RADFORD ARMY AMMUNITION PLANT, VIRGINIA

SWMU 54
Monitored Natural Attenuation Sampling
Year One Report

Prepared for:

USACE Baltimore District
10 S. Howard St.
Baltimore, MD 21201

Prepared by:

Shaw Environmental, Inc.
4696 Millennium Dr., Suite 320
Belcamp, MD 21017

Draft Document **February 2013**

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

August 20, 2013

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

Jay Stewart
Environmental Manager
BAE Systems, Ordnance Systems, Inc.
Radford Army Ammunition Plant
114 Peppers Ferry Road, P.O. Box 1
Radford, VA 24143

VIA Electronic Mail

Re: Radford Army Ammunition Plant, Radford, Virginia
Solid Waste Management Unit 54
SWMU 54 Monitored Natural Attenuation Sampling Report and Response to Comment

Dear Mr. McKenna and Mr. Stewart:

The U.S. Environmental Protection Agency and Virginia Department of Environmental Quality have reviewed the U.S. Army's Solid Waste Management SWMU 54, Monitored Natural Attenuation Sampling Report (Report), located at the Radford Army Ammunition Plant (RFAAP) in Radford, Virginia. Based on the Response to Comments, submitted Wednesday, August 14, 2013 and our review of the Report, there are no additional comments. In accordance with Part II. (E)(5)(a) of RFAAP's Corrective Action Permit, the Report 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

Leahy, Timothy

From: McKenna, James J CIV (US) [james.j.mckenna16.civ@mail.mil]
Sent: Thursday, August 15, 2013 3:39 PM
To: Weissbart, Erich; Cutler,Jim
Cc: beth lohman (ealohman@deq.virginia.gov); Stewart, Jay (US SSA); Alberts, Matt (US SSA); MaryAnn Bogucki - Radford (maryann.bogucki@baesystems.com); Meyer, Tom NAB02; Mendoza, Richard R Jr CIV (US); Davie, Robert N III CIV (US); Ortiz, Luis A LTC USARMY JMC (US); Bressette, James W CIV USARMY MEDCOM PHC (US); Leahy, Timothy
Subject: RE: Teleconference meeting notes (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: FOUO

Erich, all,

Let me clarify. Yesterday, I thought CBI/Shaw had just gotten the data validated were in the process of producing the tables and figures and so we could focus on the SWMU 54 and the ARSAR in the meantime. I just found out that we do draft data that I can share and will forward today before I go on leave and I'm also going to forward our final RTCs on the ARAR in separate emails. Having said that I'd like to focus on the SWMU 54 - getting the draft Year 1 LTM Report approved, resolve the ARSAR RTCs, then move on to SWMU 48/49 draft data. We can talk when I get back.

Thanks for your support of the Radford AAP Installation Restoration Program.

JJM

-----Original Message-----
From: Weissbart, Erich [mailto:Weissbart.Erich@epa.gov]
Sent: Thursday, August 15, 2013 8:58 AM
To: McKenna, James J CIV (US); Cutler,Jim
Cc: beth lohman (ealohman@deq.virginia.gov); Stewart, Jay (US SSA); Alberts, Matt (US SSA); MaryAnn Bogucki - Radford (maryann.bogucki@baesystems.com); Meyer, Tom NAB02; Mendoza, Richard R Jr CIV (US); Davie, Robert N III CIV (US); Ortiz, Luis A LTC USARMY JMC (US); Bressette, James W CIV USARMY MEDCOM PHC (US); Leahy, Timothy
Subject: RE: Teleconference meeting notes (UNCLASSIFIED)

Jim,
I reviewed and concur with the summary. The section on SWMUs 48/49 was pretty brief and summarized what I hope would happen, but what I heard yesterday was that the Army would spend a couple of months of internal review before sharing a report with EPA/DEQ. I prefer that we follow the original plan, and the summary, and you share the draft data with us and we discuss next steps collaboratively prior to submitting a report.

Erich Weissbart, P.G.
Land and Chemicals Division (3LC20)
USEPA Region III
1650 Arch Street
Philadelphia, PA 19103

(215) 814-3284
weissbart.erich@epa.gov

-----Original Message-----
From: McKenna, James J CIV (US) [mailto:james.j.mckenna16.civ@mail.mil]
Sent: Wednesday, August 14, 2013 4:45 PM
To: Weissbart, Erich; Cutler,Jim
Cc: beth lohman (ealohman@deq.virginia.gov); Stewart, Jay (US SSA); Alberts, Matt (US SSA); MaryAnn Bogucki - Radford (maryann.bogucki@baesystems.com); Meyer, Tom NAB02; Mendoza, Richard R Jr CIV (US); Davie, Robert N III CIV (US); Ortiz, Luis A LTC USARMY JMC (US); Bressette, James W CIV USARMY MEDCOM PHC (US); Leahy, Timothy
Subject: FW: Teleconference meeting notes (UNCLASSIFIED)

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All,

Tim just sent me his notes on our conference call today which I have reviewed. I'm providing them for your review, record and/or comment. They appear to describe the salient points of our call today, although I would take note that the delivery dates mentioned for reports, etc are subject to change and should be viewed as goals.

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

-----Original Message-----
From: Leahy, Timothy [mailto:Timothy.Leahy@CBIFederalServices.com]
Sent: Wednesday, August 14, 2013 4:31 PM
To: McKenna, James J CIV (US)
Subject: Teleconference meeting notes

Hi Jim,

Here are my notes from the call.

Tim

Description: Description: Description: Description: Description:
cid:_1_0AD725A00AD721CC001388C386257B11

Timothy Leahy, PMP

Project Manager

Project Management

Federal Services

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U.S.A

www.CBI.com <mailto:timothy.leahy@shawgrp.com>

Please note new email address effective May 17, 2013.

Classification: UNCLASSIFIED
Caveats: FOUO

Classification: UNCLASSIFIED
Caveats: FOUO

Teleconference Meeting Notes

Date: Wednesday August 14, 2013

Subject: SWMU 54 Yr 1 MNA Report comments and Responses;
ARSAR RFI/IM Completion Report Comments and Responses

Attendees:

Rich Mendoza (USAEC)
Tom Meyer (USACE)
Jim McKenna (Radford AAP)
Jim Bressette (USAIPH)
Jim Cutler (VDEQ)
Erich Weissbart (USEPA)
Betty Ann Quinn (USEPA)
Matt Alberts (BAE)
MaryAnn Bogucki (BAE)
Cindy Hassan (CB&I)
Mark Weisberg (CB&I)
Tim Leahy (CB&I)
Jeff Hillebrand (CB&I)

Notes:

SWMU 54 Yr 1 Comments and Responses Discussion

Everyone agreed with the main points of the comments and responses as follows:

1) Additional analysis of MNA parameters and demonstration that MNA is actually occurring will be added to the year 2 report.
2) Wells where all constituents have been below RGs for 2 years will be dropped from the sampling program, per the exit strategy in the workplan.
3) Additional MNA parameters specific to explosives degradation (MNX, TNX and DNX) will be added to the sampling program.
4) The Year 1 report will be considered final and the changes will be made to the Year 2 report. The Year 2 report will be submitted to the Army at the end of August for review and to the regulators by the end of September for regulatory review.

ARSAR RFI/IM Completion Report Comments and Responses Discussion

Discussed the EPA and VDEQ comments and the draft responses. Most discussion centered on the ecological risk. Additional information will be added to the RTCs to support institutional controls for the hillside area based on decisions at other Radford sites and on an expanded discussion of the home ranges of potentially affected ecological receptors. Betty Ann Quinn stated that she would discuss the RTC with the EPA ecological risk assessor.

SWMU 48/49 Groundwater sampling results

Groundwater wells have been installed and sampled. The results are back and have been validated. Another conference call will be scheduled to discuss the results and path forward for the site in the near future – possibly to coincide with an additional discussion on the ARSAR once the regulators have reviewed the responses to comments on that site.

Leahy, Timothy

From: McKenna, James J CIV (US) [james.j.mckenna16.civ@mail.mil]
Sent: Wednesday, August 14, 2013 3:47 PM
To: Weissbart, Erich; Cutler,Jim
Cc: beth lohman (ealohman@deq.virginia.gov); Stewart, Jay (US SSA); Alberts, Matt (US SSA); MaryAnn Bogucki - Radford (maryann.bogucki@baesystems.com); Meyer, Tom NAB02; Mendoza, Richard R Jr CIV (US); Davie, Robert N III CIV (US); Ortiz, Luis A LTC USARMY JMC (US); Bressette, James W CIV USARMY MEDCOM PHC (US); Leahy, Timothy
Subject: RE: SWMU 54 MNA Sampling Year 1 Report (UNCLASSIFIED)
Attachments: SWMU_54_MNA_EPA_RTCs_rev2.docx

Classification: UNCLASSIFIED
Caveats: FOUO

Erich, Jim C., All,

Attached are the final RFAAP responses to the EPA and DEQ comments listed below.

Thanks everyone for their participation in the conference call today to go over these responses and thank you for your support of the Radford AAP Installation Restoration Program, JJM

-----Original Message-----
From: Weissbart, Erich [mailto:Weissbart.Erich@epa.gov]
Sent: Wednesday, July 10, 2013 9:43 AM
To: McKenna, James J CIV (US)
Cc: Cutler,Jim
Subject: SWMU 54 MNA Sampling Year 1 Report

Jim,

EPA and VADEQ have reviewed the subject document and submit the following comments:

There was very little MNA evaluation contained in the document. The statement, "Based on data obtained in the first year of sampling and the overall site-wide decreasing concentrations of contaminants of concern.....it appears that the selected remedial action (MNA) is currently viable." The report should have included an evaluation of the performance of MNA to date and does not. I refer you to my email of Feb. 23, 2011 wherein I commented on the lack of substance in the workplan of an actual MNA demonstration.

* The water quality parameters do not appear to support conditions necessary for biodegradation of the COCs;

* The text in section 5.7 should be expanded to discuss the present potential for MNA and how the indicator parameters compare to the MNA screening tables;

* The conclusions should focus on implications, if any, for future monitoring;

* Additional MNA criteria should be considered for future rounds to better evaluate MNA for selected wells.

The reason this unit was removed from a remedy decision in 2011 was because of the lack of a true MNA evaluation pursuant to EPA guidance. That still applies. As of now Radford is monitoring SWMU 54 per an approved workplan, however the monitoring is not leading towards an MNA remedy. Based on generally declining concentrations and low overall concentrations for COC's it's possible a groundwater remedy will not be necessary but then there are the 4th quarter results where the most elevated concentrations of COCs were reported from 54MW12, a downgradient well.

I'll provide you with a couple of my thoughts: Radford can revise this report to reflect the agencies comments; Radford can tweak the monitoring based on agency comments, literature research related to MNA of the specific explosive constituents and report with an evaluation after another year; continue down the current path and hope the COCs are below RGs for two consecutive years in all site wells.

I welcome Radford's response and if necessary we can have a call that includes VADEQ.

Erich Weissbart, P.G.

Land and Chemicals Division (3LC20)

USEPA Region III

1650 Arch Street

Philadelphia, PA 19103

(215) 814-3284

weissbart.erich@epa.gov

Classification: UNCLASSIFIED
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Response to
EPA/VDEQ Comments
On the
SWMU 54 Yr 1 MNA Report

Comment #1: There was very little MNA evaluation contained in the document. The statement, "Based on data obtained in the first year of sampling and the overall site-wide decreasing concentrations of contaminants of concern.....it appears that the selected remedial action (MNA) is currently viable." The report should have included an evaluation of the performance of MNA to date and does not. I refer you to my email of Feb.23, 2011 wherein I commented on the lack of substance in the workplan of an actual MNA demonstration.

> **Response #1:** The year two report (anticipated in September, 2013) will include an evaluation of the MNA processes. Preliminary analysis does not indicate that biodegradation is occurring to any large degree. However, given the soil removal action at the site and the fact that concentrations of COCs in groundwater are below RGs in all wells except 54MW12 (and 54MW10 & 54MW13 in the fifth quarter), LTM of the groundwater in the small area that is still impacted is protective of human health and the environment. Two years of porewater sampling in the New River have demonstrated that these constituents are not negatively affecting water quality in the New River.

Comment #2: The water quality parameters do not appear to support conditions necessary for biodegradation of the COCs;

> **Response #2:** Agreed. However, given that COCs were below RGs in all quarters for 11 of 14 wells, the soil source removal appears to have addressed the bulk of contamination at the site.

Comment #3: The text in section 5.7 should be expanded to discuss the present potential for MNA and how the indicator parameters compare to the MNA screening tables;

> **Response #3:** The Section 5.7 text will be expanded in the Year 2 (anticipated in September, 2013) report to assess potential aerobic and anaerobic biodegradation pathways.

Comment #4: The conclusions should focus on implications, if any, for future monitoring;

> **Response #4:** The decision point in the workplan was that after two years of monitoring, the results would be assessed for future monitoring. As stated in the workplan Section 2.6, wells will be removed from the monitoring network if they are shown to be consistently below the RGs for two years. Based on that criterion, it is proposed that all wells and pore water sample points be dropped from the monitoring program except for wells 54MW2, 54MW10, 54MW12 and 54MW13. Additional MNA parameters specific to explosives degradation (MNX, TNX, DNX for RDX breakdown) will be added to the program for the three

downgradient wells where COCs were above the RGs (54MW10, 54MW12 & 54MW13) to assess whether degradation of RDX is occurring. 54MW2 will be retained in the monitoring program as an upgradient well.

Comment #5: Additional MNA criteria should be considered for future rounds to better evaluate MNA for selected wells.

Response #5: See Response 4

Comment #6: The reason this unit was removed from a remedy decision in 2011 was because of the lack of a true MNA evaluation pursuant to EPA guidance. That still applies. As of now Radford is monitoring SWMU 54 per an approved workplan, however the monitoring is not leading towards an MNA remedy. Based on generally declining concentrations and low overall concentrations for COC's it's possible a groundwater remedy will not be necessary but then there are the 4th quarter results where the most elevated concentrations of COCs were reported from 54MW12, a downgradient well.

Response #6: With the localized distribution of elevated constituents and the general downward trend (despite the high Q8 concentration - likely due to heavy rainfall during the week immediately prior to sampling), it does not appear that a groundwater remedy is necessary for this site. Radford suggests continued monitoring for the wells that have had exceedances during the monitoring to date (54MW10, 54MW12 and 54MW13); and in 54MW2 as an upgradient well.

Comment #7: I'll provide you with a couple of my thoughts: Radford can revise this report to reflect the agencies comments; Radford can tweak the monitoring based on agency comments, literature research related to MNA of the specific explosive constituents and report with an evaluation after another year; continue down the current path and hope the COCs are below RGs for two consecutive years in all site wells.

Response #7: Radford would prefer to tweak the monitoring program to add additional analytes related to the MNA of RDX and TNT and remove wells that have been consistently below RGs for the two years of sampling (all wells and pore water sample points except 54MW10, 54MW12 and 54MW13 and 54MW-2 to serve as an upgradient well).

I welcome Radford's response and if necessary we can have a call that includes VADEQ.

Leahy, Timothy

From: McKenna, James J CIV (US) [james.j.mckenna16.civ@mail.mil]
Sent: Thursday, August 01, 2013 10:20 AM
To: Weissbart, Erich; Cutler,Jim
Cc: beth lohman (ealohman@deq.virginia.gov); Stewart, Jay (US SSA); Alberts, Matt (US SSA); MaryAnn Bogucki - Radford (maryann.bogucki@baesystems.com); Meyer, Tom NAB02; Mendoza, Richard R Jr CIV (US); Davie, Robert N III CIV (US); Ortiz, Luis A LTC USARMY JMC (US); Bressette, James W CIV USARMY MEDCOM PHC (US); Leahy, Timothy
Subject: RE: SWMU 54 MNA Sampling Year 1 Report (UNCLASSIFIED)
Attachments: EPA_RTCs_rev1.docx

Classification: UNCLASSIFIED
Caveats: FOUO

Erich, Jim,

Attached are our preliminary responses to EPA and DEQ comments on the subject report. Rich is looking internally at USAEC for additional information on RDX breakdown products so these responses could be revised but I think they are at a point to provide for a productive discussion on our August 14, 2013 conference call. If I get additional information, etc I'll pass it along.

Tim Leahy will send out the call in information in a separate email.

Thanks in advance,
JJM

-----Original Message-----
From: Weissbart, Erich [mailto:Weissbart.Erich@epa.gov]
Sent: Wednesday, July 10, 2013 9:43 AM
To: McKenna, James J CIV (US)
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I welcome Radford's response and if necessary we can have a call that includes VADEQ.

Erich Weissbart, P.G.

Land and Chemicals Division (3LC20)

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Philadelphia, PA 19103

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weissbart.erich@epa.gov

Classification: UNCLASSIFIED
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EPA/VDEQ Comments
On the
SWMU 54 Yr 1 MNA Report

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to assess whether degradation of RDX is occurring. 54MW2 will be retained in the monitoring program as an upgradient well.

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I welcome Radford's response and if necessary we can have a call that includes VADEQ.

Leahy, Timothy

Subject: FW: SWMU 54 MNA Sampling Year 1 Report (UNCLASSIFIED)
Attachments: SWMU 40 & SWMU 54 comments

-----Original Message-----
From: Weissbart, Erich [mailto:Weissbart.Erich@epa.gov]
Sent: Wednesday, July 10, 2013 9:43 AM
To: McKenna, James J CIV (US)
Cc: Cutler,Jim
Subject: SWMU 54 MNA Sampling Year 1 Report

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Erich Weissbart, P.G.

Land and Chemicals Division (3LC20)

USEPA Region III

1650 Arch Street

Philadelphia, PA 19103

(215) 814-3284

weissbart.erich@epa.gov

Classification: UNCLASSIFIED
Caveats: FOUO

BAE SYSTEMS

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

February 20, 2013

Mr. Erich Weissbart
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 Certifications, SWMU 54 Monitored Natural Attenuation Sampling Year One Report, Draft Document, February 2013 EPA ID# VA1210020730

Dear Mr. Weissbart and Mr. Cutler:

Enclosed is the certification for the subject documents that were sent to you on February 14, 2013. Also enclosed is the February 14, 2013 transmittal email.

Please coordinate with and provide any questions or comments to myself at 540 639 7785 or Mr. Jim McKenna, ACO Staff at 540 731 5782.

Sincerely,

Jay Stewart, Environmental Manager
BAE Systems, Ordnance Systems Inc.

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

Rich Mendoza
US Army Environmental Center
2450 Connell Rd., Bldg. 2264, 1st Fl, Rm126
Attn: Richard Mendoza
San Antonio, TX 78234-7664

Tom Meyer
Corps of Engineers, Baltimore District
ATTN: CENAB-EN-HM
10 South Howard Street
Baltimore, MD 21201

bc: BAE Administrative File
J. McKenna, ACO Staff
Rob Davie-ACO Staff

Coordination: J. McKenna

Concerning the following:

13-0900-025

Radford Army Ammunition Plant
SWMU 54
Monitored Natural Attenuation Sampling
Year One Report
Draft Document, February 2013

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

SIGNATURE: _____

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

SIGNATURE: _____

PRINTED NAME: Todd D. Hayes
TITLE: Director, Facility Support Services
BAE Systems

Alberts, Matt (US SSA)

From: McKenna, James J CIV (US) <james.j.mckenna16.civ@mail.mil>
Sent: Thursday, February 14, 2013 2:37 PM
To: beth lohman (ealohman@deq.virginia.gov); Cutler,Jim; Mendoza, Richard R Jr CIV (US); Meyer, Tom NAB02; Timothy.Leahy@shawgrp.com; Weissbart.Erich@epamail.epa.gov; Alberts, Matt (US SSA); Stewart, Jay (US SSA)
Cc: Davie, Robert N.
Subject: RE: Draft SWMU 54 Year 1 Monitoring Report (UNCLASSIFIED)

Classification: UNCLASSIFIED
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All:

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

Erich Weissbart 3 Paper copy/3 CD 1Z63V8840197441658

Jim Cutler 1 Paper copy/1 CD 1Z63V8840198108061

Tom Meyer 1 Paper copy/1 CD 1Z63V8840198036022

Richard Mendoza 1 Paper copy/1 CD 1Z63V8840197064842

E.A. Lohman 1 CD 1Z63V8840195400071

Jay Stewart 1 Paper Copy/1 CD 1Z63V8840199413685

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

Jim McKenna

Classification: UNCLASSIFIED
Caveats: FOUO

Classification: UNCLASSIFIED
Caveats: FOUO

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

LIST OF ACRONYMS AND ABBREVIATIONS

µg/L.....micrograms per liter
2,4,6-TNT 2,4,6-trinitrotoluene
bgs.....below ground surface
CMO .....Corrective Measures Objective
CMS .....Corrective Measures Study
COC .....Chain of Custody
COI.....Contaminant of Interest
COPC .....Chemical of Potential Concern
DIC.....Dissolved Inorganic Carbon
DNT .....Dinitrotoluene
ft .....foot or feet
ft/day .....feet per day
ft/year .....feet per year
HHRA .....Human Health Risk Assessment
HI .....Hazard Index
IM.....Interim Measure
IMWP.....Interim Measures Work Plan
mg/kg .....milligrams per kilogram
mg/L.....milligrams per liter
MNA .....Monitored Natural Attenuation
MS.....Matrix Spike
MSD.....Matrix Spike Duplicate
msl.....mean sea level
MWP.....Master Work Plan
NG.....Nitroglycerin
ORP.....Oxidation-Reduction Potential
PID .....Photoionization Detector
QA/QC .....Quality Assurance/Quality Control
QC.....Quality Control
RCRA.....Resource Conservation and Recovery Act
RDX .....cyclotrimethylenetrinitramine
RFAAP.....Radford Army Ammunition Plant
RFI .....RCRA Facility Investigation
RG.....Remedial Goal
Shaw.....Shaw Environmental, Inc.
SL.....Screening Level
SOP .....Standard Operating Procedure
SWMU .....Solid Waste Management Unit
TOC.....Total Organic Carbon
URS.....URS Corporation
USACE .....U.S. Army Corps of Engineers
USEPA.....U.S. Environmental Protection Agency
VI .....Verification Investigation

1.0 INTRODUCTION

Shaw Environmental, Inc. (Shaw) was contracted by the U.S. Army Corps of Engineers (USACE) to perform a Monitored Natural Attenuation (MNA) at Solid Waste Management Unit (SWMU) 54 (RAAP-014), the Propellant Burning Ash Disposal Area, at Radford Army Ammunition Plant (RFAAP), Radford, VA. This report contains a description of the activities involved in the first through fourth quarterly rounds of groundwater sampling conducted in 2011 through 2012. This report includes an analysis of the results of the first through fourth quarter's data and a summary of the first year of sampling.

1.1 Purpose and Scope

Based on the *Final SWMU 54 Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) / Corrective Measures Study (CMS) Report* (URS, 2008), soil interim measures (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, 2000). The IMs included:

1. Site Preparation.
2. Excavation.
3. Waste Characterization & Off-site Disposal.
4. Confirmation Sampling.
5. Site Restoration.

The soil IMs have been completed and this report details the implementation of the groundwater MNA IMs approved in the *Final SWMU 54 MNA Interim Measures Work Plan (IMWP)* (Shaw, 2011a) including:

1. Installation and development of four groundwater monitoring wells, in accordance with the *RFAAP Master Work Plan (MWP)* (URS, 2003) Standard Operating Procedures (SOPs) 20.1 and 20.2.
2. Periodic sampling from existing and new groundwater monitoring wells and sediment pore water sample points.

The Corrective Measures Objectives (CMOs) and Remedial Goals (RGs) were developed in the *Final SWMU 54 RFI/CMS Report* (URS, 2008). The site-specific CMOs for SWMU 54 Area A are 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 site-specific CMOs for SWMU 54 Area B are 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 from soil-to-groundwater at levels that would potentially adversely impact future beneficial use of groundwater. The site-specific CMOs for Area A and Area B have been met through the soil excavation and off-site disposal completed in 2010.

The objectives of the MNA program are to:

- Measure and track the reduction of:
  - 2,4,6-trinitrotoluene (2,4,6-TNT), dinitrotoluene (DNT)-mixture, RDX, and perchlorate to levels below the RGs as defined in **Table 1-1**.

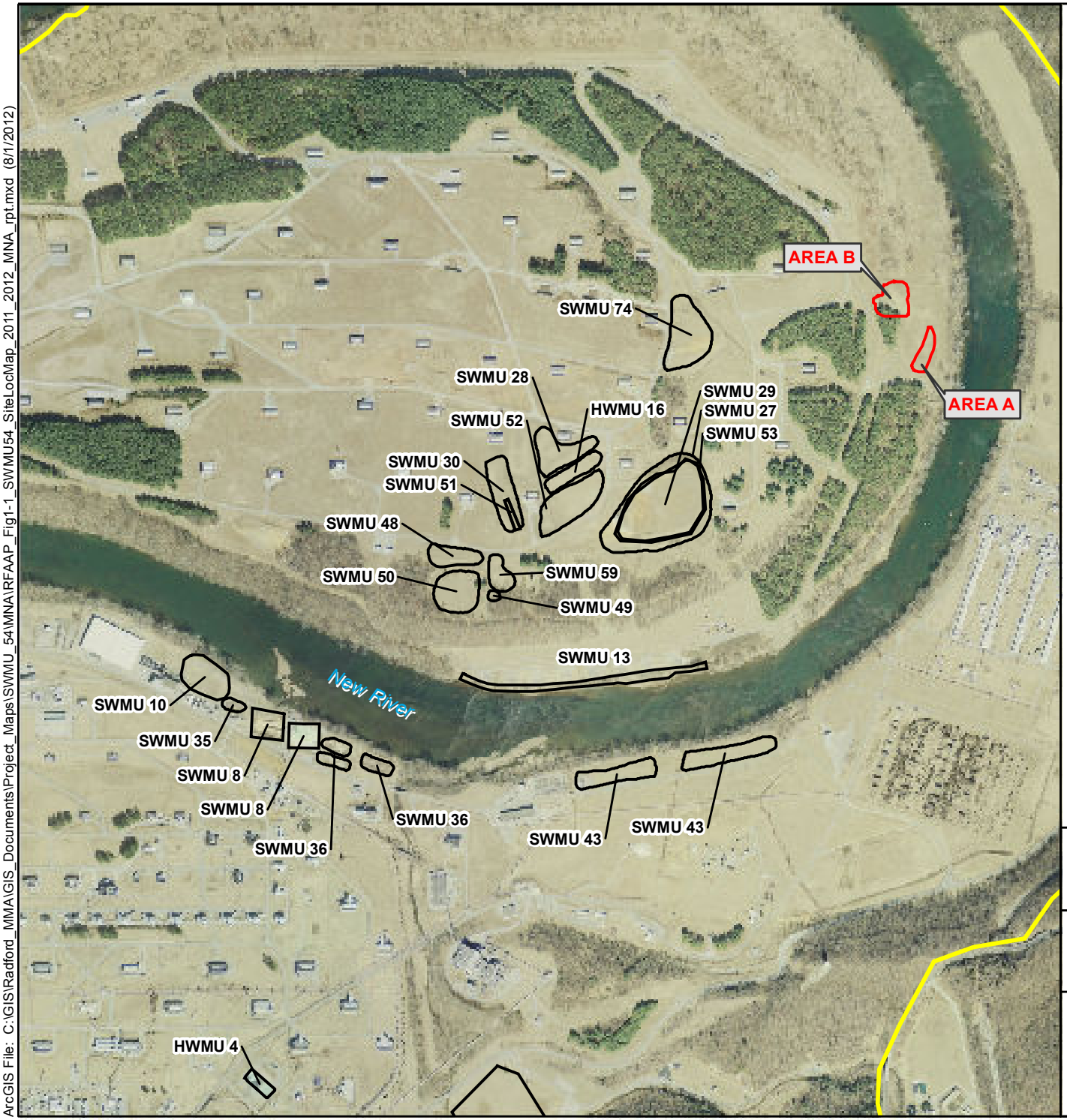
Table 1-1
SWMU 54 Groundwater Remedial Goals

Chemical of Interest	Groundwater RG (mg/L)	Groundwater RG Source(*)
2,4,6-TNT	0.00782	RG
DNT Mixture	0.000932	RG
RDX	0.0061	RG
Perchlorate	0.0109	RG

*RGs were calculated using target risk 1E-5 for the life time resident and a target hazard of 1 for the adult and child resident (see URS, 2008).

1.2 Site Description and Background

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.



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:\GIS\Radford_MMA\GIS_Documents\Project_Maps\SWMU_54\MNA\RFAAP_Fig1-1_SWMU54_SiteLocMap_2011_2012_MNA_rpt.mxd (8/1/2012)

2.0 PHYSICAL CHARACTERISTICS

2.1 Topography

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).

2.2 Surface Water

SWMU 54 is located within the eastern most portion of the Horseshoe Area at RFAAP. The SWMU is located within the floodplain of the New River. Any runoff from the SWMU will flow overland east, into the New River.

2.3 Geology

2.3.1 Regional Geology

SWMU 54 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. A more detailed description of the regional geology is presented in the *RFAAP MWP* (URS, 2003).

2.3.2 Site Specific Geology

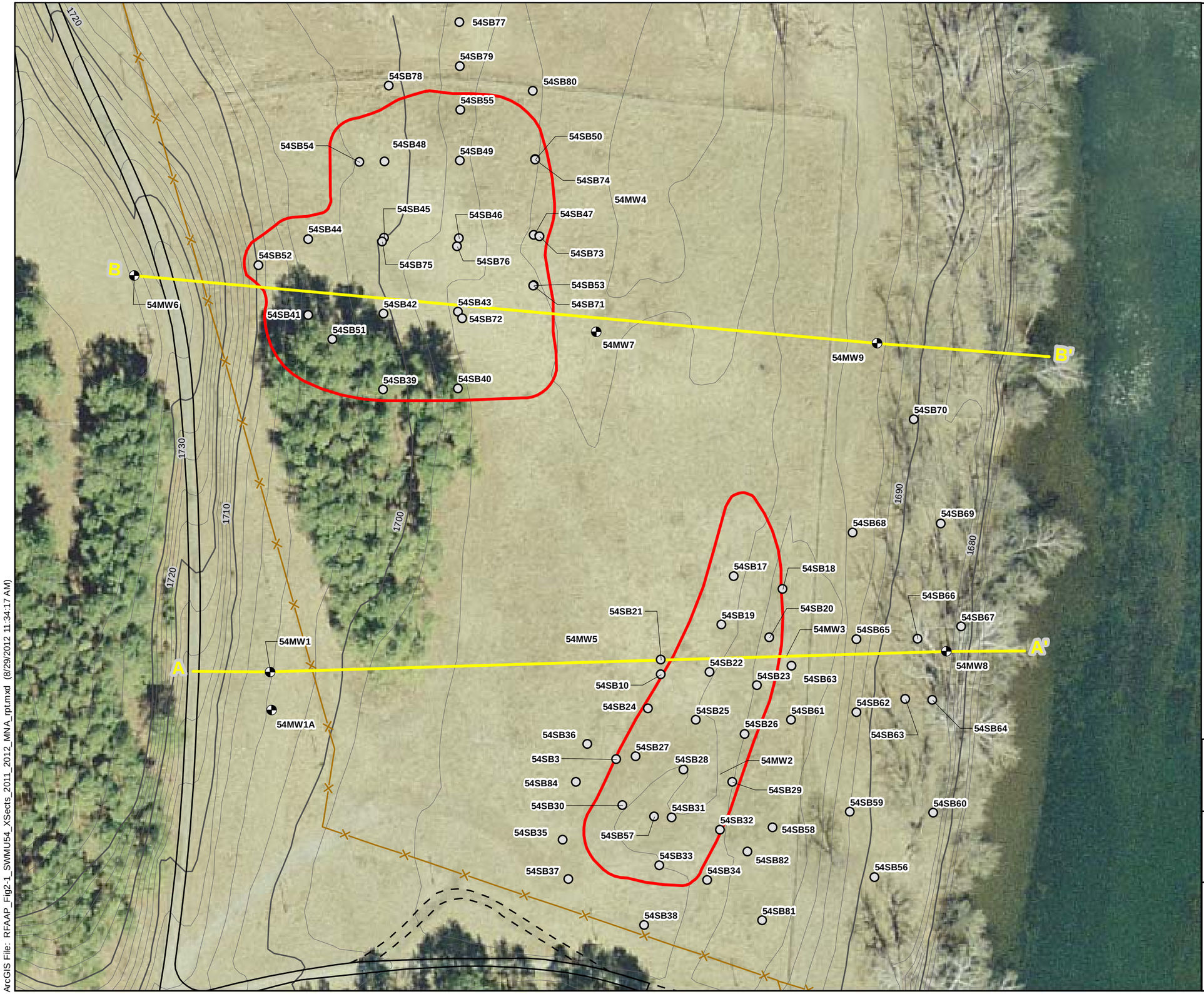
Lithologic characterization of the subsurface at SWMU 54 was performed during the advancement of soil borings and monitoring well borings at the site. Two geologic cross-sections were developed based on the logging descriptions recorded during the advancement of the soil borings. A plan view of the cross-sectional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

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 though 3.7 of the *RFAAP MWP* (URS, 2003) and in the *Facility-Wide Background Study Report* (IT, 2001).



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 2-1

SWMU 54 Cross Sections

Radford Army Ammunition Plant,
Radford, VA

ArcGIS File: RFAAP_Fig2-1_SWMU54_XSects_2011_2012_MNA_rpt.mxd (8/29/2012 11:34:17 AM)

AREA B

AREA A

A

A'

54MW1

54MW1A

54MW3

54MW5

54MW8

54MW10

54SB3

54SB10

54SB17

54SB18

54SB19

54SB20

54SB21

54SB22

54SB23

54SB24

54SB25

54SB26

54SB27

54SB28

54SB29

54SB30

54SB31

54SB32

54SB33

54SB34

54SB35

54SB36

54SB37

54SB38

54SB57

54SB58

54SB59

54SB60

54SB61

54SB62

54SB63

54SB64

54SB65

54SB66

54SB67

54SB68

54SB69

54SB70

54SB81

54SB82

54SB84

1680

1690

1700

1710

1720

1730

N

0 37.5 75 Feet

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.

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FIGURE 2-2

SWMU 54 Cross Section A-A'

Radford Army Ammunition Plant, Radford, VA

A (west) — A' (east)

Road

Area A Boundary

Silty Sand (SM)

Silty Sand (SM)

Potentiometric Surface

Interspersed Sand and Gravel (0-4 ft above bedrock)

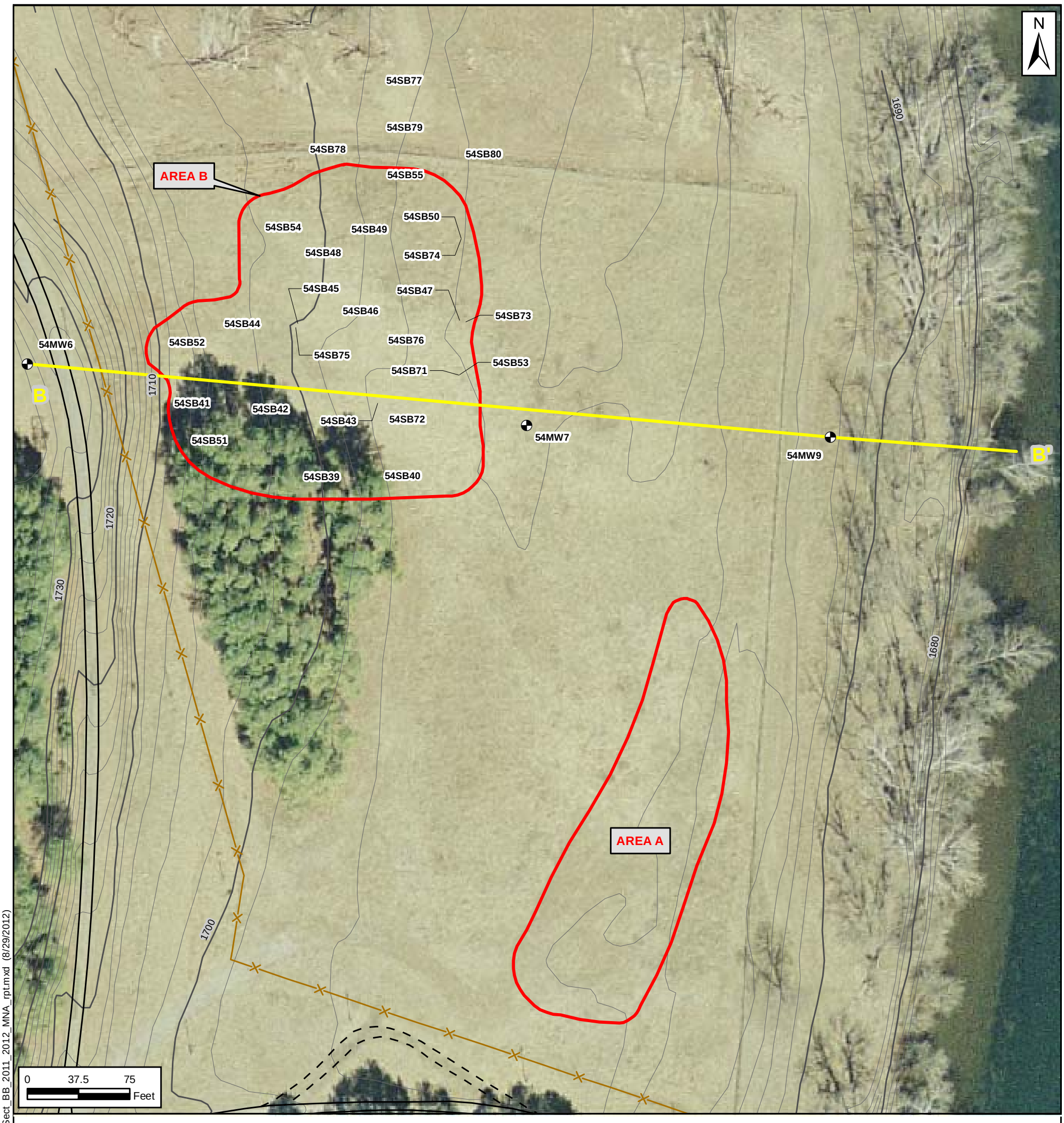
Light Gray to Greenish Gray Limestone/Dolomite Bedrock

New River

1740
1720
1700
1680
1660
1640

0 100 200 300 400 500 600 700

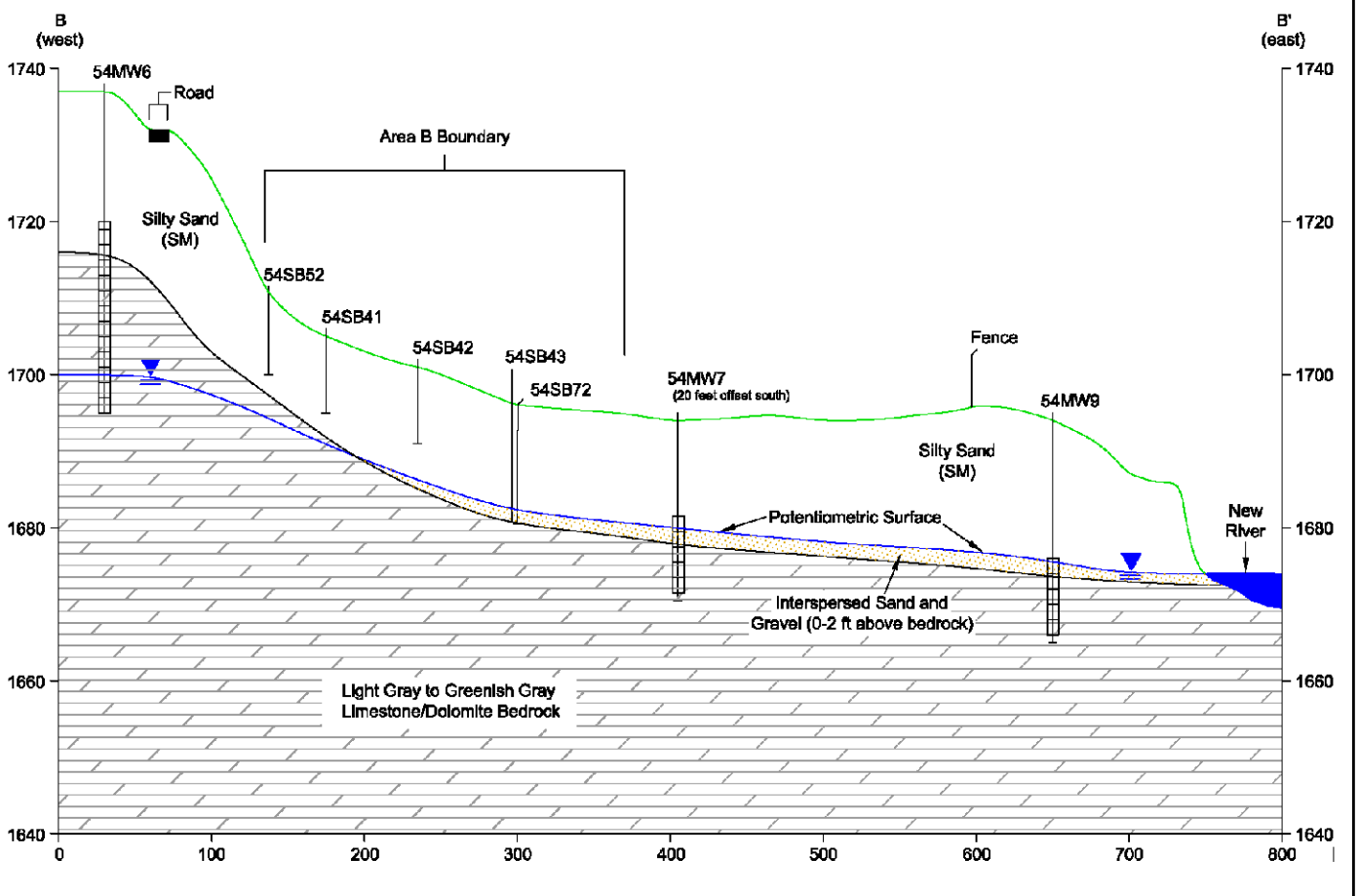
ArcGIS File: C:\GIS\Radford_MMA\GIS_Documents\Project_Maps\SWMU_54\MNA\nONE RFAAP_Fig2-2_SWMU54_XSect_AA_2011_2012_MNA_rpt.mxd (8/29/2012)



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 exageration = 5.



U.S. Army Corps of Engineers

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FIGURE 2-3

SWMU 54 Cross Section B-B'

Radford Army Ammunition Plant,
Radford, VA

ArcGIS File: C:\GIS\Radford_MMA\GIS_Documents\Project_Maps\SWMU_54\MNA\inONE RFAAP_Fig2-3_SWMU54_XSect_BB_2011_2012_MNA_rpt.mxd (8/29/2012)

2.4 Hydrogeology

2.4.1 Regional Hydrogeology

Geologically, the Appalachian Plateaus and Valley and Ridge Province encompass two major tectonic domains: the southern Appalachian Basin and the southeastern part of the Eastern Interior Basin. The hydrogeologic framework is based on generalized stratigraphic succession, with indurated sedimentary rocks of the Paleozoic age forming predominant units.

Groundwater flow paths are typically short, commonly extending no more than several miles in their longest dimension. The largest groundwater supplies are produced from the carbonate rocks, especially where they are associated with thick regolith, an important storage reservoir throughout the entire area. The regolith stores recharge that would otherwise be rapidly diverted to overland flow. It also slowly releases water to underlying carbonate aquifers. Because of the widespread distribution of carbonate rocks and associated regolith, abundant precipitation in a humid climate, and relatively steep hydraulic gradients, this region (and locality) is one of the major karstlands in the eastern United States.

Groundwater supplies in the Valley and Ridge Province are generally good quality compared to surface water supplies (Parsons, 1996). However, due to extended contact with minerals, many groundwater supplies contain higher levels of dissolved solids than the streams into which they discharge. Because of sinkholes and underground caverns in karst aquifers, there is a high potential for groundwater to be impacted by direct infiltration of contaminated surface water.

2.4.2 Site-Specific Hydrogeology

Monitoring wells installed at SWMU 54 were screened in both the shallow, surficial aquifer and shallow bedrock. Water levels were measured in the wells to calculate the groundwater flow direction at the site. Groundwater contour maps have been prepared using water level data collected prior to each round of groundwater sampling. The maps for the first year of monitoring are presented on **Figures 4-1**, **4-2**, **4-3, and 4-4**. Contour lines shown on the figures represent lines of equal elevation of the water table; consequently, groundwater flow direction is always perpendicular to the contour lines. Groundwater at the site tends to flow east and appears to discharge to the New River along the eastern side of the site.

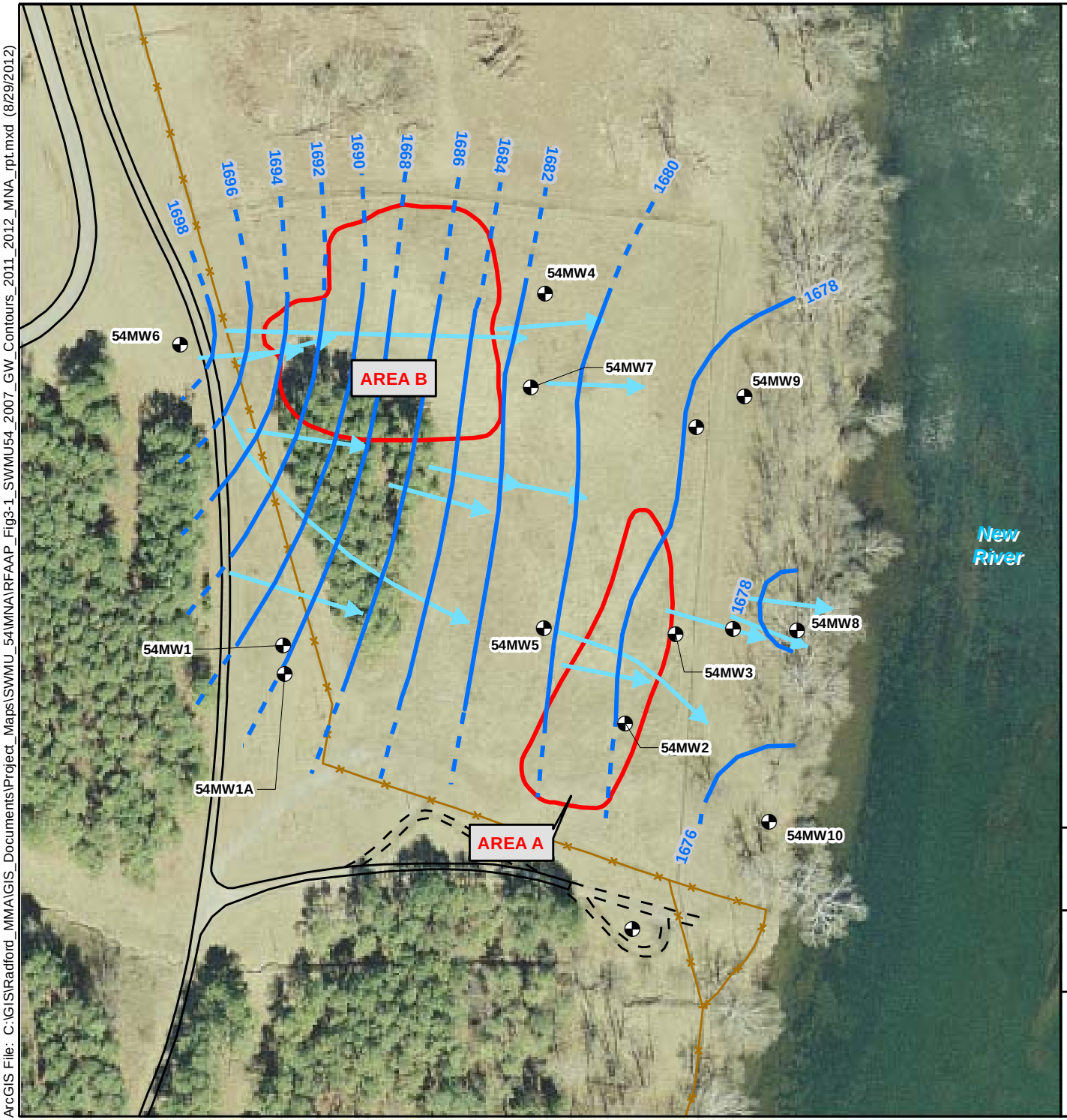
3.0 PREVIOUS INVESTIGATIONS

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 IM 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 an 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/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 IMs 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 3-1**. Historical data listing constituent concentrations in the existing wells on site can be found in **Tables 3-1 through 3-6**.

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, Nitroglycerin (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 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.



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 3-1
SWMU 54
June 5, 2007 Groundwater Contour Map
Radford Army Ammunition Plant,
Radford, VA

ArcGIS File: C:\GIS\Radford_MMA\GIS_Documents\Project_Maps\SWMU_54\MNA\RFAAP_Fig3-1_SWMU54_2007_GW_Contours_2011_2012_MNA_rpt.mxd (8/29/2012)

Table 3-1
2002 Area A Direct Push Groundwater Analytical Results with Remedial Goals
SWMU 54
Radford Army Ammunition Plant, Radford, Virginia
Page 1 of 1

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
					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,l	0.73	7.2	1.5	JB,B,z	0.33	3.3	<2.1	U,R,l	0.21	2.1	NT				NT				NT				NT			
DNT mixture*			**0.932**		ND				ND				ND				ND				ND				ND				ND			
RDX	121-82-4	C	**6.1**	ug/L	<7.2	U,R,l	1	7.2	<3.3	U,R,l	0.48	3.3	<2.1	U,R,l	0.31	2.1	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

Sample ID / Sample Date	CAS	C/N	RG	Units	54GP80 10/13/2004		MDL	RL	54GP81 10/11/2004		MDL	RL	54GP82 10/11/2004		MDL	RL	54GP83 10/11/2004		MDL	RL	54GP84 10/13/2004		MDL	RL	54GP85 10/14/2004		MDL	RL	54GP86 10/13/2004		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	NT				NT				NT				NT				NT				NT				NT			
DNT mixture*			**0.932**		ND				ND				ND				ND				ND				ND				ND			
RDX	121-82-4	C	**6.1**	ug/L	NT				NT				NT				NT				NT				NT				NT			
Perchlorate																																
Perchlorate	14797-73-0	N	**10.9**	ug/L	<1	U	0.1	1	1		0.1	1	<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

Sample ID / Sample Date	CAS	C/N	RG	Units	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	54GW60 8/24/2004		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	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	9.3		0.0749	0.65
DNT mixture*			**0.932**		ND				ND				ND	U			ND				ND				ND				ND			
RDX	121-82-4	C	**6.1**	ug/L	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	0.8		0.164	0.65
Perchlorate																																
Perchlorate	14797-73-0	N	**10.9**	ug/L	<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	1.7		0.1	1

Sample ID / Sample Date	CAS	C/N	RG	Units	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
					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	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			
DNT mixture*			**0.932**		ND				ND				ND				ND				ND				ND				ND			
RDX	121-82-4	C	**6.1**	ug/L	<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			
Perchlorate																																
Perchlorate	14797-73-0	N	**10.9**	ug/L	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

Sample ID / Sample Date	CAS	C/N	RG	Units	54GW66 8/23/2004		MDL	RL	54GW67 8/20/2004		MDL	RL	54GW67 8/23/2004		MDL	RL	54GW68 8/20/2004		MDL
					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	<0.65	U	0.0749	0.65	NT				<0.65	U	0.0749	0.65	2.6	,J,g	0.0749
DNT mixture*			**0.932**		ND				ND				ND				ND		
RDX	121-82-4	C	**6.1**	ug/L	<0.65	U	0.164	0.65	NT				<0.65	U	0.164	0.65	<0.65	U	0.164
Perchlorate																			
Perchlorate	14797-73-0	N	**10.9**	ug/L	NT				0.59	B,J,m	0.1	1	NT				<1	U	0.1

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

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 3-2
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.

Notes:

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
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

= 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 3-3
2006-2007 Area A Quarterly Groundwater Monitoring Results with Remedial Goals
SWMU 54
Radford Army Ammunition Plant, Radford, Virginia
Page 1 of 2

First Quarter - November/December 2006

Sample ID / Sample Date	CAS	C/N	RG	54MW1 11/29/2006		MDL	RL	54MW2 11/29/2006		MDL	RL	54MW3 12/5/2006		MDL	RL	54MW5 11/29/2006		MDL	RL	54MW8 12/1/2006		MDL	RL	54MW9 12/1/2006		MDL	RL	54MW10 12/1/2006		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	0.075	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		MDL	RL	54MW-2 3/28/2007		MDL	RL	54MW-3 3/28/2007		MDL	RL	54MW-5 3/28/2007		MDL	RL	54MW-8 3/27/2007		MDL	RL	54MW-9 3/27/2007		MDL	RL	54MW10 DUP AVG 3/27/2007		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	0.25	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 3-3
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 detected. The associated number indicates the approximate sample concentration necessary to be detected.
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 3-4
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		MDL	RL	54MW6 3/3/2003		MDL	RL	54MW7 3/4/2003		MDL	RL	54MW7-DUP(GW-DUP-1) 3/4/2003		MDL	RL
			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r			Result	LQ, VQ, r		
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 3-5
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 Result	LQ, VQ, r	MDL	RL	54MW6 11/29/2006 Result	LQ, VQ, r	MDL	RL	54MW7 12/5/2006 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	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			

Second Quarter - March 2007

Sample ID / Sample Date	CAS	C/N	RG	54MW-4 3/27/2007 Result	LQ, VQ, r	MDL	RL	54MW-6 3/27/2007 Result	LQ, VQ, r	MDL	RL	54MW-7 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	<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 3-5
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			

Fourth Quarter - September 2007

Sample ID / Sample Date	CAS	C/N	RG	54MW4 9/19/2007		MDL	RL	54MW6 9/19/2007		MDL	RL	54MW7 DUP AVG 9/19/2007		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**	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
ND = Not Detected

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

=Exceeds RG

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

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.

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

Table 3-6
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
				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	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
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
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
DNT mixture*			**0.932**	<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
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
Field Parameters																											
Dissolved Oxygen (mg/L)	--	--	--	17.05				15.83				14.64				12.93				14.83				15.11			
Oxidation Reduction Potential (mV)	--	--	--	219				118				47				53				32				35			
pH (SU)	--	--	--	8.9				8.1				7.96				7.81				7.67				8.3			
Conductivity (mS)	--	--	--	0.116				0.113				0.118				0.174				0.117				0.155			
Temperature (°C)	--	--	--	10.1				9.9				10.1				10.3				10.2				10.4			
Turbidity (NTU)	--	--	--	71.3				13.7				17.48				9.94				7.66				6.21			

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
				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	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
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
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
DNT mixture*			**0.932**	<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
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
Field Parameters																											
Dissolved Oxygen (mg/L)	--	--	--	10.38				10.46				12.2				9.35				10.82				11.34			
Oxidation Reduction Potential (mV)	--	--	--	-109				-174				20				-182				-44				-58			
pH (SU)	--	--	--	7.33				7.21				7.47				7.57				7.44				7.2			
Conductivity (mS)	--	--	--	0.307				0.344				0.248				0.38				0.553				0.353			
Temperature (°C)	--	--	--	12.8				10.7				10.8				10.6				13.2				11.9			
Turbidity (NTU)	--	--	--	16.35				37.9				22.7				4.86				3.63				11.85			

Table 3-6
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-7 12/1/2006		MDL	RL	NR-SW-8 12/1/2006		MDL	RL	NR-SW-8-DUP(DUP-4) 12/1/2006		MDL	RL	NR-SW-9 12/1/2006		MDL	RL	NR-SW-10 12/1/2006		MDL	RL
				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	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
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
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
DNT mixture*			**0.932**	<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
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
Field Parameters																							
Dissolved Oxygen (mg/L)	--	--	--	13.13				13.27				13.27				13.76				14.69			
Oxidation Reduction Potential (mV)	--	--	--	10				41				41				51				52			
pH (SU)	--	--	--	8.11				7.8				7.8				7.62				7.83			
Conductivity (mS)	--	--	--	0.140				0.124				0.124				0.131				0.114			
Temperature (°C)	--	--	--	11.7				12.5				12.5				11.8				11			
Turbidity (NTU)	--	--	--	148				13.8				13.8				20.5				11.46			

Pore Water

Sample ID / Sample Date	CAS	C/N	RG	NR-PW-6-DUP(DUP-3) 11/30/2006		MDL	RL	NR-PW-7 12/1/2006		MDL	RL	NR-PW-8 12/1/2006		MDL	RL	NR-PW-9 12/1/2006		MDL	RL	NR-PW-10 12/1/2006		MDL	RL
				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	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
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
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
DNT mixture*			**0.932**	<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
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
Field Parameters																							
Dissolved Oxygen (mg/L)	--	--	--	11.34				9.25				9.74				10.55				10.18			
Oxidation Reduction Potential (mV)	--	--	--	-58				-194				-173				-173				-157			
pH (SU)	--	--	--	7.2				7.54				7.36				7.23				7.47			
Conductivity (mS)	--	--	--	0.353				0.517				0.660				0.533				0.479			
Temperature (°C)	--	--	--	11.9				13				12.9				13.2				13.1			
Turbidity (NTU)	--	--	--	11.85				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.

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, 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 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 was partially based on visual observations during excavation, with analytical confirmation samples collected to confirm the observations.

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 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.

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 Report 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 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 SWMU 54 groundwater are shown in Table 1-7 in the *Final SWMU 54 RFI/CMS Report* (URS, 2008). 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. Results from the soil remedial action at SWMU 54 can be found in the approved *Final Interim Measures Completion Report for SWMU 54* (Shaw, 2011b). The groundwater RGs (displayed in **Table 1-1** of this Report) will be used to compare results from groundwater monitoring wells to assess the progress of the MNA.

4.0 FIELD ACTIVITIES

The following sections provide a discussion of field activities conducted by Shaw in the first year of monitoring at SWMU 54.

The first year of groundwater monitoring consisted of the installation of four monitoring wells and four sampling events conducted in July 2011 (first quarter), October 2011 (second quarter), January 2012 (third quarter), and April 2012 (fourth quarter). Field activities were conducted in accordance with the *Final SWMU 54 MNA IMWP* (Shaw, 2011a).

4.1 Installation of New Monitoring Wells

In June 2011, four additional monitoring wells were installed and developed at SWMU 54. As illustrated on **Figure 4-1**, monitoring wells 54MW11 and 54MW12 were installed for performance monitoring between the point of compliance wells (54MW2 and 54MW3) and downgradient wells (54MW8 and 54MW10) adjacent to the New River. Monitoring wells 54MW13 and 54MW14 were installed north and south of the unit.

Boring logs and well completion diagrams for these new monitoring wells are found in **Appendix A**.

4.2 Groundwater Sampling – First Quarter

Groundwater elevation measurements and groundwater samples were collected from 14 groundwater monitoring wells. The first quarter of groundwater sampling was conducted July 11-13, 2011. Groundwater elevation measurements were collected prior to sampling activities. The locations of the wells are displayed on **Figure 4-1**.

4.2.1 Groundwater Elevation Measurements

A round of synoptic water levels was conducted at SWMU 54 prior to each sampling event in the first year of sampling. Water levels were recorded at each of the 14 monitoring wells. **Table 4-1** presents the measured depth to water levels and groundwater elevations above msl. A groundwater elevation contour map was constructed from the groundwater elevation data collected during the first quarter and is presented on **Figure 4-2**.

Estimated groundwater flow velocities were calculated for Area A and Area B based on parameters used in the *SWMU 54 RFI/CMS Report* (URS, 2008). The Area A flow path of approximately 525 ft had a groundwater elevation difference of 15 ft, resulting in a calculated hydraulic gradient of 0.029 ft/ft. Using an average K value for Area A of 4.86 ft/day and an estimated effective porosity of 0.20, the groundwater flow velocity for Area A is approximately 0.71 ft per day (257.2 ft/year).

The Area B flow path of approximately 600 ft had a groundwater elevation difference of 10 ft, resulting in a calculated hydraulic gradient of 0.017 ft/ft. Using an average K value for Area B of 4.55 ft/day and an estimated effective porosity of 0.20, the groundwater flow velocity for Area B is approximately 0.39 ft/day (141.16 ft/year).

Table 4-1
First Quarter Groundwater Elevations at SWMU 54

Well ID	Elevation of TOC	DTW (ft TOC)	Water Level (ft msl)	Total Depth (ft TOC)
54MW1	1707.78	19.2	1688.58	62.0
54MW2	1701.41	22.45	1678.96	32.0
54MW3	1702.15	23.5	1678.65	36.0
54MW4	1696.14	14.88	1681.26	47.5
54MW5	1698.11	17.55	1680.56	25.0
54MW6	1739.19	18.27	1720.92	42.0
54MW7	1696.58	15.55	1681.03	23.0
54MW8	1692.64	14.85	1677.79	34.0
54MW9	1696.04	19.2	1676.84	28.5
54MW10	1691.10	17.55	1673.55	35.0
54MW11	1696.27	19.35	1676.92	31.0
54MW12	1702.42	25.5	1676.92	30.0
54MW13	1698.90	21.8	1677.1	22.0
54MW14	1700.66	23.05	1677.61	31.5

Notes:
TOC – Top of casing
DTW – Depth to water

LEGEND

- Monitoring Well
- Surface Water and Pore Water Sample Location
- 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

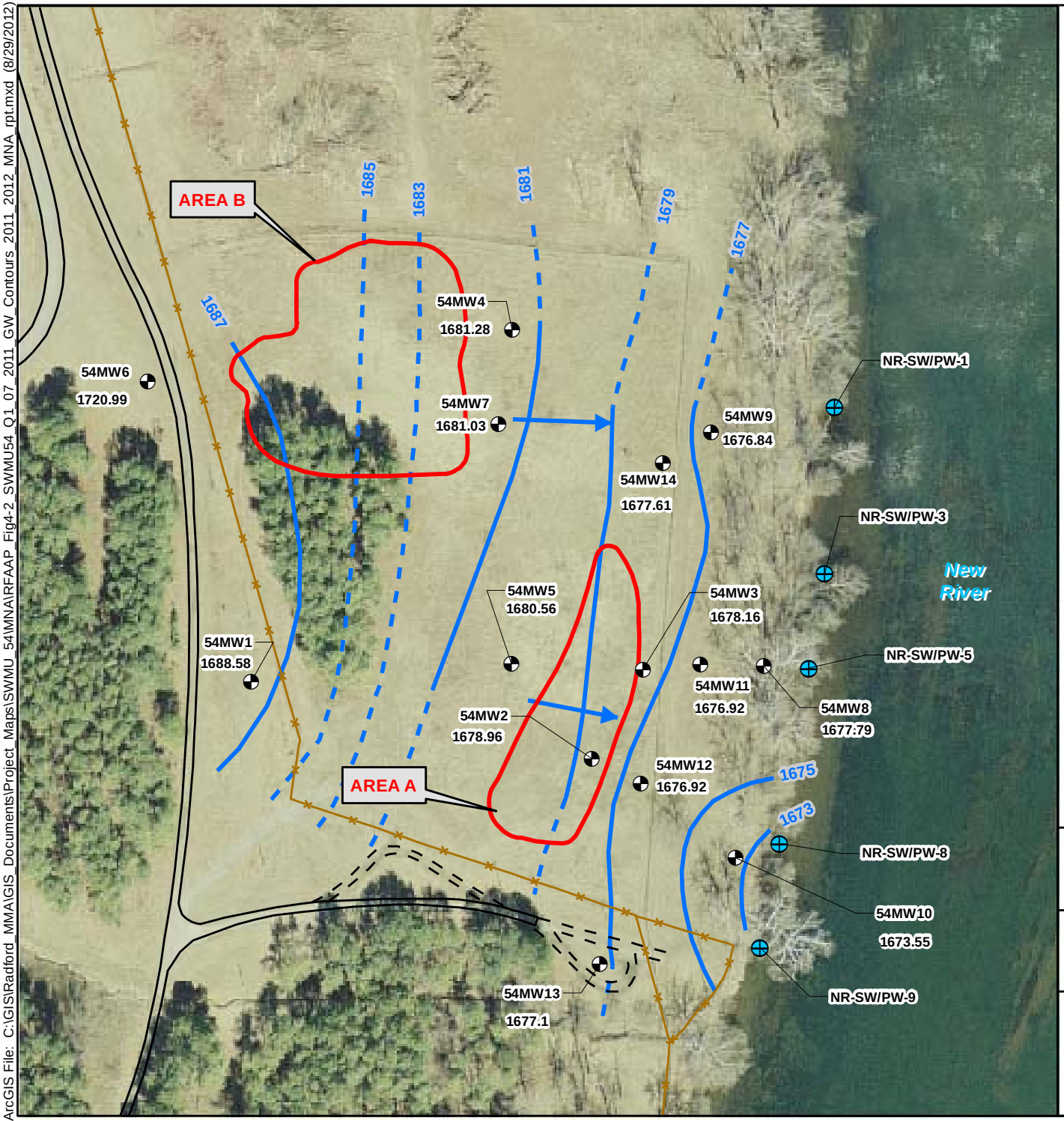
Scale:
0 75 150 300
Feet

U.S. Army Corps of Engineers

Shaw® Shaw Environmental, Inc.

FIGURE 4-1
SWMU 54
Sample Locations
Radford Army Ammunition Plant,
Radford, VA

ArcGIS File: C:\GIS\Radford_MMA\GIS_Documents\Project_Maps\SWMU_54MNA\RFAAP_Fig4-1_SWMU54_Sample_Locations_2011_2012_MNA_rpt.mxd (8/29/2012)



ArcGIS File: C:\GIS\Radford_MMA\GIS_Documents\Project_Maps\SWMU_54\MNA\RFAAP_Fig4-2_SWMU54_Q1_07_2011_GW_Contours_2011_2012_MNA_rpt.mxd (8/29/2012)

LEGEND

- Monitoring Well
- Surface Water and Pore Water Sample Location
- Dirt Road
- Paved Road
- Railroad
- Fence
- Groundwater Contour
- Inferred Groundwater Contour
- Groundwater Flow Direction
- 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 4-2
SWMU 54
July 2011 Groundwater Contour Map
Radford Army Ammunition Plant,
Radford, VA

4.2.2 Groundwater Sampling

Groundwater samples were collected from each of the 14 monitoring wells on July 11-13, 2011. Groundwater samples from the first four quarters of sampling were analyzed for the following analyte classes: Explosives and perchlorate. In addition, the following indicator parameters were also collected: Total Organic Carbon (TOC), Dissolved Inorganic Carbon (DIC), dissolved ferrous iron, dissolved manganese, nitrate, sulfate, pH, temperature, specific conductance, dissolved oxygen, oxidation-reduction potential (ORP), and turbidity. The analysis list is presented in **Table 4-2**.

Table 4-2
Sample Analysis for SWMU 54 Groundwater Monitoring

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/ PW1	Annually	X	X	X
NRSW3/ PW3	NRSW3/ PW3	Annually	X	X	X
NRSW5/ PW5	NRSW5/ PW5	Annually	X	X	X
NRSW8/ PW8	NRSW8/ PW8	Annually	X	X	X
NRSW9/ PW9	NRSW9/ PW9	Annually	X	X	X

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

Groundwater samples were collected via low-flow sampling techniques to obtain representative groundwater samples and minimize waste purge water. The following procedures were followed during the groundwater sampling event. A photoionization detector (PID) reading was taken upon opening the well to determine if potentially hazardous levels of volatiles were present. All PID readings were within acceptable levels. Depth to water and total depth measurements were recorded to determine the amount of water in the well casing and sandpack. A submersible pump was lowered into the well until the pump inlet was at the midpoint of the screen. Monitoring wells were initially pumped at a rate of approximately 400-500 milliliters per minute on average. Water quality parameters, including temperature, pH, dissolved oxygen, redox potential, turbidity, and conductivity, were monitored continuously through a flow cell during well purging, and final stabilized readings were recorded. Upon completion of the stabilization, dissolved manganese and dissolved ferrous iron were tested via a field kit. **Table 4-3** presents a summary of the final, stabilized reading for each well from the first quarter.

Table 4-3
SWMU 54 First Quarter Water Quality Parameters

Well ID	pH	Conductivity (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/kg)	ORP	Temperature (^{o}C)	Dissolved Manganese	Dissolved Ferrous Iron
54MW1	7.70	0.357	5.6	4.86	130	14.12	<5	<0.2
54MW2	6.36	0.526	0	2.35	178	17.07	<5	<0.2
54MW3	6.86	0.491	1.5	4.71	121	19.82	<5	<0.2
54MW4	7.19	0.949	1.9	0	-18	15.52	<5	<0.2
54MW5	6.36	0.371	3	4.87	178	19.88	<5	<0.2
54MW6	7.33	0.449	0.2	0.68	110	19.32	<5	<0.2
54MW7	6.6	0.419	0	3.91	170	18.87	10	<0.2
54MW8	6.98	0.544	4.6	3.53	134	17.86	<5	<0.2
54MW9	6.29	0.535	6	1.23	198	14.3	20	<0.2
54MW10	7.13	1.68	89.8	0.51	67	25.19	<5	<0.2
54MW11	7.14	0.651	62.6	0	96	14.94	5	<0.2
54MW12	6.67	0.568	100	3.52	152	18.38	10	<0.2
54MW13*	6.75	0.676	94	0.90	29	20.09	65	<0.2
54MW14	7.23	0.582	16.9	1.06	73	23.76	<5	<0.2

*Well ran dry at low flow. Allowed time for recharge and continued pumping.

Measurements conducted for SWMU 54 generally showed aerobic conditions for groundwater. Levels of dissolved oxygen in the wells ranged from 0 to 4.87 mg/L. ORP measurements in the wells ranged from -18 to 198 millivolts. Levels of pH were generally in the neutral range with measurements ranging from 6.29 to 7.70 standard units. Specific conductance measurements in the wells ranged from 0.357 to 1.68 millisiemens per centimeter.

Prior to sampling, the flow cell was disconnected and the groundwater flow rate was maintained at 400 milliliters per minute during sample collection. Samples were collected, preserved, and packed in ice until shipment to the laboratory. Chain-of-custody forms (COCs) and temperature blanks accompanied the samples at all times. Copies of the COCs are provided in **Appendix B**.

4.2.3 Quality Control Samples

Quality control (QC) samples, including rinse blanks and duplicates were collected during this field event.

Duplicate samples were collected at a rate of 10 percent, with two duplicate groundwater samples [54TM03 and 54TM12 (see **Table 4-2** for analytes)] obtained during the first quarter of groundwater sampling. Matrix spike/matrix spike duplicates (MS/MSD) were collected at a rate of 5 percent. One MS/MSD was collected for each analyte class, at well 54MW12. Duplicate and MS/MSD samples were collected by homogenizing a large sample volume and splitting it into two samples for a duplicate and three samples for an MS/MSD.

One equipment rinse blank was collected per sampling quarter. Equipment rinse blanks were collected by pouring de-ionized ultra-filtered water over decontaminated sampling equipment and into laboratory supplied bottles. Rinse blanks are collected for the same suite of parameters as the samples. Results of the quality assurance/quality control (QA/QC) sample analysis are presented in **Appendix B**.

4.3 Groundwater Sampling – Second Quarter

Groundwater elevation measurements and groundwater samples were collected from 14 groundwater monitoring wells. The second quarter of groundwater sampling was conducted October 3-6, 2011. Groundwater elevation measurements were collected prior to sampling activities. The locations of the wells are displayed on **Figure 4-1**.

4.3.1 Groundwater Elevation Measurements

Table 4-4 presents the measured depth to water levels and groundwater elevations above msl. A groundwater elevation contour map was constructed from the groundwater elevation data collected during the second quarter and is presented on **Figure 4-3**.

Estimated groundwater flow velocities were calculated for Area A and Area B based on parameters used in the *SWMU 54 RFI/CMS Report* (URS, 2008). The Area A flow path of approximately 525 ft had a groundwater elevation difference of 11 ft, resulting in a calculated hydraulic gradient of 0.021 ft/ft. Using an average K value for Area A of 4.86 ft/day and an estimated effective porosity of 0.20, the groundwater flow velocity for Area A is approximately 0.51 ft per day (185.8 ft/year).

The Area B flow path of approximately 600 ft had a groundwater elevation difference of 22 ft, resulting in a calculated hydraulic gradient of 0.037 ft/ft. Using an average K value for Area B of 4.55 ft/day and an estimated effective porosity of 0.20, the groundwater flow velocity for Area B is approximately 0.84 ft/day (307.23 ft/year).

Table 4-4
SWMU 54 Second Quarter Groundwater Elevations

Well ID	Elevation of TOC	DTW (ft TOC)	Water Level (ft msl)	Total Depth (ft TOC)
54MW1	1707.78	19.25	1688.53	62.0
54MW2	1701.41	22.79	1678.62	32.0
54MW3	1702.15	24.37	1677.78	36.0
54MW4	1696.14	16.41	1679.73	47.5
54MW5	1698.11	18.60	1679.51	25.0
54MW6	1739.19	39.42	1699.77	42.0
54MW7	1696.58	16.88	1679.70	23.0
54MW8	1692.64	15.27	1677.37	34.0
54MW9	1696.04	19.64	1676.40	28.5
54MW10	1691.10	17.74	1673.36	35.0
54MW11	1696.27	20.12	1676.15	31.0
54MW12	1702.42	25.86	1676.56	30.0
54MW13	1698.90	22.30	1676.60	22.0
54MW14	1700.66	23.51	1677.15	31.5

Notes:
TOC – Top of casing
DTW – Depth to water

4.3.2 Groundwater Sampling

Groundwater samples were collected from each of the 14 monitoring wells on July 25-26, 2011. Samples from the second quarter were tested for the analyte list presented in **Table 4-2**.

Groundwater samples were collected via low-flow sampling techniques to obtain representative groundwater samples and minimize waste purge water. The following procedures were followed during the groundwater sampling event. A PID reading was taken upon opening the well to determine if potentially hazardous levels of volatiles were present. All PID readings were within acceptable levels. Depth to water and total depth measurements were recorded to determine the amount of water in the well casing and sandpack. A submersible pump was lowered into the well until the pump inlet was at the midpoint of the screen. Water quality parameters, including temperature, pH, dissolved oxygen, redox potential, turbidity, and conductivity, were monitored continuously through a flow cell during well purging, and final stabilized readings were recorded. Upon completion of the stabilization, dissolved manganese and dissolved ferrous iron were tested via a field kit. **Table 4-5** presents a summary of the final, stabilized reading for each well.

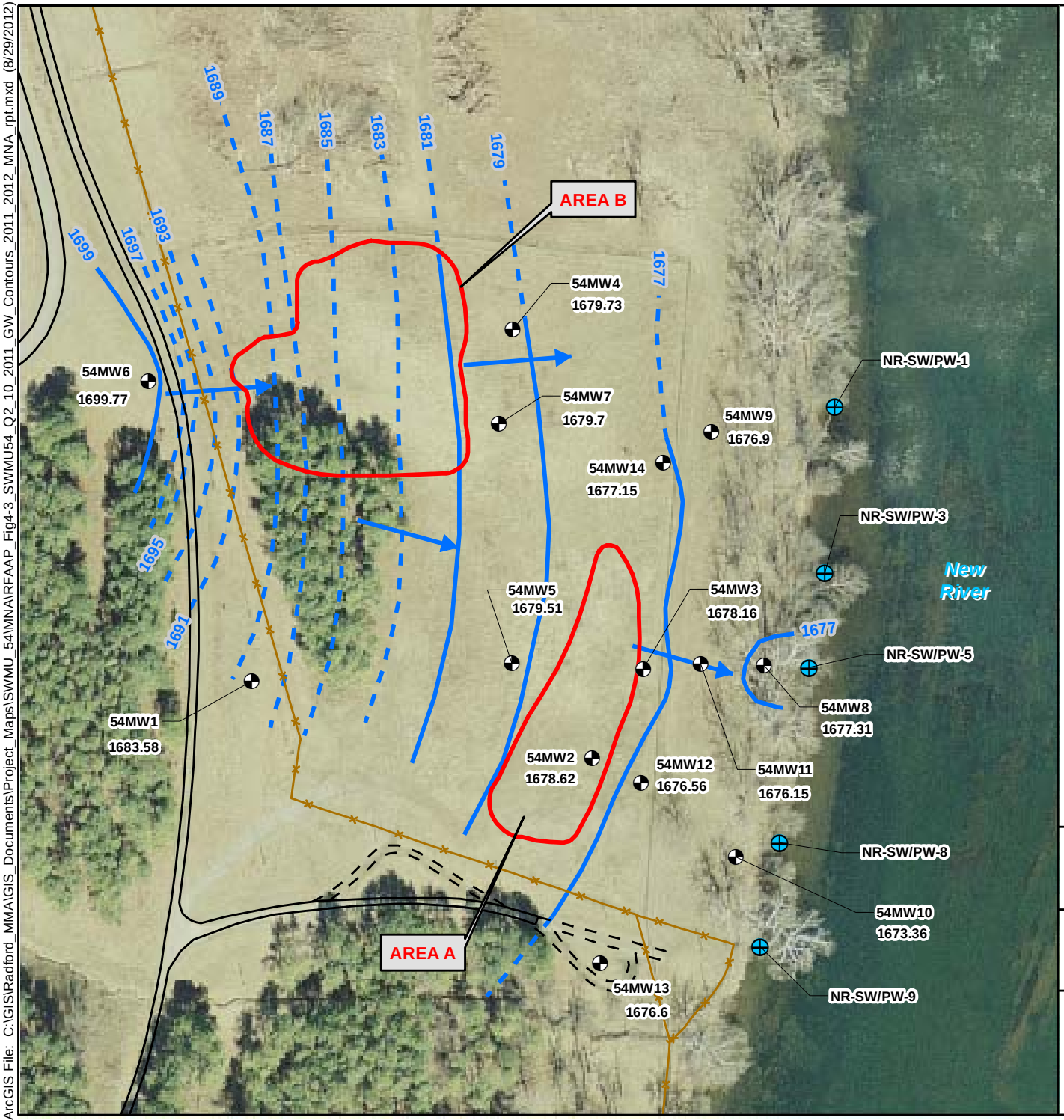
Table 4-5
SWMU 54 Second Quarter Water Quality Parameters

Well ID	pH	Conductivity (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/kg)	ORP	Temperature (^{o}C)	Dissolved Manganese	Dissolved Ferrous Iron
54MW1	7.49	0.432	164	0	102	18.04	<5	<0.2
54MW2	7.02	0.560	167	0	117	14.77	<5	<0.2
54MW3	7.05	0.674	160	0	107	14.16	10	<0.2
54MW4	7.27	0.912	81.1	2.44	-15	14.32	5	<0.2
54MW5	6.78	0.502	231	2.68	143	15.48	10	<0.2
54MW6	7.49	0.305	107	3.80	122	13.18	5	<0.2
54MW7	7.30	0.734	155	0.10	66	18.01	40	<0.2
54MW8	7.09	0.541	104	0.05	151	14.94	5	<0.2
54MW9	7.20	0.562	79.9	0.06	146	14.75	20	<0.2
54MW10	6.83	0.677	236	0	82	14.75	15	<0.2
54MW11*	7.31	0.654	685	0	-13	13.73	30	<0.2
54MW12	6.7	0.523	69	1.72	144	14.81	<5	<0.2
54MW13*	7.05	0.831	--	0.37	126	14.63	35	<0.2
54MW14	7.16	0.568	157	0	73	14.93	5	<0.2

*Sample displayed high turbidity.

Measurements conducted for the second quarter of SWMU 54 monitoring generally showed aerobic conditions for groundwater. Levels of dissolved oxygen in the wells ranged from 0 to 3.80 mg/L. ORP measurements in the wells ranged from -15 to 151 millivolts. Levels of pH were generally in the neutral range with measurements ranging from 6.70 to 7.49 standard units. Specific conductance measurements in the wells ranged from 0.305 to 0.912 millisiemens per centimeter.

Prior to sampling, the flow cell was disconnected and the groundwater flow rate was maintained during sample collection. Samples were collected, preserved, and packed in ice until shipment to the laboratory. COCs and temperature blanks accompanied the samples at all times. Copies of the COCs for the second quarter are provided in **Appendix B**.



LEGEND

- Monitoring Well
- Surface Water and Pore Water Sample Location
- Dirt Road
- Paved Road
- Railroad
- Fence
- Groundwater Contour
- Inferred Groundwater Contour
- Groundwater Flow Direction
- 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 4-3
SWMU 54
October 2011 Groundwater Contour Map
Radford Army Ammunition Plant,
Radford, VA

ArcGIS File: C:\GIS\Radford_MMA\GIS_Documents\Project_Maps\SWMU_54\MNA\RFAAP_Fig4-3_SWMU54_Q2_10_2011_GW_Contours_2011_2012_MNA_rpt.mxd (8/29/2012)

4.3.3 Quality Control Samples

QC samples, including rinse blanks and duplicates, were collected during this field event.

Duplicate samples were collected at a rate of 10 percent, with two duplicate groundwater samples [54TM06 and 54TM14 (see **Table 4-2** for analytes)] obtained during the second quarter of groundwater sampling. MS/MSDs were collected at a rate of 5 percent. One MS/MSD was collected for each analyte class at well 54MW14 during the second quarter. Duplicate and MS/MSD samples were collected by homogenizing a large sample volume and splitting it into two samples for a duplicate and three samples for an MS/MSD.

One equipment rinse blank was collected during the sampling event. Rinse blanks are collected for the same suite of parameters as the samples. Rinse blank sample, RB100611, was collected on October 6, 2011, by pouring de-ionized ultra-filtered water over decontaminated sampling equipment and into laboratory supplied bottles. Results of the QA/QC sample analysis are presented in **Appendix B**.

4.4 Groundwater Sampling – Third Quarter

Groundwater elevation measurements and groundwater samples were collected from 14 groundwater monitoring wells. The third quarter of groundwater sampling was conducted January 17-19, 2012. Groundwater elevation measurements were collected prior to sampling activities. The locations of the wells are displayed on **Figure 4-1**.

4.4.1 Groundwater Elevation Measurements

Water levels were recorded at each of the 14 monitoring wells. **Table 4-6** presents the measured depth to water levels and groundwater elevations above msl. A groundwater elevation contour map was constructed from the groundwater elevation data collected during the third quarter and is presented on **Figure 4-4**.

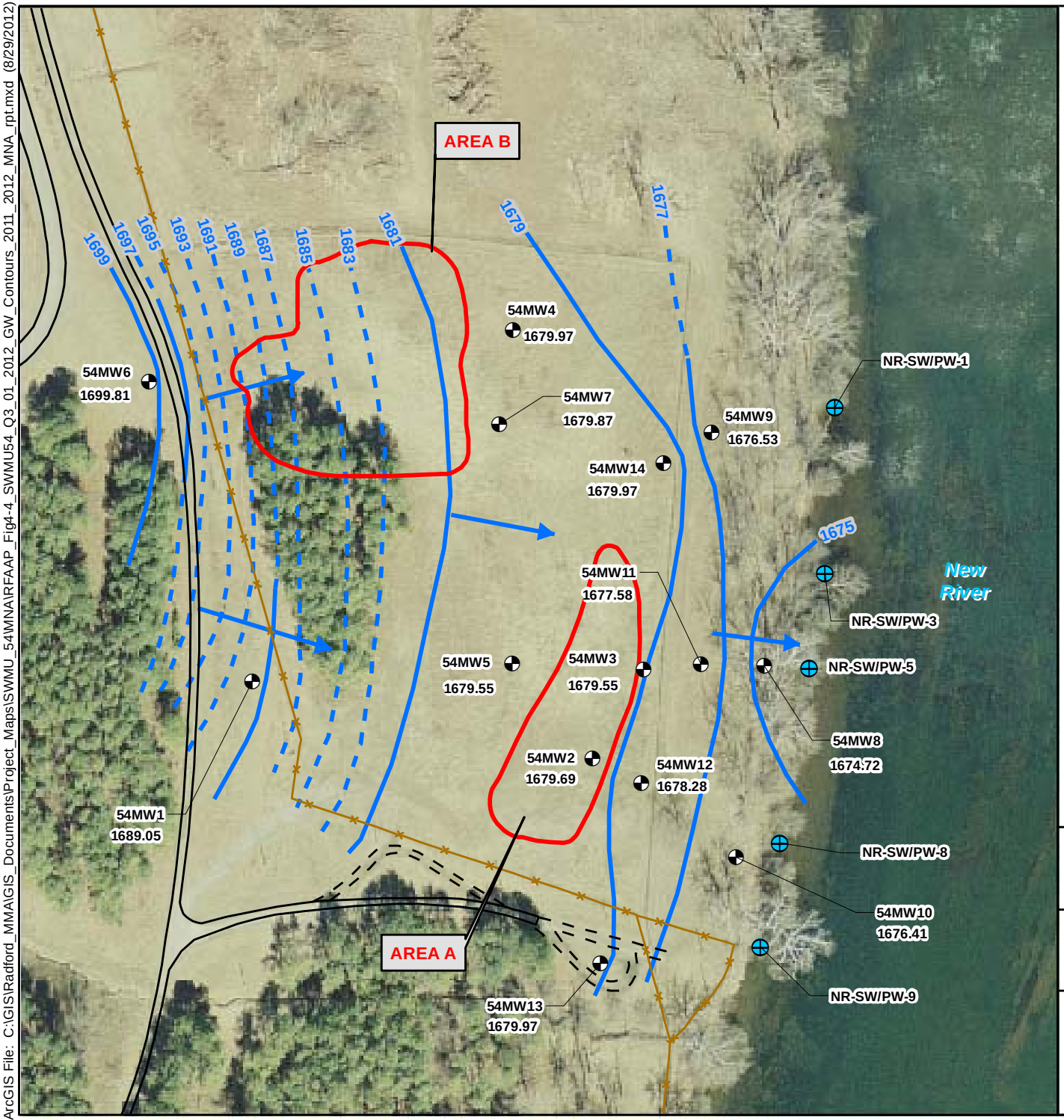
Estimated groundwater flow velocities were calculated for Area A and Area B based on parameters used in the *SWMU 54 RFI/CMS Report* (URS, 2008). The Area A flow path of approximately 525 ft had a groundwater elevation difference of 13 ft, resulting in a calculated hydraulic gradient of 0.025 ft/ft. Using an average K value for Area A of 4.86 ft/day and an estimated effective porosity of 0.20, the groundwater flow velocity for Area A is approximately 0.61 ft per day (221.7 ft/year).

The Area B flow path of approximately 600 ft had a groundwater elevation difference of 22 ft, resulting in a calculated hydraulic gradient of 0.037 ft/ft. Using an average K value for Area B of 4.55 ft/day and an estimated effective porosity of 0.20, the groundwater flow velocity for Area B is approximately 0.84 ft/day (307.23 ft/year).

Table 4-6
SWMU 54 Third Quarter Groundwater Elevations

Well ID	Elevation of TOC	DTW (ft TOC)	Water Level (ft msl)	Total Depth (ft TOC)
54MW1	1707.78	18.73	1689.05	62.0
54MW2	1701.41	21.72	1679.69	32.0
54MW3	1702.15	22.80	1679.35	36.0
54MW4	1696.14	16.17	1679.97	47.5
54MW5	1698.11	18.56	1679.55	25.0
54MW6	1739.19	39.35	1699.84	42.0
54MW7	1696.58	16.71	1679.87	23.0
54MW8	1692.64	18.42	1674.22	34.0
54MW9	1696.04	19.51	1676.53	28.5
54MW10	1691.10	14.69	1676.41	35.0
54MW11	1696.27	18.89	1677.38	31.0
54MW12	1702.42	24.14	1678.28	30.0
54MW13	1698.90	20.55	1678.35	22.0
54MW14	1700.66	22.33	1678.33	31.5

Notes:
TOC – Top of casing
DTW – Depth to water



ArcGIS File: C:\GIS\Radford_MMA\GIS_Documents\Project_Maps\SWMU_54\MNA\RFAAP_Fig4-4_SWMU54_Q3_01_2012_GW_Contours_2011_2012_MNA_rpt.mxd (8/29/2012)

LEGEND

- Monitoring Well
- Surface Water and Pore Water Sample Location
- Dirt Road
- Paved Road
- Railroad
- Fence
- Groundwater Contour
- Inferred Groundwater Contour
- Groundwater Flow Direction
- 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 4-4
SWMU 54
January 2012 Groundwater Contour Map
Radford Army Ammunition Plant,
Radford, VA

4.4.2 Groundwater Sampling

Groundwater samples were collected from each of the fourteen monitoring wells on January 17-19, 2012. Samples from the third quarter were analyzed for the analyte list presented in **Table 4-2**.

Groundwater samples were collected via low-flow sampling techniques to obtain representative groundwater samples and minimize waste purge water. The following procedures were followed during the groundwater sampling event. A PID reading was taken upon opening the well to determine if potentially hazardous levels of volatiles were present. All PID readings were within acceptable levels. Depth to water and total depth measurements were recorded to determine the amount of water in the well casing and sandpack. A submersible pump was lowered into the well until the pump inlet was at the midpoint of the screen. Water quality parameters, including temperature, pH, dissolved oxygen, redox potential, turbidity, and conductivity, were monitored continuously through a flow cell during well purging, and final stabilized readings were recorded. Upon completion of the stabilization, dissolved manganese and dissolved ferrous iron were tested via a field kit. **Table 4-7** presents a summary of the final, stabilized reading for each well.

Table 4-7
SWMU 54 Third Quarter Water Quality Parameters

Well ID	pH	Conductivity (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/kg)	ORP	Temperature (^{o}C)	Dissolved Manganese	Dissolved Ferrous Iron
54MW1	7.59	0.498	8.9	0	100	13.20	<5	<0.2
54MW2	7.48	0.662	15.3	0	33	13.91	<5	<0.2
54MW3	7.40	0.762	19.2	0	24	13.26	10	<0.2
54MW4	7.36	1.11	55.6	0	5	13.04	5	<0.2
54MW5	7.15	0.628	32.1	7.81	121	13.58	10	<0.2
54MW6	7.53	0.305	72.4	12.01	191	11.93	5	<0.2
54MW7	7.43	0.905	26.8	0	3	12.73	40	<0.2
54MW8	7.08	0.492	66.7	16.65	104	9.72	5	<0.2
54MW9	7.40	0.674	36.8	8.48	111	9.65	20	<0.2
54MW10	7.46	0.707	1.1	6.06	118	11.16	15	<0.2
54MW11	7.59	0.763	6.8	5.09	101	11.40	30	<0.2
54MW12*	6.09	0.595	---	4.02	186	12.86	<5	<0.2
54MW13	7.45	0.687	226	7.63	25	11.53	35	<0.2
54MW14	7.48	0.651	0	1.66	61	12.91	5	<0.2

*Readings exhibited very high, unchanging turbidity.

Measurements conducted for the third quarter of SWMU 54 monitoring generally showed aerobic conditions for groundwater. Levels of dissolved oxygen in the wells ranged from 0 to 16.65 mg/L. ORP measurements in the wells ranged from 3 to 191 millivolts. Levels of pH were generally in the neutral range with measurements ranging from 6.09 to 7.59 standard units. Specific conductance measurements in the wells ranged from 0.489 to 1.11 millisiemens per centimeter.

Prior to sampling, the flow cell was disconnected and the groundwater flow rate was maintained during sample collection. Samples were collected, preserved, and packed in ice until shipment to the laboratory. COCs and temperature blanks accompanied the samples at all times. Copies of the COCs for the third quarter are provided in **Appendix B**.

4.4.3 Quality Control Samples

QC samples, including rinse blanks and duplicates, were collected during this field event.

Duplicate samples were collected at a rate of 10 percent, with two duplicate groundwater samples [54TM1 and 54TM5 (see **Table 4-2** for analytes)] obtained during the third quarter of groundwater sampling. MS/MSDs were collected at a rate of 5 percent. One MS/MSD was collected for each analyte class at well 54MW10 during the third quarter. Duplicate and MS/MSD samples were collected by homogenizing a large sample volume and splitting it into two samples for a duplicate and three samples for an MS/MSD.

One equipment rinse blank was collected during the sample event. Rinse blanks are collected for the same suite of parameters as the samples. Rinse blank sample, 54RB011912, was collected on January 19, 2012, by pouring de-ionized ultra-filtered water over decontaminated sampling equipment and into laboratory supplied bottles. Results of the QA/QC sample analysis are presented in **Appendix B**.

4.5 Groundwater Sampling – Fourth Quarter

Groundwater elevation measurements and groundwater samples were collected from 14 groundwater monitoring wells. Five pore water samples were collected along the New River. The fourth quarter of groundwater sampling was conducted April 16-19, 2012. Groundwater elevation measurements were collected prior to sampling activities. The locations of the wells are displayed on **Figure 4-1**.

4.5.1 Groundwater Elevation Measurements

Water levels were recorded at each of the 14 monitoring wells. **Table 4-8** presents the measured depth to water levels and groundwater elevations above msl. A groundwater elevation contour map was constructed from the groundwater elevation data collected during the fourth quarter and is presented on **Figure 4-5**.

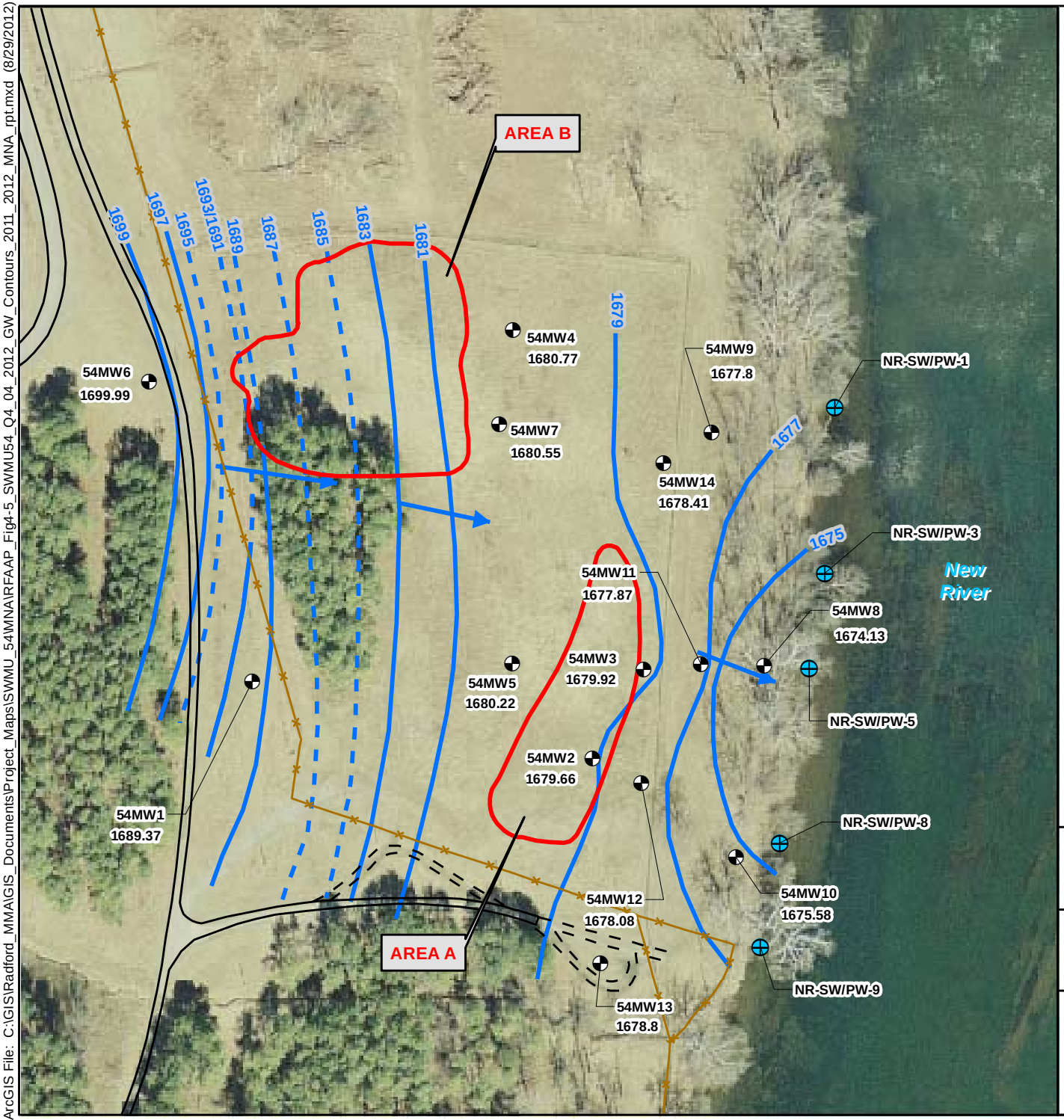
Estimated groundwater flow velocities were calculated for Area A and Area B based on parameters used in the *SWMU 54 RFI/CMS Report* (URS, 2008). The Area A flow path of approximately 525 ft had a groundwater elevation difference of 14 ft, resulting in a calculated hydraulic gradient of 0.027 ft/ft. Using an average K value for Area A of 4.86 ft/day and an estimated effective porosity of 0.20, the groundwater flow velocity for Area A is approximately 0.65 ft per day (236.5 ft/year).

The Area B flow path of approximately 600 ft had a groundwater elevation difference of 23 ft, resulting in a calculated hydraulic gradient of 0.038 ft/ft. Using an average K value for Area B of 4.55 ft/day and an estimated effective porosity of 0.20, the groundwater flow velocity for Area B is approximately 0.87 ft/day (318.3 ft/year).

Table 4-8
SWMU 54 Fourth Quarter Groundwater Elevations

Well ID	Elevation of TOC	DTW (ft TOC)	Water Level (ft msl)	Total Depth (ft TOC)
54MW1	1707.78	18.41	1689.37	62.0
54MW2	1701.41	21.75	1679.66	32.0
54MW3	1702.15	22.73	1679.42	36.0
54MW4	1696.14	15.37	1680.77	47.5
54MW5	1698.11	17.79	1680.32	25.0
54MW6	1739.19	39.20	1699.99	42.0
54MW7	1696.58	16.03	1680.55	23.0
54MW8	1692.64	18.51	1674.13	34.0
54MW9	1696.04	18.24	1677.80	28.5
54MW10	1691.10	15.52	1675.58	35.0
54MW11	1696.27	18.40	1677.87	31.0
54MW12	1702.42	24.33	1678.09	30.0
54MW13	1698.90	20.10	1678.80	22.0
54MW14	1700.66	22.25	1678.41	31.5

Notes:
TOC – Top of casing
DTW – Depth to water



LEGEND

- Monitoring Well
- Surface Water and Pore Water Sample Location
- Dirt Road
- Paved Road
- Railroad
- Fence
- Groundwater Contour
- Inferred Groundwater Contour
- Groundwater Flow Direction
- 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 4-5
SWMU 54
April 2012 Groundwater Contour Map
Radford Army Ammunition Plant,
Radford, VA

ArcGIS File: C:\GIS\Radford_MMA\GIS_Documents\Project_Maps\SWMU_54\MNA\RFAAP_Fig4-5_SWMU54_Q4_04_2012_GW_Contours_2011_2012_MNA_rpt.mxd (8/29/2012)

4.5.2 Groundwater Sampling

Groundwater samples were collected from each of the 14 monitoring wells on April 16-19, 2012. Samples from the fourth quarter were analyzed for the full analyte list presented in **Table 4-2**.

Groundwater samples were collected via low-flow sampling techniques to obtain representative groundwater samples and minimize waste purge water. The following procedures were followed during the groundwater sampling event. A PID reading was taken upon opening the well to determine if potentially hazardous levels of volatiles were present. All PID readings were within acceptable levels. Depth to water and total depth measurements were recorded to determine the amount of water in the well casing and sandpack. A submersible pump was lowered into the well until the pump inlet was at the midpoint of the screen. Water quality parameters, including temperature, pH, dissolved oxygen, redox potential, turbidity, and conductivity, were monitored continuously through a flow cell during well purging, and final stabilized readings were recorded. Upon completion of the stabilization, dissolved manganese and dissolved ferrous iron were tested via a field kit. **Table 4-9** presents a summary of the final, stabilized reading for each well.

Table 4-9
SWMU 54 Fourth Quarter Water Quality Parameters

Well ID	pH	Conductivity (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/kg)	ORP	Temperature (^{o}C)	Dissolved Manganese	Dissolved Ferrous Iron
54MW1	5.42	0.958	2.5	7.36	-30	13.37	<5	<0.2
54MW2	5.19	1.12	4.4	7.18	236	12.44	<5	<0.2
54MW3	5.38	1.46	2.4	2.24	225	12.02	10	<0.2
54MW4	5.33	0.001	125	23.45	180	11.56	5	<0.2
54MW5	4.99	0.891	70.1	10.47	168	20.98	<5	<0.2
54MW6	5.76	0.730	318	6.49	132	19.09	5	<0.2
54MW7	5.57	1.58	38.0	2.01	162	12.57	40	<0.2
54MW8	5.38	1.21	3.4	7.43	134	14.69	5	<0.2
54MW9	5.46	1.26	65.3	11.29	145	14.21	20	<0.2
54MW10	5.48	1.73	30.8	2.83	61	15.50	10	<0.2
54MW11	5.59	1.40	94.7	5.80	36	14.11	30	<0.2
54MW12	5.05	1.35	37	9.44	267	12.67	<5	<0.2
54MW13	5.32	0.981	312	7.10	116	15.52	35	<0.2
54MW14	5.50	1.20	36	5.55	149	12.69	<5	<0.2

Measurements conducted for the fourth quarter of SWMU 54 monitoring generally showed aerobic conditions for groundwater. Levels of dissolved oxygen in the wells ranged from 2.01 to 23.45 mg/L. ORP measurements in the wells ranged from -30 to 267 millivolts. Levels of pH were in the slightly acidic range with measurements ranging from 4.99 to 5.76 standard units. Specific conductance measurements in the wells ranged from 0.001 to 1.73 millisiemens per centimeter.

Prior to sampling, the flow cell was disconnected and the groundwater flow rate was maintained during sample collection. Samples were collected, preserved, and packed in ice until shipment to

the laboratory. COCs and temperature blanks accompanied the samples at all times. Copies of the COCs for the fourth quarter are provided in **Appendix B**.

4.5.3 Quality Control Samples

QC samples, including rinse blanks and duplicates, were collected during this field event.

Duplicate samples were collected at a rate of 10 percent, with two duplicate groundwater samples [54TM01 and 54TM02 (see **Table 4-2** for analytes)] obtained during the fourth quarter of groundwater sampling. MS/MSDs were collected at a rate of 5 percent. One MS/MSD was collected for each analyte class at well 54MW01 during the third quarter. Duplicate and MS/MSD samples were collected by homogenizing a large sample volume and splitting it into two samples for a duplicate and three samples for an MS/MSD.

One equipment rinse blank was collected during the sample event. Rinse blanks are collected for the same suite of parameters as the samples. Rinse blank sample, 54RB041912, was collected on April 19, 2012, by pouring de-ionized ultra-filtered water over decontaminated sampling equipment and into laboratory supplied bottles. Results of the QA/QC sample analysis are presented in **Appendix B**.

4.5.4 Pore Water Sampling

Pore water samples were collected from five locations along the New River on April 17, 2012. Pore samples from the fourth quarter were analyzed for the full analyte list presented in **Table 4-2**.

Pore water samples were collected via low-flow sampling techniques to obtain representative groundwater samples and minimize waste purge water. The following procedures were followed during the pore water sampling event. A PushPoint sampling device was inserted into the sediment approximately 6-8 inches below the sediment surface. A peristaltic pump was used to purge air in the tubing prior and draw pore water to the water level meter. A water level meter was used to monitor water quality parameters, including temperature, pH, dissolved oxygen, redox potential, turbidity, and conductivity. **Table 4-10** presents a summary of the final, stabilized reading for each pore water location.

Table 4-10
SWMU 54 Fourth Quarter Pore Water Quality Parameters

Well ID	pH	Conductivity (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/kg)	ORP	Temperature (^{o}C)
NR-SW/PW-1	5.43	0.488	15	12.31	-43	17.62
NR-SW/PW-3	5.46	0.421	12	12.34	-18	17.82
NR-SW/PW-5	5.32	0.383	7	10.84	-45	17.88
NR-SW/PW-8	5.05	0.780	9.4	12.45	-52	17.95
NR-SW/PW-9	7.02	0.606	14.2	11.10	-52	17.93

Measurements conducted for the pore water locations in the fourth quarter of SWMU 54 generally showed aerobic conditions. Levels of dissolved oxygen in the wells ranged from 10.84 to 12.45 mg/L. ORP measurements in the wells ranged from -52 to -18 millivolts. Levels of pH were in the slightly acidic range with measurements ranging from 5.05 to 7.02 standard units. Specific conductance measurements in the wells ranged from 0.383 to 0.780 millisiemens per centimeter.

Prior to sampling, the flow cell was disconnected and the pore water flow rate was maintained during sample collection. Samples were collected, preserved, and packed in ice until shipment to the laboratory. COCs and temperature blanks accompanied the samples at all times. Copies of the COCs for the fourth quarter are provided in **Appendix B**.

5.0 CHEMICAL ANALYTICAL RESULTS

5.1 Selection of Comparison Criteria

The chemical data collected during this investigation were compared to RGs selected in the *Final SWMU 54 RFI/CMS Report* (URS, 2008). **Tables 5-1** through **Table 5-10** present the sample results and summaries of the first through fourth quarter data, including number of RG exceedances, frequency of detection, the minimum and maximum detected concentrations, and the location of the maximum concentration.

5.2 First Quarter Groundwater Results

Fourteen groundwater monitoring wells were sampled during the first quarterly sampling event. Sample locations are shown on **Figure 4-1**. A duplicate sample was collected from monitoring well 54MW3 and 54MW12 and analyzed for explosives, perchlorate, and MNA indicator parameters. Groundwater samples were analyzed for explosives, perchlorate, and MNA indicator parameters. Detected constituents of concern are summarized in **Table 5-1** and presented in **Table 5-2**.

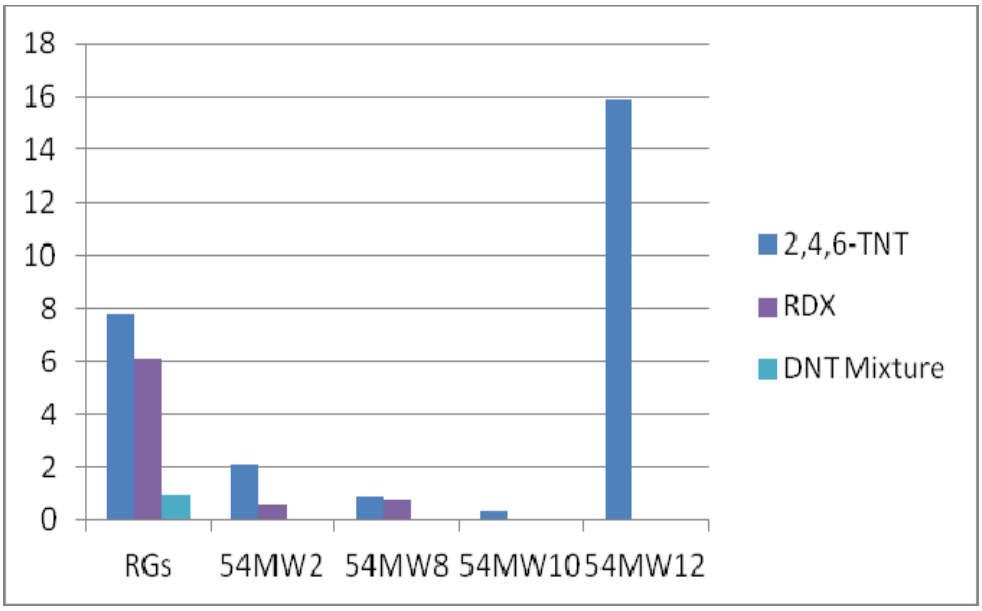
Explosives

2,4,6-TNT was detected in three wells (54MW2, 54MW8, 54MW10) at levels below RGs. RDX was detected in two wells (54MW2 and 54MW8). RDX concentrations in both wells were below RGs.

2,4,6-TNT and RDX were also detected at monitoring well 54MW12, however, upon validation, the data for 54MW12 was rejected. The data validation report for 54MW12 can be found in **Appendix B**.

The locations of detected explosives were typically consistent with the other sampling rounds. **Figure 5-1** depicts explosives concentrations for the four wells where explosives have been detected, as compared to RGs.

Figure 5-1 SWMU 54 Quarter One Summary of Detected Explosives Analytes (µg/L)

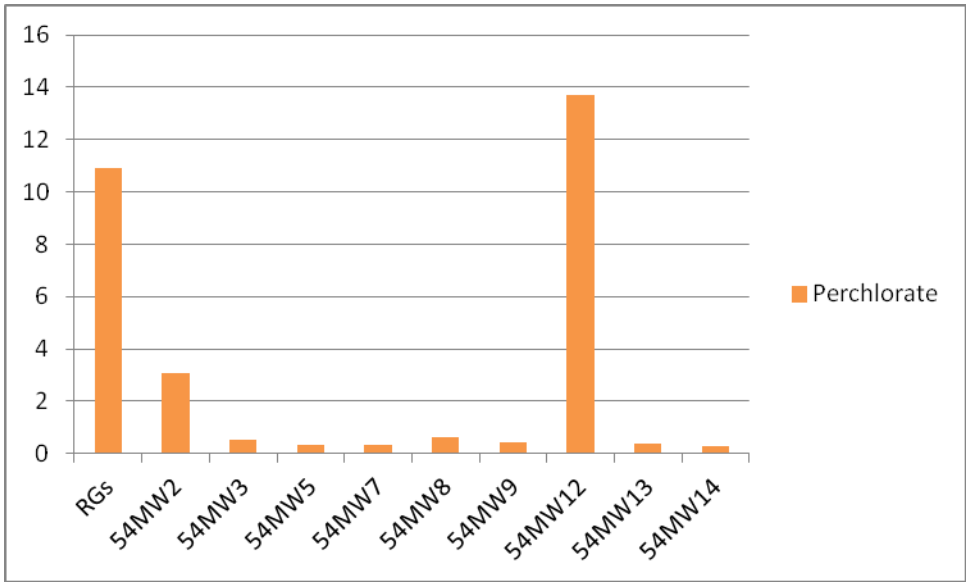


Perchlorate

Perchlorate was detected in nine samples (54MW2, 54MW3, 54MW5, 54MW7 through 54MW9, and 54MW12 through 54MW14) collected in the first quarter MNA sampling. Perchlorate exceeded its RG in 54MW12, with a concentration of 13.7 µg/L.

Figure 5-2 depicts the detected perchlorate concentrations as compared to RGs.

Figure 5-2 SWMU 54 Quarter One Summary of Detected Perchlorate (µg/L)



Miscellaneous Analytes

Groundwater samples were also analyzed for MNA indicators (TOC, DIC, dissolved ferrous iron, dissolved manganese, nitrate, and sulfate) for the purposes of establishing a baseline concentration of theses analytes.

Levels of TOC in the wells ranged from 1.95 to 7.26 mg/L. Levels of DIC ranged from 9.83 to 73.5 mg/L. Dissolved ferrous iron was measured at levels below 0.2 mg/L and dissolved manganese ranged from <5 to 65 mg/L. Nitrate was detected between 0.119 and 2.82 mg/L. Finally, sulfate detections ranged from 15.1 to 329 mg/L.

MNA indicators are displayed in **Table 4-3** and **Table 5-2**.

Table 5-1
SWMU 54 Summary of First Quarter Groundwater Samples

	RG	# of RG Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
Explosives (ug/L)							
2,4,6-Trinitrotoluene	7.82	0	3	14	0.305	2.1	54MW02
2,4-Dinitrotoluene	0.932*	0	0	14	na	na	na
2,6-Dinitrotoluene	0.932*	0	0	14	na	na	na
RDX	6.1	0	2	14	0.572	0.761	54MW08
Misc. (mg/L)							
Perchlorate (ug/L)	10.9	1	9	14	0.254	13.7	54MW12
Total Organic Carbon	na	na	14	14	1610	7260	54MW03
Chloride	na	na	14	14	1630	16700	54MW13
Nitrate (as N)	na	na	9	14	119	2790	54MW12
Sulfate	na	na	14	14	15100	329000	54MW04

*DNT remedial goal is for the DNT mixture

Table 5-2
SWMU 54 Detected Analytes in First Quarter Groundwater Samples
Page 1 of 1

Analyte	Sample ID / Sample Date	54MW01 7/13/11					54MW02 7/13/11					54MW03 7/11/11					54MW04 7/13/11					54MW05 7/13/11				
	RG	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Explosives (ug/L)																										
2,4,6-Trinitrotoluene	7.8	1.02	U		*0.255*	*1.02*	2.1			*0.255*	*1.02*	1.02	UJ	UL	*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*
2,4-Dinitrotoluene	0.932*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	1.02	UJ	UL	*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*
2,6-Dinitrotoluene	0.932*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	1.02	UJ	UL	*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*
RDX	6.1	1.02	U		*0.255*	*1.02*	0.572	J	J	*0.255*	*1.02*	1.02	UJ	UL	*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*
Misc. (mg/L)																										
Perchlorate (ug/L)	10.9	0.2	U		*0.1*	*0.2*	3.07			*0.1*	*0.2*	0.53			*0.1*	*0.2*	0.2	U		*0.1*	*0.2*	0.311			*0.1*	*0.2*
Total Organic Carbon	na	3310			*500*	*1000*	3510		J	*1000*	*2000*	7260		J	*500*	*1000*	2510		J	*500*	*1000*	6140		J	*500*	*1000*
Chloride	na	1630			*100*	*200*	3950			*100*	*200*	4220			*100*	*200*	2190			*200*	*400*	2310			*100*	*200*
Nitrate (as N)	na	600	U		*100*	*600*	1090			*100*	*600*	967			*100*	*600*	1200	U		*200*	*1200*	613			*100*	*600*
Sulfate	na	25200			*500*	*1000*	39800			*500*	*1000*	23600			*500*	*1000*	329000			*1000*	*2000*	15100			*500*	*1000*

Analyte	Sample ID / Sample Date	54MW06 7/13/11					54MW07 7/13/11					54MW08 7/12/11					54MW09 7/12/11					54MW10 7/12/11				
	RG	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Explosives (ug/L)																										
2,4,6-Trinitrotoluene	7.8	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	0.928	J	J	*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	0.305	J	J	*0.255*	*1.02*
2,4-Dinitrotoluene	0.932*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*
2,6-Dinitrotoluene	0.932*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*
RDX	6.1	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	0.761	J	J	*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*
Misc. (mg/L)																										
Perchlorate (ug/L)	10.9	0.2	U		*0.1*	*0.2*	0.321			*0.1*	*0.2*	0.634			*0.1*	*0.2*	0.449			*0.1*	*0.2*	0.2	U		*0.1*	*0.2*
Total Organic Carbon	na	1950		J	*500*	*1000*	3170		J	*500*	*1000*	6050		J	*500*	*1000*	5100		J	*500*	*1000*	1610	J	J	*1000*	*2000*
Chloride	na	2090			*100*	*200*	1740			*100*	*200*	4000			*100*	*200*	6110			*100*	*200*	3070			*100*	*200*
Nitrate (as N)	na	600	U		*100*	*600*	119	J	J	*100*	*600*	639			*100*	*600*	233	J	J	*100*	*600*	600	U		*100*	*600*
Sulfate	na	27400			*500*	*1000*	61500			*500*	*1000*	40000			*500*	*1000*	62200			*500*	*1000*	167000			*500*	*1000*

Analyte	Sample ID / Sample Date	54MW11 7/12/11					54MW12 7/11/11					54MW13 7/12/11					54MW14 7/11/11				
	RG	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Explosives (ug/L)																					
2,4,6-Trinitrotoluene	7.8	1.02	U		*0.255*	*1.02*	15.9		R	*0.25*	*1*	1.09	UJ	UL	*0.272*	*1.09*	1.02	U		*0.255*	*1.02*
2,4-Dinitrotoluene	0.932*	1.02	U		*0.255*	*1.02*	1	U	R	*0.25*	*1*	1.09	UJ	UL	*0.272*	*1.09*	1.02	U		*0.255*	*1.02*
2,6-Dinitrotoluene	0.932*	1.02	U		*0.255*	*1.02*	1	U	R	*0.25*	*1*	1.09	UJ	UL	*0.272*	*1.09*	1.02	U		*0.255*	*1.02*
RDX	6.1	1.02	U		*0.255*	*1.02*	1	U	R	*0.25*	*1*	1.09	UJ	UL	*0.272*	*1.09*	1.02	U		*0.255*	*1.02*
Misc. (mg/L)																					
Perchlorate (ug/L)	10.9	0.2	U		*0.1*	*0.2*	13.7			*0.5*	*1*	0.382			*0.1*	*0.2*	0.254		J	*0.1*	*0.2*
Total Organic Carbon	na	5970		J	*500*	*1000*	2640		J	*1000*	*2000*	2550		J	*1000*	*2000*	6730		J	*500*	*1000*
Chloride	na	3610			*100*	*200*	3120			*100*	*200*	16700			*100*	*200*	5000			*100*	*200*
Nitrate (as N)	na	600	U		*100*	*600*	2790			*100*	*600*	439	J	J	*100*	*600*	242	J	J	*100*	*600*
Sulfate	na	93600			*500*	*1000*	38100			*500*	*1000*	38800			*500*	*1000*	33600			*500*	*1000*

12	J	Bold outline indicates a RG exceedance.

*DNT remedial goal is for the DNT mixture

Data Qualifiers:
J = Analyte present. Reported value may not be accurate or precise.
R = Unreliable rejected result.
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.

5.3 Second Quarter Groundwater Results

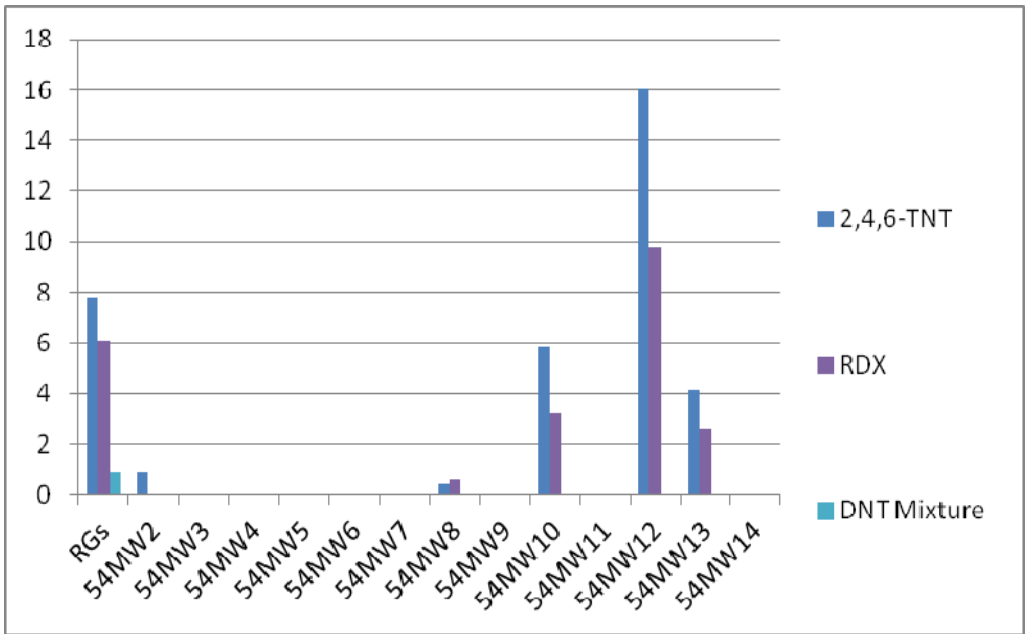
Fourteen groundwater monitoring wells were sampled during the second quarterly sampling event. Sample locations are shown on **Figure 4-1**. Duplicate samples were collected from monitoring wells 54MW6 and 54MW14 (54TM06 and 54TM14, respectively). Groundwater samples were analyzed for explosives, perchlorate and MNA indicator parameters. Detected constituents are summarized in **Table 5-3** and presented in **Table 5-4**.

Explosives

2,4,6-TNT and RDX were detected in the groundwater samples. 2,4,6-TNT was detected in five wells (54MW2, 54MW8, 54MW10, 54MW12, and 54MW13). 2,4,6-TNT exceeded its RG in one well (54MW12), with a concentration of 16.1 µg/L. RDX was detected in four wells (54MW8, 54MW10, 54MW12, and 54MW13). RDX concentrations exceeded RGs in 54MW12, with a concentration of 9.77 µg/L.

Figure 5-3 depicts explosives concentrations for the wells where explosives have been detected, as compared to RGs.

Figure 5-3 SWMU 54 Quarter Two Summary of Detected Explosives Analytes (µg/L)

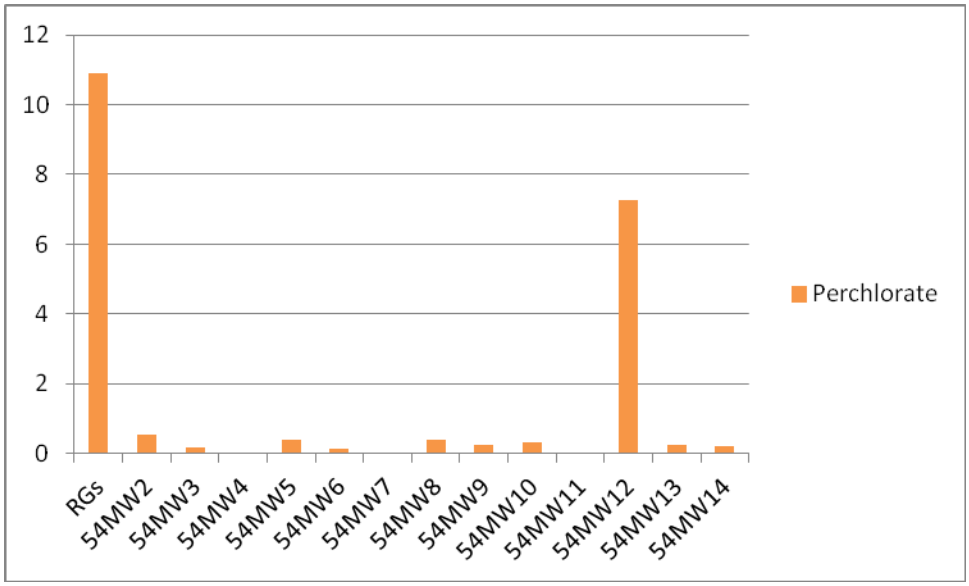


Perchlorate

Perchlorate was detected in ten samples (54MW2, 54MW3, 54MW5 through 54MW10, and 54MW12 through 54MW14) collected in the second quarter MNA sampling. Perchlorate concentrations did not exceed RGs in the second quarter MNA sampling.

Figure 5-4 depicts the detected perchlorate concentrations as compared to RGs.

Figure 5-4 SWMU 54 Quarter Two Summary of Detected Perchlorate (µg/L)



Miscellaneous Analyses

Groundwater samples were also analyzed for MNA indicators (TOC, DIC, dissolved ferrous iron, dissolved manganese, nitrate, and sulfate) for the purposes of establishing a baseline concentration of the analytes.

Levels of TOC in the wells ranged from 1.31 to 33.1 mg/L. Levels of DIC ranged from 26.7 to 80.7 mg/L. Dissolved ferrous iron was measured at levels below 0.2 mg/L and dissolved manganese ranged from <5 to 40 mg/L. Nitrate was detected between 0.138 and 2.00 mg/L. Finally, sulfate detections ranged from 7.06 to 216 mg/L.

MNA indicators are displayed in **Table 4-5** and **Table 5-4**.

Table 5-3
SWMU 54 Summary of Second Quarter Groundwater Samples

	RG	# of RG Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
Explosives (ug/L)							
2,4,6-Trinitrotoluene	7.82	1	5	14	0.433	16.1	54MW12
2,4-Dinitrotoluene	0.932*	0	0	14	na	na	na
2,6-Dinitrotoluene	0.932*	0	0	14	na	na	na
RDX	6.1	1	4	14	0.567	9.77	54MW12
Misc.							
Perchlorate	10.9	0	10	14	0.127	7.26	54MW12
Total Organic Carbon	na	na	14	14	1310	33100	54MW13
Chloride	na	na	14	14	950	9000	54MW13
Nitrate (as N)	na	na	10	14	167	2000	54MW12
Sulfate	na	na	14	14	7060	216000	54MW07

*DNT remedial goal is for the DNT mixture

Table 5-4
SWMU 54 Detected Analytes in Second Quarter Groundwater Samples

Analyte	Sample ID	54MW01					54MW02					54MW03					54MW04					54MW05				
	Sample Date	10/5/11					10/4/11					10/4/11					10/6/11					10/6/11				
	RG	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Explosives (ug/L)																										
2,4,6-Trinitrotoluene	7.8	1.03	U		*0.258*	*1.03*	0.9	J	J	*0.26*	*1.04*	1.05	U		*0.263*	*1.05*	1.03	U		*0.258*	*1.03*	1.04	U		*0.26*	*1.04*
2,4-Dinitrotoluene	0.932*	1.03	U		*0.258*	*1.03*	1.04	U		*0.26*	*1.04*	1.05	U		*0.263*	*1.05*	1.03	U		*0.258*	*1.03*	1.04	U		*0.26*	*1.04*
2,6-Dinitrotoluene	0.932*	1.03	U		*0.258*	*1.03*	1.04	U		*0.26*	*1.04*	1.05	U		*0.263*	*1.05*	1.03	U		*0.258*	*1.03*	1.04	U		*0.26*	*1.04*
RDX	6.1	1.03	U		*0.258*	*1.03*	1.04	U		*0.26*	*1.04*	1.05	U		*0.263*	*1.05*	1.03	U		*0.258*	*1.03*	1.04	U		*0.26*	*1.04*
Misc. (mg/L)																										
Perchlorate (ug/L)	10.9	0.2	U		*0.1*	*0.2*	0.547			*0.1*	*0.2*	0.18	J	J	*0.1*	*0.2*	0.2	U		*0.1*	*0.2*	0.393			*0.1*	*0.2*
Total Organic Carbon	na	3900		J	*500*	*1000*	3200		B	*500*	*1000*	3220		B	*500*	*1000*	1380		B	*500*	*1000*	1880		B	*500*	*1000*
Chloride	na	2440			*100*	*200*	4560			*100*	*200*	4170			*100*	*200*	3370			*200*	*400*	3910			*100*	*200*
Nitrate (as N)	na	600	U		*100*	*600*	394	J	J	*100*	*600*	357	J	J	*100*	*600*	1200	U		*200*	*1200*	568	J	J	*100*	*600*
Sulfate	na	27100			*500*	*1000*	27000		K	*500*	*1000*	44400		K	*500*	*1000*	210000			*2500*	*5000*	17400			*500*	*1000*

Analyte	Sample ID	54MW06					54MW07					54MW08					54MW09					54MW10				
	Sample Date	10/5/11					10/6/11					10/5/11					10/5/11					10/5/11				
	RG	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Explosives (ug/L)																										
2,4,6-Trinitrotoluene	7.8	1.04	U		*0.26*	*1.04*	1.02	U		*0.255*	*1.02*	0.433	J	J	*0.258*	*1.03*	1.05	U		*0.263*	*1.05*	5.84			*0.263*	*1.05*
2,4-Dinitrotoluene	0.932*	1.04	U		*0.26*	*1.04*	1.02	U		*0.255*	*1.02*	1.03	U		*0.258*	*1.03*	1.05	U		*0.263*	*1.05*	1.05	U		*0.263*	*1.05*
2,6-Dinitrotoluene	0.932*	1.04	U		*0.26*	*1.04*	1.02	U		*0.255*	*1.02*	1.03	U		*0.258*	*1.03*	1.05	U		*0.263*	*1.05*	1.05	U		*0.263*	*1.05*
RDX	6.1	1.04	U		*0.26*	*1.04*	1.02	U		*0.255*	*1.02*	0.567	J	J	*0.258*	*1.03*	1.05	U		*0.263*	*1.05*	3.24		J	*0.263*	*1.05*
Misc. (mg/L)																										
Perchlorate (ug/L)	10.9	0.127	J	J	*0.1*	*0.2*	0.2	U		*0.1*	*0.2*	0.408			*0.1*	*0.2*	0.229		J	*0.1*	*0.2*	0.325			*0.1*	*0.2*
Total Organic Carbon	na	2680		B	*500*	*1000*	1310		B	*500*	*1000*	7470		J	*500*	*1000*	6780		J	*500*	*1000*	6980		J	*500*	*1000*
Chloride	na	950		J	*100*	*200*	2860			*200*	*400*	4550			*100*	*200*	4930			*100*	*200*	4630			*100*	*200*
Nitrate (as N)	na	167	J	J	*100*	*600*	1200	U		*200*	*1200*	514	J	J	*100*	*600*	184	J	J	*100*	*600*	388	J	J	*100*	*600*
Sulfate	na	7060			*500*	*1000*	216000			*1000*	*2000*	39900			*500*	*1000*	46900			*500*	*1000*	96700			*500*	*1000*

Analyte	Sample ID	54MW11					54MW12					54MW13					54MW14				
	Sample Date	10/5/11					10/4/11					10/4/11					10/4/11				
	RG	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Explosives (ug/L)																					
2,4,6-Trinitrotoluene	7.8	1.05	U		*0.263*	*1.05*	16.1			*0.26*	*1.04*	4.09			*0.263*	*1.05*	1.05	U		*0.263*	*1.05*
2,4-Dinitrotoluene	0.932*	1.05	U		*0.263*	*1.05*	1.04	U		*0.26*	*1.04*	1.05	U		*0.263*	*1.05*	1.05	U		*0.263*	*1.05*
2,6-Dinitrotoluene	0.932*	1.05	U		*0.263*	*1.05*	1.04	U		*0.26*	*1.04*	1.05	U		*0.263*	*1.05*	1.05	U		*0.263*	*1.05*
RDX	6.1	1.05	U		*0.263*	*1.05*	9.77			*0.26*	*1.04*	2.59		J	*0.263*	*1.05*	1.05	U		*0.263*	*1.05*
Misc. (mg/L)																					
Perchlorate (ug/L)	10.9	0.2	U		*0.1*	*0.2*	7.26			*0.1*	*0.2*	0.244		J	*0.1*	*0.2*	0.215		J	*0.1*	*0.2*
Total Organic Carbon	na	3220	J	B	*2500*	*5000*	4710		J	*500*	*1000*	33100			*2500*	*5000*	4640		J	*500*	*1000*
Chloride	na	3610			*100*	*200*	3310			*100*	*200*	9000			*100*	*200*	4450			*100*	*200*
Nitrate (as N)	na	600	U		*100*	*600*	2000			*100*	*600*	210	J	J	*100*	*600*	202	J	J	*100*	*600*
Sulfate	na	119000			*500*	*1000*	31800		K	*500*	*1000*	90200		K	*500*	*1000*	34100		K	*500*	*1000*

12 J Bold outline indicates a RG exceedance.

*DNT remedial goal is for the DNT mixture

Data Qualifiers:

B = Not detected substantially above the level reported in laboratory or field blanks.

J = Analyte present. Reported value may not be accurate or precise.

K = Estimated concentration bias high.

U = Not detected. The associated number indicates the approximate sample concentration necessary to be detected.

5.4 Third Quarter Groundwater Results

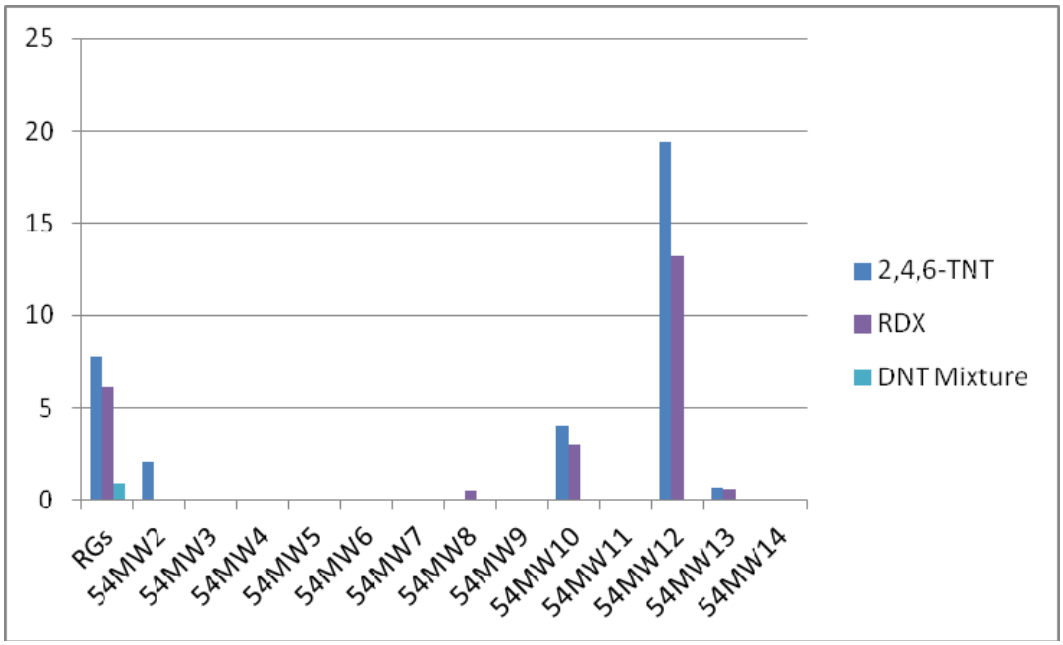
Fourteen groundwater monitoring wells were sampled during the third quarterly sampling event. Sample locations are shown on **Figure 4-1**. Duplicate samples were collected from monitoring wells 54MW1 and 54MW5 (54TM1 and 54TM5, respectively) for explosives, perchlorate, and MNA indicator parameters). Groundwater samples were analyzed for explosives, perchlorate and MNA indicator parameters. Detected constituents of concern are summarized in **Table 5-5** and presented in **Table 5-6**.

Explosives

2,4,6-TNT and RDX were detected in the groundwater samples. 2,4,6-TNT was detected in four wells (54MW2, 54MW10, 54MW12, and 54MW13). 2,4,6-TNT exceeded its RG in one well (54MW12), with a concentration of 19.4 µg/L. RDX was detected in four wells (54MW8, 54MW10, 54MW12, and 54MW13). RDX concentrations exceeded RGs in 54MW12, with a concentration of 13.2 µg/L.

Figure 5-5 depicts explosives concentrations for the wells where explosives have been detected, as compared to RGs.

Figure 5-5 SWMU 54 Quarter Three Summary of Detected Explosives Analytes (µg/L)

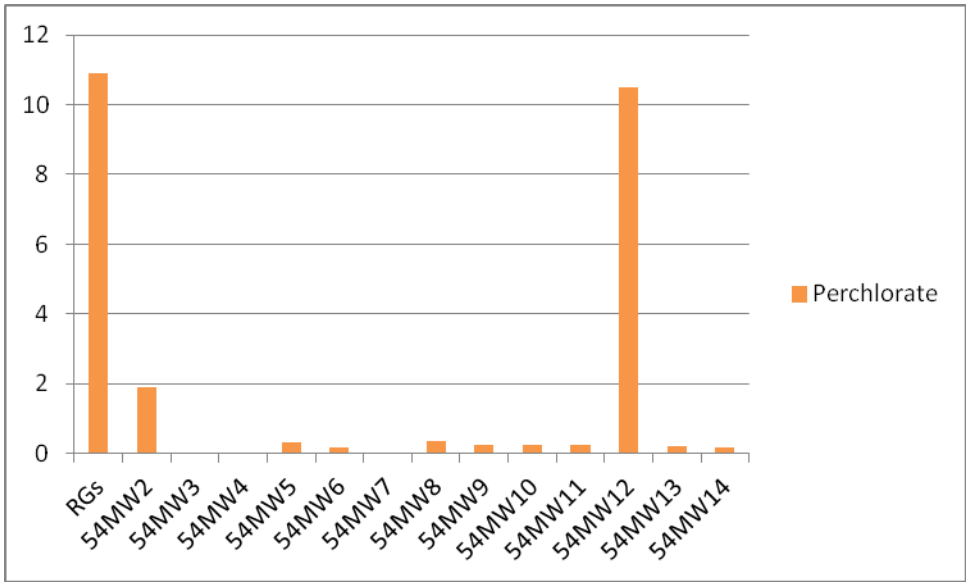


Perchlorate

Perchlorate was detected in 10 samples (54MW2, 54MW5, 54MW6, 54MW8 through 54MW14) collected in the third quarter MNA sampling. Perchlorate concentrations did not exceed RGs in the third quarter MNA sampling.

Figure 5-6 depicts the detected perchlorate concentrations as compared to RGs.

Figure 5-6 SWMU 54 Quarter Three Summary of Detected Perchlorate (µg/L)



Miscellaneous Analyses

Groundwater samples were also analyzed for MNA indicators (TOC, DIC, dissolved ferrous iron, dissolved manganese, nitrate, and sulfate) for the purposes of establishing a baseline concentration of the analyses.

Levels of TOC in the wells ranged from 1.16 to 6.71 mg/L. Levels of DIC ranged from 27.8 to 68.1 mg/L. Dissolved ferrous iron was measured at levels below 0.2 mg/L and dissolved manganese ranged from <5 to 40 mg/L. Nitrate was detected between 0.158 and 1.94 mg/L. Finally, sulfate detections ranged from 20.2 to 480 mg/L.

MNA indicators are displayed in **Table 4-7** and **Table 5-6**.

Table 5-5
SWMU 54 Summary of Third Quarter Groundwater Samples

	RG	# of RG Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
Explosives (ug/L)							
2,4,6-Trinitrotoluene	7.82	1	4	14	0.699	19.4	54MW12
2,4-Dinitrotoluene	0.932*	0	0	14	na	na	na
2,6-Dinitrotoluene	0.932*	0	0	14	na	na	na
RDX	6.1	1	4	14	0.493	13.2	54MW12
Misc.							
Perchlorate	10.9	0	10	14	0.159	10.5	54MW12
Total Organic Carbon	na	na	14	14	1160	6710	54MW11
Chloride	na	na	14	14	1020	5690	54MW5
Nitrate (as N)	na	na	10	14	158	1940	54MW12
Sulfate	na	na	14	14	4550	480000	54MW4

*DNT remedial goal is for the DNT mixture

Table 5-6
SWMU 54 Detected Analytes in Third Quarter Groundwater Samples

Analyte	Sample ID / Sample Date	RG	54MW1 1/17/12					54MW2 1/19/12					54MW3 1/19/12					54MW4 1/17/12					54MW5 1/17/12				
			Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Explosives (ug/L)																											
2,4,6-Trinitrotoluene	7.8		1.08	U		*0.269*	*1.08*	2.08			*0.25*	*1*	1.02	U		*0.255*	*1.02*	1.11	U		*0.278*	*1.11*	1.11	U		*0.278*	*1.11*
2,4-Dinitrotoluene	0.932*		1.08	U		*0.269*	*1.08*	1	U		*0.25*	*1*	1.02	U		*0.255*	*1.02*	1.11	U		*0.278*	*1.11*	1.11	U		*0.278*	*1.11*
2,6-Dinitrotoluene	0.932*		1.08	U		*0.269*	*1.08*	1	U		*0.25*	*1*	1.02	U		*0.255*	*1.02*	1.11	U		*0.278*	*1.11*	1.11	U		*0.278*	*1.11*
RDX	6.1		1.08	U		*0.269*	*1.08*	1	U		*0.25*	*1*	1.02	U		*0.255*	*1.02*	1.11	U		*0.278*	*1.11*	1.11	U		*0.278*	*1.11*
Misc. (mg/L)																											
Perchlorate (ug/L)	10.9		0.2	U		*0.1*	*0.2*	1.91			*0.1*	*0.2*	0.2	U		*0.1*	*0.2*	0.2	U		*0.1*	*0.2*	0.313			*0.1*	*0.2*
Total Organic Carbon	na		2100		B	*500*	*1000*	1800		B	*500*	*1000*	2390		B	*500*	*1000*	1160		B	*500*	*1000*	1420	J	B	*1000*	*2000*
Chloride	na		2380			*100*	*200*	4970			*100*	*200*	4360			*100*	*200*	1550			*200*	*400*	5690			*100*	*200*
Nitrate (as N)	na		600	U		*100*	*600*	609			*100*	*600*	600	U		*100*	*600*	1200	U		*200*	*1200*	578	J	J	*100*	*600*
Sulfate	na		26300			*500*	*1000*	28200			*500*	*1000*	73700			*500*	*1000*	480000	J	J	*1000*	*2000*	20300			*500*	*1000*

Analyte	Sample ID / Sample Date	RG	54MW6 1/17/12					54MW7 1/17/12					54MW8 1/18/12					54MW9 1/18/12					54MW10 1/18/12				
			Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Explosives (ug/L)																											
2,4,6-Trinitrotoluene	7.8		1.09	U		*0.272*	*1.09*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	1	U		*0.25*	*1*	4.05			*0.25*	*1*
2,4-Dinitrotoluene	0.932*		1.09	U		*0.272*	*1.09*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	1	U		*0.25*	*1*	1	U		*0.25*	*1*
2,6-Dinitrotoluene	0.932*		1.09	U		*0.272*	*1.09*	1.02	U		*0.255*	*1.02*	1.02	U		*0.255*	*1.02*	1	U		*0.25*	*1*	1	U		*0.25*	*1*
RDX	6.1		1.09	U		*0.272*	*1.09*	1.02	U		*0.255*	*1.02*	0.493	J	J	*0.255*	*1.02*	1	U		*0.25*	*1*	2.95			*0.25*	*1*
Misc. (mg/L)																											
Perchlorate (ug/L)	10.9		0.159	J	J	*0.1*	*0.2*	0.2	U		*0.1*	*0.2*	0.355			*0.1*	*0.2*	0.262		J	*0.1*	*0.2*	0.258		J	*0.1*	*0.2*
Total Organic Carbon	na		1940		B	*500*	*1000*	2380		B	*500*	*1000*	1660	J	B	*1000*	*2000*	2780	J	B	*1500*	*3000*	1660	J	B	*1000*	*2000*
Chloride	na		1020			*100*	*200*	2320			*200*	*400*	4970		L	*100*	*200*	5090		L	*100*	*200*	5210		L	*100*	*200*
Nitrate (as N)	na		158	J	J	*100*	*600*	1200	U		*200*	*1200*	401	J	J	*100*	*600*	174	J	J	*100*	*600*	572	J	J	*100*	*600*
Sulfate	na		4550			*500*	*1000*	249000	J	J	*1000*	*2000*	41500			*500*	*1000*	62500			*500*	*1000*	72700			*500*	*1000*

Analyte	Sample ID / Sample Date	RG	54MW11 1/18/12					54MW12 1/18/12					54MW13 1/17/12					54MW14 1/19/12				
			Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Explosives (ug/L)																						
2,4,6-Trinitrotoluene	7.8		1	U		*0.25*	*1*	**19.4**			*0.255*	*1.02*	0.699	J	J	*0.266*	*1.06*	1.02	U		*0.255*	*1.02*
2,4-Dinitrotoluene	0.932*		1	U		*0.25*	*1*	1.02	U		*0.255*	*1.02*	1.06	U		*0.266*	*1.06*	1.02	U		*0.255*	*1.02*
2,6-Dinitrotoluene	0.932*		1	U		*0.25*	*1*	1.02	U		*0.255*	*1.02*	1.06	U		*0.266*	*1.06*	1.02	U		*0.255*	*1.02*
RDX	6.1		1	U		*0.25*	*1*	**13.2**		J	*0.255*	*1.02*	0.614	J	J	*0.266*	*1.06*	1.02	U		*0.255*	*1.02*
Misc. (mg/L)																						
Perchlorate (ug/L)	10.9		0.239		J	*0.1*	*0.2*	10.5			*0.2*	*0.4*	0.206		J	*0.1*	*0.2*	0.181	J	J	*0.1*	*0.2*
Total Organic Carbon	na		6710			*2500*	*5000*	5090		J	*2500*	*5000*	6630		J	*2500*	*5000*	1680		B	*500*	*1000*
Chloride	na		3860		L	*100*	*200*	4940		L	*100*	*200*	3470			*100*	*200*	5490			*100*	*200*
Nitrate (as N)	na		158	J	J	*100*	*600*	1940			*100*	*600*	237	J	J	*100*	*600*	241	J	J	*100*	*600*
Sulfate	na		93000			*500*	*1000*	37600			*500*	*1000*	53900			*500*	*1000*	32200			*500*	*1000*

12	J	Bold outline indicates a RG exceedance.

*DNT remedial goal is for the DNT mixture

Data Qualifiers:

B = Not detected substantially above the level reported in laboratory or field blanks.

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.

U = Not detected. The associated number indicates the approximate sample concentration necessary to be detected.

5.5 Fourth Quarter Groundwater Results

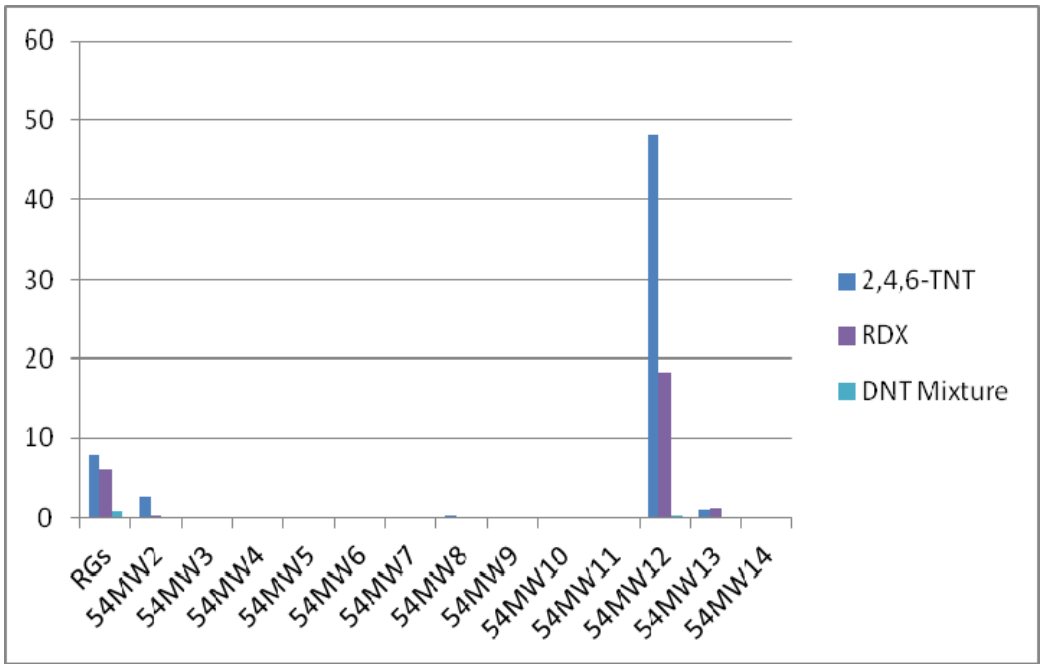
Fourteen groundwater monitoring wells were sampled during the fourth quarterly sampling event. Sample locations are shown on **Figure 4-1**. Duplicate samples were collected from monitoring wells 54MW1 and 54MW2 (54TM01 and 54TM02, respectively) for explosives, perchlorate, and MNA indicator parameters). Groundwater samples were analyzed for explosives, perchlorate, and MNA indicator parameters. Detected constituents of concern are summarized in **Table 5-7** and presented in **Table 5-8**.

Explosives

Three explosives (2,4,6-TNT, RDX, and 2,6-DNT) were detected in the groundwater samples. 2,4,6-TNT was detected in four wells (54MW2, 54MW8, 54MW12, and 54MW13). 2,4,6-TNT exceeded its RG in one well (54MW12), with a concentration of 48.1 µg/L. RDX was detected in three wells (54MW2, 54MW12, and 54MW13). RDX concentrations exceeded RGs in 54MW12, with a concentration of 18.4µg/L. 2,6-DNT was detected in well 54MW12 below the RGs.

Figure 5-7 depicts explosives concentrations for the wells where explosives have been detected, as compared to RGs.

Figure 5-7 SWMU 54 Quarter Four Summary of Detected Explosives Analytes (µg/L)



Perchlorate

Perchlorate was detected in eight samples (54MW2, 54MW5, 54MW7 through 54MW9, and 54MW12 through 54MW14) collected in the fourth quarter MNA sampling. Perchlorate concentrations exceeded RGs at 54MW12 with a concentration of 18.4µg/L.

Figure 5-8 depicts the detected perchlorate concentrations as compared to RGs.

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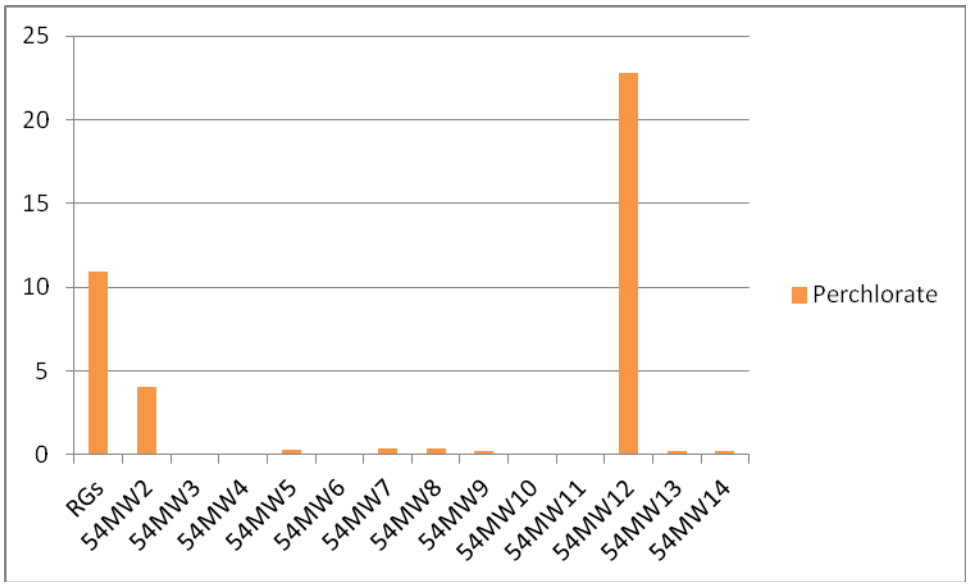
Figure 5-8 SWMU 54 Quarter Four Summary of Detected Perchlorate (µg/L)



Miscellaneous Analyses

Groundwater samples were also analyzed for MNA indicators (TOC, DIC, dissolved ferrous iron, dissolved manganese, nitrate, and sulfate) for the purposes of establishing a baseline concentration of the analyses.

Levels of TOC in the wells ranged from 0.990 to 5.46 mg/L. Levels of DIC ranged from 7.09 to 67.0 mg/L. Dissolved ferrous iron was measured at levels below 0.2 mg/L and dissolved manganese ranged from <5 to 40 mg/L. Nitrate was detected between 0.129 and 2.65 mg/L. Finally, sulfate detections ranged from 14.0 to 331 mg/L.

MNA indicators are displayed in **Table 4-9** and **Table 5-8**.

Table 5-7
SWMU 54 Summary of Fourth Quarter Groundwater Samples

	RG	# of RG Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
Explosives (ug/L)							
2,4,6-Trinitrotoluene	7.82	1	4	14	0.301	48.1	54MW12
2,4-Dinitrotoluene	0.932*	0	0	14	na	na	na
2,6-Dinitrotoluene	0.932*	0	1	14	0.381	0.381	54MW12
RDX	6.1	1	3	14	0.384	18.4	54MW12
Misc.							
Perchlorate	10.9	1	8	14	0.214	22.8	54MW12
Total Organic Carbon	na	na	14	14	990	5460	54MW06
Chloride	na	na	14	14	932	5160	54MW9
Nitrate (as N)	na	na	9	14	129	2650	54MW12
Sulfate	na	na	14	14	14000	331000	54MW04

*DNT remedial goal is for the DNT mixture

Table 5-8
SWMU 54 Detected Analytes in Fourth Quarter Groundwater Samples

Analyte	Sample ID	54MW01					54MW2					54MW3					54MW04					54MW05				
	Sample Date	4/16/12					4/18/12					4/18/12					4/19/12					4/16/12				
	RG	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Explosives (ug/L)																										
2,4,6-Trinitrotoluene	7.8	1.11	U		*0.278*	*1.11*	2.66			*0.278*	*1.11*	1.09	U		*0.272*	*1.09*	1	U		*0.25*	*1*	1.1	U		*0.275*	*1.1*
2,4-Dinitrotoluene	0.932*	1.11	U		*0.278*	*1.11*	1.11	U		*0.278*	*1.11*	1.09	U		*0.272*	*1.09*	1	U		*0.25*	*1*	1.1	U		*0.275*	*1.1*
2,6-Dinitrotoluene	0.932*	1.11	U		*0.278*	*1.11*	1.11	U		*0.278*	*1.11*	1.09	U		*0.272*	*1.09*	1	U		*0.25*	*1*	1.1	U		*0.275*	*1.1*
RDX	6.1	1.11	U		*0.278*	*1.11*	0.384	J	J	*0.278*	*1.11*	1.09	U		*0.272*	*1.09*	1	U		*0.25*	*1*	1.1	U		*0.275*	*1.1*
Misc.																										
Perchlorate	10.9	0.2	U		*0.1*	*0.2*	4.02			*0.1*	*0.2*	0.2	U		*0.1*	*0.2*	0.2	U		*0.1*	*0.2*	0.301			*0.1*	*0.2*
Total Organic Carbon	na	1800		B	*500*	*1000*	1570	J	B	*1000*	*2000*	1180	J	B	*1000*	*2000*	1820		B	*500*	*1000*	2330		B	*500*	*1000*
Chloride	na	2310			*100*	*200*	4140			*100*	*200*	4270			*100*	*200*	1980			*100*	*200*	3830			*100*	*200*
Nitrate (as N)	na	600	U		*100*	*600*	1330			*100*	*600*	600	U		*100*	*600*	600	U		*100*	*600*	677			*100*	*600*
Sulfate	na	26100			*500*	*1000*	34900			*500*	*1000*	80000			*500*	*1000*	331000			*5000*	*10000*	14000			*500*	*1000*

Analyte	Sample ID	54MW06					54MW07					54MW8					54MW9					54MW10				
	Sample Date	4/16/12					4/19/12					4/17/12					4/17/12					4/17/12				
	RG	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Explosives (ug/L)																										
2,4,6-Trinitrotoluene	7.8	1.1	U		*0.275*	*1.1*	1	U		*0.25*	*1*	0.301	J	J	*0.284*	*1.14*	1.09	U		*0.272*	*1.09*	1.08	U		*0.269*	*1.08*
2,4-Dinitrotoluene	0.932*	1.1	U		*0.275*	*1.1*	1	U		*0.25*	*1*	1.14	U		*0.284*	*1.14*	1.09	U		*0.272*	*1.09*	1.08	U		*0.269*	*1.08*
2,6-Dinitrotoluene	0.932*	1.1	U		*0.275*	*1.1*	1	U		*0.25*	*1*	1.14	U		*0.284*	*1.14*	1.09	U		*0.272*	*1.09*	1.08	U		*0.269*	*1.08*
RDX	6.1	1.1	U		*0.275*	*1.1*	1	U		*0.25*	*1*	1.14	U		*0.284*	*1.14*	1.09	U		*0.272*	*1.09*	1.08	U		*0.269*	*1.08*
Misc.																										
Perchlorate	10.9	0.2	U		*0.1*	*0.2*	0.365			*0.1*	*0.2*	0.338			*0.1*	*0.2*	0.217		J	*0.1*	*0.2*	0.2	U		*0.1*	*0.2*
Total Organic Carbon	na	5460			*500*	*1000*	990	J	B	*500*	*1000*	2360		B	*500*	*1000*	3010		B	*500*	*1000*	2400		B	*500*	*1000*
Chloride	na	932			*100*	*200*	2450			*100*	*200*	4400			*100*	*200*	5160			*100*	*200*	3250			*100*	*200*
Nitrate (as N)	na	129	J	J	*100*	*600*	231	J	J	*100*	*600*	483	J	J	*100*	*600*	139	J	J	*100*	*600*	600	U		*100*	*600*
Sulfate	na	14900			*500*	*1000*	69400			*500*	*1000*	40100			*500*	*1000*	56000			*500*	*1000*	221000	J	J	*500*	*1000*

Analyte	Sample ID	54MW11					54MW12					54MW13					54MW14				
	Sample Date	4/17/12					4/18/12					4/16/12					4/19/12				
	RG	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Explosives (ug/L)																					
2,4,6-Trinitrotoluene	7.8	1.1	U		*0.275*	*1.1*	48.1			*2.72*	*10.9*	0.979	J	J	*0.272*	*1.09*	1.06	U		*0.266*	*1.06*
2,4-Dinitrotoluene	0.932*	1.1	U		*0.275*	*1.1*	1.09	U		*0.272*	*1.09*	1.09	U		*0.272*	*1.09*	1.06	U		*0.266*	*1.06*
2,6-Dinitrotoluene	0.932*	1.1	U		*0.275*	*1.1*	0.381	J	J	*0.272*	*1.09*	1.09	U		*0.272*	*1.09*	1.06	U		*0.266*	*1.06*
RDX	6.1	1.1	U		*0.275*	*1.1*	18.4	P	J	*0.272*	*1.09*	1.14			*0.272*	*1.09*	1.06	U		*0.266*	*1.06*
Misc.																					
Perchlorate	10.9	0.2	U		*0.1*	*0.2*	22.8			*0.5*	*1*	0.243		J	*0.1*	*0.2*	0.214			*0.1*	*0.2*
Total Organic Carbon	na	2680		B	*500*	*1000*	2340		B	*1000*	*2000*	3510		J	*500*	*1000*	1090		B	*500*	*1000*
Chloride	na	3730			*100*	*200*	4720			*100*	*200*	2250			*100*	*200*	5100			*100*	*200*
Nitrate (as N)	na	600	U		*100*	*600*	2650			*100*	*600*	294	J	J	*100*	*600*	386	J	J	*100*	*600*
Sulfate	na	104000			*500*	*1000*	37900			*500*	*1000*	35400			*500*	*1000*	29300			*500*	*1000*

12 J Bold outline indicates a RG exceedance.

*DNT remedial goal is for the DNT mixture

5.6 Pore Water Sampling

Five pore water samples were collected in the fourth quarter of MNA monitoring at SWMU 54. Sample locations are shown on **Figure 4-1**. Samples were collected for explosives, perchlorate, and MNA indicator parameters. Detected constituents are summarized in **Table 5-9** and presented in **Table 5-10**.

Explosives

Explosives were not detected in pore water samples.

Perchlorate

Perchlorate was not detected in pore water samples.

Miscellaneous Analyses

Groundwater samples were also analyzed for MNA indicators (TOC, DIC, dissolved ferrous iron, dissolved manganese, nitrate, and sulfate) for the purposes of establishing a baseline concentration of the analyses.

Levels of TOC in the wells ranged from 3.76 to 5.29 mg/L. Levels of DIC ranged from 29.7 to 38.1 mg/L. Nitrate was not detected. Finally, sulfate detections ranged from 7.96 to 8.57 mg/L.

MNA indicators are displayed in **Table 4-10** and **Table 5-10**.

Table 5-9
SWMU 54 Summary of First Year Pore Water Samples

	RG	# of RG Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
Explosives (ug/L)							
Misc.							
Total Organic Carbon	na	na	5	5	3700	5290	NRSW3/PW3
Chloride	na	na	5	5	7810	8100	NRSW9/PW9
Sulfate	na	na	5	5	7960	8570	NRSW1/PW1

Table 5-10
Detected Analytes in First Year Pore Water Samples

Analyte	Sample ID	NRSW1/PW1					NRSW3/PW3					NRSW5/PW5				
	Sample Date	4/17/12					4/17/12					4/17/12				
	RG	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Explosives (ug/L)	**Not Detected**															
Misc.																
Total Organic Carbon	na	4660		J	*500*	*1000*	5290			*500*	*1000*	3700		J	*500*	*1000*
Chloride	na	7810			*100*	*200*	7860			*100*	*200*	7870			*100*	*200*
Sulfate	na	8570			*500*	*1000*	8130			*500*	*1000*	8530			*500*	*1000*

Analyte	Sample ID	NRSW8/PW8					NRSW9/PW9				
	Sample Date	4/17/12					4/17/12				
	RG	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Explosives (ug/L)	**Not Detected**										
Misc.											
Total Organic Carbon	na	4060		J	*500*	*1000*	3760		J	*500*	*1000*
Chloride	na	7880			*100*	*200*	8100			*100*	*200*
Sulfate	na	8360			*500*	*1000*	7960			*500*	*1000*

Data Qualifiers:

J = Analyte present. Reported value may not be accurate or precise.

5.7 Year One Results

This section describes the results from the first year of sampling. Samples collected during the first year were analyzed for the full suite of analytical parameters described in **Table 4-2** (explosives, perchlorate, and MNA indicators).

5.7.1 Groundwater

Explosives

Samples from the wells within SWMU 54 were analyzed for explosives during four quarters of sampling. The contaminants of concern (2,4,6-TNT, 2,4-DNT, and RDX) were detected in the groundwater samples.

Explosives concentrations were below selected RGs in each monitoring well with the exception of 54MW12. TNT concentrations found in 54MW12 exceeded RGs in Quarter 2 through Quarter 4 samples. RDX concentrations were also detected at levels exceeding RGs in Quarter 2 through Quarter 4 samples.

TNT was not detected in monitoring wells 54MW1, 54MW3 through 54MW7, 54MW9, 54MW11, and 54MW14. TNT concentrations detected in monitoring wells 54MW8 and 54MW13 have not indicated a decline over the past four quarters, yet remain under the RG. TNT concentrations have risen in the first year in 54MW2, 54MW10, and 54MW12. Detected TNT concentrations in 54MW2 and 54MW10 are still below the RG. Over the last three quarters, TNT concentrations in 54MW12 increased from 16.1 to 48µg/L.

One detection of 2,4-DNT was encountered in the fourth quarter sample of 54MW12, at levels below RGs.

RDX was not encountered in year one samples at monitoring wells 54MW1, 54MW3 through 54MW7, 54MW9, 54MW11, and 54MW14. Concentrations of RDX were found to vary slightly over four quarters in monitoring wells 54MW2, 54MW8, 54MW10, and 54MW13. These wells had concentrations of RDX below the RGs throughout the four quarters of sampling. RDX concentrations were found to increase at 54MW12. RDX concentrations in 54MW12 increased from 9.77 µg/L to 18.4µg/L in the first year samples. RDX concentrations are currently above the RG at 54MW12.

Perchlorate

Samples from the wells within SWMU 54 were analyzed for perchlorate during all four quarters of sampling. Perchlorate was detected in 11 of the 14 monitoring wells. Perchlorate concentrations were below the RGs in each monitoring well except for 54MW12, where the concentration exceeded the RG of 10.9 µg/L in the first and fourth quarter.

Perchlorate was not detected in 54MW1 and 54MW4. Concentrations were found to be in decline in wells 54MW3, 54MW5, 54MW8 through 54MW10, 54MW13, and 54MW14. Perchlorate concentrations were found to be increasing in monitoring wells 54MW2, 54MW7, and 54MW12.

MNA Indicators

Each well within the monitoring network was evaluated for a series of MNA indicators. These indicators provide insight into whether MNA is occurring, and with what driver. Baseline levels were established throughout the first year of sampling, which will be compared to data produced

in future sampling efforts. The groundwater sampled at SWMU 54 wells was typically aerobic, with the second quarter being the exception. ORP measurements ranged from -30 to 267 millivolts. pH levels were typically neutral, except for the fourth quarter where the pH trended towards acidic levels. Site-wide specific conductance, throughout the site ranged from 0.001 to 1.73 millisiemens. Conductance gradually increased at most well locations over the course of the year from fall to spring. Additional data collected in year two will be analyzed to determine if this is a seasonal phenomenon. TOC levels in the year one well samples ranged from 1.13 to 33.1 mg/L. DIC levels ranged from 7.09 to 73.5 mg/L. Dissolved ferrous iron was consistently below 0.2 mg/L at all wells. Nitrates were detected at levels ranging from 0.119 to 2.82 mg/L. Sulfate concentrations ranged from 7.06 to 480 mg/L.

5.7.2 Pore Water Sampling

Pore water samples were collected from five areas along the New River in the fourth quarter of monitoring.

Explosives

Explosives were not detected in any of the pore water sampling locations.

Perchlorate

Perchlorate was not detected in any of the pore water sampling locations.

6.0 SUMMARY AND CONCLUSIONS

Fourteen groundwater monitoring wells have been sampled on a quarterly basis for one year at SWMU 54. Additionally, in the fourth quarter of monitoring, five pore water sample locations were monitored in the New River. The first quarter was the beginning of the first year of monitoring and samples from this year were analyzed for explosives, perchlorate, and MNA indicators. Sample results were compared to RGs to evaluate whether MNA is occurring at the site. This report presents the results of the first through fourth quarters of sampling and also summarizes the data from the first year of sampling.

Throughout the first year of sampling, explosives were detected at monitoring wells 54MW2, 54MW5, 54MW8, 54MW10, 54MW12, and 54MW13. As displayed on **Figure 4-2**, these wells surround Area A. Upgradient well 54MW5 detected no concentration of TNT, RDX, or DNT.

54MW2, located within Area A had detections of 2,4,6-TNT and RDX. TNT levels in 54MW2 have risen slightly; whereas RDX has decreased from quarter one to quarter four. All explosives concentrations are below RGs.

Downgradient well 54MW8 displayed sub-RG concentrations of TNT, and RDX in quarter one. Throughout quarters two through four, concentrations of RDX fell to non-detect. TNT concentrations by the fourth quarter had fallen to levels below the first quarter and are well below the RGs. 2,4-DNT was not detected in groundwater samples from 54MW08.

Initial, first quarter samples collected from downgradient well 54MW10 detected TNT. A low magnitude concentration increase in TNT and RDX (still remaining below RGs) was exhibited between quarter two and quarter three groundwater samples. At the close of the fourth quarter sampling, concentrations of TNT, and RDX were non-detect. 2,4-DNT was not detected in groundwater samples from 54MW10.

Explosives concentrations were also detected in downgradient well 54MW13. Initial samples displayed non-detect for explosives concentrations. Concentrations of TNT and RDX spiked at levels below RGs in quarter two, and by the fourth quarter, only minor concentrations of TNT and RDX remained. 2,4-DNT was not detected at 54MW13.

The closest downgradient well to Area A, 54MW12, was the only monitoring well at SWMU 54 to record a concentration of explosives exceeding RGs. Quarter one samples for TNT were rejected as invalid. 2,4-DNT was not detected in the first quarter of groundwater monitoring. In the second quarter samples TNT and RDX were detected at concentrations exceeding their RGs. 2,4-DNT was not detected in the second quarter. Third quarter results indicated rising concentrations of TNT and RDX. 2,4-DNT was not detected in the third quarter. Finally, the fourth quarter of sampling showed a further increase in TNT and RDX concentrations; and a detection of DNT below its RG. Concentrations of TNT and RDX were detected at levels above the site RG.

Perchlorate was more widely detected at the site than explosives, detected at 10 wells at the site. From the first through fourth quarter of groundwater monitoring, perchlorate was generally found to be below RGs and decreasing in concentration. 54MW2 and 54MW12 displayed increasing trends over the course of year one monitoring. 54MW12 exceeded the perchlorate RG in quarter one and quarter four.

Increasing concentrations of explosives and perchlorate in downgradient wells were expected within the first year of sampling given their proximity to large amounts of disturbed soil during the soil remediation action. The concentration of explosives and perchlorate were consistently below RGs at all monitoring well locations except for 54MW12. Monitoring wells 54MW1 through 54MW11, 54MW13, and 54MW14 have shown one year of explosives and perchlorate concentrations below RGs.

Pore water samples collected at SWMU 54 exhibited no concentrations of explosives or perchlorate, indicating that the explosives constituents and perchlorate are attenuating prior to reaching the New River.

Based on data obtained in the first year of sampling and the overall site-wide decreasing concentrations of contaminants of concern (excluding 54MW2 and 54MW12), it appears that the selected remedial action (MNA) is currently viable. Based on the ramp down and exit criteria established in the IM MNA work plan, after an additional year of similar trends, all Area B wells be removed from the monitoring network, as well as Area A wells that have consistently shown contaminant of concern concentrations below the RGs.

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7.0 REFERENCES

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