy shall be based on the interpretation and evaluation of the data (concentrations, parameters, and indicators). The data from the following groundwater monitoring wells (54MW2, 54MW3, 54MW4, 54MW5, 54MW7, 54MW8, 54MW9, 54MW10, 54MW11, 54MW12, 54MW13, and 54MW14) and from the pore water/surface water samples must be at or below the RGs to demonstrate that the objectives have been met.
- Notification to terminate the MNA program will be provided to EPA/VDEQ 60 days in advance together with the pertinent supporting data and evaluations.
- Existing ground monitoring wells will be abandoned in accordance with VDEQ Memorandum of January 8, 2008, in **Appendix F**.

2.7 Waste Characterization and Off-Site Disposal

The monitoring of natural attenuation of groundwater is expected to generate approximately (14) 55-gallon drums of non-hazardous soil from monitoring well installation; approximately seven 55-gallon drums of decontamination and well development water from monitoring well installation, and approximately one 55-gallon drum of purge water for each sampling event.

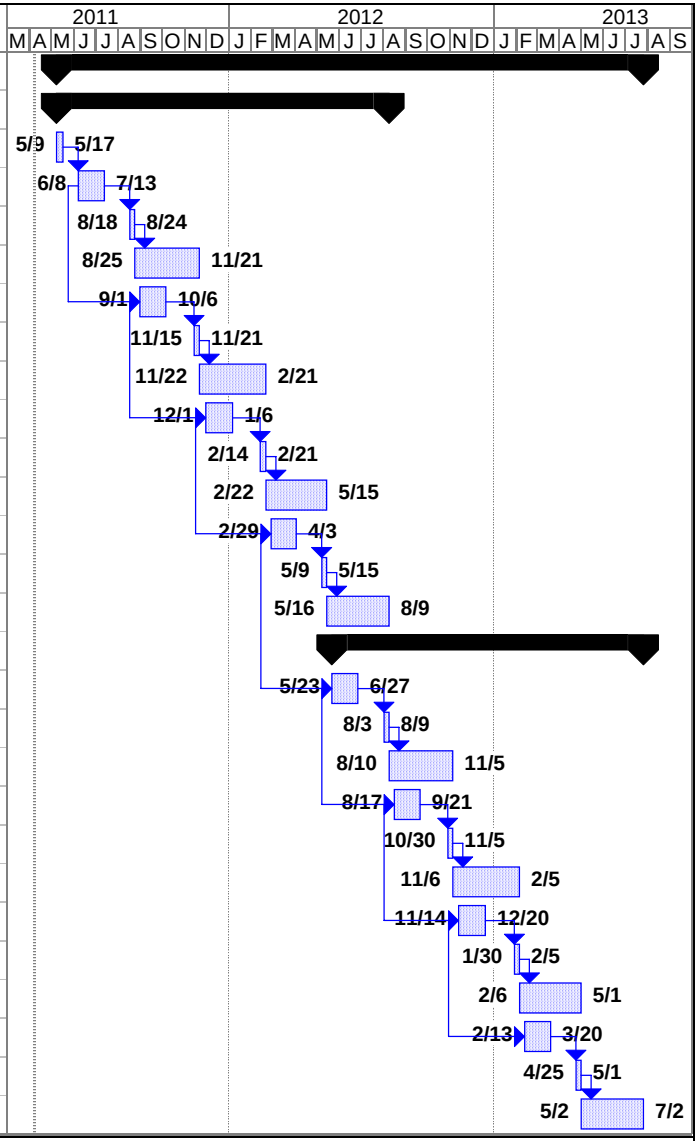
Purge water and decontamination fluids generated through the wells purged and sampled by Shaw will be containerized in 55-gallon labeled drums and sampled for target analyte list (TAL) metals, corrosivity as pH, and chemical oxygen demand (COD) prior to disposal.

2.8 Interim Measures Schedule

The field activities to be performed as part of the SWMU 54 IM began in April 2010. The proposed schedule of project tasks is provided on **Figure 2-3**.

[Note: The project schedule will be updated in each subsequent edition of this Work Plan and will be updated and maintained throughout the project.]

ID	Task Name	Duration	Start	Finish
1	**Radford - SWMU 54 MNA Interim Measures**	**556 days**	**Mon 5/9/11**	**Fri 7/26/13**
2	**Monitored Natural Attenuation Sampling (Year 1)**	**316 days**	**Mon 5/9/11**	**Thu 8/9/12**
3	Monitoring Well Installation	7 days	Mon 5/9/11	Tue 5/17/11
4	Round 1 Sampling and Analysis	25 days	Wed 6/8/11	Wed 7/13/11
5	Round 1 Data Validation	5 days	Thu 8/18/11	Wed 8/24/11
6	Round 1 Data Report	60 days	Thu 8/25/11	Mon 11/21/11
7	Round 2 Sampling and Analysis	25 days	Thu 9/1/11	Thu 10/6/11
8	Round 2 Data Validation	5 days	Tue 11/15/11	Mon 11/21/11
9	Round 2 Data Report	60 days	Tue 11/22/11	Tue 2/21/12
10	Round 3 Sampling and Analysis	25 days	Thu 12/1/11	Fri 1/6/12
11	Round 3 Data Validation	5 days	Tue 2/14/12	Tue 2/21/12
12	Round 3 Data Report	60 days	Wed 2/22/12	Tue 5/15/12
13	Round 4 Sampling and Analysis	25 days	Wed 2/29/12	Tue 4/3/12
14	Round 4 Data Validation	5 days	Wed 5/9/12	Tue 5/15/12
15	Round 4 Data Report	60 days	Wed 5/16/12	Thu 8/9/12
16	**Monitored Natural Attenuation Sampling (Year 2)**	**295 days**	**Wed 5/23/12**	**Fri 7/26/13**
17	Round 1 Sampling and Analysis	25 days	Wed 5/23/12	Wed 6/27/12
18	Round 1 Data Validation	5 days	Fri 8/3/12	Thu 8/9/12
19	Round 1 Data Report	60 days	Fri 8/10/12	Mon 11/5/12
20	Round 2 Sampling and Analysis	25 days	Fri 8/17/12	Fri 9/21/12
21	Round 2 Data Validation	5 days	Tue 10/30/12	Mon 11/5/12
22	Round 2 Data Report	60 days	Tue 11/6/12	Tue 2/5/13
23	Round 3 Sampling and Analysis	25 days	Wed 11/14/12	Thu 12/20/12
24	Round 3 Data Validation	5 days	Wed 1/30/13	Tue 2/5/13
25	Round 3 Data Report	60 days	Wed 2/6/13	Wed 5/1/13
26	Round 4 Sampling and Analysis	25 days	Wed 2/13/13	Wed 3/20/13
27	Round 4 Data Validation	5 days	Thu 4/25/13	Wed 5/1/13
28	Round 4 Data Report	60 days	Thu 5/2/13	Fri 7/26/13



Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress
Split
External Tasks
Project Summary
Group By Summary
Deadline

Figure 2-3 - Radford - SWMU 54 Monitored Natural Attenuation Interim Measures Schedule

3.0 FIELD SAMPLING PLAN

This FSP describes the field sampling activities that will be performed and defines the procedures and methods that will be used to collect field samples. Contents included in this FSP include: procedures for the installation of monitoring wells; the collection of groundwater and surface/pore water samples; waste characterization samples; and requirements for sample chain-of-custody (COC), documentation, and shipping. This FSP was developed in accordance with USACE Engineer Manual (EM) 200-1-3*, Requirements for the Preparation of Sampling and Analysis Plans* (USACE, 2001), and is to be used in conjunction with the QAPP, *Section 4.0*.

3.1 Scope and Objectives

Samples to be collected during the IM work include soil confirmation, groundwater, surface/pore water, and waste characterization samples. QC samples [i.e., field duplicate samples, rinse blanks, matrix spike (MS)/MSD, etc.] will also be collected as described in the QAPP, *Section 4.0*. The following sections describe the function of each type of field sample. Details on the methods used for collection of the samples are presented in **Appendix A**.

3.1.1 Groundwater and Pore/Surface Water Samples

Monitored Natural Attenuation of Groundwater was the remedy selected for groundwater in the approved 2008 Final *SWMU 54 RFI/CMS Report* (URS, 2008). Groundwater samples will be collected from the ten existing monitoring wells on site, as well as four proposed wells that will be installed as part of the groundwater remedy. Groundwater samples will be collected on a quarterly basis from the monitoring wells. In addition to the monitoring wells, samples will also be collected from four existing surface-water/pore-water sample stations. The surface-water/ pore-water samples will be collected annually.

3.1.2 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 54. Liquid waste streams will be generated during the IM: (purge water and decontamination water). Liquid waste characterization samples from decontamination procedures will be submitted to a USACE-approved laboratory and analyzed for COD, TAL metals, and pH.

3.1.3 Anticipated Sampling Program

The sampling program for SWMU 54 IM is discussed in detail in *Section 2.2*. Samples anticipated for collection during this scope of work include: groundwater, surface water, pore water and aqueous waste characterization samples. A list of all anticipated analytical samples, QC samples, and analyses associated with the SWMU 54 IM are provided in **Table 3-1**. Analytical methods to be used for sample analysis are detailed in the QAPP (*Section 4.0*). Additional samples and/or analyses may be required depending on site conditions and specific disposal facility requirements. If required, this plan will be modified to include any additional analyses.

Table 3-1
Anticipated Groundwater Sampling Program for SWMU 54
MNA Interim Measures

Site ID	Sample ID	Frequency*	Explosives	Perchlorate	MNA Indicator Parameters
54MW01	54MW01	Quarterly	X	X	X
54MW02	54MW02	Quarterly	X	X	X
54MW03	54MW03	Quarterly	X	X	X
54MW04	54MW04	Quarterly	X	X	X
54MW05	54MW05	Quarterly	X	X	X
54MW06	54MW06	Quarterly	X	X	X
54MW07	54MW07	Quarterly	X	X	X
54MW08	54MW08	Quarterly	X	X	X
54MW09	54MW09	Quarterly	X	X	X
54MW10	54MW10	Quarterly	X	X	X
54MW11	54MW11	Quarterly	X	X	X
54MW12	54MW12	Quarterly	X	X	X
54MW13	54MW13	Quarterly	X	X	X
54MW14	54MW14	Quarterly	X	X	X
NRSW1/ PW1	NRSW1/P W1	Annually	X	X	X
NRSW3/ PW3	NRSW3/P W3	Annually	X	X	X
NRSW5/ PW5	NRSW5/P W5	Annually	X	X	X
NRSW8/ PW8	NRSW8/P W8	Annually	X	X	X
NRSW9/ PW9	NRSW9/P W9	Annually	X	X	X

* Reduce from quarterly to an annual frequency if four consecutive quarters are below RGs.

4.0 QUALITY ASSURANCE PROJECT PLAN

This QAPP 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 is to be used in conjunction with the FSP, *Section 3.0*.

4.1 Project Description

A detailed description of the project history and the planned IM work is presented in the Introduction (*Section 1.0*) and the Organization and Technical Approach Plan (*Section 2.0*) of this WP, respectively. As part of the planned IM work, field sampling and analysis activities will be conducted. This QAPP, in conjunction with the FSP (*Section 3.0*), describes the sampling and analysis requirements to ensure DQOs are met.

4.2 Project Organization and Responsibilities

A detailed discussion of project personnel organization and responsibilities has been presented in the Organization and Technical Approach Plan, *Section 2.0*. Coordination of sample collection activities will be the responsibility of the Site Superintendent, who is responsible for running site operations. Field sampling technicians will be responsible for collection and delivery of samples to the laboratory. After delivery, the Project Chemist will be responsible for ensuring proper analytical analysis and timely delivery of sample results by the contract laboratory according to the project Statement of Work and QAPP requirements.

The contract laboratory that will be used to support the IM work at SWMU 54 has yet to be determined. A copy of the contract laboratory's Laboratory Quality Assurance Plan (LQAP) will be presented in **Appendix B** upon award.

4.3 Data Quality Objectives

Quality assurance is defined as the overall system of activities for assuring the reliability of data produced. 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 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, 1994a), *USEPA Data Quality Objectives Process for Hazardous Waste Site Investigations EPA QA/G-4HW* (USEPA, 2000b), and the *Department of Defense (DoD) Quality Systems Manual (QSM), Final Version 4.1* (DoD, 2009) formed the basis for the DQO process and development of RFAAP data quality criteria and performance specifications. The DQO process consists of the seven steps specified below. Each phase is broken out in the following

DQO elements. DQO elements are included in italics following each process step. Project-specific DQOs may be found in **Table 4-1** for the SWMU 54 IM.

1. **State the Problem:** Define the problem to focus the study. Specific activities conducted during this process step include (1) the identification of the planning team, (2) primary decision-maker, (3) statement of the problem, and (4) available resources and relevant deadlines.

   (1) The planning team consists of representatives from the VDEQ, USEPA, USACE, and RFAAP.
   (2) The Army is the primary decision-maker.
   *(3) Refer to **Table 4-1**.*
   (4) Resource specifications are contained in the RFAAP SWMU 54 WP. The period of performance for this project is approximately 12 months for the soil confirmation. For the MNA, 3 years to prove achievement of RGs.

2. **Identify the Decision:** Define the decision statement that the study will attempt to resolve. Activities conducted during this step of the process involve (1) identification of the principal study question and (2) definition of resultant alternative actions.

   (1) What are the extent of ash material and grossly-contaminated soil (Areas A and B) as well as the extent for which the site COIs have migrated and/or degraded in the groundwater (Area A), surface water, and pore water as a long-term monitoring, and are the groundwater conditions conducive for natural attenuation as remediation alternative at SWMU 54? If the areas show symptoms of contamination or confirmation samples exceed the RGs, the soil will be removed and replaced with clean fill.
   (2) Resultant alternative actions include:
      (2a) Further determine extent of contaminated soil for removal.
      (2b) The extent of contamination has been determined.
      (2c) If contaminants are consistent to historical levels at all existing wells above the action levels, no migration and/or degradation will be observed and additional monitoring and/or remediation may to be recommended.
      (2d) If contaminants are detected at lower concentrations and not increasing at downgradient wells, degradation is occurring and natural attenuation will be considered as alternative remediation.
      (2e) If contaminants are detected above the action levels at downgradient wells, migration is occurring and additional monitoring and/or remediation may to be recommended.

3. **Identify Inputs to the Decision:** Identify information inputs required to resolve the decision statement and which inputs require environmental measurements. This step of the process includes (1) identification of the data that will be required to make the decision, (2) information source determination, (3) identification of data required for study action level goals, and (4) confirmation of appropriate field sampling and analytical methods.

Table 4-1. Specific Data Quality Objectives for SWMU 54 Interim Measures and Long-Term Monitoring/Monitored Natural Attenuation

DQO Elements		Post-Excavation Soil Confirmation Sampling and Analysis	Long-Term Monitoring/Monitored Natural Attenuation of Groundwater	Waste Characterization Sampling and Analysis	Borrow/Top Soil Characterization Sampling and Analysis
PROBLEM STATEMENT	PROBLEM AND OBJECTIVES	Confirm all ash and grossly-contaminated soil has been removed.	Long-term quarterly monitoring of groundwater to confirm natural attenuation of COIs.	Waste characterization for disposal.	Confirm borrow soil is suitable for fill.
DECISION INPUTS	CHEMICAL DATA	Discrete confirmation soil samples will be collected and analyzed for Aroclor 1254 (Area B only), heptachlor epoxide, dieldrin, 1,3-DNB, 2,4-DNT, 2,6-DNT, NG, 2-NT, 4-NT, 2-amino-DNT, 4-amino-DNT, 2,4,6-TNT, RDX, dioxins/furans, and lead. At the boundary where found to be fully delineated below the RGs. Field SOPs may be found in **Appendix A**.	Groundwater, surface water, and pore water samples will be collected and analyzed for 1,3-DNB, 2,4-DNT, 2,6-DNT, NG, 2-NT, 4-NT, 2-amino-DNT, 4-amino-DNT, 2,4,6-TNT, RDX, and perchlorate. In addition, the natural attenuation parameters nitrate, chloride, sulfate, soluble manganese (field kit), ferrous iron (field kit), total and dissolved organic carbon and inorganic carbon will be collected. The field measurements pH, specific conductivity, DO, temperature, turbidity, and ORP will be recorded for each sample. All of these analyses will be analyzed to demonstrate decreasing levels of COIs due to natural attenuation. Field SOPs may be found in **Appendix A**.	Discrete waste characterization samples will be collected and analyzed off site. The soil samples will be analyzed for TCLP metals, explosives, dioxins/furans, corrosivity as pH, reactivity, and ignitability. For reactivity, the analysis will also include explosives, total cyanide, and total sulfide. Decon water will be analyzed for COD, TAL metals, and pH. Field SOPs may be found in **Appendix A**.	Discrete characterization samples will be collected for borrow material and top soil prior to placement and analyzed off site for TAL metals, TCL VOCs, TCL SVOCs, PAHs, TCL pesticides & PCBs, explosives, and pH. Field SOPs may be found in **Appendix A**.
	PHYSICAL DATA	Map locations for all sample locations will be generated.	Map locations for all sample locations will be generated.	Not Applicable	Not Applicable
	SAMPLING METHOD	Environmental, biased, grab, and intrusive.	Environmental, biased, grab, and intrusive.	Environmental, biased, grab and non-intrusive.	Environmental, grab and non-intrusive.
	DATA USE	Interim Measures	Long-Term Monitoring and Monitored Natural Attenuation	Waste Characterization	Interim Measures
	VALIDATION DATA LEVEL	Full Validation (USEPA Region III Validation M3 & IM2)	Full Validation (USEPA Region III Validation M3 & IM2)	Limited Validation	Full Validation (USEPA Region III Validation M3 & IM2)
	ANALYTICAL METHOD	Chemical Data (Soils - SW-846) Heptachlor epoxide and Dieldrin: 3550C/8081A/8082 Aroclor 1254: 3550C/8082A Select Explosives: 8330B Dioxins/Furans: 8290 Lead: 3050B/6010C	Chemical Data: (Groundwater – SW-846 & MCAWW) Select Explosives: 3535A/8330B Perchlorate: 6850 Natural Attenuation Parameters: Nitrate, Chloride, and Sulfate: 9056 Soluble Manganese (Field Kit): Hach 8149 Ferrous Iron (Field Kit): Hach 8146 Total and Dissolved Organic Carbon: 9060A Total and Dissolved Inorganic Carbon: 9060A Field Measurements: pH: 150.1 Specific Conductivity: 120.1 Dissolved Oxygen: 360.1 Temperature: 170.1 Turbidity: 180.1 Oxidation Reduction Potential: SM 2580B	Chemical Data (Soils - SW-846) TCLP Metals: 1311/3010A/6010C/7470A Explosives (full list):8330B Herbicides: 8151A Pesticides: 8081A Corrosivity as pH: 9045D Ignitability: 1030 Reactivity (CN & H_2S): CN: 9012A H2S: 9030B/9034 Chemical Data (Aqueous - SW-846 and MCAWW) pH: 9040C COD: 410.4 TAL Metals: 3010A/6010C/7470A	Chemical Data (Soils - SW-846) TAL Metals: 3050B/6010C/7471B TCL Pesticides & PCBs: 3550C/8081A/8082, TCL VOCs: 5035/8260B, TCL SVOCs: 3550C/8270C, Explosives (full list):8330B pH: 9045D
	METHOD QUANTITATION LIMIT	Refer to **Table 4-2**.	Refer to **Table 4-2**.	Refer to **Table 4-3**.	Refer to **Table 4-4**.
	FIELD QUALITY CONTROL SAMPLES	Rinse Blank (5% per matrix per sampling technique) Field Duplicate (10% per matrix)	For Chemical Data Only: Rinse Blank (5% per matrix per sampling technique) Field Duplicate (10% per matrix)	Not Applicable	Not Applicable
STUDY BOUNDARY		1) 29,970 ft^2 2) No public access permitted, no notable geographic characteristics, ash material and grossly-contaminated soil expected in excavation area 3) None	1) 29,970 ft^2 2) No public access permitted, no notable geographic characteristics, ash material and grossly-contaminated soil expected in sampling area 3) None	1) 29,970 ft^2 2) No public access permitted, no notable geographic characteristics, ash material and grossly-contaminated soil expected in excavation area 3) None	1) 29,970 ft^2 2) No public access permitted, no notable geographic characteristics, ash material and grossly-contaminated soil expected in excavation area 3) None

*(1) Refer to **Table 4-1**.*

(2) Samples for the soil confirmation, long-term monitoring, MNA, and waste and borrow characterization will be analyzed using USEPA Office of Solid Waste and Emergency Response (OSWER) Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW-846), Update IV (USEPA, 2007), and USEPA Methods for Chemical Analysis of Water and Wastes (USEPA, 1983) methodology, and the DoD QSM for Environmental Laboratories, Final Version 4.1 (DoD, 2009) methodology. Refer to Section 4.6.

(3) The RGs for soil confirmation and groundwater MNA in SWMU 54 Area A and Area B are based on Tables 8-1 and 8-2 of the Final SWMU 54 RFI/CMS Report (URS, 2008). The soil backfill material screening criteria are based on the Oakridge National Laboratory (ORNL) Regional Screening Table – Industrial and Residential Regional Screening Levels (RSLs) (ORNL, 2009) and the established background values for TAL metals found in Tables C.9-2 and C.9-3 in the Final SWMU 54 RFI/CMS Report (URS, 2008). The soil waste characterization screening criteria are based on the ORNL Regional Screening Table (ORNL, 2009) and the RCRA disposal criteria for TCLP metals, reactivity, ignitability, and corrosivity as pH (40 Code of Federal Regulations [CFR] 261.24 and USEPA SW-846 Chapter 7). The aqueous waste characterization screening criteria are based on the current RFAAP Treatment Plant disposal criteria. [Note: RSLs will be updated as new versions of the RSL table become available.]

(4) Field sampling will be performed in accordance with the RFAAP SWMU 54 WP. Refer to Section 3.0.

4. Define the Boundaries: Define decision statement spatial and temporal boundaries. This step specifies (1) the spatial boundary, (2) population characteristics, applicable geographic areas and associated homogeneous characteristics, and (3) constraints on sample collection.

*(1, 2, 3) Refer to **Table 4-1**.*

5. Develop a Decision Rule: Define the (1) parameters of interest, (2) action levels, and (3) develop a decision rule.

*(1) Parameters of interest are listed in the decision inputs. Refer to **Table 4-1**.*

(2) The action levels for the soil confirmations, groundwater long-term monitoring and natural attenuation, the soil and aqueous waste characterization, and the back fill soil criteria may be found in bullet 3 (3) in the Inputs to Decision section.

(3) If the soil characterization sample exceeds the RG, the soil will be removed. If the confirmation sample exceeds RGs, excavation will continue until all soil above RGs has been removed. Waste characterization samples will be compared to disposal facility criteria. If concentrations of chemicals in these samples exceed target levels, the soil will be disposed at an appropriate disposal facility. MNA groundwater samples will be compared to the RGs. Upon completion of IM excavations, quarterly groundwater sampling will monitor the natural attenuation of chemicals of interest to levels below RGs.

6. **Specify Acceptable Limits on Decision Errors:** Specify the decision maker's tolerable limits on decision errors. This step of the process includes (1) parameter range of interest, (2) decision errors, (3) potential parameter values, and (4) the probability tolerance for decision errors are identified during this phase.

   (1) Parameter ranges are not defined at this time.

   (2) Decision errors include:

   (2a) Deciding that the soil and groundwater characteristics exceed cleanup goals (soil removed/natural attenuation of groundwater achieved) when they do not and deciding that the soil and groundwater characteristics do not exceed cleanup goals (soil not removed/natural attenuation of groundwater not achieved) when they actually do. The consequences of deciding that the soil and groundwater characteristics exceed cleanup goals (soil removed/natural attenuation of groundwater achieved) when they do not will result in unnecessary removal actions. The consequences of deciding that the soil and groundwater characteristics do not exceed cleanup goals (soil not removed/natural attenuation not achieved) when they do will result in liabilities associated with future damages and environmental cleanup costs. Additionally, public opinion will be compromised.

   (2b) (I) The true state when the most severe decision error occurs [deciding that the soil and groundwater characteristics exceed cleanup goals (soil removed/natural attenuation of groundwater achieved) when they actually do] is that the soil and groundwater characteristics exceed cleanup goals and it is removed/attenuated. (II) The true state when the less severe decision error occurs (deciding the soil and groundwater characteristics do not exceed cleanup goals (soil not removed/groundwater not attenuated) when they do not) is that the soil and groundwater characteristics do not exceed cleanup goals and no removal or attenuation occurs.

   (2c) The null hypothesis (H0) is: the soil and groundwater characteristics exceed cleanup goals (soil removed/ groundwater attenuated). The alternative hypothesis (Ha) is the soil and groundwater characteristics do not exceed cleanup goals (soil not removed/groundwater not attenuated).

   (2d) The false positive decision error occurs when H0 is erroneously rejected corresponding to decision error I. The false negative decision error occurs when Ha is erroneously accepted corresponding to decision error II. Project-specific Type I and II error rates are 0.05 and 0.2, respectively.

   (3, 4) The consequence of decision errors and acceptable probability will be determined as part of the final report.

7. **Optimize Data Design:** Identify data collection activities commensurate with data quality specifications. This final step in the process consists of (1) reviewing DQO outputs and existing environmental data, (2) developing data collection design alternatives, (3) formulating mathematical expressions to resolve design problems for each alternative, (4) selecting cost-effective data design capable of achieving DQOs, and (5) documentation of operational details and theoretical assumptions.

(1) This WP contains the proposed IM sampling design program for SWMU 54. A phased focus approach has been adopted for site characterization, confirmation, and waste characterization to optimize resource utilization and minimize decision errors. DQO refinement will be an iterative process throughout the project life cycle.
(2) Non-statistical sampling procedures are proposed. Biased and judgmental sampling will be performed for the collection of the characterization and confirmation samples for the removal action.
(3) Mathematical and qualitative assessments will be established during the refinement process.
(4) This WP contains the proposed IM sampling design program based on cost and project DQOs.

4.4 Background

The propellant ash material and grossly-contaminated soil removal and MNA of groundwater action objective, rationale, and sampling scope for SWMU 54 are presented in **Table 4-1**.

4.5 Applicable or Relevant and Appropriate Requirements

Applicable or relevant and appropriate requirements selected for the ash material and grossly-contaminated soil removal action and groundwater RGs at SWMU 54 may be found in **Table 4-2**. Waste characterization guidelines for soil and aqueous matrices are included in **Table 4-3**. To-Be-Considered Guidance selected at SWMU 54 includes:

- RGs for groundwater MNA in SWMU 54 Area A and Area B are based on Tables 8-1 and 8-2 of the Final *SWMU 54 RFI/CMS Report* (URS, 2008).
- The aqueous waste characterization screening criteria are based on the current RFAAP Treatment Plant disposal criteria.

Sampling locations and procedures and sampling activities and procedures for the IM at SWMU 54 are presented in the FSP (*Section 3.0*). Parameter, container, and preservation requirements, and holding times for analytical samples to be collected as part of the SWMU 54 IM are presented in **Table 4-5**.

Table 4-2
Analyte List and Levels of Concern for SWMU 54
Monitored Natural Attenuation

Parameter	Quantitation Limits[5]		Selected Remedial Goals for Soils (mg/kg)[1]		Selected Remedial Goals for Groundwater Area A (µg/L)[1]
	Aqueous (µg/L)	Soil (mg/kg)	Area A	Area B	
Select Metals					
Lead	2.5	0.20	NA	400	NA
Select PCBs					
Aroclor 1254	1.0	0.033	NA	0.25	NA
Select Pesticides					
Dieldrin	0.10	0.0034	NA	0.00446	NA
Heptachlor Epoxide	0.050	0.0017	0.0047	0.0039	NA
Select Dioxins/Furans[2]					
2,3,7,8-TCDD	0.000010	0.0000010	0.00000789	0.00000657	NA
Perchlorate					
Perchlorate	0.20	0.00020	NA	NA	10.9
Select Explosives					
2,4,6-Trinitrotoluene	1.0	0.25	1.7	1.45	7.82
2,4-Dinitrotoluene	0.15	0.25	NA	NA	NA
2,6-Dinitrotoluene	0.15	0.25	NA	NA	NA
DNT Mixture[3]	NA	NA	0.044	0.037	0.932
RDX	0.25	0.25	0.161	0.134	6.1
2-amino-4,6-Dinitrotoluene	0.30	0.30	NA	NA	NA
4-amino-2,6-Dinitrotoluene	0.15	0.25	NA	NA	NA
Amino DNTs[4]	NA	NA	1.095	0.912	NA
Nitroglycerin	1.0	0.50	0.069	0.057	NA
Monitored Natural Attenuation Parameters					
Nitrate	100	NA	NA	NA	NA
Chloride	1000	NA	NA	NA	NA
Sulfate	1000	NA	NA	NA	NA
Soluble Manganese (Field)	50	NA	NA	NA	NA
Ferrous Iron (Field)	200	NA	NA	NA	NA
Total Organic Carbon	1000	NA	NA	NA	NA
Dissolved Organic Carbon	1000	NA	NA	NA	NA
Total Inorganic Carbon	1000	NA	NA	NA	NA
Dissolved Inorganic Carbon	1000	NA	NA	NA	NA

NA = Not Applicable. Analyte is not part of specified scope or there is no value available.
(1) RGs for soils and groundwater are based on Tables 8-1 and 8-2 of the Final *SWMU 54 RFI/CMS Report* (URS, 2008).
(3) DNT Mixture = 2,4-dinitrotoluene and 2,6-dinitrotoluene
(4) Amino DNTs[4] = 4-amino-2,6-dinitrotoluene and 2-amino-4,6-dinitrotoluene
(5) The achievable QLs noted are limits that an individual laboratory can achieve when performing a specific analytical method. *Laboratory Generated Limits are subject to change, the laboratory will use the most current limits at the time of analysis.* The listed QLs are based upon a wet weight basis for soils.

Table 4-3
Analyte List and Levels of Concern for SWMU 54 Waste Characterization

Aqueous Waste Characterization[2]	Aqueous (µg/L)	Soil (mg/kg)	RCRA Limits (Units)	RSL – tap (µg/L)
Corrosivity as pH	±1 Units	±1 Units	<2 or >12 Units	NA
Chemical Oxygen Demand (COD)	3000	NA	NA	NA
Aqueous Waste Characterization[2]	**Aqueous (µg/L)**	**Soil (mg/kg)**	**MCL (µg/L)**	**RSL – tap (µg/L)**
TAL Metals				
Aluminum	200	20	50	3700
Antimony	6.0	0.60	6.0	1.5
Arsenic	3.0	0.50	10	0.045
Barium	1.5	0.30	2000	730
Beryllium	1.0	0.10	4.0	7.3
Cadmium	1.5	0.15	5.0	1.8
Calcium	500	50.0	NA	NA
Chromium	5.0	0.60	100	11
Cobalt	3.0	0.30	NA	1.1
Copper	3.0	0.50	1300	150
Iron	100	10.0	300	2600
Lead	2.5	0.20	15	NA
Magnesium	500	50.0	NA	NA
Manganese	6.0	0.80	50	88
Mercury	0.10	0.05	2.0	0.057
Nickel	0.30	3.0	NA	73
Potassium	100	1000	NA	NA
Selenium	0.30	3.0	50	18
Silver	0.10	1.0	100	18
Sodium	100	1000	NA	NA
Thallium	0.15	1.5	2.0	0.24
Vanadium	2.0	12.0	NA	26
Zinc	2.0	12.0	5000	1100

NA = Not Applicable. Analyte is not part of specified scope or there is no value available.
(1) The soil waste characterization screening criteria are based on the *ORNL Regional Screening Table – Industrial and Residential RSLs* (ORNL, 2009) and the RCRA disposal criteria for TCLP metals, reactivity, ignitability, and corrosivity as pH (40 CFR 261.24 and USEPA SW-846 Chapter 7).
(2) The aqueous waste characterization screening criteria are based on the current RFAAP Treatment Plant disposal criteria.
(3) The achievable QLs noted are limits that an individual laboratory can achieve when performing a specific analytical method. *Laboratory Generated Limits are subject to change, the laboratory will use the most current limits at the time of analysis.* The listed QLs are based upon a wet weight basis for soils.

4.6 Sample Number and Type

The anticipated number and type of samples to be collected during the IM study at SWMU 54 are presented in **Table 4-4**. **Table 4-4** also presents guidelines for the collection of QC samples that will be taken in conjunction with environmental sampling during the IM study at SWMU 54.

Table 4-4
Estimated Number and Type of Samples for SWMU 54 Interim Measures

Sample Type	Total Samples
Environmental[1]	
Groundwater Monitored Natural Attenuation	280
Pore and Surface Water Monitored Natural Attenuation	25
Total Environmental	**305**
QC (For Groundwater/Pore/Surface Water Samples only)	
Rinse Blank (5% frequency)	16
Matrix Spike/Matrix Spike Duplicate (5% frequency)	16
Field Duplicate (10% frequency)	32
Total QC for Aqueous	**64**
Waste Characterization	
Aqueous Waste Characterization (Decontamination Water/Purge Water)	12
Total Waste and Borrow	**12**
TOTAL SAMPLES	**369**

(1) The number of samples and period of performance for this project are based upon approximately 3 years to prove achievement of RGs and 5 years to reach long-term monitor goals at 14 groundwater samples per quarter and 5 pore/surface water samples per year.

4.6.1 Field Quality Control Samples

Field operations performed during IM will include the collection of several types of QC samples on **Table 4-5**. Rinse blanks, trip blanks, and field duplicates will be collected during the acquisition of environmental samples at RFAAP IM. In addition, every cooler transporting samples will have a temperature blank. If a target analyte is detected in any of the QC blanks, data will be evaluated to determine if corrective action measures will be required.

Table 4-5
Field Quality Control Samples

Type of Control	Purpose of Sample	Collection Frequency
Duplicate Sample	Ensure precision in sample homogeneity during collection and analysis	1 per 20 (5%) samples per matrix.
Rinse Blank	Ensure the decontamination of sampling equipment has been adequately performed; to assess cross contamination and/or incidental contamination to the sample container	1 per 20 (5%) samples per matrix per sampling technique.
Trip Blank	Assess whether cross-contamination occurs during shipment or storage with aqueous VOC samples	1 trip blank per cooler containing aqueous VOC samples
Temperature Blank	Verify sample cooler temperature during transport	1 temperature blank per cooler

4.7 Sample Identification

The sample identification system will be similar with past nomenclature at RFAAP. The sample identification number will consist of an alphanumeric designation related to the sampling location, media type, and sequential order sampling location, sample type, and sequential order according to the sampling event. Each sample will be assigned a unique sequential number at the time of sampling on the sample label, which will be permanently affixed to the sample

container. **Table 3-1** in the FSP (*Section 3.0*) contains sample identification numbers that will be used for the IM at SWMU 54.

4.7.1 Environmental Samples

The field sample identification number consists of an alphanumeric designation according to the following convention:

- **Site Location Code:** The first two or three characters will be the site location number or code. The identification will include the following:

54	= SWMU 54
TM	= Blind Field Duplicate

- **Sample/Media Type:** The second two or three characters will be the sample/media type. Sample types will be designated by the following codes:

GW	= Groundwater
SW	= Surface Water
PW	= Pore Water
ADW	= Aqueous Waste Characterization

- **Sampling Location Number:** The next two characters will be the number of the sampling location (e.g., 01, 02, 03).
- **Duplicate:** Field duplicate samples will be identified with a "TM" designation as noted in the "Site Location Code." A record of the samples that correspond to the duplicates will be kept in the field logbook.

4.7.2 Field QC Blank Samples

Rinse Blanks: All field rinse blanks will use the following designation system:

- Date: month, day, year as MMDDYY
- Type: R = Rinse Blank
- Sequential Collection Order (if more than one collected per day): This consists of one digit such as 1, 2, 3 and so on.

For example, the second rinse blank collected on 07 January 2010 would be identified as 010710R2.

Trip Blanks: All trip blanks will use the following designation system:

- Date: month, day, year as MMDDYY
- Type: T = Trip Blank
- Sequential Collection Order (if more than one collected per day): This consists of one digit such as 1, 2, 3 and so on.

For example, a trip blank collected on 07 January 2010 would be identified as 010710T.

4.7.3 Documentation Requirements

Information pertinent to the sampling effort will be recorded in a field logbook, and a COC form will trace the sample. Field logbook SOP 10.1 may be found in **Appendix A**. All entries will be

made in indelible ink on consecutively numbered pages, and corrections will consist of lineout deletions that are initialed and dated. At a minimum, required field logbook entries include:

- Time and date of sample collection.
- Sampler identification.
- Sample identification number.
- Sample type.
- Analytical request.
- Sampling methodology (grab and composite sample).
- Preservation used, as applicable.
- Associated QA/QC samples.
- Physical field measurements.
- Signature and date of personnel responsible for observations.

Each sample will be assigned a unique sequential number at the time of sampling, which will be permanently affixed to the sample container with polyethylene tape to prevent the loss of the label during shipment. Further discussion as to sample labeling is provided in SOP 50.1 in **Appendix A**. The sample label will be filled out using indelible ink and will include the following information:

- Project name and number.
- Sample location/site ID.
- Sampling date and time.
- Analyses to be performed.
- Preservative, as applicable.
- Sampler name.

4.8 Packaging and COC Requirements

Environmental samples required for shipment must be packaged appropriately in leak-proof coolers to the laboratory. Appropriate custody procedures and documentation must be performed to ensure sample integrity. Further discussion as to sample shipping and packing is provided in SOP 50.2 in **Appendix A**. The following sections discuss sample packaging, shipment, and custody requirements.

4.8.1 Shipping Coolers

Leak proof sample coolers will be shipped to arrive at the laboratory the morning after sampling (priority overnight). The laboratory will be notified of the sample shipment and the estimated date of arrival of the samples being delivered. Shipping coolers are to be clean, leak proof, contamination-free, and in good condition. These containers will be used to transport environmental samples to the laboratory. Suitable sample cooler(s) to handle sample containers packed with double-bagged ice will be required for sample shipment.

4.8.2 Temperature Blanks

Temperature blanks are to be provided to Shaw and will be included in each environmental sample shipping container requiring wet ice. Temperature blanks are required for each cooler for where samples have to meet the USEPA storage requirements of 4±2 degrees Celsius (°C) during shipment. See **Table 4-6** for sample preservation requirements. These blanks will be used by

the laboratory to measure the shipping container internal temperatures at receipt. These samples will not be analyzed for any scoped analysis.

4.8.3 Sample Packaging and Shipment

Samples will be transferred to the contract laboratory for analysis via waterproof plastic coolers. Before samples can be put in the cooler, any drains will be sealed with tape to prevent leaking. Each cooler will be packed in the following manner:

1. Ensure sample lids are tight.
2. Wrap environmental samples and associated QC samples in bubble wrap.
3. Fill cooler with enough packing material to prevent breakage of glass bottles.
4. Place sufficient ice in cooler to maintain the internal temperature at 4±2°C during transport. The ice will be double-bagged in sealed 1-gallon size Zip-loc bags to prevent contact of the melt water with the samples.
5. Place a temperature blank (if applicable) in cooler.
6. Place associated COCs in a water proof plastic bag and tape it to the inside lid of the cooler.
7. Seal coolers at a minimum of two locations with signed custody seals or evidence tape before being transferred off site. Attach completed shipping label and Saturday Delivery label (if applicable) to top of the cooler. Cover seals with wide, clear packing tape, and continue around the cooler to seal the lid. If the cooler has a drain spout, it may also be sealed with tape.

4.8.4 Chain-of-Custody

Sampling will be evidenced through the completion of a COC form, which accompanies the sample containers in the field, during transit to the laboratory, and upon receipt by the laboratory. The COC will be annotated to indicate time and date that samples are relinquished. In addition, shipping containers will be affixed with custody seals. Further discussion of COC may be found in SOP 10.4 of **Appendix A**. The COC will be filled out using indelible ink and will include the following information:

- Project name and number.
- The signatures of the sampling personnel.
- The site code and sample number.
- Sampling dates, locations, and times (military format).
- List of the chemical analysis, volume, and preservatives used.
- The total number of sample containers per location.
- The custody seal number.
- Sample relinquisher, date, and time.
- Any special remarks (e.g., MS/MSD this sample).

Table 4-6
Parameter, Container, Preservation Requirements, and Holding Times for SWMU 54 Interim Measures

Parameter	Sample Container*		Preservation Requirement*	Holding Time
	Solid	Aqueous		
TCL VOCs	3x, 5 gram EnCore sampler or 2 MeOH & 1 DIUF Tarred vials, zero headspace	3x, 40 mL vials with Teflon septum, zero headspace	Cool: 4 ± 2°C, HCl to pH<2 for aqueous, No Sodium Bisulfate (for EnCore) solids due to sample effervescence	Aqueous: Analysis: 14 days Solid: Preparation: 2 days to solvent Analysis: 14 days
TCL SVOCs	1x, 8 oz, wide mouth glass with Teflon cap	2x, 1-L amber glass with Teflon lined cap	Cool: 4 ± 2°C	Aqueous: Extraction: 7 days Analysis: 40 days Solid: Extraction: 14 days Analysis: 40 days
TCL Pesticides/ PCBs	1x, 8 oz, wide mouth glass with Teflon cap	2x, 1-L amber glass with Teflon lined cap	Cool: 4 ± 2°C	Aqueous: Extraction: 7 days Analysis: 40 days Solid: Extraction: 14 days Analysis: 40 days
Polynuclear Aromatic Hydrocarbons	1x, 8 oz, wide mouth glass with Teflon cap	2x, 1-L amber glass with Teflon lined cap	Cool: 4 ± 2°C	Aqueous: Extraction: 7 days Analysis: 40 days Solid: Extraction: 14 days Analysis: 40 days
Explosives	1x, 8 oz, wide mouth glass with Teflon cap	2x, 1-L amber glass with Teflon lined cap	Cool: 4 ± 2°C	Aqueous: Extraction: 7 days Analysis: 40 days Solid: Extraction: 14 days Analysis: 40 days
Herbicides	1x, 8 oz, wide mouth glass with Teflon cap	2x, 1-L amber glass with Teflon lined cap	Cool: 4 ± 2°C	Aqueous: Extraction: 7 days Analysis: 40 days Solid: Extraction: 14 days Analysis: 40 days
Dioxins/Furans	1x, 8 oz, wide mouth glass with Teflon cap	2x, 1-L amber glass with Teflon lined cap	Cool: 4 ± 2°C	Aqueous: Extraction: 30 days Analysis: 40 days Solid: Extraction: 14 days Analysis: 40 days
Perchlorate	1x, 8 oz, wide mouth glass with Teflon cap	1x, 1-L HDPE	Cool: 4 ± 2°C	28 days
TAL Metals and lead	1x, 8 oz, wide mouth glass with Teflon cap	1x, 1-L HDPE	Cool: 4 ± 2°C solid; Cool: 4 ± 2°C; HNO_3 to pH<2 for aqueous	ICP Metals: 180 days Mercury: 28 days
Sulfate, Chloride, and Nitrate	Not Applicable	2x, 250-mL HDPE	Cool: 4 ± 2°C; Cool: 4 ± 2°C; H_2SO_4 to pH<2 for nitrate	Sulfate and chloride: 28 days Nitrate: 2 days
Organic and Inorganic Carbon (Total and Dissolved)	Not Applicable	2x 250mL amber Glass, Teflon-lined septum	Cool: 4 ± 2°C; H_2SO_4 to pH<2; zero headspace for total fraction Plain; zero headspace for dissolved fraction (lab filtered)	28 days
TCLP Metals	1x, 8 oz, wide mouth glass with Teflon cap	1x, 1-L glass or HDPE	Cool: 4 ± 2°C	TCLP Extraction: 180 days ICP Mercury : 28 days Sample Analysis: 180 days ICP Mercury : 28 days
Ignitability	1x, 8 oz, wide mouth glass with Teflon cap	1x, 1-L glass or HDPE	Cool: 4 ± 2°C	28 days
Total Sulfide	1x, 8 oz, wide mouth glass with Teflon cap	1x, 1-L glass or HDPE	Cool: 4 ± 2°C solid; Cool: 4 ± 2°C; NaOH to pH>9 & Zn Acetate for aqueous	7 days
Total Cyanide	1x, 8 oz, wide mouth glass with Teflon cap	1x, 1-L glass or HDPE	Cool: 4 ± 2°C solid; Cool: 4 ± 2°C; NaOH to pH>12 for aqueous	14 days

Table 4-6 (Continued)
Parameter, Container, Preservation Requirements, and Holding Times
for SWMU 54 Interim Measures

Parameter	Sample Container*		Preservation Requirement*	Holding Time
	Solid	Aqueous		
Corrosivity as pH	1x, 8 oz, wide mouth glass with Teflon cap	1x, 250 mL glass or HDPE	Cool: 4 ± 2°C	ASAP
Chemical Oxygen Demand	Not Applicable	1x, 250 mL glass	Cool: 4 ± 2°C, HCl or H_2SO_4 to pH<2 for aqueous	28 days

*Parameters with same preservation requirements may be combined at laboratory's discretion.
Legend:
ASAP = As Soon As Possible
HDPE = High Density Polyethylene
ICP = Inductively Coupled Plasma
L = Liter
mL = milliliter
NA = Not Applicable
PCB = Polychlorinated Biphenyl
SVOC = Semivolatile Organic Compound
TAL = Target Analyte List
TCL = Target Compound List
TCLP = Toxicity Characteristic Leaching Procedure
VOC = Volatile Organic Compound

4.9 Analytical Procedures and Data Validation

4.9.1 Method Selection for Chemical Analyses

Sample collection will be performed in accordance with established SOPs designed to ensure the collection of representative samples. Field SOPs may be found in **Appendix A**. An accredited laboratory through the Environmental Laboratory Accreditation Program (ELAP) and National Environmental Laboratory Accreditation Program (NELAP) will perform the analytical sample analysis. All laboratory analytical methods will be performed in accordance with the requirements outlined in this QAPP, *DoD QSM, Final Version 4.1* (DoD, 2009), and USEPA methods described here-in. Shaw will have the laboratory data validated in accordance with these criteria. Data validation qualifiers will be consistent with the *USEPA Region III Modifications to the National Functional Guidelines for Organic Data Review* (USEPA, 1994b), *Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (USEPA, 1993), and *USEPA Region III Dioxin/Furan Data Validation Guidance* (USEPA, 1999), as applicable. The analysis methods, analytical compound lists, and QLs are provided in **Tables 4-2 and 4-3**.

Analytical QLs were compared to screening levels to ensure that they do not exceed the screening criteria listed in **Tables 4-2 and 4-3**. The listed QLs are based upon a wet weight basis for soils. During the planning stage, the QLs are used for comparison rather than method reporting limits (MRLs) because MRLs are sample specific and take into account characteristics such as dilutions, sample volumes, and percent moistures which are unknown prior to sampling and analysis. The laboratory will be required to perform and report MDLs for each sample and analysis specific to the laboratory, instrumentation, and methodology. The MDLs should be updated at least annually and represent the lowest level the laboratory can detect a constituent at a 99% confidence for a specific compound. If a compound is detected >MDL and <MRL, it will be treated as estimated "J." The QLs are conservative limits that an individual laboratory can

achieve when performing a specific analytical method and, although some exceedances of the screening levels are indicated, this does not necessarily indicate that the method will not detect the compound at, or below, the screening level. Laboratory generated limits are subject to change and the laboratory will use the most current limits at the time of analysis.

Although some QLs are above the screening levels for certain compounds because the values cannot be met practically with the given USEPA methodology, the best available methods were selected to attain screening level requirements. Economical, technical, comparability, and sensitivity factors were considered during the method selection process for this IM study. The MRLs and MDLs will be compared to screening levels during the data analysis stage in the IM study.

4.9.2 Laboratory Procedures for Chemical Analyses

Analytical testing will be performed by the contracted NELAP and ELAP accredited laboratory. The methods listed for the SWMU 54 IM are in accordance with *USEPA OSWER Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW-846), Update IV* (USEPA, 2007) and *USEPA Methods for Chemical Analysis of Water and Wastes* (USEPA, 1983). The LQAP for the subcontracted analytical laboratory for the SWMU 54 IM is presented as **Appendix B**. Analytical compound lists and minimum QLs to be used are given in **Tables 4-2 and 4-3**. The laboratory analytical sensitivity, accuracy, and precision data may be found in **Table 4-7**. The QC requirements are based on the DoD QSM and may be found in **Tables 4-8 through 4-13**. The soil confirmation analysis is being performed for explosives, lead, and polychlorinated biphenyls (PCBs) (Area B only). Twenty-five (25) percent of all confirmation samples will be analyzed for dioxins/furans. The groundwater, surface water, and pore water samples will be collected and analyzed for explosives, perchlorate, TAL metals, and natural attenuation parameters including, sulfate, chloride, nitrate, total and dissolved organic carbon, and total and dissolved inorganic carbon. The soil waste characterization samples will be analyzed for TCLP metals, explosives, herbicides, pesticides, corrosivity as pH, reactivity, and ignitability. For reactivity, the analysis will also include total cyanide and total sulfide. The aqueous waste characterization samples (decontamination rinse water) will be analyzed for COD, TAL metals, and pH. The soil borrow fill material will be analyzed for TAL metals, target compound list (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), explosives, TCL pesticides/PCBs, and pH.

Table 4-7
Analyte List and Laboratory Sensitivity, Precision, and Accuracy Control Limits
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Analyte	Aq. QL	Soil QL	CAS #	Aq. BS/MS/MSD	Aq. RPD	Soil BS/MS/MSD	Soil RPD
TCL VOCs SW-846 5030B/5035A/8260B	ug/L	mg/kg		(%)	(%)	(%)	(%)
1,1,1-Trichloroethane	1.0	0.005	71-55-6	65-130	30	70-135	30
1,1,1,2-Tetrachloroethane	1.0	0.005	630-20-6	80-130	30	75-125	30
1,1,2-Trichloroethane	1.0	0.005	79-00-5	75-125	30	60-125	30
1,1-Dichloroethane	1.0	0.005	75-34-3	70-135	30	75-125	30
1,1-Dichloroethylene	1.0	0.005	75-35-4	70-130	30	65-135	30
1,2-Dichloroethane	1.0	0.005	107-06-2	80-120	30	70-135	30
1,2-Dichloropropane	1.0	0.005	78-87-5	75-125	30	70-120	30
2-Butanone	2.0	0.010	78-93-3	30-150	30	30-160	30
2-Hexanone	2.0	0.010	591-78-6	55-130	30	45-145	30
4-Methyl-2-pentanone	2.0	0.010	108-10-1	60-135	30	45-145	30
Acetone	10.0	0.020	67-64-1	40-140	30	20-160	30
Benzene	1.0	0.005	71-43-2	80-120	30	75-125	30
Bromodichloromethane	1.0	0.005	75-27-4	75-120	30	70-130	30
Bromoform	1.0	0.005	75-25-2	70-130	30	55-135	30
Carbon disulfide	2.0	0.010	75-15-0	35-160	30	45-160	30
Carbon tetrachloride	1.0	0.005	56-23-5	65-140	30	65-135	30
Chlorobenzene	1.0	0.005	108-90-7	80-120	30	75-125	30
Chloroethane	1.0	0.005	75-00-3	60-135	30	40-155	30
Chloroform	1.0	0.005	67-66-3	65-135	30	70-125	30
cis-1,2-Dichloroethylene	1.0	0.005	156-59-2	70-125	30	65-125	30
cis-1,3-Dichloropropene	1.0	0.005	10061-01-5	70-130	30	70-125	30
Dibromochloromethane	1.0	0.005	124-48-1	60-135	30	65-130	30
Ethylbenzene	1.0	0.005	100-41-4	75-125	30	75-125	30
m,p-Xylene	1.0	0.005	m,p-Xyl	75-130	30	80-125	30
Methyl bromide	1.0	0.005	74-83-9	30-145	30	30-160	30
Methyl chloride	1.0	0.005	74-87-3	40-125	30	50-130	30
Methylene chloride	1.0	0.010	75-09-2	55-140	30	55-140	30
o-Xylene	1.0	0.005	95-47-6	80-120	30	75-125	30
Styrene	1.0	0.005	100-42-5	65-135	30	75-125	30
Tetrachloroethylene	1.0	0.005	127-18-4	45-150	30	65-140	30
Toluene	1.0	0.005	108-88-3	75-120	30	70-125	30
trans-1,2-Dichloroethylene	1.0	0.005	156-60-5	60-140	30	65-135	30
trans-1,3-Dichloropropene	1.0	0.005	10061-02-6	55-140	30	65-125	30
Trichloroethylene	1.0	0.005	79-01-6	70-125	30	75-125	30
Vinyl chloride	1.0	0.005	75-01-4	50-145	30	60-125	30
Surrogates:							
1,2-Dichloroethane-d4	NA	NA	17060-07-0	70-120	NA	75-125*	NA
4-Bromofluorobenzene	NA	NA	460-00-4	75-120	NA	85-120	NA
Dibromofluoromethane	NA	NA	1868-53-7	85-115	NA	75-125*	NA
Toluene-d8	NA	NA	2037-26-5	85-120	NA	85-115	NA
TCL SVOCs SW-846 3510C/3550B/8270C	ug/L	mg/kg		(%)	(%)	(%)	(%)
1,2,4-Trichlorobenzene	10	0.33	120-82-1	35-105	30	45-110	30
1,2-Dichlorobenzene	10	0.33	95-50-1	35-100	30	45-100	30
1,3-Dichlorobenzene	10	0.33	541-73-1	30-100	30	40-100	30
1,4-Dichlorobenzene	10	0.33	106-46-7	30-100	30	35-105	30
2,4,5-Trichlorophenol	10	0.33	95-95-4	50-110	30	50-110	30
2,4,6-Trichlorophenol	10	0.33	88-06-2	50-115	30	45-110	30
2,4-Dichlorophenol	10	0.33	120-83-2	50-105	30	45-110	30
2,4-Dimethylphenol	10	0.5	105-67-9	30-110	30	30-105	30
2,4-Dinitrophenol	60	2.0	51-28-5	15-140	30	15-130	30
2,4-Dinitrotoluene	10	0.33	121-14-2	50-120	30	50-115	30
2,6-Dinitrotoluene	15	0.5	606-20-2	50-115	30	50-110	30
2-Chloronaphthalene	10	0.33	91-58-7	50-105	30	45-105	30
2-Chlorophenol	10	0.33	95-57-8	35-105	30	45-105	30
2-Methylnaphthalene	10	0.33	91-57-6	45-105	30	45-105	30
2-Methylphenol	10	0.33	95-48-7	40-110	30	40-105	30
2-Nitroaniline	50	1.6	88-74-4	50-115	30	45-120	30
2-Nitrophenol	10	0.33	88-75-5	40-115	30	40-110	30
3,3'-Dichlorobenzidine	50	1.6	91-94-1	20-110	30	10-130	30
3-Nitroaniline	60	2.0	99-09-2	20-125	30	25-110	30
4,6-Dinitro-2-Methylphenol	10	0.33	534-52-1	40-130	30	30-135	30
4-Bromophenyl Phenyl Ether	10	0.33	101-55-3	50-115	30	45-115	30
4-Chloro-3-methylphenol	10	0.33	59-50-7	45-110	30	45-115	30
4-Chloroaniline	10	0.33	106-47-8	15-110	30	10-100	30
4-Chlorophenyl Phenyl Ether	30	1.0	7005-72-3	50-110	30	45-110	30
3,4-Methylphenol	60	2.0	3,4-MP	30-110	30	40-105	30

Table 4-7
Analyte List and Laboratory Sensitivity, Precision, and Accuracy Control Limits
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Analyte	Aq. QL	Soil QL	CAS #	Aq. BS/MS/MSD	Aq. RPD	Soil BS/MS/MSD	Soil RPD
4-Nitroaniline	10	0.33	100-01-6	35-120	30	35-115	30
4-Nitrophenol	10	0.33	100-02-7	0-125	30	15-140	30
Acenaphthene	10	0.33	83-32-9	45-110	30	45-110	30
Acenaphthylene	10	0.33	208-96-8	50-105	30	45-105	30
Anthracene	10	0.33	120-12-7	55-110	30	55-105	30
Benzo(a)anthracene	10	0.33	56-55-3	55-110	30	50-110	30
Benzo(a)pyrene	10	0.33	50-32-8	55-110	30	50-110	30
Benzo(b)fluoranthene	10	0.33	205-99-2	45-120	30	45-115	30
Benzo(g,h,i)perylene	75	1.6	191-24-2	40-125	30	40-125	30
Benzo(k)fluoranthene	10	0.51	207-08-9	45-125	30	45-125	30
Benzoic acid	10	0.33	65-85-0	0-125	30	0-110	30
Benzyl Alcohol	10	0.33	100-51-6	30-110	30	20-125	30
bis(2-Chloroethoxy)methane	10	0.33	111-91-1	45-105	30	45-110	30
Bis(2-chloroethyl)ether	10	0.33	111-44-4	35-110	30	40-105	30
Bis(2-chloroisopropyl)ether	10	0.33	108-60-1	25-130	30	20-115	30
Bis(2-ethylhexyl)phthalate	10	0.33	117-81-7	40-125	30	45-125	30
Butylbenzylphthalate	10	0.33	85-68-7	45-115	30	50-125	30
Chrysene	10	0.33	218-01-9	55-110	30	55-110	30
Di-n-butylphthalate	10	0.33	84-74-2	55-115	30	55-110	30
Di-n-octylphthalate	10	0.33	117-84-0	35-135	30	40-130	30
Dibenz(a,h)Anthracene	10	0.33	53-70-3	40-125	30	40-125	30
Dibenzofuran	10	0.33	132-64-9	55-105	30	50-105	30
Diethylphthalate	10	0.33	84-66-2	40-120	30	50-115	30
Dimethylphthalate	10	0.33	131-11-3	25-125	30	50-110	30
Fluoranthene	10	0.33	206-44-0	55-115	30	55-115	30
Fluorene	10	0.33	86-73-7	50-110	30	50-110	30
Hexachlorobenzene	10	0.33	118-74-1	50-110	30	45-120	30
Hexachlorobutadiene	50	1.6	87-68-3	25-105	30	40-115	30
Hexachlorocyclopentadiene	10	0.33	77-47-4	50-150*	30	50-150*	30
Hexachloroethane	15	0.33	67-72-1	30-100	30	35-110	30
Indeno(1,2,3-cd)pyrene	10	0.33	193-39-5	45-125	30	40-120	30
Isophorone	10	0.33	78-59-1	50-110	30	45-110	30
N-Nitrosodi-n-propylamine	10	0.33	621-64-7	35-130	30	40-115	30
N-Nitrosodiphenylamine	60	2.0	86-30-6	50-110	30	50-115	30
Naphthalene	10	0.33	91-20-3	40-100	30	40-105	30
Nitrobenzene	10	0.33	98-95-3	45-110	30	40-115	30
Pentachlorophenol	10	0.33	87-86-5	40-115	30	25-120	30
Phenanthrene	10	0.33	85-01-8	50-115	30	50-110	30
Phenol	10	0.33	108-95-2	0-115	30	40-100	30
Pyrene	10	0.33	129-00-0	50-130	30	45-125	30
Surrogates:							
2-Fluorobiphenyl	NA	NA	367-12-4	50-110	NA	45-105	NA
Terphenyl-d14	NA	NA	1718-51-0	50-135	NA	30-125	NA
2,4,6-Tribromophenol	NA	NA	118-79-6	40-125	NA	35-125	NA
2-Fluorophenol	NA	NA	367-12-4	20-110	NA	35-105	NA
Phenol-d5/d6	NA	NA	4165-62-2	10-115	NA	40-110	NA
Nitrobenzene-d5	NA	NA	4165-60-0	40-110	NA	35-100	NA
PAHs SW-846 3510C/3550B/8270C SIM	ug/L	mg/kg		(%)	(%)	(%)	(%)
2-Methylnaphthalene	0.050	0.005	91-57-6	45-105	30	45-105	30
Acenaphthene	0.050	0.005	83-32-9	45-110	30	45-110	30
Acenaphthylene	0.050	0.005	208-96-8	50-105	30	45-105	30
Anthracene	0.050	0.005	120-12-7	55-110	30	55-105	30
Benzo(a)anthracene	0.050	0.005	56-55-3	55-110	30	50-110	30
Benzo(a)pyrene	0.050	0.005	50-32-8	55-110	30	50-110	30
Benzo(b)fluoranthene	0.050	0.005	205-99-2	45-120	30	45-115	30
Benzo(g,h,i)perylene	0.050	0.005	191-24-2	40-125	30	40-125	30
Benzo(k)fluoranthene	0.050	0.005	207-08-9	45-125	30	45-125	30
Chrysene	0.050	0.005	218-01-9	55-110	30	55-110	30
Dibenz(a,h)Anthracene	0.050	0.005	53-70-3	40-125	30	40-125	30
Fluoranthene	0.050	0.005	206-44-0	55-115	30	55-115	30
Fluorene	0.050	0.005	86-73-7	50-110	30	50-110	30
Indeno(1,2,3-cd)pyrene	0.050	0.005	193-39-5	45-125	30	40-120	30
Naphthalene	0.050	0.005	91-20-3	40-100	30	40-105	30
Phenanthrene	0.050	0.005	85-01-8	50-115	30	50-110	30
Pyrene	0.050	0.005	129-00-0	50-130	30	45-125	30

Table 4-7
Analyte List and Laboratory Sensitivity, Precision, and Accuracy Control Limits
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Analyte	Aq. QL	Soil QL	CAS #	Aq. BS/MS/MSD	Aq. RPD	Soil BS/MS/MSD	Soil RPD
Surrogates:							
2-Fluorobiphenyl	NA	NA	367-12-4	50-110	NA	45-105	NA
Terphenyl-d14	NA	NA	1718-51-0	50-135	NA	30-125	NA
Nitrobenzene-d5	NA	NA	4165-60-0	40-110	NA	35-100	NA
TCL Pesticides SW-846 3510C/3550B/8081A	ug/L	mg/kg		(%)	(%)	(%)	(%)
4,4'-DDD	0.10	0.0034	72-54-8	25-150	20	30-135	20
4,4'-DDE	0.10	0.0034	72-55-9	35-140	20	70-135	20
4,4'-DDT	0.10	0.0034	50-29-3	45-140	20	45-140	20
Aldrin	0.050	0.0017	309-00-2	25-140	20	45-140	20
alpha-BHC	0.050	0.0017	319-84-6	60-130	20	60-125	20
alpha-Chlordane	0.050	0.0017	5103-71-9	65-125	20	65-120	20
beta-BHC	0.050	0.0017	319-85-7	65-125	20	65-120	20
delta-BHC	0.050	0.0017	319-86-8	45-135	20	55-130	20
Dieldrin	0.10	0.0034	60-57-1	60-130	20	65-125	20
Endosulfan I	0.10	0.0034	959-98-8	50-110	20	15-135	20
Endosulfan II	0.050	0.0017	33213-65-9	30-130	20	35-140	20
Endosulfan Sulfate	0.10	0.0034	1031-07-8	55-135	20	60-135	20
Endrin	0.10	0.0034	72-20-8	55-135	20	60-135	20
Endrin aldehyde	0.10	0.0034	7421-93-4	55-135	20	35-145	20
Endrin ketone	0.10	0.0034	53494-70-5	75-125	20	65-135	20
gamma-Chlordane	0.050	0.0017	5103-74-2	60-125	20	60-125	20
Heptachlor	0.050	0.0017	76-44-8	40-130	20	50-140	20
Heptachlor Epoxide	0.050	0.0017	1024-57-3	60-130	20	65-130	20
Lindane (gamma-BHC)	0.050	0.0017	58-89-9	25-135	20	60-125	20
Methoxychlor	2.0	0.017	72-43-5	55-150	20	55-145	20
Toxaphene	2.0	0.067	8001-35-2	NA	NA	NA	NA
Surrogates:							
Decachlorobiphenyl	NA	NA	2051-24-3	30-135	NA	55-130	NA
TCMX	NA	NA	877-09-8	25-140	NA	70-125	NA
TCL PCBs SW-846 3510C/3550B/8082	ug/L	mg/kg		(%)	(%)	(%)	(%)
PCB-1016	1.0	0.033	12674-11-2	25-145	20	40-140	20
PCB-1221	1.5	0.033	11104-28-2	NA	NA	NA	NA
PCB-1232	1.0	0.033	11141-16-5	NA	NA	NA	NA
PCB-1242	1.0	0.033	53469-21-9	NA	NA	NA	NA
PCB-1248	1.0	0.033	12672-29-6	NA	NA	NA	NA
PCB-1254	1.0	0.033	11097-69-1	NA	NA	NA	NA
PCB-1260	1.0	0.033	11096-82-5	30-145	20	60-130	20
Surrogates:							
Decachlorobiphenyl	NA	NA	2051-24-3	30-135	NA	55-130	NA
TCMX	NA	NA	877-09-8	50-150*	NA	50-150*	NA
TAL Metals SW-846 3010A/3050B/6010B/7470A/7471A	ug/L	mg/kg		(%)	(%)	(%)	(%)
Aluminum	200	20	7429-90-5	80-120	20	80-120	20
Antimony	6.0	0.60	7440-36-0	80-120	20	80-120	20
Arsenic	3.0	0.50	7440-38-2	80-120	20	80-120	20
Barium	1.5	0.30	7440-39-3	80-120	20	80-120	20
Beryllium	1.0	0.10	7440-41-7	80-120	20	80-120	20
Cadmium	1.5	0.15	7440-43-9	80-120	20	80-120	20
Calcium	500	50	7440-70-2	80-120	20	80-120	20
Chromium	5.0	0.60	7440-47-3	80-120	20	80-120	20
Cobalt	3.0	0.30	7440-48-4	80-120	20	80-120	20
Copper	3.0	0.50	7440-50-8	80-120	20	80-120	20
Iron	100	10	7439-89-6	80-120	20	80-120	20
Lead	2.5	0.20	7439-92-1	80-120	20	80-120	20
Magnesium	500	50	7439-95-4	80-120	20	80-120	20
Manganese	6.0	0.80	7439-96-5	80-120	20	80-120	20
Mercury	0.10	0.05	7439-97-6	80-120	20	80-120	20
Nickel	0.30	3.0	7440-02-0	80-120	20	80-120	20
Potassium	100	1000	7440-09-7	80-120	20	80-120	20
Selenium	0.30	3.0	7782-49-2	80-120	20	80-120	20
Silver	0.10	1.0	7440-22-4	80-120	20	75-120	20
Sodium	100	1000	7440-23-5	80-120	20	80-120	20
Thallium	0.15	1.5	7440-28-0	80-120	20	80-120	20
Vanadium	2.0	12	7440-62-2	80-120	20	80-120	20
Zinc	2.0	12	7440-66-6	80-120	20	80-120	20
Dioxin Furans SW-846 8290	ug/L	mg/kg		(%)	(%)	(%)	(%)
2,3,7,8-TCDD	0.000010	0.0000010	1746-01-6	40-135	20	40-135	20
1,2,3,7,8-PeCDD	0.000050	0.0000050	40321-76-4	40-135	20	40-135	20
1,2,3,4,7,8-HxCDD	0.000050	0.0000050	39227-28-6	40-135	20	40-135	20
1,2,3,6,7,8-HxCDD	0.000050	0.0000050	57653-85-7	40-135	20	40-135	20
1,2,3,7,8,9-HxCDD	0.000050	0.0000050	19408-74-3	40-135	20	40-135	20

Table 4-7
Analyte List and Laboratory Sensitivity, Precision, and Accuracy Control Limits
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Analyte	Aq. QL	Soil QL	CAS #	Aq. BS/MS/MSD	Aq. RPD	Soil BS/MS/MSD	Soil RPD
1,2,3,4,6,7,8-HpCDD	0.000050	0.0000050	35822-46-9	40-135	20	40-135	20
OCDD	0.00010	0.000010	3268-87-9	40-135	20	40-135	20
2,3,7,8-TCDF	0.000010	0.0000010	51207-31-9	40-135	20	40-135	20
1,2,3,7,8-PeCDF	0.000050	0.0000050	57117-41-6	40-135	20	40-135	20
2,3,4,7,8-PeCDF	0.000050	0.0000050	57117-31-4	40-135	20	40-135	20
1,2,3,4,7,8-HxCDF	0.000050	0.0000050	70648-26-9	40-135	20	40-135	20
1,2,3,6,7,8-HxCDF	0.000050	0.0000050	57117-44-9	40-135	20	40-135	20
2,3,4,6,7,8-HxCDF	0.000050	0.0000050	60851-34-5	40-135	20	40-135	20
1,2,3,7,8,9-HxCDF	0.000050	0.0000050	72918-21-9	40-135	20	40-135	20
1,2,3,4,6,7,8-HpCDF	0.000050	0.0000050	67562-39-4	40-135	20	40-135	20
1,2,3,4,7,8,9-HpCDF	0.000050	0.0000050	55673-89-7	40-135	20	40-135	20
OCDF	0.00010	0.000010	39001-02-0	40-135	20	40-135	20
Total TCDD	0.000010	0.0000010	NA	NA	NA	NA	NA
Total PeCDD	0.000050	0.0000050	NA	NA	NA	NA	NA
Total HxCDD	0.000050	0.0000050	NA	NA	NA	NA	NA
Total HpCDD	0.000050	0.0000050	NA	NA	NA	NA	NA
Total TCDF	0.000010	0.0000010	NA	NA	NA	NA	NA
Total PeCDF	0.000050	0.0000050	NA	NA	NA	NA	NA
Total HxCDF	0.000050	0.0000050	NA	NA	NA	NA	NA
Total HpCDF	0.000050	0.0000050	NA	NA	NA	NA	NA
Surrogates:							
1,2,3,4,7,8-HxCDD-13C12	NA	NA	39227-28-6	40-135*	NA	40-135*	NA
2,3,7,8-TCDD-37Cl4	NA	NA	1746-01-6	40-135*	NA	40-135*	NA
2,3,4,7,8-PeCDF-13C12	NA	NA	57117-31-4	40-135*	NA	40-135*	NA
1,2,3,4,7,8-HxCDF-13C12	NA	NA	70648-26-9	40-135*	NA	40-135*	NA
1,2,3,4,7,8,9-HpCDF-13C12	NA	NA	55673-89-7	40-135*	NA	40-135*	NA
Herbicides SW-846 8151A	ug/L	mg/kg		(%)	(%)	(%)	(%)
2,4,5-TP (Silvex)	1.0	0.020	93-72-1	50-115	20	45-125	20
2,4,5-T	1.0	0.020	93-76-5	35-110	20	45-135	20
2,4-DB	4.0	0.080	94-82-6	45-130	20	50-155	20
2,4-D	4.0	0.080	94-75-7	35-115	20	35-145	20
Dalapon	2.0	0.040	75-99-0	40-110	20	50-150*	NA
Dicamba	2.0	0.040	1918-00-9	60-110	20	55-110	20
Dichlorprop	4.0	0.080	120-36-5	70-120	20	75-140	20
Dinoseb	0.60	0.012	88-85-7	20-100	20	5-130	20
MCPA	450	8.0	94-74-6	60-145	20	50-150*	NA
MCPP	400	8.0	93-65-2	50-150*	NA	50-150*	NA
Surrogates:							
2,4-DCAA	NA	NA	19719-28-9	50-150*	NA	50-150*	NA
Explosives SW-846 3535A/8330B	ug/L	mg/kg		(%)	(%)	(%)	(%)
1,3,5-Trinitrobenzene	0.10	0.25	99-35-4	65-140	20	75-125	20
1,3-Dinitrobenzene	0.15	0.25	99-65-0	45-160	20	80-125	20
2,4,6-Trinitrotoluene	1.0	0.25	118-96-7	50-145	20	55-140	20
2,4-Dinitrotoluene	0.15	0.25	121-14-2	60-135	20	80-125	20
2,6-Dinitrotoluene	0.15	0.25	606-20-2	60-135	20	80-120	20
2-Amino-4,6-Dinitrotoluene	0.30	0.30	35572-78-2	50-155	20	80-125	20
2-Nitrotoluene	0.50	0.25	88-72-2	45-135	20	80-125	20
3-Nitrotoluene	0.50	0.25	99-08-1	50-130	20	75-120	20
4-Amino-2,6-Dinitrotoluene	0.15	0.25	19406-51-0	55-155	20	80-125	20
4-Nitrotoluene	0.50	0.25	99-99-0	50-130	20	75-125	20
HMX	0.15	0.25	2691-41-0	80-115	20	75-125	20
Nitrobenzene	0.15	0.25	98-95-3	50-140	20	75-125	20
RDX	0.25	0.25	121-82-4	50-160	20	70-135	20
Tetryl	0.15	0.25	479-45-8	20-175	20	10-150	20
Nitroglycerin	1.0	0.50	55-63-0	50-150*	20	50-150*	20
PETN	1.0	0.50	78-11-5	50-150*	20	50-150*	20
Surrogates:							
3,4-Dinitrotoluene	NA	NA	610-39-9	50-150*	NA	50-150*	NA
Perchlorate SW-846 6850	ug/L	mg/kg		(%)	(%)	(%)	(%)
Perchlorate SW-846 6850	0.20	0.0020	14797-73-0	80-120*	20	80-120*	20
Anions SW-846 9056	ug/L	mg/kg		(%)	(%)	(%)	(%)
Chloride	1000	NA	16887-00-6	80-120	20	80-120	20
Nitrate	100	NA	17778-88-0	80-120	20	80-120	20
Sulfate	1000	NA	14808-79-8	80-120	20	80-120	20
Organic and Inorganic Carbon SW-846 9060A	ug/L	mg/kg		(%)	(%)	(%)	(%)
Organic Carbon	1000	NA	TOC	75-125	20	75-125	20
Inorganic Carbon	1000	NA	TIC	75-125	20	75-125	20
Field Kits - Hach 8146 & 8149	ug/L	mg/kg		(%)	(%)	(%)	(%)
Soluble Manganese	50	NA	7439-96-5	NA	NA	NA	NA
Ferrous Iron	200	NA	7439-89-6	NA	NA	NA	NA

Table 4-7
Analyte List and Laboratory Sensitivity, Precision, and Accuracy Control Limits
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Analyte	Aq. QL	Soil QL	CAS #	Aq. BS/MS/MSD	Aq. RPD	Soil BS/MS/MSD	Soil RPD
Ignitability SW-846 1030	deg F	deg F		(%)	(%)	(%)	(%)
Ignitability	NA	±1°F	Ignitability	NA	NA	NA	NA
Corrosivity as pH or pH SW-846 9040C/9045D	units	units		(%)	(%)	(%)	(%)
pH	±1 Units	±1 Units	pH	NA	NA	NA	NA
Reactivity SW-846 9012A and 9030B	ug/L	mg/kg		(%)	(%)	(%)	(%)
Cyanide	NA	5.0	57-12-5	80-120*	20	80-120*	20
Hydrogen Sulfide	NA	2.0	7783-06-4	80-120*	20	80-120*	20
COD 410.4	ug/L	mg/kg		(%)	(%)	(%)	(%)
Chemical Oxygen Demand	3000	NA	COD	80-120*	20	NA	NA

Limits Ref: *DoD QSM, Final Version 4.1* (DoD, 2009). Dioxin MS/MSD/BS are method limits.
* = No DoD QSM Version 4.1 control limits are available. The noted or lab generated limits are acceptable.
ug/L = microgram per liter
BS = Blank Spike
CAS # = Chemical Abstracts Service
COD = Chemical Oxygen Demand
mg/kg = milligram per kilogram
MS = Matrix Spike
MSD = Matrix Spike Duplicate
NA = Not Applicable
PAH = Polynuclear Aromatic Hydrocarbon
PCB = Polychlorinated Biphenyl
RPD = Relative Percent Difference
QL = Quantitation Limit
SIM = Selective Ion Monitoring
SVOC = Semivolatile Organic Compound
TAL = Target Analyte List
TCL = Target Compound List
VOC = Volatile Organic Compound

Table 4-8
Quality Control Method Criteria for Explosives by SW-846 8330B

Table F-3. Nitroaromatics, Nitramines, and Nitrate Esters Analysis by High-Performance Liquid Chromatography (Method 8330B)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise, method-specified criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria (see Section C.1.f).	Flagging criteria are not appropriate.	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD determination and verification (See Box D-13)					
LOQ establishment and verification (See Box D-14)					
Soil drying procedure	Each sample and batch LCS.	Laboratory must have a procedure to determine when the sample is dry to constant weight. Record date, time, and ambient temperature on a daily basis while drying samples.	NA.	Flagging criteria are not appropriate.	
Soil sieving procedure	Each sample and batch LCS.	Weigh entire sample. Sieve entire sample with a 10 mesh sieve. Breakup pieces of soil (especially clay) with gloved hands. Do not intentionally include vegetation in the portion of the sample that passes through the sieve unless this is a project specific requirement. Collect and weigh any portion unable to pass through the sieve.	NA.	Flagging criteria are not appropriate.	

Table 4-8 (Continued)
Quality Control Method Criteria for Explosives by SW-846 8330B

Table F-3. Nitroaromatics, Nitramines, and Nitrate Esters Analysis by High-Performance Liquid Chromatography (Method 8330B) (continued)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Aqueous sample preparation	Each sample.	Solid phase extraction (SPE) using resin-based solid phase disks or cartridges is required. The salting-out procedure is not permitted.	NA.	Flagging criteria are not appropriate.	
Initial calibration (ICAL)	Minimum of 5 calibration standards with the lowest standard concentration at or below the RL. Once calibration curve or line is generated, the lowest calibration standard must be re-analyzed.	The apparent signal-to-noise ratio at the RL must be at least 5:1. If linear regression is used, $r \geq 0.995$. If using Internal Standardization, RSD ≤ 15%.	Correct problem, then repeat ICAL.	Flagging criteria are not appropriate.	No samples can be run without a valid ICAL. Analysis by HPLC UV, LC/MS, or LC/MS/MS is allowed.
Second source calibration verification (ICV)	Immediately following ICAL.	All analyte(s) and surrogates within ± 20% of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.
Continuing calibration verification (CCV)	Prior to sample analysis, after every 10 field samples, and at the end of the analysis sequence.	All target analytes and surrogates within ± 20% of the expected value from the ICAL.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Method blank	One per preparatory batch.	No analytes detected > ½ RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem, then see criteria in Box D-1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

Table 4-8 (Continued)
Quality Control Method Criteria for Explosives by SW-846 8330B

Table F-3. Nitroaromatics, Nitramines, and Nitrate Esters Analysis by High-Performance Liquid Chromatography (Method 8330B) (continued)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
LCS containing all analytes to be reported	One per preparatory batch.	A solid reference material containing all reported analytes must be prepared (e.g., ground and subsampled) and analyzed in exactly the same manner as a field sample. In-house laboratory control limits for the LCS must demonstrate the laboratory's ability to meet the project's MQOs.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix G).	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike (MS)	One per preparatory batch per matrix (see Box D-7).	For matrix evaluation only, therefore is taken post grinding from same ground sample as parent subsample is taken. Percent recovery must meet LCS limits.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.
Matrix spike duplicate (MSD) or sample duplicate	One per preparatory batch per matrix (see Box D-7).	For matrix evaluation only, therefore is taken post grinding from same ground sample as parent subsample is taken. Percent recovery must meet LCS limits and relative percent difference (RPD) < 20%.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.

Table 4-8 (Continued)
Quality Control Method Criteria for Explosives by SW-846 8330B

Table F-4. Organic Analysis by Gas Chromatography/Mass Spectrometry (Methods 8260 and 8270) (continued)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Evaluation of relative retention times (RRT)	With each sample.	RRT of each target analyte within ± 0.06 RRT units.	Correct problem, then rerun ICAL.	Flagging criteria are not appropriate.	Laboratories may update the retention times based on the CCV to account for minor performance fluctuations or after routine system maintenance (such as column clipping). With each sample, the RRT shall be compared with the most recently updated RRT. If the RRT has changed by more than ±0.06 RRT units since the last update, this indicates a significant change in system performance and the laboratory must take appropriate corrective actions as required by the method and rerun the ICAL to reestablish the retention times.
Continuing calibration verification (CCV)	Daily before sample analysis and every 12 hours of analysis time.	1. Average RF for SPCCs: VOCs ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane; ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. SVOCs ≥ 0.050. 2. %Difference/Drift for all target compounds and surrogates: VOCs and SVOCs ≤ 20%D (Note: D = difference when using RFs or drift when using least squares regression or non-linear calibration).	DoD project level approval must be obtained for each of the failed analytes or corrective action must be taken. Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since last acceptable CCV.	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

Table 4-9
Quality Control Method Criteria for Metals by SW-846 6010B and 7470A/7471A

Table F-7. Inorganic Analysis by Inductively Coupled Plasma (ICP) Atomic Emission Spectrometry and Atomic Absorption Spectrophotometry (AA) (Methods 6010 and 7000 Series)					
QC Check	**Mininum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise, method-specified criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria (see Section C.1.f).	NA.	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD determination and verification (See Box D-13)					
LOQ establishment and verification (See Box D-14)					
Instrument detection limit (IDL) study (ICP only)	At initial set-up and after significant change in instrument type, personnel, test method, or sample matrix.	IDLs shall be ≤ LOD.	NA.	NA.	Samples may not be analyzed without a valid IDL.
Linear dynamic range or high-level check standard (ICP only)	Every 6 months.	Within ± 10% of true value.	NA.	NA.	

Table 4-9 (Continued)
Quality Control Method Criteria for Metals by SW-846 6010B and 7470A/7471A

Table F-7. Inorganic Analysis by Inductively Coupled Plasma (ICP) Atomic Emission Spectrometry and Atomic Absorption Spectrophotometry (AA) (Methods 6010 and 7000 Series) (continued)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Initial calibration (ICAL) for all analytes **ICP: minimum one high standard and a calibration blank;** **GFAA: minimum three standards and a calibration blank;** **CVAA: minimum 5 standards and a calibration blank**	Daily ICAL prior to sample analysis.	If more than one calibration standard is used, $r \geq 0.995$.	Correct problem, then repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until ICAL has passed.
Second source calibration verification (ICV)	Once after each ICAL, prior to beginning a sample run.	Value of second source for all analyte(s) within ± 10% of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.
Continuing calibration verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	ICP: within ± 10% of true value; GFAA: within ± 20% of true value; CVAA: within ± 20% of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Low-level calibration check standard (ICP only)	Daily, after one-point ICAL.	Within ± 20% of true value.	Correct problem, then reanalyze.	Flagging criteria are not appropriate.	No samples may be analyzed without a valid low-level calibration check standard. Low-level calibration check standard should be less than or equal to the reporting limit.

Table 4-9 (Continued)
Quality Control Method Criteria for Metals by SW-846 6010B and 7470A/7471A

Table F-7. Inorganic Analysis by Inductively Coupled Plasma (ICP) Atomic Emission Spectrometry and Atomic Absorption Spectrophotometry (AA) (Methods 6010 and 7000 Series) (continued)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Method blank	One per preparatory batch.	No analytes detected > ½ RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL (see Box D-1).	Correct problem, then see criteria in Box D-1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Calibration blank	Before beginning a sample run, after every 10 samples, and at end of the analysis sequence.	No analytes detected > LOD.	Correct problem. Re-prep and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed.	Apply B-flag to all results for specific analyte(s) in all samples associated with the blank.	
Interference check solutions (ICS) (ICP only)	At the beginning of an analytical run.	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ± 20% of true value.	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze all samples.	If corrective action fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the ICS.	
LCS containing all analytes to be reported	One per preparatory batch.	QC acceptance criteria specified by DoD, if available; see Box D-3 and Appendix G.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix G).	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

Table 4-9 (Continued)
Quality Control Method Criteria for Metals by SW-846 6010B and 7470A/7471A

Table F-7. Inorganic Analysis by Inductively Coupled Plasma (ICP) Atomic Emission Spectrometry and Atomic Absorption Spectrophotometry (AA) (Methods 6010 and 7000 Series) (continued)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Matrix spike (MS)	One per preparatory batch per matrix (see Box D-7).	For matrix evaluation, use QC acceptance criteria specified by DoD for LCS.	Examine the project-specific DQOs. If the matrix spike falls outside of DoD criteria, additional quality control tests are required to evaluate matrix effects.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.
Matrix spike duplicate (MSD) or sample duplicate	One per preparatory batch per matrix (see Box D-7).	MSD: For matrix evaluation use QC acceptance criteria specified by DoD for LCS. MSD or sample duplicate: RPD ≤ 20% (between MS and MSD or sample and sample duplicate).	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.
Dilution test (ICP and GFAA only)	One per preparatory batch.	Five-fold dilution must agree within ± 10% of the original measurement.	ICP: Perform post-digestion spike (PDS) addition; GFAA: Perform recovery test.	Flagging criteria are not appropriate.	Only applicable for samples with concentrations > 50 x LOQ.
Post-digestion spike (PDS) addition (ICP only)	When dilution test fails or analyte concentration in all samples < 50 x LOD.	Recovery within 75-125% (see Table B-1).	Run all associated samples in the preparatory batch by method of standard additions (MSA) or see flagging criteria.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Spike addition should produce a concentration of 10 – 100 x LOQ.
Recovery test (GFAA only)	When dilution test fails or analyte concentration in all samples < 25 x LOD.	Recovery within 85-115%.	Run all associated samples in the preparatory batch by method of standard additions (MSA) or see flagging criteria.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	
Method of standard additions (MSA)	When matrix interference is confirmed.	NA.	NA.	NA.	Document use of MSA in the case narrative.
Results reported between DL and LOQ	NA.	NA.	NA.	Apply J-flag to all results between DL and LOQ.	

Table 4-10
Quality Control Method Criteria for Cyanide by SW-846 9012A

Table F-10. Cyanide Analysis (Methods 9010, 9012, and 9014)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise use method-specified criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria (see Section C.1.f).	NA.	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD determination and verification (See Box D-13)					
LOQ establishment and verification (See Box D-14)					
Initial calibration (ICAL) (six standards and a calibration blank)	Daily ICAL prior to sample analysis.	$r \geq 0.995$.	Correct problem, then repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has passed. All calibration standards must be distilled if samples are expected to contain sulfides.
Distilled standards (one high and one low)	Once per multipoint calibration.	Within ± 15% of true value.	Correct problem, then repeat distilled standards.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until distilled standards have passed.
Second source calibration verification (ICV)	Once after each ICAL, prior to beginning a sample run.	Within ± 15% of true value.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.

Table 4-10 (Continued)
Quality Control Method Criteria for Cyanide by SW-846 9012A

Table F-10. Cyanide Analysis (Methods 9010, 9012, and 9014) (continued)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Method blank	One per preparatory batch.	No analytes detected > ½ RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL (see Box D-1).	Correct problem, then see criteria in Box D-1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
LCS	One per preparatory batch.	QC acceptance criteria specified by DoD, if available; see Box D-3 and Appendix G.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix G).	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix spike (MS)	One per preparatory batch per matrix (see Box D-7).	For matrix evaluation, use QC acceptance criteria specified by DoD for LCS.	Examine the project-specific DQOs. If the matrix spike falls outside of DoD criteria, the method of standard additions shall be used for the analysis.	For the specific analyte in the parent sample, apply J-flag if acceptance criteria are not met.	If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.
Matrix spike duplicate (MSD) or sample duplicate (replicate)	One per preparatory batch per matrix (see Box D-7).	MSD: For matrix evaluation use QC acceptance criteria specified by DoD for LCS. MSD or sample duplicate: RPD ≤ 20% (between MS and MSD or sample and sample duplicate).	Correct problem and reanalyze sample and duplicate.	Apply J-flag if sample cannot be rerun or reanalysis does not correct problem.	The data shall be evaluated to determine the source of difference.
Results reported between DL and LOQ	NA.	NA.	NA.	Apply J-flag to all results between DL and LOQ.	

Table 4-11
Quality Control Method Criteria for Chloride, Sulfate, and Nitrate by SW-846 9056

Table F-11. Common Anions Analysis (Method 9056)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise, method-specified criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria (see Section C.1.f).	NA.	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD determination and verification (See Box D-13)					
LOQ establishment and verification (See Box D-14)					
Retention time (RT) window width calculated for each analyte	After method set-up and after major maintenance (e.g., column change).	RT width is ± 3 times standard deviation for each analyte RT over a 24-hour period.	NA.	NA.	
Initial calibration (ICAL) for all analytes (minimum three standards and one calibration blank)	ICAL prior to sample analysis.	$r \geq 0.995$.	Correct problem, then repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until ICAL has passed.
Initial calibration verification (ICV) (second source)	Once after each ICAL, prior to beginning a sample run.	All analytes within ± 10% of true value and retention times within appropriate windows.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.
Retention time window position establishment for each analyte	Once per multipoint calibration.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	NA.	NA.	

Table 4-11 (Continued)
Quality Control Method Criteria for Chloride, Sulfate, and Nitrate by SW-846 9056

Table F-11. Common Anions Analysis (Method 9056) (continued)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Midrange continuing calibration verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All project analytes within established retention time windows. Within ± 10% of true value.	Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed. Retention time windows are updated per the method.
Method blank	One per preparatory batch.	No analytes detected > ½ RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results (see Box D-1).	Correct problem, then see criteria in Box D-1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
LCS containing all analytes to be reported	One per preparatory batch.	Laboratory in-house limits not to exceed ± 20%. Control limits may be not greater than ± 3 times the standard deviation of the mean LCS recovery. See Box D-3.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix G).	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike (MS)	One per preparatory batch per matrix (see Box D-7).	For matrix evaluation, use laboratory in-house LCS limits (not to exceed ± 20%).	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.

Table 4-11 (Continued)
Quality Control Method Criteria for Chloride, Sulfate, and Nitrate by SW-846 9056

Table F-11. Common Anions Analysis (Method 9056) (continued)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Matrix spike duplicate (MSD)	One per preparatory batch per matrix (see Box D-7).	For matrix evaluation, use laboratory in-house LCS limits (not to exceed ± 20%). RPD ≤ 15% (between MS and MSD).	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.
Sample duplicate (replicate)	One per every 10 samples.	%D ≤ 10% (between sample and sample duplicate).	Correct problem and reanalyze sample and duplicate.	Apply J-flag if sample cannot be rerun or reanalysis does not correct problem.	The data shall be evaluated to determine the source of difference.
Results reported between DL and LOQ	NA.	NA.	NA.	Apply J-flag to all results between DL and LOQ.	

Table 4-12
Quality Control Method Criteria for Perchlorate by SW-846 6850

Table F-12. Perchlorate Analysis (Methods 6850 and 6860)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise, method-specified criteria.	Recalculate results; locate and fix problem, then rerun demonstration for the analyte that did not meet criteria (see Section C.1.f).	Flagging criteria are not appropriate.	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD determination and verification (See Box D-13)					
LOQ establishment and verification (See Box D-14)					
Initial calibration (ICAL)	Minimum of 5 calibration standards to establish linearity at method set-up and after major maintenance.	$r \geq 0.995$ or RSD $\leq 20\%$. The concentration corresponding to the absolute value of the calibration curve's Y-intercept must be $\leq$ LOD.	Correct problem, then repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until ICAL has passed. The calibration is linear and shall not be forced through the origin.
Initial calibration verification (ICV)	Once after each ICAL, analysis of a second source standard at the midpoint of the calibration.	Within ± 15% of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.
Continuing calibration verification (CCV)	Analysis of mid-level standard after every 10 field samples. All samples must be bracketed by the analysis of a standard demonstrating that the system was capable of accurately detecting and quantifying perchlorate.	Within ± 15% of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

Table 4-12 (Continued)
Quality Control Method Criteria for Perchlorate by SW-846 6850

Table F-12. Perchlorate Analysis (Methods 6850 and 6860) (continued)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Limit of detection verification (LODV) (per batch)	Prior to sample analysis and at the end of the analysis sequence. It can be analyzed after every 10 samples in order to reduce the reanalysis rate.	Within ± 30% of true value.	Correct problem and rerun LODV and all samples analyzed since last successful LODV. If a sample with perchlorate concentration at or between the LOD and RL is bracketed by a failing LODV, it must be reanalyzed. A sample with concentration above the RL can be reported.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable LODV.	Problem must be corrected. Results may not be reported without a valid LODV. Flagging is only appropriate in cases where the samples cannot be reanalyzed. Perchlorate spike concentration is approximately 2 times the limit of detection.
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.).	Apply J-flag if acceptance criteria are not met.	Decision to report data failing ratio check should be thoroughly documented in case narrative.
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 IS area counts of the ICAL. RRT of the perchlorate ion 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 reprepped using additional pretreatment steps.	Apply Q-flag and discuss in the case narrative.	If peak is not within retention time window, presence is not confirmed. Use for quantitation and to ensure identification. Failing internal standard should be thoroughly documented in the case narrative.

Table 4-12 (Continued)
Quality Control Method Criteria for Perchlorate by SW-846 6850

Table F-12. Perchlorate Analysis (Methods 6850 and 6860) (continued)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
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. It verifies the method performance at the matrix conductivity threshold (MCT). At least one ICS must be analyzed daily.	Within ± 30% of true value.	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.	Flagging criteria are not appropriate.	Analysis of a standard containing perchlorate at the RL and interfering anions at the concentration determined by the interference threshold study. Monitor recovery of perchlorate and retention time. No samples may be reported that are associated with a failing ICS.
Laboratory reagent blank	Prior to calibration, after samples with overrange concentration of perchlorate, and at the end of the analytical sequence.	No perchlorate detected > ½ RL.	Reanalyze reagent blank (until no carryover is observed) and all samples processed since the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated batch.	Problem must be corrected. Results may not be reported without a valid reagent blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Tuning	Prior to ICAL and after any mass calibration or maintenance is performed.	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.	Flagging criteria are not appropriate.	Problem must be corrected. Sample analysis shall not proceed without acceptable tuning.

Table 4-12 (Continued)
Quality Control Method Criteria for Perchlorate by SW-846 6850

Table F-12. Perchlorate Analysis (Methods 6850 and 6860) (continued)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
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).	Mass calibration range must bracket the ion masses of interest without greatly exceeding the range. The most recent mass calibration must be used for an analytical run, and the same mass calibration must be used for all data files in an analytical run. Mass calibration must be verified by acquiring a full scan continuum mass spectrum of a perchlorate stock standard. Perchlorate ions should be within ± 0.3 *m/z* of mass 99, 101, and 107 or their respective daughter ion masses (83, 85, and 89), depending on which ions are quantitated.	If the mass calibration fails, recalibrate. If it still fails, consult manufacturer instructions on corrective maintenance.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be analyzed under a failing mass calibration.
Interference threshold study	At initial setup and when major changes occur in the method's operating procedures (e.g., addition of cleanup procedures, column changes, mobile phase changes).	Measure the threshold of common suppressors (chloride, sulfate, carbonate, bicarbonate) that can be present in the system without affecting the quantitation of perchlorate. The threshold is the concentration of the common suppressors where perchlorate recovery falls outside an 85-115% window.	NA.	Flagging criteria are not appropriate.	This study and site history will determine the concentration at which the ICS suppressors should be set.

Table 4-12 (Continued)
Quality Control Method Criteria for Perchlorate by SW-846 6850

Table F-12. Perchlorate Analysis (Methods 6850 and 6860) (continued)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Method blank (MB)	One per preparatory batch.	No perchlorate detected > ½ RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem, then see criteria in Box D-1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed. Method blank must undergo the same preparation and pretreatment steps as the samples in the batch.
Laboratory control sample (LCS)	One per preparatory batch. LCS must be spiked at the RL.	Recovery within method requirements, laboratory-generated limits, or 80-120% (whichever is more stringent) to verify calibration and to check method performance.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available (see full explanation in Appendix G).	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed. LCS must undergo the same preparation and pretreatment steps as the samples in the batch.
Matrix spike (MS)	One per preparatory batch per matrix (see Box D-7). The MS must be spiked at the RL.	Recovery within 80-120% or within laboratory generated limits, whichever is more stringent.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	For matrix evaluation only. If MS results are outside the limits, the data must be evaluated to determine the source of the difference and to determine if there is a matrix effect or analytical error. MS must undergo the same preparation and pretreatment steps as the samples in the batch.

Table 4-12 (Continued)
Quality Control Method Criteria for Perchlorate by SW-846 6850

Table F-12. Perchlorate Analysis (Methods 6850 and 6860) (continued)					
QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Matrix spike duplicate (MSD) or laboratory duplicate (LD)	One per preparatory batch per matrix (see Box D-7). The MSD must be spiked at the RL.	MSD: Recovery within 80-120% or within laboratory generated limits, whichever is more stringent. MSD or laboratory duplicate: RPD < 15%.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.
Results reported between DL and LOQ	Positive detections calculated per method.	NA.	NA.	Apply J-flag to all results between DL and LOQ.	

Table 4-13
Quality Control Method Criteria for Organic and Inorganic Carbon by SW-846 9060

Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action
Initial calibration curve 5-pt curve	Major maintenance, instrument modification, per manufacturer's specifications	r > 0.995 r: linear correlation coefficient Qualify results between MDL and MRL as estimated.	If r < 0.995, the standards must be prepared again.
Initial calibration standard (calibration verification)	1 per batch	Recovery ±10% of true value.	If criteria are not met, reanalyze the daily standards. If the daily standard fails a second time, initial calibration must be repeated.
Continuing calibration verification (CCV)	Every 10 samples, end of analytical run	Recovery ±10% of true value.	Reanalyze CCV. If the CCV fails second time, the analysis must be terminated, the problem corrected, the instrument re-calibrated, and the calibration re-verified prior to continuing sample analyses.
Continuing calibration blank (CCB)	Every 10 samples, end of analytical run	< ½ MRL; <MRL for common laboratory contaminants.	If not within criteria, terminate the analysis, correct the problem, re-calibrate, and reanalyze all samples analyzed since the last acceptable CCB.
Preparation blank	1 per 20 samples per matrix	< ½ MRL; <MRL for common laboratory contaminants.	Documented source of contamination.
Laboratory control sample	Every batch for all compounds	75%≤%Rec.≤125% or ± 3 standard deviations of the mean from historical data points.	%R are outside criteria, sample batch should be re-calibrated and re-analyzed. If still outside criteria, qualify associated data biased high or biased low as appropriate.
Matrix spike and duplicate	1 per 20 samples per matrix	75%≤%Rec.≤125% or ± 3 standard deviations of the mean from historical data points. 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 QC samples or systematic. Qualify as appropriate.

Ref: *USEPA Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Update IV* (USEPA, 2007) and *DoD QSM for Environmental Laboratories, Final Version 4.1* (DoD, 2009).

4.10 Field Equipment Calibration

Field equipment that may be used during collection of environmental samples at the site includes a Horiba U-10 water quality instrument or equivalent and a photoionization detector (PID) equipped with a 10.6 eV lamp.

Field QC check control limits (pH, conductivity, and turbidity) for the Horiba U-10 water quality instrument are outlined below. Water quality parameters are considered to be stable for sample collection for when there are three consecutive readings as defined as follows:

- pH ± 0.2 units
- Temperature ± 1.0°C
- Turbidity ± 10 percent or 5 NTUs, whichever is greater
- Specific conductivity ± 3 percent of reading
- DO ± 10 percent of reading or 0.2 mg/L, whichever is greater
- Redox Potential (ORP or Eh) ± 20 mV

4.10.1 Horiba (or equivalent)

The Horiba (or equivalent) will be calibrated upon arrival to the site and daily while in the field. The calibration of pH, conductivity, DO, and ORP 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 logbook or on a separate calibration log form by the field personnel performing the calibration.

- pH: If the pH QC sample (pH 7.0 or pH 10.0 buffer after initial automatic calibration with pH 4.0 buffer) exceeds ±0.5 pH units from the true value, the source of the error is determined and the instrument re-calibrated. If a continuing calibration check with pH 7.0 buffer is off by ±0.5 pH unit, the instrument is re-calibrated.
- Conductivity: QC samples must be within ±10% of the true values. The true value for conductivity in the automatic calibration solution is 4,490 µmhos/cm or as received by the supplier.

4.10.2 Turbidity Meter

The turbidity meter will be calibrated upon arrival and departure of the site and daily while in the field. The calibration of the turbidity meters 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 logbook or on a separate calibration log form by the field personnel performing the calibration. QC samples must be within ±10% of the true values. Turbidity QC samples are commercially prepared polymer standards such as those available from Advanced Polymer System, Inc. or equivalent.

4.10.3 Other Field Equipment

The PID is calibrated according to the manufacturer's instructions at the beginning of the day, whenever the instrument is turned off for more than 2 hours, and at the discretion of the SSHO. The Hach test kit calibration and maintenance procedures for ferrous iron and soluble manganese may be found in the field SOPs located in **Appendix A**.

4.10.4 Field Equipment Maintenance

Prior to field sampling events, each piece of field equipment is inspected to ensure it is operational. If necessary, the equipment is serviced. Meters that require charged batteries are fully charged or have fresh batteries. Due to Shaw's relationship with a number of firms that rent instrumentation and safety and sampling equipment, significant downtime should not occur. In addition to this, key spare parts and equipment are available on site to prevent downtime.

The proper calibration and documentation of field equipment are designed to assure that the field equipment is functioning optimally. Equipment logbooks are required to record usage, maintenance, calibration, and repair. Further details as to field calibrations and equipment use may be found in the field SOPs located in **Appendix A**.

4.11 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 steps include the performing of solution validation, initial calibration, daily calibration, and continuing calibration procedures. Protocols defining the QC procedures, rounding rules, corrective actions, and QC measurements for instrument calibration should be done in accordance with criteria specified in the analytical method, laboratory QA plan, and the prime contractor's SOPs. The units and method QLs for the analytical methods to be used are found in **Tables 4-2 and 4-3**. The analyte list and laboratory analytical accuracy and precision data may be found in **Table 4-7**. The QA/QC method calibration requirements may be found in **Tables 4-8 through 4-13**. Further details as to laboratory calibrations and equipment use may be found in the laboratory's LQAP located in **Appendix B**.

4.11.1 Chemical Analyses for Long-term Monitoring Natural Attenuation Groundwater Samples

Explosives. Samples will be analyzed for aqueous samples for perchlorate using USEPA SW-846 Method 8330B. Aqueous samples will be extracted using solid-phase extraction (SPE) procedure USEPA SW-846 3535A. A measured volume of sample is adjusted to a specified pH and then extracted using an SPE device. Target analytes are eluted from the solid-phase media using methylene chloride. The resulting solvent extract is dried using sodium sulfate and concentrated. The concentrated extract may be exchanged into a solvent compatible with subsequent cleanup procedures and then measurement of the target analytes separated on a C-18 reverse phase column.

Perchlorate. Samples will be analyzed for aqueous samples for perchlorate using USEPA SW-846 Method 6850. This method provides reverse phase high performance liquid chromatographic and thermospray mass spectrometric conditions for the detection of the target analytes. Quantitative analysis is performed by Liquid Chromatography/Mass Spectrometry using an external or internal standard approach. Sample extracts are analyzed by direct injection into the thermospray or onto a liquid chromatographic-thermospray interface. A gradient elution program is used on the chromatograph to separate the compounds. Detection is achieved both by negative ionization (discharge electrode) and positive ionization, with a single quadrupole mass spectrometer. In general, water samples are extracted at a neutral pH with methylene chloride, using an appropriate 3500 series method. A micro-extraction technique is included for the

extraction of Tris-BP from aqueous and non-aqueous matrices. Confirmation is obtained by using the mass spectrometer.

Chloride, Sulfate, and Nitrate. Samples will be analyzed for aqueous samples for chloride, sulfate, and nitrate using ion chromatography method USEPA SW-846 9056. The anions of interest are separated on the basis of their relative affinities for a low capacity, strong basic anion exchanger when they are converted to their highly conductive acid forms and measured by conductivity on the basis of retention times. Concentrations are determined from a linear curve for each anion based on peak height or area under each peak produced.

Organic and Inorganic Carbon (Total and Dissolved). Samples will be analyzed for aqueous samples for organic and inorganic carbon using USEPA SW-846 Method 9060A. Aqueous samples are subjected to either a catalytic combustion or wet chemical oxidation to convert the organic carbon in the sample to carbon dioxide. The carbon dioxide formed is then measured directly by an infrared detector or converted to methane and measured by a flame ionization detector. The amount of carbon dioxide or methane produced is directly proportional to the concentration of carbonaceous material.

Ferrous Iron (Field Test). Samples will be analyzed in the field for aqueous samples for ferrous iron using Hach method 8146. This procedure is a colorimetric determination. The 1,10-phenanthroline indicator in Ferrous Iron Reagent reacts with ferrous iron in the sample to form an orange color in proportion to the iron concentration. Ferric iron does not react. The ferric iron (Fe3+) concentration can be determined by subtracting the ferrous iron concentration from the results of a total iron test. A chelation occurs producing an orange-red color.

Soluble Manganese (Field Test). Samples will be analyzed for soluble manganese using Hach method 8149. The 1-(2-Pyridylazo)-2-Naphthol (PAN) method is a highly sensitive and rapid procedure for detecting low levels of manganese. An ascorbic acid reagent is used initially to reduce all oxidized forms of manganese to Mn2+. An alkaline-cyanide reagent is added to mask any potential interferences. PAN Indicator is then added to combine with the Mn2+ to form an orange-colored complex.

4.11.2 Chemical Analyses for Aqueous Waste Characterization Samples

COD. COD will be analyzed for aqueous waste characterization samples using USEPA Methods for Chemical Analysis of Water and Wastes Method 410.4 (USEPA, 1983). A sample is heated under acidic conditions at a slow, constant rate in an oven or block digestor in the presence of dichromate at 150°C for 2 hours. The COD is measured at 600 nm spectrophotometrically.

pH. pH and corrosivity as pH will be analyzed for aqueous waste characterization samples using USEPA SW-846 Method 9040C. A sample pH is directly measured electrometrically using either a glass electrode in combination with a reference potential or a combination electrode. For solids, samples are mixed 1:1 with reagent water prior to measurement.

TAL Metals. The TAL metals will be analyzed using a combination of inductively coupled plasma (ICP) and cold vapor atomic absorption (CVAA). Trace metals are analyzed using USEPA SW-846 Methods 3010A/6010B for aqueous samples. The ICP method involves the simultaneous or sequential multi-element assessment of trace elements in solution. The basis of the method is the measurement of atomic emission by optical spectrometry. Samples are nebulized and the aerosol that was produced was transported to the plasma torch where excitation occurs. Characteristic atomic-line emission spectra are produced by a radio-frequency

ICP. A background correction technique is utilized to compensate for variable background contribution for the assessment of trace elements.

Mercury will be analyzed using CVAA according to USEPA SW-846 Method 7470A for aqueous samples. A sample aliquot is initially digested with nitric acid to free combined mercury. The mercury is then reduced to its elemental state and aerated from the solution into a closed system. The mercury vapor is passed through a cell positioned in the path of the mercury light source, and the measured abundance is proportional to the concentration of mercury in the sample.

4.12 Data Validation for Chemical Analyses

Data validation is the process whereby data are determined to be of acceptable or unacceptable quality based on a set of predefined criteria by Shaw. These criteria depend upon the type(s) of data involved and the purpose for which data are collected. Data packages will be validated to ensure project compliance with specified analytical, QA, and data reduction procedures; data reporting requirements; and required accuracy, precision, and completeness criteria. USEPA Level IV Contract Laboratory Program-like raw data packages will be provided for the full data validation samples. All parameters of interest for the post-excavation soil confirmation samples, long-term groundwater natural attenuation, and back fill borrow-top soil samples will be validated for the IM. Validation for organic data will be performed at USEPA Region III level M3 and for inorganic data will be performed at USEPA Region III level IM2. The aqueous and solid waste characterization sample data will not require the full USEPA Region III data validation. The Project Chemist will oversee the performance of data validation functions. Specific validation levels may be found in the DQO tables in *Section 4.3* of this QAPP. Data validation results will be reported with the final findings. Data will be validated using a combination of the following criteria:

- Project-specific WP and/or QAPP criteria.
- Master Quality Assurance Plan (Section 9.5) requirements.
- *DoD QSM, Final Version 4.1* (DoD, 2009).
- Method-specific criteria following *USEPA OSWER Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW-846), Update IV* (USEPA, 2007) and *USEPA Method for Chemical Analysis of Water and Wastes* (USEPA, 1983).

Table 4-14 presents the laboratory and data validation qualifiers to be used for IM and are applied as appropriate. The laboratory qualifiers are as per DoD QSM, and the data validation qualifiers are consistent with the following USEPA guidance:

- *USEPA Region III Modifications to the National Functional Guidelines for Organic Data Review Multi-media, Multi-concentration* (USEPA, 1994b).
- *USEPA Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses* (USEPA, 1993).
- *USEPA Region III Dioxin/Furan Data Validation Guidance* (USEPA, 1999).

Table 4-14
Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is an estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more QC criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
U	Not detected. The associated number indicates the compound reporting limit for the sample.
B	The analyte has been detected in the sample and the associated laboratory or field blank.
J	Indicates an estimated value for 1) estimated value due to QC non-conformance. Reported value may not be accurate or precise, 2) estimating a concentration as a tentatively identified compound as indicated by the mass spectral and retention time data, or 3) estimating a concentration ≥MDL and <MRL or <3*MDL, whichever is greater.
K	Analyte present. Reported value may be biased high (estimated) due to QC non-conformance.
L	Analyte present. Reported value may be biased low (estimated) due to QC non-conformance.
UL	Value is estimated bias low and not detected due to QC non-conformance. Reporting limit may be inaccurate or imprecise. QL is probably higher.
UJ	The analyte was analyzed for, but was not detected above the reported sample QL. The reported QL is approximate and may be inaccurate or imprecise.
N	The analysis indicates the present of an analyte for which there is presumptive evidence to make a "tentative identification."
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
R	The data are unusable. The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meeting the QC criteria. The analyte may or may not be present in the sample.

[1] The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DoD QSM for Environmental Laboratories, Final Version 4.1* (DoD, 2009).

[2] The USEPA data validation qualifiers are referenced from USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (USEPA, September 1994), USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA, April 1993) and USEPA Region III Dioxin/Furan Data Validation Guidance (USEPA, March 1999).

Shaw will direct the overall data management. Data activity for the sampling program will be divided between Shaw and the subcontract laboratory. Each firm has the equipment needed to perform the required data management functions. The laboratory will perform data entry and manipulation operations associated with the analysis of raw analytical data and provisions of chemical analysis results by sampling location. These data will be transmitted to Shaw for evaluation and interpretation. Data generated will be assessed for accuracy, precision, comparability, representativeness, completeness, and sensitivity.

4.13 Corrective Action Procedures

Corrective action will be initiated through the development and implementation of routine internal QC checks. Specific limits beyond which corrective action is required will be established for each system. Corrective action requirements will be implemented in response to deficiencies encountered during system inspections. A closed-loop corrective action system will be used to address system and data quality issues. Steps comprising a closed-loop corrective action system include:

- Defining the problem.
- Assigning responsibility for problem investigation.
- Investigating and determining the cause of the problem.
- Assigning responsibility for problem resolution.
- Verifying that the resolution has corrected the problem.

Documentation will be done on all of the steps of the corrective action system, including the dates and parties involved. Such documentation will be reviewed during system inspections. Problems identified by assessment procedures will be resolved at the level it occurred with support from upper management. Problems that cannot be resolved at this level will be reported to the QC Manager for resolution, who will determine at which management level the problem can best be resolved, and will notify the appropriate manager.

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 QC staff.

4.13.1 Routine Corrective Action

WPs and SOPs will establish technical procedures and the associated QC requirements. Where possible, SOPs will include specific criteria for determining the expected quality and examples of the appropriate corrective action procedures that may be taken if the criteria are not met. Routine corrective action will involve either short-term action for sporadic problems or long-term action for more chronic problems. Corrective action initiated at the project level will be reported to the QC Manager to ensure corrective action is implemented and the problem is resolved.

4.13.2 Non-Routine Corrective Action

Activities that are not covered by a specific SOP require an iterative process whereby the systems and QC specifications are estimated prior to the activity, and adjustments are made, as needed, during the course of the activity. Documentation on the corrective action requirements,

the assignment of responsibility for corrective action, due dates for completion of corrective action, and validation of completion will be maintained. Such documentation will be reviewed during system inspections.

Problems identified by assessment procedures will be resolved at the level it occurred with support from upper management. Problems that cannot be resolved at this level will be reported to the QC Manager for resolution, who will determine at which management level the problem can best be resolved, and will notify the appropriate manager.

4.13.3 Quality Improvement

The Shaw Quality Improvement Process (QIP) comprises the internal systems that evaluate our quality program's effectiveness in ensuring and continually improving the quality of our work. The primary goals of our QIP and the QC program defined in this document are to prevent non-conformances and facilitate continual process improvement. The Shaw QIP is based on problem prevention, resolution, and corrective action. QIP goals include the timely identification and resolution of the quality problems in a manner that minimizes their impact on work products and prevents their reoccurrence. To the extent that the first of these goals is not achieved, identified deficiencies or non-conformances are to be corrected in a timely and cost-effective manner and with the intent of preventing their recurrence. This QC Plan includes provisions for preventing quality problems and facilitating process improvements as well as for identifying, documenting, and tracking deficiencies until corrective action has been verified.

Project staff is encouraged to provide recommendations for improvements in established work processes and techniques. The intent is to identify activities that are compliant but can be performed in a more efficient or cost-effective manner. Typical quality improvement recommendations include identifying an existing practice that should be improved (e.g., a bottleneck in production) and/or recommending an alternative practice that provides a benefit without compromising prescribed standards of quality. Project staff is encouraged to bring their recommendations to the attention of project management or the QC staff through verbal or written means. Deviations from established protocols will not be implemented without prior written approval by the USACE Project Manager and concurrence of the Shaw CQC Systems Manager. Prior to receipt of such approvals, the Shaw Project Manager will determine whether the change requires a modification to the WP or a generation of a Project Procedure. If so, proposed changes to the WP and protocols will be evaluated and implemented in accordance with the process described herein. Where a staff-initiated recommendation results in a tangible benefit to the project, acknowledgment will be given by the Shaw Project Manager.

4.13.4 Problem Prevention

The preventive action program is intended to identify problems before they are adverse to quality. Inspections, self-assessments, and peer review are examples of the tools that will be used by the project staff to identify potential quality problems. Input regarding project operations will be regularly sought from clients, subcontractors, and staff. The Project Manager will foster a no-fault attitude for problem identification, and staff is encouraged to identify process improvement opportunities, problems, and solutions. While the entire QC program is directed towards problem prevention, certain elements of the program have greater potential to be proactive. The primary tools for problem prevention on this project and the specific sections of this QAPP where they are addressed include: a project organization, instrument calibration,

preventive maintenance, and QC data checks and inspections. Should these preventive measures fail, tracking and communicating deficiencies provides a mechanism for preventing their recurrence.

4.13.5 Stop Work Protocols

All Shaw personnel 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 must be made to the Project Manager, SSHO, QA Manager, CQC System Manager, and Program Manager. Proper notification will also be made to the USACE.

4.14 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 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 QA system and physical facilities for sampling/analysis, calibration, and measurement.

4.14.1 Document Review

Project plans will be reviewed and approved prior to implementation. The Project Manager and QC 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 Project Manager 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.

4.14.2 Document Control

The goal of Shaw's 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 control system, 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.
- Investigation requirements.
- Reports and correspondence material.
- Contract documents.

5.0 SITE SAFETY AND HEALTH PLAN

This section discusses safety and health concerns for the SWMU 54 IM actions and serves as the SSHP. The safety and health policies and procedures that will be followed during the removal actions are defined within this section. This SSHP has been prepared by the RFAAP Health and Safety Manager. The SSHP signature approval form is provided in **Appendix C** and documents health and safety and project management's acceptance of the plan for the performance of IM at SWMU 54.

This SSHP was prepared for use at SWMU 54 by Shaw personnel and subcontractors performing a specific scope of work. It was prepared based on the best available information regarding the physical and chemical hazards known, or suspected, to be present on the project site. Adherence to the requirements of this Plan will significantly reduce, but not eliminate, the potential for occupational injury or illness at the project site. The guidelines contained in this SSHP were developed specifically for the project site described herein, and should not be used at any other site without the review and approval of a qualified health and safety professional.

5.1 Pre-Work Meeting

Due to the potentially dangerous nature of the explosives-related work conducted at RFAAP, a Pre-Work Meeting will be conducted by Alliant TechSystems, Inc. (ATK), the operating contractor at RFAAP. All Shaw employees and subcontractors will attend this meeting prior to initiating work on site. SWMU 54 is located in the Magazine Area, which has strict safety requirements that may differ from the requirements specified in this plan. Where there are differences, ATK's rules will apply. A copy of ATK's *Safety, Security and Environmental Rules for Contractors, Subcontractors, Tenants and Government Employees* (ATK, 2005) will be provided to employees and subcontractors before mobilization on site.

5.2 Introduction

This SSHP was developed to provide the field team/visitors with safe working conditions during field activities to ensure protection of personnel during the excavation, removal, waste handling, and restoration activities at SWMU 54. In addition, an objective of this SSHP is to provide site-specific safety and health controls that will prevent and minimize personal injuries, illnesses, and physical damage to equipment and property. The plan stresses management responsibilities, pre-planning for new activities, medical surveillance, training, periodic work site evaluations and audits, accident prevention and investigation recordkeeping, personal protective equipment (PPE), air monitoring requirements, site controls, decontamination procedures, and general safety requirements.

Shaw and subcontractor personnel performing field activities are responsible for the adherence to the SSHP procedures and policies during the performance of all work. Site personnel and visitors will be required to read or be instructed in the content of this SSHP and to sign the acknowledgment form (located in **Appendix C**) to document their understanding of the contents. Shaw will not, however, accept responsibility for the use of the plan by others.

Site personnel will exercise caution at all times and immediately report any site conditions to supervisory personnel, which may pose safety or health and environmental hazards to workers or the public.

5.2.1 Site Removal Activities

Site IM activities to be completed as part of this scope of work at SWMU 54 include excavation and disposal of ash material and grossly-contaminated soil. Background site information and details on the approach and components for each of the removal actions are provided in the Organization and Technical Approach Plan (*Section 2.0*).

5.2.2 Applicable Standards and Regulations

Site activities covered by this SSHP must comply with the requirements of the following regulations and appropriate guidance including, but not limited to:

- 29 CFR 1910, Occupational Safety and Health Standards, General Industry.
- 29 CFR 1926, Safety and Health Regulations, Construction Industry.
- FAR, Clause 52.236-13, Accident Prevention.
- USEPA OSWER Directive 9355.3-01.
- USACE Safety and Health Requirements Manual EM 385-1-1.
- USACE Safety and Occupational Health Document Requirements for Hazardous, Toxic, and Radioactive Waste and Ordnance and Explosives Activities, ER 385-1-92.
- Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities [National Institute for Occupational Safety and Health (NIOSH) 85-115].
- 40 CFR 260-276, Hazardous Waste Management.
- 40 CFR Subchapter C, Air Programs.
- Occupational Safety and Health Guidance for Hazardous Waste Site Activities, U.S. Department of Health and Human Services, October 1985.
- Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists (ACGIH).
- Shaw Safety and Health Requirements Program Manual.
- ATK's *Safety, Security and Environmental Rules for Contractors, Subcontractors, Tenants and Government Employees* (ATK, 2005).

All Shaw and subcontractor field staff will be required to follow these and other applicable federal and/or state safety and health standards, regulations, and guidance manuals.

5.2.3 Site Safety and Health Documentation

Recordkeeping requirements for safety and health are necessary to ensure accurate and complete monitoring of all personnel. Any changes to the approved SSHP will be documented using the Shaw Revision Form presented in **Appendix C**, and reviewed and approved by the USACE prior to implementation. All on-site personnel shall read or be instructed in this SSHP and sign the acknowledgment form (located in **Appendix C**) to document their understanding of the contents. The SSHO will keep this form on file.

5.2.4 Safety Statement

It is Shaw's plan to provide a safe work environment for all personnel involved in the IM activities at SWMU 54. Shaw considers no phase of operations or administration to be of greater importance than the prevention of personnel injury and illness at the work site.

Any authorized USACE representative has the right to notify Shaw and/or any subcontractor of any condition that poses a serious or imminent danger to health and safety. Upon such notification, Shaw and/or any subcontractor shall immediately take corrective action. Furthermore, any authorized USACE representative may issue an order stopping all or part of the work until satisfactory corrective action has been taken.

This SSHP prescribes the procedures that must be followed by all site personnel. Operational changes which could affect the health and safety of personnel, the community, or the environment will not be made without prior approval of the USACE, Shaw Project Manager, Shaw Health and Safety Manager, and SSHO.

The following is Shaw's corporate policy as it pertains to safety:

The Shaw Group, Inc. is firmly committed to operating all of its facilities and projects in a safe, efficient manner and in compliance with applicable safety, health, and environmental regulations. Its goal is to provide an injury-free work environment where facilities and projects are free of recognized hazards; and people, equipment, and the environment are not placed at unreasonable risk of injury or damage.

The most valuable resource Shaw has is its people. While quality and productivity are critical to operations, they will never take precedence over the safety of personnel or protection of the environment.

Accomplishing these goals requires a unified team effort from all levels of the organization. Safety must be planned into all of our activities and receive the same level of attention as quality and productivity.

This project will be conducted under the guidance of applicable federal, state, and local requirements. It is the policy of Shaw to adhere to or exceed the minimum requirements of each governing document (see References, *Section 6.0*). When any conflict exists between referenced documents, the most stringent position of the standard will apply.

The Shaw Group, Inc. believes in two fundamental principles of safety:

- All accidents, injuries, and occupational illnesses are preventable.
- If an operation cannot be done safely, it will not be done.

To put these principles into practice, all Shaw personnel and subcontractor employees will receive the appropriate training, equipment, and other resources necessary to complete their assigned tasks in a safe and efficient manner. Subcontractors must also be appropriately trained, participate in the necessary medical surveillance programs, and comply with the required policies, procedures, and regulations.

Safety, industrial hygiene, and loss prevention are the direct responsibility of all members of management, who must create an environment in which everyone shares a concern for their own

safety and the safety of their associates. Safety will take precedence over expediency. It is a condition of employment that all employees work safely.

5.3 Project Organization and Personnel Qualifications and Responsibilities

The project organization and reporting structure is presented in *Section 2.0* of this WP. Qualifications for key individuals are as follows:

- The Health and Safety Manager must be a Certified Industrial Hygienist or Certified Safety Professional with experience in hazardous waste site operations.
- The SSHO must be fully trained and experienced and able to implement and continually enforce the SSHP.
- At least two site workers will be certified in first aid/cardiopulmonary resuscitation (CPR) by the Red Cross, or equivalent agency.

All personnel are responsible for the adherence to the SSHP procedures and policies during the performance of all work. Site personnel and visitors will be required to read this SSHP and to sign the acknowledgment form (located in **Appendix C**) to document their understanding of the contents. Failure to comply with the provisions of this Plan may lead to disciplinary action and/or dismissal from the work site. Ensuring the safe and healthful conduct of site operations is the responsibility of everyone assigned to the site; therefore, all personnel are responsible for the following:

- Complying with the SSHP and all other required safety and health guidelines.
- Taking all necessary precautions to prevent injury to themselves and to their fellow employees.
- Continually being alert to any potentially harmful situation and immediately informing the SSHO of any such conditions.
- Performing only those tasks that they believe they can do safely and have been trained to do.
- Notifying the SSHO of any special medical conditions (i.e., allergies, restrictions, diabetes, etc.) which could affect their ability to safely perform site operations.
- Notifying the SSHO of any prescription and/or over-the-counter medication which they are taking that might cause drowsiness, anxiety, or other unfavorable side effects.
- Preventing spillage and splashing of materials to the greatest extent possible.
- Practicing good housekeeping by keeping the work area neat, clean, and orderly.
- Immediately reporting all injuries, no matter how minor, to the SSHO.
- Maintaining site equipment in good working order, and reporting defective equipment to the SSHO.
- Properly inspecting and using the PPE required by the SSHP or the SSHO.

5.3.1 Subcontractor Responsibilities

In conformance with the Department of Labor, Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations (29 CFR 1910.120), each subcontractor employee proposed for on-site activities must participate in a medical monitoring program, must be certified for hazardous waste field work by a licensed physician, and must have successfully completed the required safety and health training. The subcontractor shall also be responsible for providing equipment that is safe for operations and free from any hazards.

5.3.2 Visitor Responsibilities

Authorized visitors to IM areas on site will be briefed on the hazards present at that location by the SSHO. Visitors will be responsible for compliance with the requirements specified in this SSHP. Visitors will not be permitted to enter potentially contaminated work zones unless they have completed the appropriate training and medical surveillance requirements, and have the proper PPE. All visitors will be escorted by a member of Shaw site management.

5.4 Hazard Analysis

5.4.1 Activity Hazard Analysis

Activity Hazard Analyses define the activities being performed and identify the sequences of work, the specific hazards anticipated, and the control measures to be implemented to eliminate or reduce each hazard to an acceptable level.

5.4.1.1 Soil Removal

An activity hazard analysis for the SWMU 54 soil removal is included as **Tables 5-1a and 5-1b**. This activity will be performed subject to the safety provisions of 29 CFR Parts 1910 and 1926, and USACE EM 385-1-1.

5.4.2 Physical Hazards

This section discusses specific physical hazards that may be encountered at RFAAP during the removal actions. If additional hazards other than the ones listed in this section are encountered, this SSHP will be revised to address these hazards.

5.4.2.1 Heavy Equipment

Tests shall be made at the beginning of each day during which the equipment is to be used to determine that the brakes and operating systems are in proper working condition and that all required safety devices are in place. Whenever any machinery or equipment is found to be unsafe or a deficiency which affects the safe operation of equipment is observed, the equipment shall be immediately taken out of service and shall not be used until all of the unsafe conditions are corrected. Machinery and mechanized equipment shall be operated by designated qualified personnel. Equipment safety requirements must be in accordance with 29 CFR 1926 and EM 385-1-1, Section 16 and the guidelines listed below:

- Operation of heavy equipment will be limited to properly trained personnel.
- Operator's certifications, qualification letters, and necessary SOPs will be maintained on site.

Table 5-1. Activity Hazard Analysis – Soil Removal

a. Soil Removal

Activity: Soil Removal **Analyzed by/date:** _____

Reviewed by/date: _____ (/ /) **Approved by/date:** _____ (/ /)

PRINCIPLE STEPS	POTENTIAL SAFETY/HEALTH HAZARDS	RECOMMENDED CONTROLS
• Excavate soil and direct load into dump trucks • Collect waste characterization samples ***Stop work and notify your supervisor if you are not sure how to perform your task!***	**Physical Hazards**	
	General heavy equipment hazards	Safety training, personal awareness, and safety devices Maintain a safe equipment distance exclusion zone Use hand signals See *Section 5.4.2.1* for general heavy equipment controls
	Power and hand tools hazard	See *Section 5.4.2.2* for power and hand tool controls
	Electrical shock	Locate and shut down all utilities in work zone, obtain dig permit, watch out for overhead power lines, use GFCI on all temporary electrical devices
	Noise	Use hearing protection if noise exceeds 85 dBA, see *Section 5.4.2.8*
	Cold or heat stress	Wear appropriate clothing and follow recommended work schedules and monitoring controls as stated in *Sections 5.4.2.6 or 5.4.2.7*
	Manual lifting	Use proper lifting techniques as discussed in *Section 5.4.2.10*
	Slip, trip, and fall hazards	Safety training and personal and situational awareness, see *Section 5.4.2.11*.
	Electrical storm	Shut down operations, follow the 30/30 rule, see *Section 5.4.2.12*
	Chemical Hazards	
	Exposure to contaminants in soil, lead, 2,4,6-TNT, DNT, RDX, amino DNTs, NG, heptachlor epoxide, Aroclor 1254, and dioxins/furans.	Minimize dust generation, wash hands and face, see *Section 5.4.3* for chemical hazard controls Use appropriate PPE
	Cross Contamination	Avoid spillage from excavator bucket, utilize plastic sheeting where spillage may occur
	Biological Hazards	
	Ticks	Tape pant legs to boots, avoid tall grass and bushes if possible, check for ticks frequently, see *Section 5.4.4.1*
	Stinging insects	Watch out for and avoid stinging insects, see *Section 5.4.4.2*
	Spiders	Watch out for and avoid black widow and brown recluse spiders, see *Section 5.4.4.3*
	Poisonous Plants ***Stop work and notify your supervisor if you are not sure how to perform your task!***	Watch out for and avoid poisonous plants, avoid contact with plant oils that may be present on clothes or equipment, wash hands to prevent spreading oils, see *Section 5.4.4.6* ***Stop work and notify your supervisor if you are not sure how to perform your task!***
EQUIPMENT TO BE USED	**INSPECTION REQUIREMENTS**	**TRAINING REQUIREMENTS**
Excavator, shovels	Daily inspection and maintenance of equipment	All site workers must have OSHA Training in accordance with 29 CFR 1910.120 All site workers must attend the Daily Safety Meetings Hazard Communication for all site workers Appropriate heavy equipment and/or power tools training

Table 5-1. Activity Hazard Analysis – Soil Removal

b. Backfill and Site Restoration

Activity: Backfill and Site Restoration **Analyzed by/date:** _____

Reviewed by/date: _____ (/ /) **Approved by/date:** _____ (/ /)

PRINCIPLE STEPS	POTENTIAL SAFETY/HEALTH HAZARDS	RECOMMENDED CONTROLS
• Backfill excavation • Re-seed ***Stop work and notify your supervisor if you are not sure how to perform your task!***	**Physical Hazards**	
	General heavy equipment hazards	Safety training, personal awareness, and safety devices Maintain a safe exclusion zone Use hand signals See *Section 5.4.2.3* for general heavy equipment controls
	Electrical shock	Watch for overhead power lines
	Cold or heat stress	Wear appropriate clothing and follow recommended work schedules and monitoring controls as stated in *Sections 5.4.2.10 or 5.4.2.11*
	Manual lifting	Use proper lifting techniques as discussed in *Section 5.4.2.14*
	Slip, trip, and fall hazards	Safety training and personal awareness *See Section 5.4.2.15* for general slip, trip, and fall controls
	Electrical storm	Shut down operations, see *Section 5.4.2.16*
	Chemical Hazards – The potential for exposure to chemical hazards will be minimal	
	Biological Hazards	
	Ticks	Tape pant legs to boots, avoid tall grass and bushes if possible, check for ticks frequently, see *Section 5.4.4.1*
	Stinging insects	Watch out for and avoid stinging insects, see *Section 5.4.4.2*
	Spiders	Watch out for and avoid black widow and brown recluse spiders, see *Section 5.4.4.3*
	Poisonous Plants ***Stop work and notify your supervisor if you are not sure how to perform your task!***	Watch out for and avoid poisonous plants, avoid contact with plant oils that may be present on clothes or equipment, wash hands to prevent spreading oils, see *Section 5.4.4.6* ***Stop work and notify your supervisor if you are not sure how to perform your task!***
EQUIPMENT TO BE USED	**INSPECTION REQUIREMENTS**	**TRAINING REQUIREMENTS**
Excavator, shovels	Daily inspection and maintenance of equipment	All site workers must have OSHA Training in accordance with 29 CFR 1910.120 All site workers must attend the Daily Safety Meetings Hazard Communication for all site workers Appropriate heavy equipment training

- Operator shall use the safety devices provided with the equipment (i.e., seatbelts, backup warning indicators, and horns).
- Visually inspect equipment daily, prior to operation, and report any deficiencies. Document observations.
- Good housekeeping practices will be maintained in the cab area of heavy equipment.
- Additional riders shall not be allowed on equipment, unless it is specifically designed for that purpose.

As presented in **Appendix D**, Shaw Procedure HS810, Commercial Motor Vehicle Operation and Maintenance, will be implemented.

5.4.2.2 Power and Hand Tools

By their very nature, power tools have great capability for inflicting serious injury upon site personnel if they are not used and maintained properly. Use of improper or defective tools can contribute significantly to the occurrence of accidents on site. To control the hazards associated with power and hand tool operation, the requirements outlined in EM 385-1-1 and the safe work practices listed below shall be observed when using these tools:

- Operation/use will be conducted by authorized and experienced personnel.
- Tools will be inspected prior to use, and defective equipment will be removed from service until repaired.
- Tools will be selected and used in the manner for which they were designed and in accordance with manufacturer's recommendations.
- Be sure of footing and grip before using any tool.
- Power tools designed to accommodate guards will have such guards properly in place prior to use.
- Do not use tools that have split handles, mushroom heads, and worn parts.
- Safety glasses or a face shield will be used if use of tools presents an eye or face hazard.
- Do not use makeshift tools or other improper tools.
- Use non-sparking tools in the presence of explosive vapors, gases, or residue.
- Loose-fitting clothing or long hair will not be permitted around moving parts.
- Hands, feet, etc. will be kept away from moving parts.
- Maintenance and adjustments to equipment will not be made while equipment is in operation. Power will be disconnected prior to maintenance.
- An adequate operating area will be provided, allowing sufficient clearance and access for operation.
- Proper PPE in accordance with equipment operating manual will be used (i.e., chainsaw chaps, leather gloves, hard hats, hearing protection, shin guards, face shield, safety glasses, etc.).

5.4.2.3 Fire and Explosion Hazards

SWMU 54 is located within the Magazine Area and Shaw employees and subcontractors MUST strictly follow ATK's protocols to prevent fires and/or explosions in this area.

Although fires and explosions may arise spontaneously, they are more commonly the result of carelessness during the conduct of site activities such as mixing/bulking of site chemicals, and during refueling of heavy or handheld equipment. Some potential causes of explosions and fires include:

- Mixing of incompatible chemicals, which cause reactions that spontaneously ignite due to the production of both flammable vapors and heat.
- Ignition of explosive or flammable chemical gases or vapors by external ignition sources.
- Ignition of materials due to oxygen enrichment.
- Agitation of shock or friction-sensitive compounds.
- Sudden release of materials under pressure.
- Improper labeling of flammable and combustible material containers.

Explosions and fires not only pose the obvious hazards of intense heat, open flames, smoke inhalation, and flying objects, but may also cause the release of toxic chemicals into the environment. Such releases can threaten both personnel on site and members of the general public living or working nearby. Site personnel involved with potentially flammable material or operations will follow the guidelines listed below and EM 385-1-1, Section 9, to prevent fires and explosions:

- Potentially explosive/flammable atmospheres involving gases or vapors will be monitored using a combustible gas indicator/oxygen (CGI/O_2) meter.
- Prior to initiation of site activities involving explosive/flammable materials, all potential ignition sources will be removed or extinguished.
- Non-sparking and explosion-proof equipment will be used whenever the potential for ignition of flammable/explosive gases/vapors/liquids exists.
- Dilution or induced ventilation may be used to decrease the airborne concentration of explosive/flammable atmospheres.
- Smoking will be prohibited anywhere inside the restricted gate of RFAAP.
- Flammable and/or combustible liquids must be handled only in approved, properly labeled metal safety cans equipped with flash arresters and self-closing lids.
- Transfer of flammable liquids from one metal container to another will be done only when the containers are electrically interconnected (bonded).
- The motors of all equipment being fueled will be shut off during the fueling operations.
- Spark or flame-producing operations will require a hot work permit in accordance with Shaw Procedure HS314.

5.4.2.4 Electrical

While it is anticipated that all electrical hookups at SWMU 54 have been terminated, this section is included as this will be verified prior to demolition. All electrical work performed shall comply with applicable National Electric Safety Code, National Electric Code, and National Fire Protection Association regulations. All electrical work shall be performed by qualified personnel familiar with applicable code requirements. All safe guarding of hazardous energy sources will comply with Shaw Procedure HS315.

Above or below ground utilities may pose a hazard to team members during field activities. Below ground utilities will need to be located by Department of Public Works personnel prior to excavation activities. As presented in **Appendix D**, Shaw Procedure HS308, Underground and Overhead Utility Contact Prevention, will be followed to prevent utility damage and employee injury. A safe distance between all equipment and overhead power lines must be maintained at all times. Minimum safe clearances are as follows:

Nominal System Voltage	Minimum Rated Clearance
0 to 50 kV	9.8 ft (3 meters)
51 to 200 kV	14.7 ft (4.5 meters)
201 to 300 kV	19.7 ft (6 meters)
301 to 500 kV	24.6 ft (7.5 meters)
501 to 750 kV	34.4 ft (105 meters)
751 to 1000 kV	44.3 ft (135 meters)

5.4.2.5 Excavations and Trenching

Excavation activities will be conducted in accordance with EM 385-1-1, Section 25 and Subpart P of 29 CFR 1926. As presented in **Appendix D**, Shaw Procedure HS307, Excavation and Trenching, will be implemented during excavation and trenching operations. The guidelines below are intended to reflect minimum requirements to be followed on this site:

- Prior to initiation of any excavation or trenching activity, the location of underground installations will be determined in accordance with Shaw Procedure HS308.
- The excavation(s) will be inspected and documented daily by the SSHO or by the Competent Excavation and Trenching person prior to commencement of work activities.
- Evidence of cave-ins, slides, sloughing, or surface cracks will be cause for work to cease until necessary precautions are taken to safeguard workers.
- Excavations 5 ft or deeper where employees must enter and cannot be sloped will require a registered civil engineer to design a protective system.
- Protective systems shall be selected from OSHA 29 CFR 1926 Subpart P and/or designed by a registered professional civil engineer.
- Spoils and other materials will be placed 2 ft or more from the edge of the excavation.
- Materials used for sheeting, shoring, or bracing will be in good condition.

- Timbers will be sound, free of large or loose knots, and of appropriate dimensions for the excavation.
- Safe access will be provided into the excavation(s) by means of a gradually sloped personnel access/egress ramp or ladders.
- Excavations 4 ft or more in depth will have a means of egress at a frequency such that lateral travel to the egress point does not exceed 25 ft.

5.4.2.6 Heat Stress

Heat stress is caused by a number of interacting factors including environmental conditions, clothing, workload, and the individual characteristics of the worker. Because heat stress is probably one of the most common illnesses at a site, regular monitoring and other preventive measures are vital.

Heat stress manifests itself in progressive stages (listed below), each increasing in severity, and if not remedied, can threaten life or health. Factors which may predispose a worker to heat stress include: lack of physical fitness, lack of acclimatization to hot weather, degree of hydration, current health status, alcohol or drug use, and the worker's age and sex. Therefore, it is important that all workers be able to recognize symptoms of these conditions and be capable of arresting the problem as quickly as possible.

As with any illness, the best cure for heat stress is avoidance/prevention. Heat stress is most likely to occur early in the summer, prior to acclimatization. Full acclimatization takes 5 to 7 days of consecutive controlled exertion in heat. Individual physical conditioning, pre-existing illnesses, and use of alcohol contribute significantly to the potential for heat stress. Avoidance includes drinking plenty of fluids, taking frequent breaks, revising work schedule around hot periods of the day, and assuring that workers are acclimated before allowing them to work for extended periods of time. **Table 5-2** shows an example work/rest schedule to be implemented as it relates to the work load and regimen. The SSHO will determine when work/rest schedules will be implemented based on temperature and work load.

Table 5-2
Examples of Permissible Heat Exposure Threshold Limit Values

Work – Rest Regimen	*Work Load		
	Light	Moderate	Heavy
Continuous Work	30.0 (86)	26.7 (80)	25.0 (77)
75% Work - 25% Rest, each hour	30.6 (87)	28.0 (82)	25.9 (78)
50% Work - 50% Rest, each hour	31.4 (89)	29.4 (85)	27.9 (82)
25% Work - 75% Rest, each hour	32.2 (90)	31.1 (88)	30.0 (86)

*Consult the ACGIH TLV booklet for definitions of Light, Moderate and Heavy workloads. Values are given in °C and (°F) Wet Bulb Globe Temperature, and are intended for workers wearing single layer summer type clothing. As workload increases, the heat stress impact on an unacclimatized worker is exacerbated. For unacclimatized workers performing a moderate level of work, the permissible heat exposure TLV should be reduced by approximately 2.5°C.

As presented in **Appendix D**, Shaw Procedure HS400, Working in Hot Environments, will be implemented to control heat-related illness. The SSHO will determine the potential for heat stress based on planned activities and weather forecasts.

Heat Rash

Heat rash is caused by continuous exposure to heat and humid air and is aggravated by wet chafing clothes. This condition can decrease a worker's ability to tolerate hot environments.

Symptoms – Symptoms of heat rash include a mild red rash, especially in areas of the body which sweat heavily.

Treatment – Treatment includes decreasing the amount of time in protective gear and providing powder (such as corn starch or baby powder) to help absorb moisture and decrease chafing. Maintain good personal hygiene standards and change into dry clothes if needed.

Heat Fatigue

Heat fatigue is characterized by discomfort and reduced mental awareness, with a greater effect in unacclimated workers. Medical treatment is usually not needed. Heat fatigue usually effects people who work in hot environments and perspire a great deal. Loss of salt from the body causes very painful cramps of the leg and abdominal muscles. Heat fatigue also may result from drinking iced water or other drinks too quickly or in too large a quantity.

Symptoms – Heat fatigue symptoms include muscle cramps in legs and abdomen, pain accompanying the cramps, faintness, and profuse perspiration.

Treatment – Treatment includes removing a victim to a cool area and loosening clothing, stretching and massaging affected muscle, drinking 1 to 2 cups of water immediately, and every 20 minutes thereafter.

Heat Exhaustion

Heat exhaustion results from sustained exertion in heat, combined with failure to replace water and salts lost in sweat. Heat syncope results in fainting and can occur when standing immobile in heat. It is caused by the pooling of venous blood in the dilated vessels of the skin and lower body.

Symptoms – Symptoms include weak pulse, rapid and shallow breathing, fatigue, nausea, headache, profuse perspiration, dizziness, unconsciousness, and clammy, moist skin which may be flushed or pale.

Treatment – Replacement of water is required to recover. Electrolyte replacement fluids should be taken until urine volume increases. Recovery is complete and rapid following rest in a recumbent position at a cool location. Treat the person for shock if necessary, and remove him/her to a medical facility if there is any indication of a more serious problem.

Heat Stroke

The most serious heat injury is *heat stroke*. Heat stroke is a medical emergency; treatment must be immediate, and professional medical attention must be obtained. Heat stroke is caused by a combination of factors including heavy exertion heat, inadequate replacement of fluids, poor physical condition, and individual susceptibility.

Symptoms – Failure of sweat response occurs, leading to a rapidly accelerated increase in core temperature. The victim usually has hot, dry red skin and, if conscious, is confused; convulsions may be present. Additional symptoms include dilated pupils and a full and fast pulse.

Treatment – The victim must be cooled immediately; heat stroke is fatal if treatment is incomplete or delayed. Emergency care includes transportation to a medical facility, placing person in a cool environment, assuring an open airway, reducing the body temperature (wrap in wet sheet or douse body with water), and if available, placing cold packs under arms, around neck, at the ankles, or any place where blood vessels lie close to skin.

5.4.2.7 Cold Stress

As with high temperatures, outdoor work in low temperatures can result in risks to the health of employees exposed without adequate preparation. The combined temperature/wind chill affect is shown in **Table 5-3**. To minimize impacts from cold stress, the information and precautions given below shall be observed.

Table 5-3
Wind Chill

COOLING POWER OF WIND ON EXPOSED FLESH EXPRESSED AS EQUIVALENT TEMPERATURE

Estimated Wind Speed (in mph)	Actual Temperature Reading (°F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (°F)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds greater than 40 mph have little additional effect)	***LITTLE DANGER*** In<hr with dry skin. Maximum danger of false sense of security.				***INCREASING DANGER*** Danger from freezing of Exposed flesh within One minute.				***GREAT DANGER*** Flesh may freeze within 30 seconds.			
	Trenchfoot and immersion foot may occur at any point on this chart.											

Cold-related worker fatalities have resulted from failure to escape low environmental air temperatures, or from immersion in low temperature water. Most hypothermia cases develop in air temperatures between 30-50 degrees Fahrenheit (°F). The single most important aspect of life-threatening hypothermia is a fall in the deep core temperature of the body. Lower body temperature will very likely result in reduced mental alertness, reduction in rational decision making, or loss of consciousness with the threat of fatal consequences.

Persons working outdoors in temperatures at or below freezing may be frostbitten. Extreme cold for a short time may cause severe injury to the surface of the body, or result in profound

generalized cooling, causing death. Areas of the body that have high surface-area-to-volume ratio, such as fingers, toes, and ears, are the most susceptible.

Local injury resulting from cold is included in the generic term frostbite. There are several degrees of damage. Frostbite of the extremities can be categorized into:

- Frost Nip or Initial Frostbite: Characterized by sudden blanching or whitening of skin.
- Superficial Frostbite: Skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.
- Deep Frostbite: Tissues are cold, pale, and solid; extremely serious injury.
- Systemic Hypothermia: This condition is caused by exposure to freezing or rapidly dropping temperature. Its symptoms are usually exhibited in five stages: 1) shivering; 2) apathy, listlessness, sleepiness, and sometimes rapid cooling of the body to less than 95°F; 3) unconsciousness, glassy stare, slow pulse, and slow respiratory rate; 4) freezing of the extremities; and finally 5) death.

Treatment of cold stress includes bringing the body core temperature back to its normal temperature of 98.6°F. Personnel exhibiting symptoms of cold stress should be brought into a warm area and allowed to rest and warm up. Warm, non-alcoholic, decaffeinated drinks (not coffee) or soup should be given to increase body temperature, and rewarming should be gradual.

For frostbite emergency treatment, the victim should be sheltered from the wind and cold and given warm drinks. If superficial, the frozen area should be covered with extra clothing or warmed against the body. Do not use direct heat, and do not pour hot water over or rub the affected area. Warming should be gentle and gradual. If the frostbite is deep (area is frozen and hard to the touch), immediate medical attention should be obtained.

For hypothermia emergency treatment, all stages are treated by either passive or active rewarming. This is accomplished by better conservation of the patient's body heat. It is important to note that if a victim is found in a remote area, despite the death-like appearance, the person may be saved. All attempts should be made to revive the victim. Active rewarming means heat is applied to the victim by an external source, either to the skin surface and/or through the core. Treatment includes:

- Preventing further heat loss. Remove the victim to a warm, dry place.
- Remove wet clothing piece-by-piece and dry underlying skin.
- Dress in several layers of warm, dry clothing, giving preference to the central body core rather than the extremities.
- Cover the victims head, then wrap the victim in blankets.
- If the victim is conscious, ask him/her to drink hot fluids.
- Monitor oral body temperature every 15 minutes. If the body temperature falls below 98.6°F, the team member should not be allowed outside until the body temperature returns to normal.
- In more severe cases of hypothermia, implement the above actions, but also institute some type of active rewarming, including:

- Electric pads or blankets.
- Hot-air blowers or heaters.
- Heated blankets or clothes.
- Use of human body heat.

- It is important to watch for signs of return of the normal thermoregulatory mechanisms (shivering, teeth chattering, etc.) and to monitor mental status.
- The victim should be transferred to a medical facility after the emergency care steps have been initiated and should not be allowed to return to work for at least 48 hours.
- Perform CPR if the victim is pulseless and not breathing.
- Avoidance of cold stress emergencies can be performed by the general practices stated below:
  - Wear layered clothing, including a water-repellent outer layer.
  - Wear gloves, socks, and a hat that are synthetic or wool insulated.
  - Remove outer layers of clothing during breaks to prevent inner layer from getting wet from perspiration.
  - Eat well-balanced meals and maintain an adequate intake of fluids.
  - Seek shelter in a warm protected area when signs and symptoms of cold stress become evident.

Table 5-4 provides a work/warm-up schedule for a 4-hour shift as it relates to temperature and wind speed. This schedule will be applied during all field work.

Table 5-4
Threshold Limit Values Work/Warm-Up Schedule for 4-Hour Shift*

Air Temperature-Sunny Sky		No Wind		5 MPH Wind		10 MPH Wind		15 MPH Wind		20 MPH Wind	
°C (approx.)	°F (approx.)	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
-26° to -28°	-15° to -19°	Normal	1	Normal	1	75 min.	2	55 min.	3	40 min.	4
-29° to -31°	-20° to -24°	Normal	1	75 min.	2	55 min.	3	40 min.	4	30 min.	5
-32° to 34°	-25° to -29°	75 min.	2	55 min.	3	40 min.	4	30 min.	5		
-35° to -37°	-30° to -34°	55 min.	3	40 min.	4	30 min.	5				
-38° to -39°	-35° to -39°	40 min.	4	30 min.	5						
-40° to -42°	-40° to -44°	30 min.	5								
-43° to below	-45° & Below	Non-emergency work should cease		Non-emergency work should cease		Non-emergency work should cease		Non-emergency work should cease		Non-emergency work should cease	

Notes:

1. Schedule applies to any 4-hour work period with moderate to heavy work activity, with warm-up periods of 10 minutes in a warm location and with an extended break (e.g., lunch) at the end of the 4-hour work period in a warm location. For Light-to-Moderate Work (limited physical movement): apply the schedule one step lower. For

example, at -35°C (-30°F) with no noticeable wind (Step 4), a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4-hour period (Step 5).

2. The following is suggested as a guide for estimating wind velocity if accurate information is not available:
   mph: light flag moves; 10 mph: light flag fully extended; 15 mph: raises newspaper sheet; 20 mph: blowing and drifting snow.
3. If only the wind chill cooling rate is available, a rough rule of thumb for applying it rather than the temperature and wind velocity factors given above would be: 1) special warm-up breaks should be initiated at a wind chill cooling rate of about 1750 W/m^2; 2) all non-emergency work should have ceased at or before a wind chill of 2250 W/m^2. In general, the warm-up schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart slightly over-compensates for the actual temperatures in the colder ranges because windy conditions rarely prevail at extremely low temperatures.
4. TLVs apply only for workers in dry clothing.

* Adapted from the *1995-1996 Threshold Limit Values and Biological Exposure Indices*, American Conference of Governmental Industrial Hygienists. Cincinnati, OH.

As presented in **Appendix D**, Shaw Procedure HS401, Cold Stress, will be implemented to control cold-related illness.

5.4.2.8 Noise

Hearing protection may be required during certain noisy activities. Hearing protection will be required when sound pressure levels in work areas or on equipment exceed 85 dBA, the TLV for noise. Permissible noise exposure levels for different durations are shown in **Table 5-5**. A field guideline for knowing when hearing protection is recommended is if people 3 ft apart must raise their voices to be heard in normal conversation.

Table 5-5
Permissible Noise Exposure

A-Weighted Sound Level (dB)	Permitted Duration Per Workday (Hours)	A-Weighted Sound Level (dB)	Permitted Duration Per Workday (Hours)
80	32.0	106	0.87
81	27.9	107	0.76
82	24.3	108	0.66
83	21.1	109	0.57
84	18.4	110	0.50
85	16.0	111	0.44
86	13.9	112	0.38
87	12.1	113	0.33
88	10.6	114	0.29
89	9.2	115	0.25
90	8.0	116	0.22
91	7.0	117	0.19
92	6.2	118	0.16
93	5.3	119	0.14
94	4.6	120	0.125
95	4.0	121	0.11
96	3.5	122	0.095
97	3.0	123	0.082

Table 5-5 (Continued)
Permissible Noise Exposure

A-Weighted Sound Level (dB)	Permitted Duration Per Workday (Hours)	A-Weighted Sound Level (dB)	Permitted Duration Per Workday (Hours)
98	2.6	124	0.072
99	2.3	125	0.063
100	2.0	126	0.054
101	1.7	127	0.047
102	1.5	128	0.041
103	1.3	129	0.038
104	1.1	130	0.031
105	1.0		

Source: Shaw Procedure HS402.

As presented in **Appendix D**, Shaw Procedure HS402, Hearing Conservation Program, will be implemented when elevated noise levels exist. The SSHO will provide training on the proper use of hearing protection in accordance with 29 CFR 1910.95. The training will be conducted as a part of the pre-work safety and health briefing and documented in the safety files.

5.4.2.9 Dust

It is possible that dust could be generated during soil excavation and load-out operations. In such cases, a water spray will be used to minimize dust generation. Real-time dust monitors may be used if necessary to protect site personnel (*Section 5.7*).

5.4.2.10 Manual Lifting

Investigation and IM activities may require personnel to move large, heavy objects by hand. The human body is subject to severe damage in the forms of back injury and hernia if caution is not observed when handling, lifting, or moving these large, heavy objects.

The following fundamentals should be followed while manual lifting objects:

- The size, shape, and weight of the object to be lifted must be considered. Site personnel will not lift more than they can handle comfortably. No individual employee is permitted to lift any object that weighs over 60 pounds. Multiple employees or the use of mechanical lifting devices are required for objects over the 60-pound limit.
- A firm grip on the object is essential; therefore, the hands and objects shall be free of oil, grease, and water.
- The hands and fingers shall be kept away from any points that could cause them to be pinched or crushed, especially when setting the object down.
- The item shall be inspected for metal slivers, jagged edges, burrs, and pinch points, and gloves shall be used to protect the hands.
- The feet will be placed far enough apart for good balance and stability.
- Personnel will ensure that solid footing is available prior to lifting the object.

- To lift the object, the legs are straightened from their bending position.
- Never carry a load that you cannot see around.
- When placing an object down, the stance and position are identical to that for lifting.
- If needed, back support devices will be provided to aid in preventing back injury.

The following steps will be followed during manual lifting:

- Ensure the route on which you will carry the object is clear and free from trip hazards.
- Get a good footing.
- Place feet about one shoulder-width apart.
- Bend at knees to grasp weight.
- Keep the back straight.
- Get a firm hold.
- Lift gradually by straightening the legs.
- If weight is uncomfortable to lift, get help.

5.4.2.11 Slips, Trips, Falls

Field operations may place personnel in situations where they may be exposed to slip, trip, and fall hazards. Slipping hazards will exist when the ground is wet, or on steep slopes. Tripping hazards will exist on rough, uneven terrain, or if the work area is cluttered with tools, equipment, debris, soil piles, etc. Falling hazards will exist as a result of slip or trip hazards, or in elevated work areas with inadequate railing.

The following precautions should be followed by all site personnel:

- Field personnel shall become familiar with the general terrain of the site and potential physical hazards (i.e., rocky conditions, uneven terrain) that would be associated with accidental slips, trips, and falls.
- Be cautious after periods of heavy rainfall, which may cause earth movement and slides.
- Be attentive where you walk since pits, holes, or similar hazards may be partially covered or visually obstructed.
- Be cautious around soil or terrain which recently may have been disturbed, relocated, or otherwise made less stable.
- Avoid the top edges of drop-off areas whether they have been disturbed or not.
- Use the three-point rule when getting on and off heavy equipment.

5.4.2.12 Lightning

Electrical storms commonly occur during Spring and Fall. The resulting lightning poses a safety hazard to field personnel. Since the storms are sometimes fast moving, field personnel should watch for indications of electrical storms. The distance to an electrical storm can be estimated by observing the interval between the lightning flash and the sound of thunder. Since sound

travels approximately 1,100 ft per second, an interval of 5 seconds corresponds to a storm distance of approximately 1 mile. This is also referred to as the flash/bang process. If lightning is observed and thunder is heard within 30 seconds, work shall be suspended. Work will not resume for 30 minutes or until the flash/bang time exceeds 30 seconds (30:30 rule).

If an electrical storm is observed within 6 miles of the site, field personnel shall cease outside activities and proceed to the site office for further instructions, and all heavy equipment will be shut down. If caught in the open by an electrical storm, all personnel will immediately seek shelter in their vehicle and proceed as above. In the event that their vehicle is inaccessible, they will move to a topographically low area away from tall objects and conductors (e.g., transformer, power lines, metal sheds) and wait for the storm to leave the area.

5.4.2.13 Drum Handling

Hazardous materials are often shipped, stored, or disposed in 55-gallon drums. If a drum or other container is encountered with unknown contents, caution will be exercised to avoid explosion or chemical hazards. The discovery of unknown drums shall require immediate notification to the Health and Safety Manager. Unknown drums will not be handled until the appropriate precautions and PPE are in place.

5.4.3 Chemical Hazards

This section discusses chemical hazards that may be encountered at RFAAP during the IM at SWMU 54. Chemical hazards can be encountered either from chemicals brought on site by the contractor for use during activities, chemicals stored at the site, or chemicals that have been released to the environment and are present in various media such as air, soil, or water.

5.4.3.1 Site-Related Chemicals

According to the RFI at SWMU 54 (URS, 2008), as presented in **Tables 1-1 and 1-2**, the COIs in Area A, including 2,4,6-TNT, DNT mixture, RDX, Amino DNTs, NG, heptachlor epoxide, and dioxins/furans, were identified as above the calculated RGs. Additionally, 2,4,6-TNT, DNT mixture, RDX, and perchlorate were identified as above the calculated RGs in Area A groundwater. In Area B soils, 2,4,6-TNT, DNT mixture, RDX, Amino DNTs, NG, lead, Aroclor 1254, heptachlor epoxide, dieldrin, and dioxins/furans were identified as above the calculated RGs.

5.4.3.2 Exposure Pathways

Chemicals may pose a hazard to humans when inhaled, ingested, or through dermal absorption. Inhalation can occur when chemicals are present as vapors, aerosols, or attached to airborne dust particles. Ingestion usually occurs incidentally, as chemicals present in the air enter the mouth or nose, or from hand to mouth activities such as eating, drinking, and smoking. Dermal absorption occurs when chemicals contact unprotected skin.

5.4.3.3 Exposure Assessment

The toxic hazards to site personnel associated with chemicals can be assessed through comparison of actual exposures with several established occupational exposure limits using quantitative collection and analysis through real-time and/or time-integrated personal air sampling.

Permissible Exposure Limits (PELs) are established by OSHA. TLVs are established by ACGIH. Immediately Dangerous to Life or Health (IDLH) values are established by NIOSH. **Table 5-6** presents occupational exposure limits (if available) for potential chemicals, including OSHA PELs, ACGIH TLVs, and NIOSH IDLH values. The table also indicates if there are potential significant contributions to the overall exposure for the chemical of concern through dermal contact, and identifies the acute symptoms resulting from exposure.

Table 5-6
Occupational Health Exposure Guidelines for Potential Contaminants

Contaminant	Acute Symptoms of Exposure	PEL (TWA unless otherwise noted)	TLV-TWA	Skin Notation (Yes/No)	IDLH
2,4-DNT as DNT	Anoxia, cyanosis; anemia, jaundice; reproductive effects; [potential occupational carcinogen]	1.5 mg/m^3	1.5 mg/m^3	Y	50
NG	Throbbing headache; dizziness; nausea, vomiting, abdominal pain; hypotension; flush; palpitations; methemoglobinemia; delirium, central nervous system depression; angina; skin irritation	2 mg/m^3	0.1 mg/m^3 Short Term	Y	75 mg/m^3
2,4,6-TNT	Skin or mucous membrane irritation; liver damage, jaundice; cyanosis; sneezing; cough, sore throat; peripheral neuropathy, muscle pain; kidney damage; cataract; sensitization dermatitis; leukocytosis (increased blood leukocytes); anemia; cardiac irregularities	1.5 mg/m^3	0.5 mg/m^3	Y	500 mg/m^3
RDX	Headache, dizziness, nausea, irritation of eyes and respiratory tract, narcosis and unconsciousness	NE	1.5 mg/m^3	Y	NE
Perchlorate	Dermatitis, nephrotoxic, aplastic anemia; irritation of the eyes, skin and throat; may cause vomiting, diarrhea, abdominal pain, cardiac arrythmia	0.5 mg/m^3	0.5 mg/m^3	Y	NE

Table 5-6 (Continued)
Occupational Health Exposure Guidelines for Potential Contaminants

Contaminant	Acute Symptoms of Exposure	PEL (TWA unless otherwise noted)	TLV-TWA	Skin Notation (Yes/No)	IDLH
Aroclor-1254	Eye irritation, chloracne; liver damage; reproductive effects [potential occupational carcinogen]	0.5 mg/m^3	0.001 mg/m^3	Y	5 mg/m^3
Heptachlor Epoxide	Dizziness, nausea, muscle weakness, narcosis, and respiratory failure	0.5 mg/m^3	0. 5 mg/m^3	Y	35 mg/m^3
Dieldrin	Headache, dizziness, vomiting, myoclonic limb jerks, convulsions	0.25 mg/m^3	0.25 mg/m^3	Y	50 mg/m^3
Dioxins/Furans	Cough, dyspnea (breathing difficulty), wheezing; decreased pulmonary function, progressive respiratory symptoms (silicosis); eye irritation; [potential occupational carcinogen]	NE	NE	Y	NE
Lead	Lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; wrist or ankle paralysis; encephalopathy; kidney disease; eye irritation; hypotension	0.05 mg/m^3	0.05 mg/m^3	Y	100 mg/m^3

The occupational exposure limits are described as follows:

PELs may be expressed as an 8-hour Time-Weighted Average (TWA), a Short-Term Exposure Limit (STEL), or a ceiling limit. Ceiling limits may not be exceeded at any time. PELs are enforceable by law. STELs are allowable exposure limits for durations ranging from 5 to 15 minutes, without causing the 8-hour TWA to be exceeded.

The ACGIH TLV is defined as the TWA concentrations for a substance to which nearly all workers (8 hours/day, 40 hours/week) may be repeatedly exposed, day after day, without experiencing adverse health effects. For some substances, the overall exposure to a substance is enhanced by skin, mucous membrane, or eye contact. These substances are identified by "yes" in the skin notation column.

The IDLH values represent the maximum concentrations from which, in the event of respirator failure, one could escape within 30 minutes without a respirator and without experiencing any escape-impairing symptoms or any irreversible health effects.

5.4.3.4 Chemical Hazard Communication

In order to comply with Shaw Procedure HS060 and with the OSHA Hazard Communication Standard 29 CFR 1910.1200 to ensure that site personnel are informed of the hazards associated with the materials with which they work, the following requirements will apply to all commercial products containing hazardous substances which are brought on site.

- Material Safety Data Sheets (MSDSs) will be maintained for each product containing a hazardous substance that will be used on site. MSDSs will also be maintained for COIs identified in site soil. MSDSs are included in **Appendix E**.
- All containers not supplied with adequate hazard labeling will have a hazard communication label affixed to the container providing the health and physical hazards associated with the material.
- All personnel, including subcontractors who work with products containing hazardous substances, will be trained in accordance with the requirements of 29 CFR 1910.1200. This training will be performed and documented by the SSHO and maintained on site in the safety files.
- An inventory of all products containing hazardous substances used on site will be maintained using a site-specific Chemical Inventory.

5.4.4 Biological Hazards

Biological hazards that may be found at SWMU 54 include ticks, spiders, snakes, and poisonous plants. The following sections discuss the potential biological hazards that may be encountered at SWMU 54 during removal actions.

5.4.4.1 Ticks

From April through October, particular caution will be exercised to prevent site workers from being bitten by deer ticks and potentially contracting Lyme Disease. The Centers for Disease Control has noted an increase of Lyme Disease and Rocky Mountain Spotted Fever (RMSF), which are caused by tick bites. Ticks are small, ranging from the size of a comma up to about 1/4 inch; when embedded in the skin, they may look like a freckle. Ticks live in and near wooded areas, tall grass, and brush.

Lyme Disease – Lyme Disease is caused by deer ticks and lone star ticks that have become infected with spirochetes. Female deer ticks are about 1/4 inch in size, and are black and brick red in color. Male deer ticks are smaller and completely black. Lone star ticks are larger and chestnut brown in color. The illness typically occurs in the summer and is characterized by a slowly expanding red rash that develops in a few days to a few weeks after the bite of an infected tick. This may be accompanied by flu-like symptoms along with headache, stiff neck, fever, muscle aches, and/or general malaise. At this stage, treatment by a physician usually is effective. If left alone, these early symptoms may disappear, but more serious problems may follow. The most common late symptom of the untreated disease is arthritis. Other problems which may occur include meningitis, neurological abnormalities, and cardiac abnormalities. It is important

to note that some people do not get the characteristic rash and may have diminished progress to the later manifestations. Treatment of later symptoms is more difficult than early symptoms and is not always successful.

Rocky Mountain Spotted Fever – RMSF has occurred in this area of the country. It is caused by Rocky Mountain wood ticks and dog ticks which have become infected with rickettsia. Both are black in color.

RMSF disease is transmitted by the infected dog tick *Dermacentor variabilis* and is common in the western U.S. It is important to note that the dog tick is significantly larger than the deer tick, previously discussed. Nearly all cases of RMSF occur in the Spring and Summer, generally several days after exposure to infected ticks. The onset of illness is abrupt, often with high fever, headache, chills, and severe weakness. After the fourth day of fever, victims develop a spotted pink rash, which usually starts at the hands and feet and gradually extends to most of the body.

The first symptoms of either disease are flu-like chills, fever, headache, dizziness, fatigue, stiff neck, and bone pain. If immediately treated by a physician, most individuals recover fully in a short period of time. If not treated, more serious symptoms can occur.

If a site employee believes they have been bitten by a tick, or if any of the signs and symptoms noted above appear, the employee will contact the SSHO, who will authorize the employee to visit a physician for an examination and possible treatment.

The following precautions should be taken when working in areas that might be infested with ticks:

- Cover your body as much as possible. Wear long pants and long-sleeved shirts. Light color clothing makes spotting of ticks easier.
- Try to eliminate possible paths by which the deer tick may reach unprotected skin. For example, tuck bottoms of pants into socks or boots and sleeves into gloves. (Duct tape may be used to help seal cuffs and ankles.) If heavy concentrations of ticks or insects are anticipated or encountered, Tyvek® coveralls may be used for added protection.
- Conduct periodic and frequent (e.g., hourly) surveys of your clothing for the presence of ticks. Remove any ticks and insects that become attached to clothing.
- Spray outer clothing, particularly your pant legs and socks, but not your skin, with an insect repellent that contains permethrin or permanone, or use a repellent with DEET, which can be applied to the skin.
- When walking in wooded areas, avoid contact with bushes, tall grass, or brush as much as possible.
- Tuck pant legs into boot tops or tape pants to boot tops to prevent ticks from crawling up the pant leg (this may not be an option at sites where extreme heat stress is anticipated).
- If dressed in Level D or Modified Level D and no other head protection is required, wear a hat to prevent ticks from getting into the hair.

The following actions should be taken if a tick is found:

- If you find a tick, remove it by pulling on it gently with tweezers.

- If the tick resists, cover the tick with salad oil for about 15 minutes to asphyxiate it, then remove it with tweezers.
- Do not use matches, a lit cigarette, nail polish, or any other type of chemical to "coax" the tick out.
- Be sure to remove all parts of the tick's body and disinfect the area with alcohol or a similar antiseptic after removal.
- For several days to several weeks after removal of the tick, look for the signs of the onset of Lyme disease, such as a rash that looks like a bulls-eye or an expanding red circle surrounding a light area.
- Look for the signs of the onset of RMSF, such as a rash-like inflammation consisting of red spots under the skin that appear 3 to 10 days after the tick bite.

Removal of ticks is best accomplished using small tweezers. Do not squeeze the tick's body. Grasp it where the mouth parts enter the skin and tug gently, but firmly, until it releases its hold on the skin. Save the tick in a jar labeled with a date, body location of the bite, and place it where it may have been acquired.

Wipe the bite thoroughly with an antiseptic and notify the safety officer as soon as possible. The various stages and symptoms are well recognized and if detected can be treated with antibiotics. Early detection and treatment with antibiotics significantly reduces the severity of Lyme disease and RMSF. If necessary, seek medical attention.

5.4.4.2 Ants, Bees, Wasps, Hornets, and Yellow Jackets

Contact with stinging insects like bees, hornets, and wasps may result in site personnel experiencing adverse health effects that range from being mild discomfort to life threatening. Therefore, stinging insects present a serious hazard to site personnel, and extreme caution must be exercised whenever site and weather conditions increase the risk of encountering stinging insects.

Nests and hives for bees, wasps, hornets, and yellow jackets often occur in ground, trees, and brush. The area will be checked for obvious nests and hives before it is cleared. If a nest or hive is found, the SSHO will be contacted before the nest is disturbed or removed; and, if possible, an alternate sampling location will be selected. Bites and stings can be painful and may elicit an allergic reaction. Medical surveillance will identify any individuals with life-threatening allergies. These individuals will not work in areas where there is a great potential for insect stings. If simple first aid measures do not alleviate the symptoms, the victim will be taken to the nearest medical center. An attempt will be made to kill the offending insect and take it to the emergency room with the victim if this can be done quickly and without endangering personnel.

Some of the factors related to stinging insects that increase the degree of risk associated with accidental contact are as follows:

- The nests for these insects are frequently found in remote, wooded, grassy areas.
- The nests can be situated in trees, rocks, bushes, or in the ground, and are usually difficult to see.

- Accidental contact with these insects is highly probable, especially during warm weather conditions when the insects are most active.
- If a site worker accidentally disturbs a nest, the worker may be inflicted with multiple stings, causing extreme pain and swelling which can leave the worker incapacitated and in need of medical attention.
- Some people are hypersensitive to the toxins injected by a sting, and when stung, experience a violent and immediate allergic reaction resulting in a life-threatening condition known as anaphylactic shock.
- Anaphylactic shock manifests itself very rapidly and is characterized by extreme swelling of the body, eyes, face, mouth, and respiratory passages.
- The hypersensitivity needed to cause anaphylactic shock, can in some people, accumulate over time and exposure; therefore, even if someone has been stung previously, and has not experienced an allergic reaction, there is no guarantee that they will not have an allergic reaction upon receipt of another sting.

With these things in mind and with the high probability of contact with stinging insects, all site personnel shall comply with the following safe work practices:

- If a worker knows that he is hypersensitive to bee, wasp, or hornet stings, they must inform the SSHO of this condition prior to participation in site activities. The SSHO will question all site personnel concerning allergies or sensitivities prior to initiating work on site.
- All site personnel will be watchful for the presence of stinging insects and their nests, and shall advise the SSHO if a stinging insect nest is located or suspected in the area.
- Any nests located on site shall be flagged off, and site personnel shall be notified of its presence.
- If stung, site personnel shall immediately notify the SSHO to obtain treatment and allow the SSHO to observe them for signs of allergic reaction.
- Site personnel with a known hypersensitivity to stinging insects shall keep required emergency medication on or near their person at all times.

Stings of these insects are responsible for more deaths in the U.S. than bites and stings of all venomous creatures. This is due to the sensitization by the victim to the venom from repeated stings, which can result in anaphylactic reactions. The stinger may remain in the skin and should be removed by teasing or scraping rather than pulling. An ice cube placed over the sting will reduce pain. An analgesic-corticosteroid lotion is often used. People with known hypersensitivity to such stings should carry a kit containing antihistamine and epinephrine.

5.4.4.3 Spiders

The biting insects of greatest concern are spiders, especially the black widow and the brown recluse. These spiders are of special concern due to the significant adverse health effects that can be caused by their bite.

Black Widow – The black widow is a coal-black, bulbous spider 3/4 to 1-1/2 inches in length, with a bright red hourglass on the underside of the abdomen. The black widow is usually found in dark moist locations, especially under rocks and rotting logs, and may even be found in outdoor toilets where they inhabit the underside of the seat. Victims of a black widow bite may exhibit the following signs or symptoms:

- Sensation of pinprick or minor burning at the time of the bite.
- Appearance of small punctures (sometimes none are visible).
- After 15 to 60 minutes, intense pain is felt at the site of the bite which spreads quickly and is followed by profuse sweating, rigid abdominal muscles, muscle spasms, breathing difficulty, slurred speech, poor coordination, dilated pupils, and generalized swelling of face and extremities.

Brown Recluse – The brown recluse is brownish to tan in color, rather flat, 1/2 to 5/8 inches long with a dark brown "violin" shape on the underside. It may be found in trees or in dark locations. Victims of a brown recluse bite may exhibit the following signs or symptoms:

- Blistering at the site of the bite, followed by a local burning at the site 30 to 60 minutes after the bite.
- Formation of a large, red, swollen, pustulating lesion with a bull's-eye appearance.
- Systemic effects may include a generalized rash, joint pain, chills, fever, nausea, and vomiting.
- Pain may become severe after 8 hours with the onset of tissue necrosis.

There is no effective first aid treatment for either of these bites. Except for very young, very old, or weak victims, these spider bites are not considered to be life threatening; however, medical treatment must be sought to reduce the extent of damage caused by the injected toxins. If either of these spiders are suspected or known to be on site, the SSHO shall brief the site personnel as to the identification and avoidance of the spiders. Site personnel should notify the SSHO if they locate either of these spiders.

5.4.4.4 Snakes

The possibility for encountering snakes exists. Although rare in the southwestern Virginia area, the species of greatest concern is the copperhead *(Agkistrodon contortix)*. Copperheads grow to 36 inches and can be recognized by the copper-color head and a reddish-brown hourglass pattern on the body. Copperheads are normally lethargic; once aroused, however, they strike vigorously and may rapidly vibrate their tails. Rocky hillsides are favorite habitats.

To minimize the threat of snake bites, all personnel walking through the brush will be aware of the potential for encountering snakes and will avoid actions that increase the likelihood of encounters (e.g., turning over logs). Additional caution will be exercised around sawdust or rock piles, which are known to support copperheads. In the event of a snake bite, the following rules should be followed:

- Do no cut "X's" over the bite area as this will intensify the effect of the venom.
- Do not apply suction to the wound since this has a minimal effect in removing venom.

- Do not apply a tourniquet since this will concentrate the venom and increase the amount of tissue damage in the immediate area.
- If possible, kill the snake, bag it, and transport it with the victim. Try to identify the snake for proper selection of anti-venom.
- Do not allow the victim to run for help since running increases the heart rate and will increase the spread of the venom throughout the body.
- Keep the victim calm and immobile.
- Have the victim hold the affected extremity lower than the body while waiting for medical assistance.
- Transport the victim to a medical facility immediately.

5.4.4.5 Animals

Normally, wildlife avoid people and areas where activities are ongoing. Small animals, such as raccoons, infected with rabies or when cornered, may become aggressive. When working remain alert for likely locations that animals inhabit. Avoid nests, dens, and holes in the ground that may be the animal's home.

The only effective measure to preclude animal bites is avoidance. Contact with all wild animals at SWMU 54 will be avoided at all times. Persons bitten by an animal should seek medical assistance immediately, especially if it is suspected that the animal is rabid. Aggressive or disoriented behavior as well as foaming of the mouth can be signs of rabid animals. Until medical assistance can be reached, persons should watch for symptoms of severe swelling, nausea, and shock.

5.4.4.6 Poison Ivy, Poison Oak, Poison Sumac

Poison ivy thrives in all types of light and usually grows in the form of a trailing vine; however, it can also grow as a bush and can attain heights of 10 ft or more. Poison ivy has shiny, pointed leaves that grow in clusters of three. Poison sumac is a tall shrub or slender tree that usually grows along swampy areas or ponds in wooded areas. Each poison sumac leaf stalk has 7 to 13 leaflets which have smooth edges. Poison oak is mostly found in the southeast and west. Poison oak resembles poison ivy, with one important difference. Poison oak leaves are more rounded than jagged like poison ivy, and the underside of poison oak leaves are covered with hair.

Summer Poison Ivy

Poison Oak

Poison Sumac

All personnel should become familiar with and be able to recognize poison ivy, poison oak, and poison sumac in the field. All personnel that know they are over-sensitive to poison ivy or poison sumac will notify their Site Superintendent or the SSHO. They will not be allowed to work in the area until the poison ivy/sumac has been removed. This information will be noted on their medical data sheet. Reaction to poison ivy can be prevented if the exposed skin is washed with mild soap and water within 10 minutes of contact. Contact can be prevented by site workers wearing appropriate clothing. Preventive measures which can prove effective for most site personnel are:

- Avoid contact with any poisonous plants on site and keep a steady watch to identify, report, and mark poisonous plants found outside.
- Wash hands, face, or other exposed areas at the beginning of each break period and at the end of each work day.
- Avoid contact with, and wash on a daily basis, contaminated tools, equipment, and clothing.
- Barrier creams, detoxification/wash solutions, and orally administered desensitization may prove effective and should be tried to find the best preventive solution.
- Avoid spreading oils from these plants to hands and other parts of the body.

The skin reaction associated with contacting these plants is caused by the body's allergic reaction to toxins contained in the oils produced by the plant. Contamination from the oils of these plants may occur through contact with leaves, branches, stems or berries, or contact with contaminated items such as tools and clothing. The allergic reaction associated with exposure to these plants will generally cause the following signs and symptoms:

- Blistering at the site of contact, usually occurring within 12 to 48 hours after contact.
- Reddening, swelling, itching, and burning at the site of contact.
- Pain, if the reaction is severe.
- Conjunctivitis, asthma, and other allergic reactions if the person is extremely sensitive to the poisonous plant toxin.

Blisters form during the subsequent 24 to 36 hours. Crusting and scaling occurs within a few days. Signs and symptoms included redness, swelling, and sometimes intense itching. Symptoms usually disappear in 1 to 2 weeks in cases of mild exposure and up to 3 weeks when exposure is severe.

5.4.4.7 Biological Agents

Microbial hazards can potentially occur when workers handle materials with biological contamination. One source of infection for response workers is poor sanitation. Waterborne and foodborne diseases can be a problem if adequate precautions are not taken to keep food and drinking water properly stored and isolated. An example of such a disease is salmonellosis. Workers must also avoid creating any sanitation problems by making sure that properly designed lavatory facilities are available at the work site.

Tetanus is another biological hazard encountered on hazardous materials sites. Workers must avoid puncture hazards, wear appropriate protective clothing, and should be current in Tetanus inoculations.

5.4.4.8 Bloodborne Pathogens

In July of 1992, OSHA issued a final Standard for Protection of Workers Potentially Exposed to Bloodborne Pathogens (29 CFR 1910.1030). This primarily involves medical and research personnel. Bloodborne pathogens are pathogenic microorganisms which may be present in human blood and can cause disease in humans. These pathogens include, but are not limited to, hepatitis B virus and human immunodeficiency virus.

Potential exposure during site activities results from workers who are infected. The OSHA Standard specifically includes first aid providers and is enforceable on site subject to the Hazardous Waste Site Work and Emergency Response Standard (29 CFR 1910.120). The basic concept of this standard is that medical care workers and first aiders must take the "Universal Precaution" of assuming that any blood-containing fluid or person bleeding or contaminated with blood-containing fluid is positive (infected) with both viruses.

Protection involves the use of personal protection such as gloves, eye shields, one-way valve rescue breather devices, and training. In order to effectively protect against any hazards, workers must have a basic understanding of the hazard. This is particularly true of Site Superintendents and SSHOs and others expected to administer first aid if necessary.

5.5 Site Control Procedures

5.5.1 Site Control

To protect the public and maintain security at SWMU 54 during working hours, the site will be controlled as follows:

- Work areas and support areas will be established prior to the start of activities.
- Only authorized workers will be permitted in work areas.
- Work will cease if unauthorized personnel enter work areas.
- Temporary fencing will be utilized around excavations to protect site visitors.

5.5.2 Site Work Zones

If site conditions dictate an upgrade in PPE due to the presence of contaminants at high concentrations, work zones will be established to ensure against the accidental spread of hazardous substances by workers from contaminated areas to clean areas. Zones will be delineated on site where removal activities occur, and the flow of personnel in these zones will be controlled. The establishment of site work zones will help ensure that personnel are properly protected against the hazards present where they are working, work activities and contamination are confined to the appropriate areas, and personnel can be located and evacuated in an emergency. The site work zones that will be used during site activities, as deemed necessary by the SSHO, will include:

- Exclusion Zone (EZ) – the contaminated area.
- Contamination Reduction Zone (CRZ) – the area where decontamination of PPE takes place.
- Support Zone (SZ) – the uncontaminated area where workers should not be exposed to hazardous conditions.

A "hotline" where personnel routinely enter or exit the EZ will be located upwind of the work activities. Site work zones, including hotlines, will be established as deemed necessary by the SSHO during field activities. All site work zones will be adequately marked using traffic cones or banner guard.

Access to the EZ and CRZ will be strictly limited to individuals who meet all medical monitoring, training, and PPE requirements of the site. Visitors who have received the appropriate training, are medically qualified, and are wearing the appropriate level of protection must receive a site safety briefing and will be escorted within these zones by the SSHO. Visitors who do not meet the specified requirements will remain in the SZ.

5.5.3 Buddy System

The buddy system will be employed by all personnel entering a hazardous waste operation. This system requires that a partner, or buddy, accompany each worker. The buddy provides the co-worker/partner with assistance, observes the partner for signs of exposure, periodically checks the integrity of the partner's PPE, and notifies the SSHO if help is needed. The buddy must be in a line of sight or hearing of the partner and be prepared to enter any area the partner enters. The buddy must be fully certified to work in the level of protection that the employee is working in, and must have the appropriate PPE available.

5.5.4 Communications

This section describes the on- and off-site communications that are required during operations at SWMU 54. At SWMU 54, at least one cellular telephone will be available at each work site for off-site transmissions and emergency response.

5.6 Personal Protective Equipment

PPE consistent with Shaw Procedure HS600 (**Appendix D**) will be required during field work at SWMU 54. **Table 5-7** presents the PPE requirements for the IM actions planned at SWMU 54. The SSHO will review the required level of protection and safety equipment with each work crew. The ultimate decision on which protective level is most appropriate will be made by the SSHO. The level of protection selected will be based on:

- The type and measured concentration of the chemical substance having the lowest PEL, TLV, and/or IDLH concentration in the ambient atmosphere, its range of toxic properties and lower explosive limit, and the evaluated degree of hazard.
- Potential for exposure to substances in the air, liquid splashes, or other direct contact with hazardous materials.
- Hazardous materials.

Table 5-7
Personal Protective Equipment Requirements

Activity/Location	PPE Level	Comment
Delineation Sampling and Soil Removal	Level D/ Modified D	Modified Level D when in contact with contaminated material. Upgrade to Level C if action levels warrant.
Site Setup and Restoration	Level D	Level D when no contact with contaminated material exists.
Groundwater Monitoring	Level D	Level D when no contact with contaminated material exists.

In situations where the chemical identity, concentrations, and possibility of contact are not well-characterized, the appropriate level of protection will be one level higher than the suspected level of protection, based on professional experience and judgment, until the hazards can be better identified.

PPE shields the body against contact with a known or suspected chemical. OSHA specifies four PPE levels: A, B, C, and D. The minimum level of protection for all Shaw sites is Level D. It is not expected that the type and level of contaminant exposure during activities performed under this task will require either Level A or B protection. If unforeseen conditions arise which would require Level A or B, work will halt so that the task can be reevaluated and this SSHP can be revised or replaced.

5.6.1 Level D

Level D protection will be worn only as a work uniform and not on any site with respiratory or skin hazards. It provides minimal protection and consists of:

- Coveralls or work clothes (dictated by weather).
- Leather safety boots, steel toes, and shanks.
- Nitrile surgical gloves: non-latex or non-powdered, low-protein latex gloves (when necessary).
- Work gloves: cotton or leather (when necessary).
- Eye protection (safety glasses or goggles).
- Hearing protection (when necessary).
- Hard hat.

5.6.2 Modified Level D

- Cotton, Saranex, Chemrel (or equivalent), or polycoated Tyvek® or regular Tyvek® coveralls (dependent upon location and splash potential).
- Rain suit or Saranex apron, and face shield (when there is a splash hazard).
- Leather safety boots/shoes with chemical-resistant soles, steel toes, and shanks with chemical resistant (disposable latex) boot covers (outer).
- Inner gloves: non-latex or non-powdered, low-protein latex gloves.

- Outer gloves: chemical-resistant butyl/neoprene or Viton/neoprene gloves.
- Eye protection (safety glasses or goggles).
- Hearing protection (when necessary).
- Hard hat.

5.6.3 Level C

Level C protection will be worn when the criteria for using air-purifying respirators are met. Level C consists of:

- Tyvek® or Saranex coveralls (dependent upon location and splash potential).
- Full-face air-purifying respirator (NIOSH-approved) or Powered air-purifying respirator w/HEPA cartridge.
- Prescription insert for workers who require corrective lenses (individuals will not be permitted to wear contact lenses).
- Leather safety boots/shoes with chemical-resistant soles, steel toes, and shanks.
- Latex boot covers or pullover slush boots (dependent upon location and splash potential).
- Inner gloves: chemical-resistant nitrile or non-latex surgical gloves.
- Outer gloves: chemical-resistant butyl or neoprene gloves.
- Other PPE such as hearing protection (dependent upon the activities performed).
- Hard hat.

5.6.4 Respirator Selection and Fit Test

Shaw's Safety and Health Program Requirements Manual requires that all personnel who work on potentially hazardous sites participate in Shaw's Respiratory Protection Program (Shaw Procedure HS600 provided in **Appendix D**). A qualitative fit test will be performed on each individual required to wear respiratory protection at least once per year. Training on use, maintenance, cleaning, and sanitizing of respiratory protective equipment is included as part of the employee's 8-hour annual refresher training course. Each person receives documentation of the size, brand, and model number of the air purifying respirator that he or she is approved to use. This information is retained in Shaw's corporate safety and health files and also in the site safety files.

5.7 Air Monitoring Requirements

Environmental monitoring equipment to be used at SWMU 54 is discussed in this section, along with action levels for each monitoring instrument. Based on these action levels, the SSHO, or designated alternate, will authorize downgrades or upgrades in the level of PPE, as appropriate. One or more of the following instruments may be used as directed/needed by task:

- CGI/O_2 meter.
- Real-time dust monitor.
- PID.

Initial air monitoring instruments for the IM activity are presented in **Table 5-8**.

Table 5-8
Air Monitoring Requirements

Activity/Location	Air Monitoring Instrument Required
Soil Removal	CGI/O_2; Real-Time Dust Monitor; PID
Groundwater Monitoring	PID

Air monitoring data from these instruments will be recorded in field logbooks. The use of this equipment is intended to provide warning and allow appropriate action to be taken to prevent exposure to contaminants released into the atmosphere. Instruments are calibrated annually by the manufacturers. In addition, calibration and maintenance checks of monitoring equipment will be performed daily prior to each use according to the manufacturer's specifications.

5.7.1 Real-Time Particulate Monitor

A real-time particulate monitoring instrument is used to determine the concentration of total particulate in the breathing zone. Dust monitoring will not initially be required during SWMU 54 Removal Actions, as justified in this section. This instrument will be employed during ground intrusive activities where heavy metals and dioxins/furans are the point of contact. A water spray will be used to minimize dust generation during soil removal activities.

The following calculation represents the total particulate in milligrams per cubic meter (mg/m^3) which must be detected in the breathing zone of site workers to potentially exceed the PEL for inorganic chemicals:

$$\frac{10^6 \text{ mg/kg} \times \text{PEL in mg/m}^3}{\text{maximum soil concentration (mg/kg)}} = \text{Calculated Action Level}$$

Using this equation and sampling results for soil from SWMU 54, action levels were calculated for NG, 2,4,6-TNT, lead, Aroclor 1254, heptachlor epoxide, and dieldrin. The calculated action levels are as follows:

COI	PEL	Max. Concentration in Soil	Calculated Action Level
2,4-DNT	NA	17 mg/kg	NA
2,6-DNT	NA	11 mg/kg	NA
NG	2 mg/m^3	400 mg/kg	5,000 mg/m^3
RDX	NA	8.2 mg/kg	NA
2,4,6-TNT	1.5 mg/m^3	132 mg/kg	11,363 mg/m^3
Lead	0.05 mg/m^3	3,610 mg/kg	12.0 mg/m^3
Aroclor 1254	0.5	2.8 mg/kg	178,571 mg/m^3
Heptachlor Epoxide	0.5	0.11 mg/kg	4,237,288 mg/m^3
Dieldrin	0.25	0.011 mg/kg	22,727,273 mg/m^3
Dioxins/Furans	NA	180 ng/kg	NA

In addition to these concentrations, the 15 mg/m^3 OSHA PEL for "particulates not otherwise regulated" applies to this site. This action level is shown in **Table 5-9**.

Table 5-9
Air Monitoring Action Levels for PNOR

Readings	Level of Protection/Action
Real-Time Particulate Monitor	
≤ 15 mg/m^3	Normal Operations
> 15 mg/m^3	Use engineering controls to reduce dust levels.

Since the OSHA PEL for the SWMU 54 contaminants is lower than the calculated dust action level, the real-time particulate monitor action level has been based on the sum of the maximum contaminant concentrations in soil. The dust exposure level as a mixture of the compounds and safety factor of 4 as recommended by ACGIH is 0.95 mg/m^3 and this will be considered the dust action level for the site. Water spray shall be used for dust control when the real-time particulate monitor measures 0.95 mg/m^3 or greater for 5 minutes sustained or 5 separate measurements within a 15-minute period (**Table 5-10**).

5.7.2 Time-Integrated Air Sampling

Time-integrated air sampling may be performed during activities when site characterization data and real-time instrumentation indicate that chemical and/or dust exposures to personnel are suspected to be approaching established limits (PEL/TLV) for target compounds such as 2,4-DNT, 2,6-DNT, NG, RDX, 2,4,6-TNT, lead, Aroclor 1254, heptachlor epoxide, dieldrin, or dioxins/furans. Initially, personal air samples will be collected for each craft job classification to determine if an employee may be exposed to these chemicals/materials at or above the action levels. Additional periodic monitoring may be performed based on the results of the initial monitoring. Samples will be collected and analyzed following OSHA or NIOSH methods. All time-integrated, personal air samples for chemical constituents will be analyzed using a laboratory accredited by the American Industrial Hygiene Association. Employees who are subject to time-integrated air sampling will be informed of the results in accordance with Shaw Procedure HS104.

Table 5-10
Air Monitoring Action Levels for SWMU 54

Readings	Level of Protection/Action
Real-Time Particulate Monitor	
≤ 0.95 mg/m^3	Normal Operations, Modified Level D PPE
> 0.95 mg/m^3	Use engineering controls to reduce dust levels. Upgrade to Level C PPE if engineering controls are not effective.

Water spray shall be used for dust control when the real time particulate monitor measures > 0.95 mg/m^3 for 5 minutes sustained or 5 separate measurements > 0.95 mg/m^3 within a 15-minute period.

Readings	Level of Protection/Action
Combustible Gas/Oxygen Meter	
≤ 10% LEL	Normal Operations, Modified Level D PPE
> 10% LEL	Stop work, eliminate ignition sources and locate source of elevated combustible gases.

Four instantaneous peaks in any 15-minute period or a sustained reading for 5 minutes in excess of the action level will trigger a response.

Readings	Level of Protection/Action
PID	
≤ 2.0 ppm	Normal Operations, Modified Level D PPE
> 2.0 ppm	Use engineering controls to reduce VOC levels. Allow area to passively volatilize. Upgrade to Level C PPE if engineering controls are not effective.

Four instantaneous peaks in any 15-minute period or a sustained reading for 5 minutes in excess of the action level will trigger a response.

5.8 Decontamination Procedures

Decontamination procedures are necessary to protect field personnel and to control the spread of contamination by either personnel or equipment. Decontamination procedures to be followed are discussed below, and additional information is provided in SOP 80.1 (**Appendix A**).

5.8.1 Personnel Decontamination Procedures

During site activities, personnel will attempt to minimize the degree of contact with contaminated materials. This involves a conscientious effort to keep "clean" during site activities. Personnel will minimize physical contact with contamination (when possible). This may ultimately minimize the degree of decontamination required and the generation of waste materials from site operations.

A step-by-step description of decontamination procedures for contaminated personnel for Levels C and Modified D is as follows:

- Segregated Equipment Drop – All monitoring instruments, samples, hand tools, and notebooks are dropped in this area to be decontaminated by one of the decontamination team members. To aid in decontamination, instruments can be sealed in plastic bags or wrapped in polyethylene. This will also protect the instruments against contaminants.

- Outer Boot Cover and Outer Glove Wash and Rinse – Scrub the outer disposable boot covers and outer gloves with a brush, soap, and water. Rinse the boot covers and glove covers.
- Tape Removal – Remove all sealing tape from around boots, gloves, zippers, etc. Place in the disposable clothing drum.
- Outer Boot Cover and Outer Glove Cover Removal – Remove the outer boots and gloves by pulling down the items and exposing the clean inner lining. Place the boots and gloves in the disposable equipment drum.
- Outer Coverall Removal – Unzip and remove the outer coverall. Remove protective clothing in an "inside out" manner. Do not remove contaminants from clothing by blowing, shaking, or any other means that may disperse material into the air. Secure disposable PPE in plastic bags placed in 55-gallon drums designated for PPE.
- Facepiece Removal – Remove facepiece and place in a designated area for further cleaning.
- Inner Glove Removal – Remove inner gloves and place in the disposable clothing drum. Remove inner coverall, if one is used, and wash hands and face.

The decontamination line will be oriented so that the SZ and CRZ exit is upwind from the EZ and the first stages of decontamination. The decontamination line will be assembled so that it can be easily moved in case of a significant change in wind direction. All receptacles for contaminated protective clothing will be equipped with a lid that can be closed to prevent the release of contaminants.

The SSHO will determine whether conditions warrant wet or dry personnel decontamination procedures based on weather conditions, contaminant risk, and experience.

5.8.1.1 Decontamination During Medical Emergencies

If immediate life-saving first aid or medical treatment is required, decontamination procedures will be omitted. Outer garments can be removed as long as it does not delay giving the proper care or aggravate the condition. Grossly-contaminated clothing should be removed carefully, because clothing can transfer contaminants to people administering first aid. If the outer contaminated garments cannot be safely removed, the individual will be wrapped in plastic, rubber, or blankets to help prevent the spread of contamination to emergency personnel. On-site personnel will accompany contaminated victims to the medical facility to advise on matters involving decontamination.

5.8.2 Equipment Decontamination Procedures

Equipment used to excavate contaminated soil will be decontaminated after use to minimize the spread of contaminants. Decontamination procedures will vary depending upon the contaminant involved, but may include sweeping, wiping, scraping, hosing, or steaming the exterior of the equipment. Personnel performing this task will wear the proper PPE as prescribed by the SSHO.

5.9 Emergency Response Plan

5.9.1 General

The frequency and severity of emergency situations can be dramatically reduced through proper implementation of the SSHP Emergency Response Plan. If an emergency does occur, quick, decisive action is required since delays in minutes can create or escalate life-threatening situations. In an emergency situation, site personnel involved in emergency response and rescue must be prepared to respond immediately, and all required equipment must be on hand, in proper working order, and ready to use. To ensure rapid, effective response to a site emergency, the procedures and contingency plans outlined in this section are implemented prior to and during the conduct of any site activities involving exposure to safety and health hazards.

5.9.2 Pre-Emergency Planning

5.9.2.1 Identification of Local Emergency Services

Prior to the conduct of site operations, Shaw contacted and/or gathered information/phone numbers of the local and site emergency response authorities. The authorities contacted were informed of the nature of the site activities to be performed under this SSHP, and the potential hazards that the conduct of these activities pose to investigation personnel, the environment, and the general public. Shaw personnel were informed as to the type of emergency services available through the local authorities and were given the contact phone numbers for these services. In the event that evacuation of the general public is required due to either normal site operations or an emergency event, the SSHO is responsible for contacting the appropriate local authorities who execute and coordinate an evacuation. The phone numbers for local and site emergency services, as well as key personnel involved with the investigation, are listed in **Table 5-11**.

5.9.2.2 Identification of Potential Emergencies

During the development of this SSHP, great attention has been given to identifying potential health and safety hazards associated with the conduct of site activities. Once identified, these hazards were assessed to determine the risk that these hazards could result in an emergency situation. Contingency plans for responding to the potential emergency situations have been developed and are included in this section. The potential emergencies which may result during the conduct of site activities are as follows:

- Injury or illness.
- Fire/explosion.
- Adverse weather conditions.

5.9.2.3 Other Hazard Information

In the event that additional site or task hazard information becomes available during the conduct of site investigation activities, this information will be assessed by the SSHO to determine if the contingency plans in this section need to be updated.

Table 5-11
Emergency Assistance Information
RFAAP, Radford, Virginia

Contact	Phone Number
Tom Meyer (USACE)	(410) 962-0032 (office)
Steve Bowers, C.C.M. (USACE ERRO Project Officer)	(410) 671-6003 (office)
Jim McKenna (Environmental Coordinator and Site Contact)	(540) 731-5782 (office)
Jerry Redder, P.E. (ATK Environmental Manager)	(540) 639-7536 (office)
Tim Leahy (Shaw RFAAP Project Manager)	(410) 612-6332 (office)
Bob Culbertson, P.E. (Shaw LMARC Program Manager	(865) 694-7402 (office)
RFAAP Field Office (Site Superintendent/SSHO)	(540) 922-3316 (Cellular)
David Mummert (Shaw East Region Health and Safety Manager)	(419) 348-1544 (Cellular)
Shaw Help Desk	(866) 299-3445
Health Resources	(800) 350-4511
Emergency Response Services	
Installation Fire Department	7457 (On Post)
Installation Security Police	7325 (On Post) (540) 639-7325 (Off Post)
Installation Safety Department	7294 (On Post) (540) 639-7294 (Off Post)
Installation Spill Response	7323, 7324 or 7325 (On Post) (540) 639-7323, 7324, or 7325 (Off Post)
Installation Medical Facility (Occupational Medicine Services)	7123 (On Post) (540) 639-7123 (Off Post)
Installation Ambulatory Services	7323 (On Post) (540) 639-7323 (Off Post)
Local Non-Emergency Clinic (Occupational Medical Services)	(540) 961-4675
Local Police Department	911
National Poison Control Center	(800) 492-2414
National Response Center	(800) 424-8802
Regional USEPA Emergency Response	(215) 597-9800
Chemical Manufacturers Association Chemical Referral Center	(800) 262-8200

Non-Emergency Services:
Occupational Medical Services
3700 S. Main Street
Blacksburg, VA 24060
Hours of Operation: M-F 8:30-3:30 pm; closed 12-1 pm for lunch

Directions to Occupational Medical Services from RFAAP (see Figure 5-1):

Turn Left out of RFAAP onto Route 114 (Pepper's Ferry Road), go 6.5 mi.
Turn Left onto Route 460 Business (Franklin Street), go 1.0 mi.
Make a U-turn at Yellow Sulphur Rd, Hightop Rd onto S. Main St [US-460-Business], go 0.2 mi.
Arrive at 3700 S. Main Street, on the Right

- Comfort Inn and Cinco de Mayo restaurant will be on the right

Table 5-11 (Continued)
Emergency Assistance Information
RFAAP, Radford, Virginia

Emergency Services:
RFAAP Installation Hospital
Alliant Techsystems, Inc.
Rt. 114
PO Box 1
Radford, VA 24141

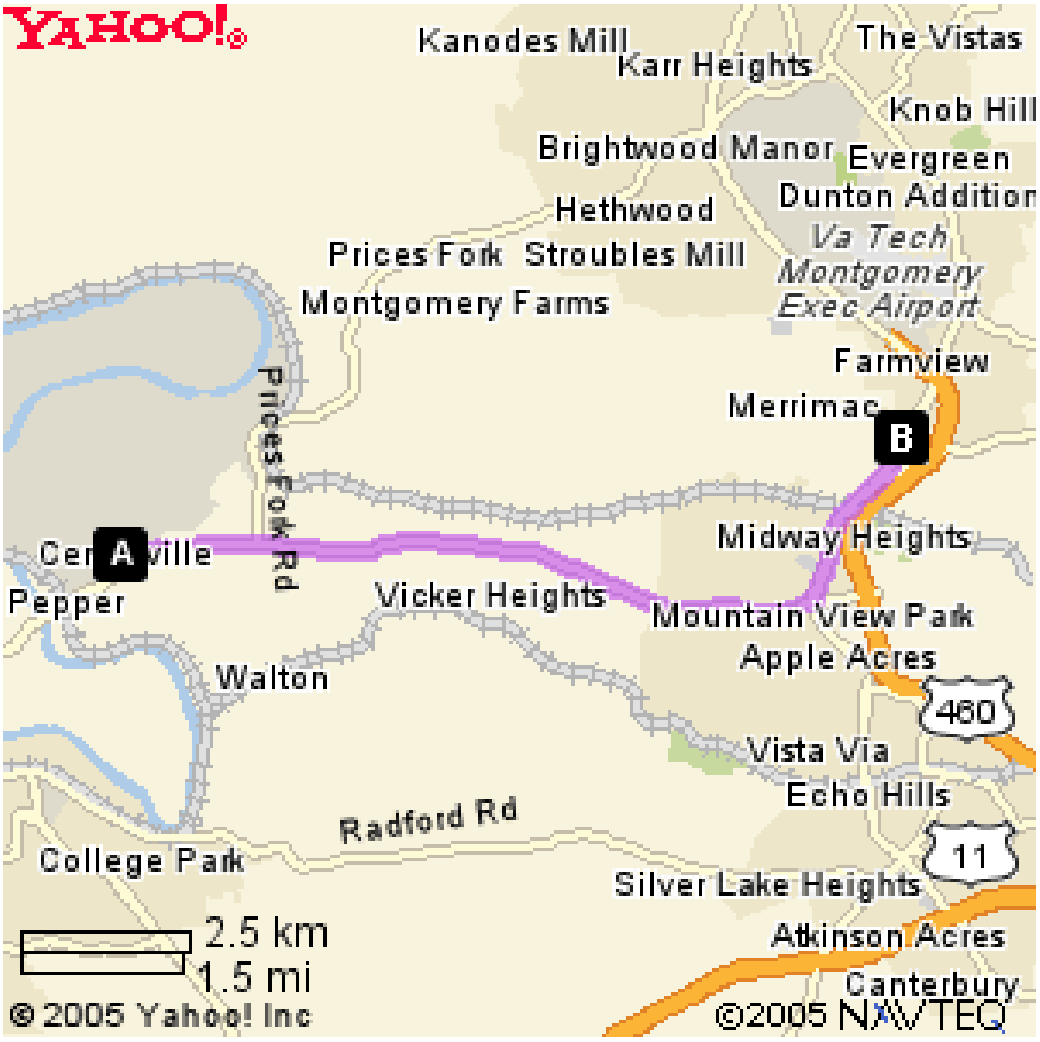
Directions from the Main Gate to the Radford Army Ammunition Plant Hospital:

Enter through Main Gate
Turn Left at Building 220, Administrative Building
Proceed downhill to gate house at Gate 1
White building on right through gate house (Building 205)

Directions from SWMU 54 to the Radford Army Ammunition Plant Hospital (see Figure 5-2):

Follow Contractor Route back across bridge to Gate No. 1
Hospital is white building on left just inside of the gate (Building 205)

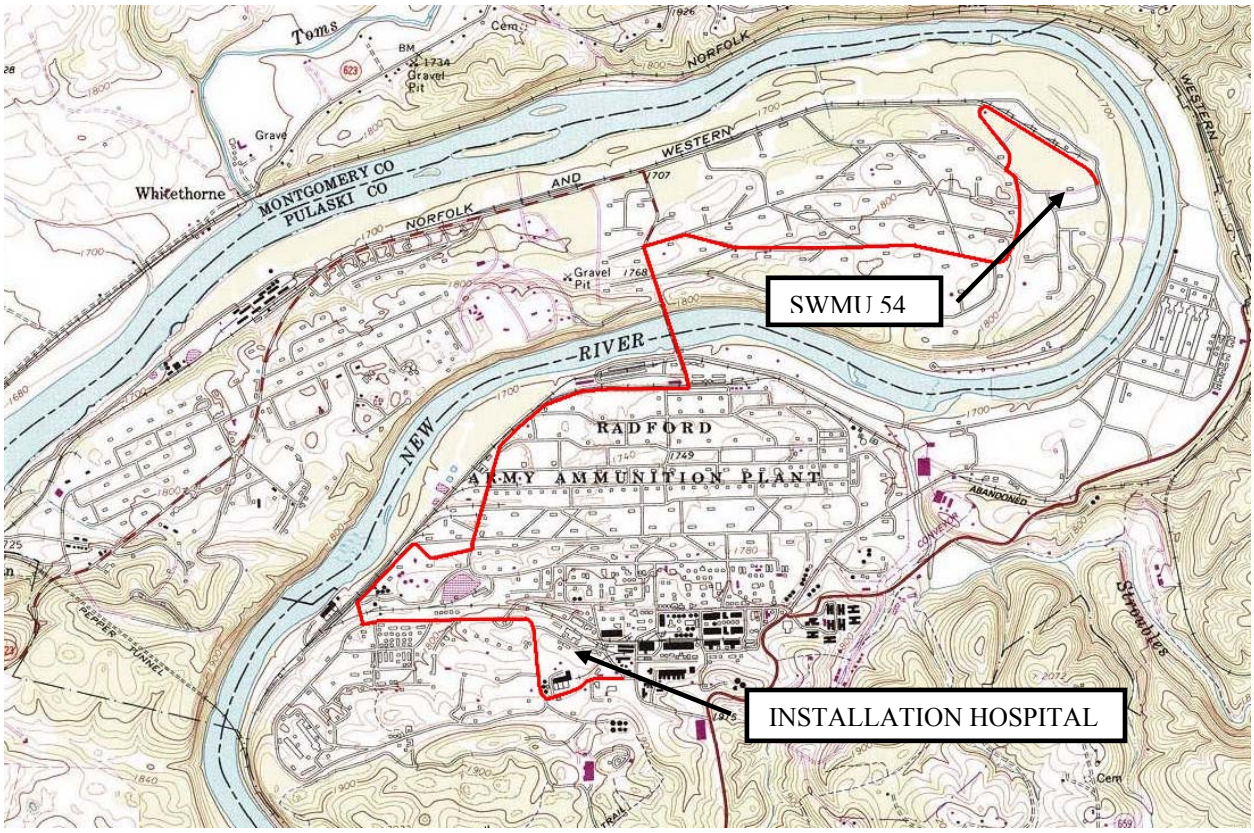
Figure 5-1
Directions to Occupational Medical Services



Turn Left out of RFAAP onto Route 114 (Pepper's Ferry Road), go 6.5 mi.
Turn Left onto Route 460 Business (Franklin Street), go 1.0 mi.
Make a U-turn at Yellow Sulphur Rd, Hightop Rd onto S. Main St [US-460-Business], go 0.2 mi.
Arrive at 3700 S. Main Street, on the Right

- Comfort Inn and Cinco de Mayo restaurant will be on the right

Figure 5-2
Directions to Radford Army Ammunition Plant Hospital



Directions from the Main Gate:

Enter through Main Gate
Turn Left at Building 220, Administrative Building
Proceed downhill to gate house at Gate 1
White building on right through gate house (Building 205)

Directions from SWMU 54:

Follow Contractor Route back across bridge to Gate No. 1
Hospital is white building (Building 205) on left just before Gate 1

5.9.3 Personnel Responsibilities

5.9.3.1 On-Scene Incident Commander

In the event of an emergency, the SSHO assumes the responsibility of On-Scene Incident Commander (OSIC). The alternate person to assume this role, in the event that the SSHO is unavailable or incapacitated, is the task supervisor. The OSIC has responsibility for directing all on-site and off-site response personnel.

5.9.3.2 On-Site Emergency Response Services

Shaw personnel/subcontractor personnel are trained to provide first aid treatment for minor injuries. At least two persons on site at all times are first aid and CPR certified.

The SSHO will determine if the injury requires further treatment. If emergency response is needed, the SSHO, or other designee, will call emergency response personnel by dialing 911.

5.9.3.3 Off-Site Emergency Response Services

Off-site emergency response services that may be needed in the event of a site emergency, such as fire, medical, and police personnel, are listed in **Table 5-11**.

5.9.3.4 Medical Evacuation

Medical Evacuation (MedEvac) requirements are determined by the emergency first responder. Personnel requiring additional treatment are evacuated to the New River Valley Medical Center by ambulance. Helicopter MedEvac will be initiated by the emergency first responder, if necessary.

5.9.4 Emergency Site Control and Security

In an emergency, it is imperative that site control and security be maintained. To control site personnel, the OSIC will utilize the Site Entry/Exit Log to ensure all personnel are present or accounted for at the assembly point(s). Depending upon site size and configuration, weather and wind conditions, and the nature of the emergency, the following will, as applicable, be used to maintain site security:

- Close, but do no lock, gates as evacuation occurs.
- Erect flagging or barrier tape to prevent accidental entry.
- Use a megaphone, walkie-talkies, and/or cell phones to alert personnel to stay clear of the site.
- Use vehicles to block access routes to the site, but ensure they can be moved rapidly if emergency vehicles must use the access route.

5.9.5 Medical Facilities

The directions to the Occupational Medical Facilities are presented on **Figure 5-1**. Directions for emergency services at the RFAAP Installation Hospital are presented in **Table 5-11**.

5.9.6 General Emergency Procedures

Emergency response procedures include all steps to be taken for notifying, evaluating, reacting to, documenting, and following-up on a given emergency situation. To ensure all necessary

elements are covered, the procedural steps outlined in this paragraph are implemented for each emergency, regardless of its nature.

5.9.6.1 Notification

Once the OSIC has been informed of the emergency, the OSIC alerts site personnel to the presence of the emergency by radios. This is done to:

- Notify personnel and get their attention.
- Stop all work activity as required.
- Lower noise levels in order to speed and simplify communication.
- Begin emergency and/or evacuation procedures.

If on-site Shaw personnel/subcontractors or off-site emergency personnel are to enter the site in response to the emergency, the OSIC, to the extent possible, will notify response personnel about the nature of the emergency, to include:

- What happened and when it happened.
- Where on site the emergency situation occurred.
- Who is involved and, if possible, the cause of the emergency.
- The extent of damage and what hazards may be involved.
- What actions should be taken.

5.9.6.2 Assessing the Emergency

Available information related to the emergency and the on-site response capabilities should be evaluated and the information listed below obtained to the extent possible:

- What happened.
- Type of incident.
- Casualties involved.
- Victims (number, location, and condition).
- Treatment required.
- Missing personnel.
- Cause of incident.
- Extent of damage to structures, equipment, and terrain.
- What could happen from this point.
- Potential for fire or explosion.
- Location of all personnel in relation to hazardous areas.
- Potential for emergency affecting the general public or the environment.
- What can be done to remediate the situation.

- Equipment and personnel needed for rescue and hazard mitigation.
- Number of uninjured personnel available for response.
- Resources available on site.
- Resources available from off-site response groups and agencies.
- Time needed for off-site response to reach the site.
- Hazards involved in rescue and response.

5.9.6.3 Rescue and Response Actions

Based on the information collected during the emergency assessment, the general actions listed below are taken, with some actions being conducted concurrently. No one is to attempt emergency response/rescue until the situation has been assessed and the appropriate response outlined by the OSIC.

- Enforce the Buddy System.
- Allow no one to enter a hazardous area without a partner.
- Personnel in the EZ should be in line-of-sight or in communication with the OSIC or his designee.
- Survey Casualties.
- Locate all victims and assess their condition.
- Determine resources needed for stabilization and transport.
- Assess Existing and Potential Hazards and Determine.
- Whether and how to respond.
- The need for evacuation of site personnel and off-site population.
- The resources needed for evacuation and response.
- Request Aid.
- Contact the required off-site and on-site personnel or facilities, such as ambulance, fire department, police, etc.
- Allocate Resources.
- Allocate on-site personnel and equipment to rescue and initiate incident response operations.
- Control.
- Assist in bringing the hazardous situation under complete or temporary control and use measures to prevent the spread of the emergency (i.e., control fire, secure site, etc.).
- Extricate.
- Remove or assist victims from the area.

- Stabilize.
- Administer any medical procedures that are necessary before the victims can be moved.
- Stabilize or permanently fix the hazardous condition.
- Attend to what caused the emergency and anything damaged or endangered by the emergency (e.g., drums, tanks, etc.).
- Transport.
- Using either on-site or off-site assets.
- Casualty Logging.
- Record who, time, destination and condition upon transport.
- Evacuate.
- Move site personnel to the rally point, a safe distance upwind of the incident.
- Monitor the incident for significant changes; the hazards may diminish, permitting personnel to re-enter the site, or hazards may increase and require public evacuation.
- Casualty Tracking.
- Record disposition, condition, and location.

5.9.6.4 Post Emergency Follow-Up

Immediately following an emergency, it is imperative that all federal, state, and local regulatory agencies be notified of the emergency. The following activities will be conducted:

- Notify all appropriate governmental agencies as required. Accidents will be reported immediately by telephone to the USACE and in writing within 2 working days of occurrence. Complete the USACE Accident Investigation Report (Eng Form 3394-see **Appendix C**). Any chemical exposure or occupational injuries and illnesses also will be reported and recorded, if recordable per 29 CFR 1904, on an OSHA Form No. 300 Log (see **Appendix C**). Any incident will be reported to OSHA by Shaw's Health and Safety Manager as soon as possible. Any incident or accident will be reported to the LMARC Safety Manager and the Shaw Corporate Help Desk. If a person is injured, Health Resources need to be notified prior to/during transportation of the injured party to the emergency room or the Health Clinic. Any damage to government or contractor property (which occurs during the performance of the contract at the project site) in excess of $2,000 will be reported to the USACE within 8 hours of occurrence.
- Complete a Shaw Accident Report (see **Appendix C**). Any recommended hazard control will be discussed with the Shaw Health and Safety Manager for approval prior to implementing the control. The SSHO will maintain records of all site accidents and first aid treatments. Accident investigation and injury/illness record-keeping procedures are outlined in Shaw Procedure HS020 (**Appendix D**).
- Conduct an accident investigation and root cause analysis to determine the cause of the emergency and what preventive measures could be taken to ensure the emergency does not occur again.

- Review and revise, as needed, the site operational procedures, and if necessary, update the SSHP to reflect the new procedures.
- Restock and clean all equipment and supplies utilized or damaged in the emergency.

5.9.6.5 Documentation

Documentation related to the emergency will be recorded in an accurate, authentic, and complete fashion. Documentation shall be recorded as soon as possible after the emergency to ensure it is recorded while the events are vivid in the minds of the personnel involved. The information recorded will include:

- A chronological record of events.
- A listing of the personnel involved, including personnel on site, site personnel who responded, personnel in charge, and off-site groups or agencies that responded.
- A listing of the actions taken to minimize the effects of or mitigate the emergency.
- An assessment of the potential exposures received by site personnel and the surrounding public.
- A recording of the injuries or illnesses which occurred as a result of the emergency. All information gathered will be forwarded to the LMARC Safety Manager and to the Corporate Safety Group in Louisiana.

5.9.7 On-Site Emergency Equipment

The emergency equipment listed in **Table 5-12** below will be available at each work site. The team support vehicle is designated as an emergency vehicle. All emergency equipment will be maintained in proper working order and inspected by the SSHO to ensure completeness and proper working order. The results of the inspection will be documented in the safety log. In the event that any of the disposable items are utilized, the SSHO will ensure they are replaced immediately. Site operations will not be conducted if the required emergency equipment is not available on site.

Table 5-12
Emergency Response Equipment

Emergency Equipment	Number per Location	Location where Emergency Equipment is Stored
First Aid/Burn Kit	1 each	Team Support Vehicle
Eye Wash	1 each	All First Aid Kits
CPR Pocket Mask	1 each	All First Aid Kits
Disposable Latex Gloves	5 each	All First Aid Kits
Fire Extinguisher 10 BC Rated	1 each	Team Support Vehicle

5.9.8 Contingency Plans

The following paragraphs contain emergency specific contingency plans. These plans outline the procedures for mitigating each of the potential emergency situations that were identified in the pre-emergency planning. These contingency plans specify the minimum emergency procedures and may be subject to alteration by the SSHO, based on actual or changing site conditions.

5.9.8.1 Injury or Illness

In the event of an emergency involving personal injury or illness, immediate response is key in preventing further injury/illness and providing comfort to the affect party. When personnel are injured or overcome by illness, the following procedure is followed:

- Upon notification of the occurrence and nature of the injury/illness, the OSIC, if deemed necessary, summon emergency personnel.
- Administer life support if necessary until emergency response personnel arrive.

5.9.8.2 Fires and Explosions

The occurrence of a fire on site presents a serious threat to all site personnel, the environment, and the general public. Due to the site's location within the Magazine Area, it is imperative that Radford's emergency services be notified immediately [(540) 639-7325 – from cell phone; x7325 from Installation phone]. To ensure immediate, aggressive response to emergencies dry-chemical-type fire extinguishers will be available at each individual work site. Dry chemical fire extinguishers are also provided at any other site location where flammable materials may present a fire risk. Additionally, a fire extinguisher rated at least 2A:10B:C will be located with each piece of heavy equipment and in each site vehicle.

Small Fires

A small fire is defined as a fire that can be extinguished with a 4A:20B:C type fire extinguisher. In the event of a small fire, site personnel take the following actions:

- All unnecessary personnel are evacuated from the immediate area, to an upwind location.
- Extinguish the fire using portable fire extinguishers or by smothering from an upwind location.
- 911 Emergency response services (ambulance, fire, police) will be notified by the OSIC immediately.
- Do not attempt to extinguish a fire, even a small one, involving explosives.
- Notify the SSHO and site supervisor.

Large Fires

In the event of a large fire or small fire which cannot be extinguished, the following actions are taken:

- All personnel will be evacuated from the site, to an upwind location.
- The 911 emergency response services (police, ambulance, hospital, etc.) will be notified by the OSIC immediately.

- If it can be conducted safely, the OSIC will direct personnel to move vital equipment/ supplies from the fire path.
- Do not attempt to extinguish a fire involving explosives.
- Notify the SSHO and site supervisor.

Explosion

In the event of an explosion, all personnel evacuate, the OSIC requests the required support equipment and personnel, and the USACE and ATK representatives are notified. It is essential that the site be evacuated and no one allowed to re-enter until an ATK representative authorizes re-entry. The OSIC determines what actions are appropriate.

5.9.8.3 Inclement Weather

In the event of inclement weather [i.e., high winds, electrical storms, tornadoes, extremely hot weather (>100°F), or extremely cold weather (<0°F)], it may be necessary to cease operations and evacuate the site.

5.9.8.4 Spill Containment

A spill containment program will be implemented during all site activities that meet drum and container handling requirements in accordance with 29 CFR 1910.120. Hazardous substances and contaminated soils, liquids, and other residues also will be handled, transported, labeled, and disposed of in accordance with this regulation. If a spill occurs, Shaw will follow the *Spill Notification Procedures* in *Section 5.15.5* of this WP and, if possible, implement controls to contain and isolate the spilled substance.

5.10 Personnel Training and Medical Surveillance Program

5.10.1 General

Work at RFAAP will be performed in accordance with the *RFAAP MWP* (URS, 2003). Section 8.0 of the MWP details the security and entry requirements for the installation. All Shaw employees, managers, supervisors, consultants, and subcontractors who perform field activities at RFAAP are required to have received the following:

- OSHA 1910.120 initial 40-hour training or OSHA 1910.120 annual 8-hour refresher training within the last year. In addition, 3 days of documented field experience under the direct supervision of a trained, experienced supervisor is required.
- Managers and supervisors directly responsible for site activities must complete an 8-hour supervisor training course in addition to the 40-hour training and 8-hour refresher course. Training certificates for all personnel (including subcontractor personnel) conducting site activities will be maintained in the Project File or Shaw's corporate safety and health file.
- An occupational medical surveillance examination (in compliance with OSHA 1910.120) within the last year, which demonstrates no restrictions for hazardous waste site work, and ability to wear a respirator.
- Site-specific safety and health training that specifically addresses the activities, procedures, monitoring, and equipment applicable to ongoing field activities.

- At least two members of the team are required to have first aid and CPR certification. These personnel will be on site with the team at all times.

5.10.2 Site-Specific Training

To ensure that all personnel understand the hazards associated with this specific project, the SSHO will conduct initial site-specific training for personnel before participating in the field activities. The SSHO will use the following outline for the initial training of personnel:

- Names of personnel and alternates responsible for site safety and health.
- Safety, health, and hazards present at the site.
- Contingency Plans Training.
- Hazard Communications Training.
- Use of PPE.
- Work practices by which the employee can minimize risks from hazards.
- Safe use of engineering controls and equipment on site.
- Medical surveillance requirements.
- Decontamination procedures.
- Emergency Response Plan.
- Spill containment.

5.10.2.1 Activity/Hazard Specific Training

Prior to initiating soil remediation activities, all personnel will receive additional training in lead awareness, explosives awareness, pesticide/PCB awareness, and dioxin/furan awareness.

5.10.3 Daily Safety Meetings

Safety meetings/training will be held each morning on site at the daily safety meeting. This meeting will be conducted by the SSHO. Attendance is mandatory for all site personnel and will be documented in a log book. The safety and health considerations for the day's activities will be reviewed at this meeting. Additional training, Job Safety Analyses creation, and review of safety concerns will be conducted when circumstances dictate. The meeting will re-affirm safety issues, specific hazards, and emergency procedures, including:

- Notification procedures and phone numbers.
- Rally points and safe areas.
- Hospital and evacuation routes.
- Emergency equipment.

The SSHO will conduct tailgate safety meetings and new employee orientation at the beginning of each shift, whenever new personnel arrive at the site, as site conditions change, or as needed.

5.10.4 Medical Monitoring Program

Shaw employees who conduct field activities at SWMU 54 must participate in Shaw's medical surveillance program. Personnel performing site work must have received a medical baseline or follow-up examination within the past 12 months. A physician's statement declaring that each Shaw field team member is medically qualified to perform hazardous waste related activities, including medical qualification to wear a respirator, will be maintained on site and in the Shaw corporate safety and health files.

Subcontractor employees must participate in their employer's medical monitoring program consistent with 29 CFR 1910.120. The SSHO must ensure that all subcontractors participate in a medical monitoring program and that subcontractors provide appropriate documentation. Documentation will be maintained on site and should include a statement declaring that each subcontractor employee is medically qualified to perform hazardous waste site work, including medical qualification to wear a respirator.

5.11 General Safety Items

Additional safety items include the following:

- Safety and health audits will be conducted by the SSHO to ensure that all site activities are being performed in accordance with the SSHP, USACE requirements, OSHA regulations, Shaw procedures, and contract requirements.
- The SSHO will ensure that appropriate PPE is available for personnel and is used as directed in this SSHP. The SSHO will be responsible for ensuring that job site hazards are properly controlled to provide safe ingress and egress from the sites. Cones and high-visibility banner guard (when deemed necessary by the SSHO) will be used to control traffic and limit access to hazardous and restricted areas.
- A tailgate safety meeting will be conducted to discuss pertinent site safety topics at the beginning of each shift, whenever new personnel arrive at the job site, as site conditions change, and whenever otherwise deemed necessary. These meetings will be conducted by the SSHO, and all relevant information will be recorded in the site logbooks. Site personnel and visitors are required to attend these meetings. Proof of attendance will be documented. Necessary information from these meetings will be forwarded to the SSHO.
- Shaw and its subcontractors will emphasize compliance with state, local, and Installation motor vehicle laws, regulations, and safety guidelines as part of each daily safety briefing. Special considerations, such as current or anticipated hazardous road conditions, will be addressed at the daily safety briefings.
- Emergency telephone numbers will be posted for the fire department, emergency medical response, and the nearest emergency medical clinic/hospital. These numbers are listed in this SSHP.
- At least one copy of this SSHP shall be available at each work site.
- Horseplay, practical joking, or any other actions that jeopardize safety will not be tolerated.
- Running is not permitted.

- Alcoholic beverages and non-medicinal drugs are not permitted at the project site. Personnel suspected of being under the influence of alcohol or drugs will be removed from the site.
- Radios (excepting two-way radios), tape players, or other forms of entertainment devices are prohibited during work.
- Legible and understandable precautionary labels shall be affixed prominently to containers of contaminated scrap, waste, debris, and clothing.
- Removal of contaminated soil from protective clothing or equipment by blowing, shaking, or any other means which disperse contaminants into the air is prohibited.
- Transportation and disposal of contaminated materials shall comply with all applicable local, state, and federal regulations. These items will be addressed by the generator, transporter, and disposer.
- Containers shall be moved only with the proper equipment and shall be secured to prevent dropping or loss of control during transport.
- Emergency equipment (including first aid equipment, emergency-use respirators, spill control materials, and fire extinguishers) shall be located in readily accessible locations.
- All trenching, shoring, and excavation work must comply with all federal OSHA rules and Shaw Procedure HS307.
- No food or beverages shall be present or consumed in the EZ. No tobacco products shall be present or used and cosmetics shall not be applied in the EZ.
- All personnel shall avoid contact with potentially contaminated substances. Walking through puddles or mud, kneeling on the ground, or leaning against drums shall be avoided.
- Monitoring equipment shall not be placed on potentially contaminated surfaces.

Field personnel must observe each other for signs of toxic exposure. Indications of adverse effects include, but are not limited to:

- Changes in complexion and skin discoloration.
- Changes in coordination.
- Changed in demeanor.
- Excessive salivation and papillary response.
- Changes in speech pattern.

Field personnel shall be cautioned to inform each other of non-visual effects of toxic exposure such as:

- Headaches or dizziness.
- Nausea.
- Blurred vision.
- Cramps.
- Irritation of eyes, skin, or respiratory tract.

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