RADFORD ARMY AMMUNITION PLANT, VIRGINIA

SWMUs 50 and 59
RCRA Facility Investigation Report

Prepared for:

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

Prepared by:

Shaw Environmental, Inc.
2113 Emmorton Park Rd.
Edgewood, MD 21040

Final Document **September 2009**

09-141

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

October 23, 2009

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

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

Re: Radford Army Ammunition Plant, Va.
Review of Army's Final RCRA Facility Investigation (RFI) Report for
Solid Waste Management Units (SWMUs) 50 & 59

Dear Mr. McKenna and Ms. Holt:

The U.S. Environmental Protection Agency (EPA) and Virginia Department of Environmental Quality (VDEQ) have reviewed the U.S. Army's (Army's) October 2009 Final RFI Report for SWMUs 50 & 59, located at the Radford Army Ammunition Plant (RFAAP) in Radford, Virginia. Based upon our review, the report is approved, and in accordance with Part II. (E) (5) of RFAAP's Corrective Action Permit, it can now be considered final.

If you have any questions, please call me at 215-814-3413. Thanks.

Sincerely,

William Geiger
RCRA Project Manager
Office of Remediation (3LC20)

cc: James Cutler, VDEQ

ATK Armament Systems
Energetic Systems
Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, VA 24143-0100

www.atk.com

September 30, 2009

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

Mr. James L. Cutler, Jr.
Virginia Department of Environmental Quality
629 East Main Street
Richmond, VA 24143-0100

Subject: With Certification, SWMUs 50 and 59 RCRA Facility Investigation Report, Final Document September 2009
EPA ID# VA1 210020730

Dear Mr. Geiger and Mr. Cutler:

Enclosed is the certification for the subject document that was sent to you on September 28, 2009. Also enclosed is the 28 September 2009 transmittal email and with its attached response to comments.

This document was revised per the response to comments and we anticipate approval.

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

Sincerely,

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

c: Karen Sismour
Virginia Department of Environmental Quality
P. O. Box 10009
Richmond, VA 23240-0009

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

09-815-162
JMcKenna

Rich Mendoza
U.S. Army Environmental Command
1 Rock Island Arsenal
Bldg 90, 3rd Floor, Room 30A
IMAE-CDN
Rock Island, Illinois 61299

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

09-815-162
JMcKenna

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

Coordination: J. McKenna M. A. Miano

09-815-162
JMcKenna

Concerning the following:

Radford Army Ammunition Plant
SWMUs 50 and 59
RCRA Facility Investigation Report
Final September 2009

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

SIGNATURE:
PRINTED NAME: Antonio Munera
TITLE: LTC, CM
Commanding

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

09-815-162
JMcKenna

Greene, Anne

From: McKenna, Jim
Sent: Monday, September 28, 2009 12:35 PM
To: Greene, Anne; ealohman@deq.virginia.gov; Druck, Dennis E Mr CIV USA MEDCOM CHPPM; diane.wisbeck@arcadis-us.com; durwood willis2; Geiger.William@epamail.epa.gov; Redder, Jerome; jim spencer; jlcutler@deq.virginia.gov; kjsismour@deq.virginia.gov; Llewellyn, Tim; Mendoza, Richard R Mr CIV USA IMCOM; Meyer, Tom NAB02; Parks, Jeffrey N; Timothy.Leahy@shawgrp.com; Tina_Devine@URSCorp.com
Subject: Final SWMU 50 and 59 RFI Report (UNCLASSIFIED)
Attachments: SWMU 50 59 Modified conclusions jjm edit.doc

Importance: High

Classification: UNCLASSIFIED
Caveats: FOUO

All:

Note the contractor will ship the subject document with a copy of this email to the POCs and tracking numbers below. Also attached is a summary of comments received and responses to comments.

A certification letter will follow.

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

Jim McKenna	1Z63V8840195482108
Mr. Richard Mendoza	1Z63V8840196630133
Ms. Susan Ryan	1Z63V8840197453341
Mr. Tom Meyer	1Z63V8840197620517
Mr. Dennis Druck	1Z63V8840196904525
Mr. James Cutler	1Z63V8840198416568
Ms. Elizabeth Lohman	1Z63V8840195068575
Mr. William Geiger	1Z63V8840199990150

Classification: UNCLASSIFIED
Caveats: FOUO

Original Text

Groundwater Remediation Plan

All the groundwater data from SWMUs 48, 49, 50, and 59 were assessed together for the HHRA. From that assessment, it was concluded that additional steps were needed to remediate the contaminants of interest (COIs) (CT, TCE) in site groundwater. The approved next step would be to perform MNA with LTM (Shaw, 2008). Within the LTM, all the wells at SWMUs 48, 49, 50, and 59 will be monitored to ensure that COIs are decreasing to acceptable levels within a timely rate.

Conclusion

Overall, it appears that risk and hazard to current workers associated with exposure to soil at the site are within or below acceptable limits. In addition, risks and hazards were within acceptable limits for hypothetical future residential soil receptors. The SLERA concluded that based on uncertainties of toxicity, the fact that no wildlife RTE species have been confirmed at the SWMU study area, alternative exposure and/or toxicity factors that could be used, and the relatively small size of the solid waste management unit (0.57 acres), remedial measures solely to address ecological concerns are not warranted for soil.

In lieu of a CMS, it is proposed that the alternative selected within the SWMUs 48 and 49 RFI/CMS (MNA with LTM) (Shaw, 2008) be used for the groundwater at SWMUs 50 and 59. Groundwater from the four SWMUs will be associated with SWMU 49. Since risk and hazard associated with soil at SWMUs 50 and 59 is acceptable, addressing the groundwater should alleviate any concerns that this site poses a future risk to human or ecological receptors. It is believed that a CMS will not be necessary due to the lack of soil contaminant concentrations of concern at the site and risk at the site. The groundwater will be addressed along with SWMUs 48 and 49 and soil at SWMUs 50 and 59 will require no further action.

Revised Text

Groundwater Remediation Plan

Groundwater data from SWMUs 48, 49, 50, and 59 were assessed together for the HHRA. The results of that assessment indicated that additional steps are needed to remediate the contaminants of interest (COIs) (CT, TCE) in site groundwater. The nature and extent of these constituents suggests that SWMU 49 is the source area and remediation of the affected groundwater under SWMUs 50 and 59 will be associated with SWMU 49. As with the initial assessment, wells from all four SWMUs (48, 49, 50, and 59) will be monitored to ensure that COIs are decreasing to acceptable levels within a timely rate.

Conclusion

Risks and hazards to current workers associated with exposure to soil at the site are within or below acceptable limits. In addition, risks and hazards were within acceptable limits for hypothetical future residential soil receptors. The SLERA concluded that based on uncertainties of toxicity, the fact that no wildlife RTE species have been confirmed at the SWMU study area, alternative exposure and/or toxicity factors that could be used, and the relatively small size of the

solid waste management unit (0.57 acres), remedial measures solely to address ecological concerns are not warranted for soil.

The results of the contamination assessment indicate that COIs in groundwater in the area of SMWUs 49, 48, 50 and 59 are associated with SWMU 49; therefore, groundwater remediation for these four SWMUs is to be addressed as part of any SWMU 49 effort. As the current and future risks and hazards for human and ecological receptors associated with soil at SWMUs 50 and 59 are within acceptable ranges and any groundwater effort is deferred to SWMU 49, the soil at SWMUs 50 and 59 will require no further action.

Leahy, Timothy

From: Geiger.William@epamail.epa.gov
Sent: Wednesday, September 23, 2009 11:28 AM
To: McKenna, Jim J Mr CIV USA AMC
Cc: Parks, Jeffrey; jerome.redder@atk.com; jlcutler@deq.virginia.gov; Mendoza, Richard R Mr CIV USA IMCOM; Leahy, Timothy; Meyer, Tom NAB02
Subject: RE: FW: SWMUs 50 & 59 RFI Comments (UNCLASSIFIED)

Yeah, Jim C. and I are ok with this

William A. Geiger
Remedial Project Manager
Office of Remediation (3LC20)
U.S. Environmental Protection Agency
1650 Arch Street
Philadelphia, PA 19103-2029
Phone: 215.814.3413
Geiger.William@epa.gov

From: "McKenna, Jim J Mr CIV USA AMC" <jim.mckenna@us.army.mil>
To: William Geiger/R3/USEPA/US@EPA
Cc: "Parks, Jeffrey N" <Jeffrey.Parks@shawgrp.com>, <jerome.redder@atk.com>, <jlcutler@deq.virginia.gov>, "Mendoza, Richard R Mr CIV USA IMCOM" <richard.r.mendoza@us.army.mil>, <Timothy.Leahy@shawgrp.com>, "Meyer, Tom NAB02" <Tom.Meyer@usace.army.mil>
Date: 09/22/2009 03:15 PM
Subject: RE: FW: SWMUs 50 & 59 RFI Comments (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: FOUO

Will and all,

Here's our revised text along with the original. If this is ok, then we can prepare the final version and submit it.

-----Original Message-----
From: Geiger.William@epamail.epa.gov
[mailto:Geiger.William@epamail.epa.gov]
Sent: Monday, September 21, 2009 2:58 PM
To: McKenna, Jim J Mr CIV USA AMC
Cc: Parks, Jeffrey N; jerome.redder@atk.com; jlcutler@deq.virginia.gov; Mendoza, Richard R Mr CIV USA IMCOM; Timothy.Leahy@shawgrp.com; Meyer, Tom NAB02
Subject: Re: FW: SWMUs 50 & 59 RFI Comments (UNCLASSIFIED)

Some of the language in the last few paragraphs of Section 8 may also need to be changed, since the SWMU 48 & 49 report technically has not

been approved yet. Unless you just want to wait on submitting this one until after that is approved.

William A. Geiger
Remedial Project Manager
Office of Remediation (3LC20)
U.S. Environmental Protection Agency
1650 Arch Street
Philadelphia, PA 19103-2029
Phone: 215.814.3413
Geiger.William@epa.gov

From: "McKenna, Jim J Mr CIV USA AMC" <jim.mckenna@us.army.mil>
To: William Geiger/R3/USEPA/US@EPA, <jlcutler@deq.virginia.gov>
Cc: "Meyer, Tom NAB02" <Tom.Meyer@usace.army.mil>, "Mendoza, Richard R Mr CIV USA IMCOM" <richard.r.mendoza@us.army.mil>, <Timothy.Leahy@shawgrp.com>, "Parks, Jeffrey N" <Jeffrey.Parks@shawgrp.com>, <jerome.redder@atk.com>
Date: 09/15/2009 11:23 AM
Subject: FW: SWMUs 50 & 59 RFI Comments (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: FOUO

Will and Jim C.,

Based on the email below, we are planning to re-submit the SWMU 50 & 59 RFI report as "Final." We will add a sentence to the Executive summary that makes it clear that groundwater is addressed as part of SWMU 49. Does this meet your and Jim Cutler's expectation?

Thanks,

Jim M.

From: Geiger.William@epamail.epa.gov [mailto:Geiger.William@epamail.epa.gov <mailto:Geiger.William@epamail.epa.gov>]
Sent: Wednesday, September 09, 2009 2:32 PM
To: McKenna, Jim J Mr CIV USA AMC
Cc: Druck, Dennis E Mr CIV USA MEDCOM CHPPM; diane.wisbeck@arcadis-us.com; jim spencer; Parks, Jeffrey; jerome.redder@atk.com; McKenna, Jim J Mr CIV USA AMC; jlcutler@deq.virginia.gov; Mendoza, Richard R Mr CIV USA IMCOM; Leahy, Timothy; Llewellyn, Tim; Tina_Devine@URSCorp.com; Meyer, Tom NAB02; Cramer.Mike@epamail.epa.gov
Subject: SWMUs 50 & 59 RFI Comments

Jim, EPA/VDEQ concur with the report conclusion that no further action is required for site soils. The report can be finalized if all ground water characterization and proposed action is deferred to the SWMUs 48 & 49 report. The conclusions of this report may have to be slightly modified to make it clear that no groundwater remedy (MNA, etc.) has been accepted as part of this report. Thanks

William A. Geiger
Office of Remediation (3LC20)
USEPA Region III
1650 Arch Street
Philadelphia, PA 19103
(215)814-3413

Classification: UNCLASSIFIED
Caveats: FOUO

[attachment "SWMU 50 59 Modified conclusions jjm edit.doc" deleted by William Geiger/R3/USEPA/US]

Original Text

Groundwater Remediation Plan

All the groundwater data from SWMUs 48, 49, 50, and 59 were assessed together for the HHRA. From that assessment, it was concluded that additional steps were needed to remediate the contaminants of interest (COIs) (CT, TCE) in site groundwater. The approved next step would be to perform MNA with LTM (Shaw, 2008). Within the LTM, all the wells at SWMUs 48, 49, 50, and 59 will be monitored to ensure that COIs are decreasing to acceptable levels within a timely rate.

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Overall, it appears that risk and hazard to current workers associated with exposure to soil at the site are within or below acceptable limits. In addition, risks and hazards were within acceptable limits for hypothetical future residential soil receptors. The SLERA concluded that based on uncertainties of toxicity, the fact that no wildlife RTE species have been confirmed at the SWMU study area, alternative exposure and/or toxicity factors that could be used, and the relatively small size of the solid waste management unit (0.57 acres), remedial measures solely to address ecological concerns are not warranted for soil.

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Revised Text

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Risks and hazards to current workers associated with exposure to soil at the site are within or below acceptable limits. In addition, risks and hazards were within acceptable limits for hypothetical future residential soil receptors. The SLERA concluded that based on uncertainties of toxicity, the fact that no wildlife RTE species have been confirmed at the SWMU study area, alternative exposure and/or toxicity factors that could be used, and the relatively small size of the

solid waste management unit (0.57 acres), remedial measures solely to address ecological concerns are not warranted for soil.

The results of the contamination assessment indicate that COIs in groundwater in the area of SMWUs 49, 48, 50 and 59 are associated with SWMU 49; therefore, groundwater remediation for these four SWMUs is to be addressed as part of any SWMU 49 effort. As the current and future risks and hazards for human and ecological receptors associated with soil at SWMUs 50 and 59 are within acceptable ranges and any groundwater effort is deferred to SWMU 49, the soil at SWMUs 50 and 59 will require no further action.

ATK Ammunition Systems
Energetic Systems
Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, VA 24143-0100

www.atk.com

May 13, 2009

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

Mr. James L. Cutler, Jr.
Virginia Department of Environmental Quality
629 East Main Street
Richmond, VA 24143-0100

Subject: With Certification, SWMUs 50 and 59 RCRA Facility Investigation Report, Draft Document, May 2009
EPA ID# VA1 210020730

Dear Mr. Geiger and Mr. Cutler:

Enclosed is the certification for the subject document that was sent to you on May 8, 2009. Also enclosed is the 8 May 2009 transmittal email.

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

Sincerely,

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

c: Karen Sismour
Virginia Department of Environmental Quality
P. O. Box 10009
Richmond, VA 23240-0009

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

09-815-81
JMcKenna

Rich Mendoza
U.S. Army Environmental Command
1 Rock Island Arsenal
Bldg 90, 3rd Floor, Room 30A
IMAE-CDN
Rock Island, Illinois 61299

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

Coordination: J. McKenna M. A. Miano

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

09-815-81
JMcKenna

Concerning the following:

Radford Army Ammunition Plant
SWMUs 50 and 59
RCRA Facility Investigation Report
Draft Document May 2009

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: Jon R. Drushal
TITLE: Colonel, US Army
Commanding

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

09-815-81
JMcKenna

Greene, Anne

From: McKenna, Jim
Sent: Friday, May 08, 2009 1:51 PM
To: Greene, Anne; ealohman@deq.virginia.gov; Druck, Dennis E Mr CIV USA MEDCOM CHPPM; diane.wisbeck@arcadis-us.com; durwood willis2; Geiger.William@epamail.epa.gov; Redder, Jerome; jim spencer; jlcutler@deq.virginia.gov; kjsismour@deq.virginia.gov; Llewellyn, Tim; Mendoza, Richard R Mr CIV USA IMCOM; Meyer, Tom NAB02; Parks, Jeffrey N; Timothy.Leahy@shawgrp.com; Tina_Devine@URSCorp.com
Subject: Radford AAP - SWMUs 50 and 59 RFI Report - Draft (UNCLASSIFIED)

Importance: High

Classification: UNCLASSIFIED
Caveats: FOUO

All:

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

Certification letter will follow from Radford AAP under separate cover.

Immediately below are the POCs with tracking numbers:

Jim McKenna, RFAAP, 1Z63V8840192148289
Rich Mendoza, USAEC-RIA, 1Z63V8840194200459 William Geiger, US EPA Region III, 1Z63V8840192994678 Jim Cutler, VDEQ, 1Z63V8840193359844 Elizabeth Lohman, VDEQ, 1Z63V8840193291621 Tom Meyer, USACE-Baltimore, 1Z63V8840194712067 Dennis Druck, USACHPPM, 1Z63V8840194090239

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

Jim McKenna
540 731 5782
Classification: UNCLASSIFIED
Caveats: FOUO

Leahy, Timothy

From: McKenna, Jim J Mr CIV USA AMC [jim.mckenna@us.army.mil]
Sent: Friday, May 08, 2009 10:29 AM
To: Druck, Dennis E Mr CIV USA MEDCOM CHPPM; Leahy, Timothy
Cc: Meyer, Tom NAB02; Druck, Dennis E Mr CIV USA MEDCOM CHPPM
Subject: RE: Radford AAP - SWMUs 50 & 59 - Revisions per Conference Call - 4 May 2009 (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Ok, looks like Shaw can begin revising this report. Thanks everyone, Jim

-----Original Message-----
From: Druck, Dennis E Mr CIV USA MEDCOM CHPPM [mailto:dennis.druck@us.army.mil]
Sent: Friday, May 08, 2009 7:17 AM
To: Leahy, Timothy
Cc: McKenna, Jim J Mr CIV USA AMC; Meyer, Tom NAB02; Druck, Dennis E Mr CIV USA MEDCOM CHPPM
Subject: RE: Radford AAP - SWMUs 50 & 59 - Revisions per Conference Call
- 4 May 2009 (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Tim,

Thanks so much for the responses which are fine with me. Also thanks for the explanation for comment 2; and the sentence referring to the source of PAHs being from the asphalt can be left in as far as I'm concerned.

Dennis

-----Original Message-----
From: Leahy, Timothy [mailto:Timothy.Leahy@shawgrp.com]
Sent: Thursday, May 07, 2009 5:06 PM
To: Druck, Dennis E Mr CIV USA MEDCOM CHPPM
Cc: McKenna, Jim J Mr CIV USA AMC; Meyer, Tom NAB02
Subject: RE: Radford AAP - SWMUs 50 & 59 - Revisions per Conference Call
- 4 May 2009 (UNCLASSIFIED)

Hi Dennis,

I've attached responses to your original comments. We just made a couple of the changes to the text this afternoon. I apologize - I looked at your response to Charles Lechner's Comments instead of your actual comments.

As far as your additional comments below, we will replace the "1." with "1.0" in Table 6-4 and fix the rounding issue (back to tenths instead of hundredths).

Thanks,
Tim

-----Original Message-----
From: Druck, Dennis E Mr CIV USA MEDCOM CHPPM [mailto:dennis.druck@us.army.mil]

Sent: Thursday, May 07, 2009 2:44 PM
To: Leahy, Timothy
Cc: McKenna, Jim J Mr CIV USA AMC; Druck, Dennis E Mr CIV USA MEDCOM CHPPM
Subject: RE: Radford AAP - SWMUs 50 & 59 - Revisions per Conference Call
- 4 May 2009 (UNCLASSIFIED)

Classification: UNCLASSIFIED
Caveats: NONE

Jim and Tim,

I believe with the additional language in the text and adding manganese to the note about background, it is clearer that any exceedance of unity
for the child resident is due to natural background. This addresses my
first comment but I didn't see any changes made related to comments 2 thru 5. If you didn't agree with those comments, could you please give me short responses explaining why?

Also, Table 6-4 looks OK but I mentioned this in a previous email
(attached) that note a has the following:
"a) Cumulative HIs and individual HQs are rounded to the nearest tenth.
HIs > 1 and HQs > 0.1 are listed."

But now some individual HQs are given rounded to the nearest hundredth.

The other thing in my previous email is that in Table 6-5 under Target Organ Segregation it says "No individual chemical or organ HI exceeds 1.0". But in Table 6-4 for SWMU 50, that same entry reads "...exceeds 1.". I think the entry for Table 6-4 should be "1.0" for consistency.

Thanks, Dennis

-----Original Message-----
From: Leahy, Timothy [mailto:Timothy.Leahy@shawgrp.com]
Sent: Thursday, May 07, 2009 1:36 PM
To: Druck, Dennis E Mr CIV USA MEDCOM CHPPM
Cc: McKenna, Jim J Mr CIV USA AMC
Subject: FW: Radford AAP - SWMUs 50 & 59 - Revisions per Conference Call
- 4 May 2009

Hi Dennis,

Here is the revised SWM 50/59 RFI report with tracked changes. Table
6-4 is also attached. The changes in the table are highlighted in yellow. Could you confirm to Jim McKenna that this addresses your comments (or doesn't, if that is the case)?

Thanks,

Tim

Timothy Leahy

Project Manager

Shaw Environmental, Inc

2113 Emmorton Park Road

Edgewood, MD 21040

(410) 322-6430 (phone)

(410) 612-6351 (fax)

www.Shawgrp.com

_____

From: Hassan, Cindy
Sent: Monday, May 04, 2009 3:11 PM
To: Leahy, Timothy
Cc: Rossbach, Anne; Sims, Robin E
Subject: Radford AAP - SWMUs 50 & 59 - Revisions per Conference Call - 4 May 2009

Tim,

Per today's conference call, I have attached my revisions to the SWMU 50 & 59 report. Please see the Executive Summary (Human Health Risk Assessment and Summary & Conclusions), Section 6.6.1, and Section 8.0 (Human Health Risk Assessment and Conclusions). The revisions are in "track changes". I also made some changes to Table 6-4 (highlighted in yellow).

Let me make sure I have one thing straight. We were only adding verbiage re: background to the target organ evaluation for SWMU 50, correct? I did not add any caveats about background in cases where the HI exceeded 1, but none of the individual COPC HIs exceeded 1. Therefore, I did not make any changes to Table 6-5 (for SWMU 59). If this is not correct, please let me know.

Thanks,

Cindy

Cindy Hassan

Shaw Environmental, Inc.

5050 Section Avenue

Cincinnati, Ohio 45212-2025

513.782.4967 direct

513.782.4807 fax

www.shawgrp.com <blockedhttp://www.shawgrp.com>

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Please advise immediately if you or your employer do not consent to Internet email for messages of this kind. Opinions, conclusions and other information in this message that do not relate to the official business of The Shaw Group Inc. or its subsidiaries shall be understood as neither given nor endorsed by it.
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http://www.shawgrp.com
Classification: UNCLASSIFIED
Caveats: NONE

Classification: UNCLASSIFIED
Caveats: NONE

TABLE OF CONTENTS

LIST OF TABLES

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LIST OF FIGURES

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LIST OF APPENDICES

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

LIST OF ACRONYMS AND ABBREVIATIONS

µg/kg .....micrograms per kilogram
µg/L.....micrograms per liter
ADAF.....Age-Dependent Adjustment Factor
ARCS .....Assessment and Remediation of Contaminated Sediments
ASTM .....American Society for Testing and Materials
ATSDR .....Agency for Toxic Substances Disease Registry
AUF.....Area Use Factor
BAF.....Bioaccumulation Factor
BCF.....Bioconcentration Factor
bgs.....below ground surface
BTAG.....Biological Technical Assistance Group
CCA .....Chromated Copper Arsenate
CCME .....Canadian Council of Ministers of the Environment
CDI.....Chronic Daily Intake
CFR.....Code of Federal Regulations
cm.....centimeters
CMO .....Corrective Measures Objective
CMS .....Corrective Measures Study
COI.....Contaminant of Interest
COPC .....Chemical of Potential Concern
COPEC.....Chemical of Potential Ecological Concern
CSEM.....Conceptual Site Exposure Model
CSF .....Cancer Slope Factor
CSM .....Conceptual Site Model
CT .....Carbon Tetrachloride
DA.....dose absorbed per unit area per event
DNB .....Dinitrobenzene
DNT .....Dinitrotoluene
DO.....Dissolved Oxygen
DQO.....Data Quality Objective
EcoSSL .....Ecological Soil Screening Level
EEQ.....Environmental Effects Quotient
EPC .....Exposure Point Concentration
EPD.....Effective Prediction Domain
ERAGS .....Ecological Risk Assessment Guidance for Superfund
FA .....fraction absorbed dose
FOD.....Frequency of Detection
ft msl .....feet above mean sea level
ft .....feet
g/dL .....grams per deciliter
GI .....Gastrointestinal
HEAST.....Health Effects Assessment Summary Tables
HHRA .....Human Health Risk Assessment
HI .....Hazard Index
HQ.....Hazard Quotient
HSA.....Horseshoe Area
IEUBK .....Integrated Exposure Uptake Biokinetic
IRIS .....Integrated Risk Information System
ISEB .....In-Situ Enhanced Bioremediation
i-SL .....Industrial Screening Level
IUR.....Inhalation Unit Risk
LC/MS.....Liquid Chromatography/Mass Spectrometry
LOAEL .....Lowest-Observed-Adverse-Effect Level
LTM .....Long-Term Monitoring
MCL .....Maximum Contaminant Level
MDC .....Maximum Detected Concentration
MDL.....Method Detection Limit
mg/kg .....milligrams per kilogram
mg/L .....milligrams per liter
MMA.....Main Manufacturing Area

MNA .....Monitored Natural Attenuation
MRL.....Minimum Risk Level
mV.....millivolts
MW .....Molecular Weights
MWP.....Master Work Plan
NIBC.....Not Important Bioaccumulative Constituents
NOAA.....National Oceanic and Atmospheric Administration
NOAEL.....No-Observed-Adverse-Effect Level
NTU .....Nephelometric Turbidity Unit
ORNL.....Oak Ridge National Laboratory
ORP.....Oxidation-Reduction Potential
PAH.....Polynuclear Aromatic Hydrocarbon
PCB.....Polychlorinated Biphenyl
PCE .....Tetrachloroethene
PEF.....Particulate Emission Factor
PEL .....Probable Effects Level
PETN.....Pentaerythritol tetranitrate
PPRTV .....Provisional Peer Reviewed Toxicity Value
PRG.....Preliminary Remediation Goal
QA.....Quality Assurance
QC.....Quality Control
RAGS.....Risk Assessment Guidance for Superfund
RBC.....Risk-Based Concentration
RBCA.....Risk-Based Corrective Action
RCRA.....Resource Conservation and Recovery Act
RDA .....Recommended Daily Allowance
RFA.....RCRA Facility Assessment
RFAAP.....Radford Army Ammunition Plant
RfD.....Risk Reference Dose
RFI .....RCRA Facility Investigation
r-SL .....Residential Screening Level
RTE.....Rare, Threatened, or Endangered
Shaw.....Shaw Environmental, Inc.
SL.....Screening Level
SLERA.....Screening Level Ecological Risk Assessment
SMDP.....Scientific/Management Decision Point
SRC.....Syracuse Research Corporation
SSL.....Soil Screening Level
SVOC.....Semivolatile Organic Compound
TAL.....Target Analyte List
TCE.....Trichloroethene
TCL.....Target Compound List
TCLP.....Toxicity Characteristic Leachate Procedure
TE.....Toxicity Equivalents
TEF .....Toxicity Equivalence Factor
TEQ.....Toxicity Equivalent
TNT.....Trinitrotoluene
TOC.....Total Organic Carbon
TOX .....Total Organic Halides
TPH.....Total Petroleum Hydrocarbons
TRV.....Toxicity Reference Value
tw-SL.....Tap Water Screening Level
UCL.....Upper Confidence Limit
UF .....Uncertainty Factor
USACE .....U.S. Army Corps of Engineers
USAEC .....U.S. Army Environmental Command
USATHAMA.U.S. Army Toxic and Hazardous Materials Agency
USEPA.....U.S. Environmental Protection Agency
VDEQ .....Virginia Department of Environmental Quality
VF .....Volatilization Factor
VI .....Verification Investigation
VOC .....Volatile Organic Compound
VRP.....Voluntary Remediation Program
WHO.....World Health Organization

EXECUTIVE SUMMARY

Shaw Environmental, Inc. (Shaw) conducted a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) at Solid Waste Management Unit (SWMU) 50 (RAAP-025) – Calcium Sulfate Disposal/Treatment Area, and SWMU 59 (RAAP-028) – Bottom Ash Pile, during 2007. These investigations are required by the 2000 RCRA Corrective Action permit (USEPA, 2000a) for Radford Army Ammunition Plant (RFAAP) and were performed in accordance with *Master Work Plan (MWP) Addendum 019* (Shaw, 2007). MWP Addendum 019 was prepared to facilitate the investigation effort to comply with the requirements set forth in the 2000 RCRA Corrective Action permit and was approved by the U.S. Environmental Protection Agency (USEPA) Region III and the Virginia Department of Environmental Quality.

Previous investigations combined sites SWMUs 48, 49, 50, and 59 into one combined study site. More recently, SWMUs 48 and 49 were combined into a single report (Shaw, 2008) and 50 and 59 have been combined in this report. Due to the similarity of constituents in groundwater from these four sites, groundwater was assessed as a single unit and associated with SWMU 49 as this site is the most likely source of the VOCs detected in groundwater. The SWMUs 48 and 49 RFI/CMS Report (Shaw, 2008) describes the remedial actions that have been proposed for groundwater in the area [Monitored Natural Attenuation (MNA) for volatile organic compounds (VOCs)].

SWMUs 50 and 59 have been grouped together in this report because of their close proximity to each other and because groundwater from these two sites is being addressed in the SWMUs 48 and 49 RFI/CMS Report (Shaw, 2008). This report describes the soil investigations undertaken at SWMUs 50 and 59 and also includes the groundwater component from the SWMUs 48 and 49 RFI/CMS Report (Shaw, 2008) in the human health risk assessment (HHRA).

In addition to the MWP Addendum 019 field investigation, three previous field investigations were conducted at SWMUs 50 and 59 between 1991 and 2006. These investigations provide a good, long-term dataset that; in conjunction with the current data, can be used to assess trends in the data.

During the development of MWP Addendum 019, a review of the data indicated that additional surface and subsurface soil sampling at SWMU 50 was needed to provide additional data for a risk assessment at that site. Additional surface and subsurface sampling at SWMU 59 was performed in order to fill the data gap in the horizontal and vertical extent of elevated arsenic at the site because of one previously-detected industrial screening level surface soil exceedance.

Additional wells were also installed to confirm the extents of constituents in groundwater and to collect groundwater samples for herbicides and perchlorate. 2007 RFI activities included the installation of four new monitoring wells and the collection and chemical analysis of groundwater samples from the new and existing wells in the area. Ten surface soil samples and 20 subsurface soil samples were also collected from SWMU 50. In addition, ten surface soil samples and ten subsurface soil samples were collected from SWMU 59.

Contamination Assessment

Soil – SWMU 50. The primary analytes detected at SWMU 50 above screening levels (SLs) are chloroform, two PAHs [benzo(a)pyrene and benzo(b)fluoranthene], PCB-1254, five metals, and dioxins/furans. However, all detections can be explained. The only detection of chloroform

above SLs was a fairly low 1992 detection. Later sampling events were unable to confirm this result. Chloroform is a common laboratory contaminant and its unconfirmed presence is likely due to that phenomenon. PAHs at low concentrations can be attributed to the old, deteriorating asphalt from the paved road at the north (upgradient) end of the sites. PCB-1254 was only detected in 6 out of 31 samples tested and at relatively low concentrations. Additionally, the PCBs were detected in soil between 0 and 5 ft bgs and are highly immobile in the environment. Metals at low concentrations are found all throughout Radford and are within the site-wide background ranges. Dioxins in surface soil are considered ubiquitous in soil at RFAAP, from anthropogenic sources such as combustion and incineration of municipal waste, coal, wood, and fuel.

Soil – SWMU 59. The primary analytes detected at SWMU 59 are three PAH [benzo(a)pyrene, benzo(a)anthracene, and benzo(b)fluoranthene], PCB-1254, two metals, and two dioxins/furans. These PAHs at low concentrations are usually attributed to old, deteriorating asphalt from the paved roads in the area. PCB-1254 concentrations were greater than the residential SL (r-SL) in 2 out of 27 samples tested. None of the sample concentrations were greater than the industrial SL (i-SL). Additionally, PCBs are highly immobile in the environment. Metals at low concentrations are found throughout Radford and are within the site-wide background ranges. Only two dioxins/furans were detected (in 1 and 2 out of 25 samples tested) and at relatively low concentrations. Dioxins are considered ubiquitous in soil at RFAAP, from anthropogenic sources such as combustion and incineration of municipal waste, coal, wood, and fuel.

The majority of the elevated constituents in soil are present in small quantities in localized areas. None of the constituents detected above SLs at SWMU 50 and 59 are migrating to groundwater. Therefore, soil is not a major concern at SWMUs 50 and 59.

Groundwater. Groundwater at SWMUs 50 and 59 was evaluated during the 2007 investigation. Three wells were installed and sampled during this investigation. As noted above, groundwater from these SWMUs has been associated with SWMU 49 and groundwater remediation will also be associated with SWMU 49. Results are presented here so that a comparison can be made between soil constituents and groundwater constituents. Results indicated that three VOCs [carbon tetrachloride (CT), tetrachloroethene (PCE), and trichloroethene (TCE)], one SVOC [bis(2-ethylhexyl)phthalate], ten TAL metals (aluminum, arsenic, cadmium, chromium, cobalt, iron, lead, manganese, mercury, and vanadium), and five dioxins/furans (2,3,4,7,8-PECDF; total PECDD; total HXCDD; total HPCDD; and total HXCDF) exceeded SLs in site samples.

Human Health Risk Assessment

An HHRA (*Section 6.0*) was conducted at SWMUs 50 and 59 to evaluate the potential human health effects associated with previous activities at the sites. Risks associated with surface soil, total soil and groundwater (for sites 48, 49, 50, and 59) were evaluated for several different current and hypothetical future exposure scenarios. Risks and hazards from these scenarios are summarized below.

For soil at SWMU 50 and SWMU 59, the total cancer risk for all evaluated constituents exposures to all media types were either within or below their target risk range or equal to the lower limit of their target risk range. The analytes that contributed to these results at SWMU 50 were dioxins/furans, Aroclor-1254, benzo(a)pyrene, and arsenic. Only benzo(a)pyrene and arsenic contributed to these results at SWMU 59. In addition, each total hazard index (HI) for all

media types evaluated at both SWMUs were less than 1. The only value at SWMU 50 not fitting these results was the HI for the child resident's exposure to total soil, which was above 1. No individual COPC had an HI above 1; however, the target organ HI for the nervous system slightly exceeded 1. Of the constituents that contribute to the nervous system HI, manganese was found to be within the background range. By excluding the hazard quotient for manganese, the nervous system HI is less than 1. The only constituent at SWMU 59 not fitting these results was the HI for the child resident's exposure to total soil, which was above 1. No individual chemical or target organ HI was above 1.

Groundwater in the vicinity of SWMUs 48, 49, 50, and 59 was evaluated and addressed as part of the SWMUs 48 and 49 RFI/CMS (Shaw, 2008), as discussed throughout the HHRA. For purposes of information, the results of the groundwater evaluation are summarized below.

The total cancer risk associated with groundwater was below the target risk range for the current/future maintenance worker and the future excavation worker. In addition, the total HI was less than 1 for these receptors, with the exception that the target organ HI for the liver exceeded an HI of 1 for the excavation worker.

For future industrial worker, future lifetime resident, and child resident exposures to groundwater, the total cancer risks associated with groundwater were all above their target risk ranges, due to some of the following: bis(2-ethylhexyl)phthalate, CT, 1,2-dichloroethane, pentachlorophenol, dioxins/furans, PCE, TCE, and arsenic. Their total HIs were all above 1, primarily due to some of the following: CT, TCE, aluminum, arsenic, barium, iron, manganese, nickel, thallium, and vanadium.

Off-site residents were evaluated to address potential future migration of COPCs in groundwater. The risks and hazards for the off-site receptors were similar to those on-site because it was conservatively assumed that there was no change to groundwater concentrations as COPCs migrated off site.

Screening Level Ecological Risk Assessment (SLERA)

A SLERA (*Section 7.0*) was performed to provide an estimate of current and future ecological risk associated with potential hazardous substance releases at SWMU 50 and/or 59. The data, results, and conclusions of the SLERA evaluated risks to ecological populations inhabiting SWMU 59. Conclusions are derived from the risk assessment and are based on the responses to the assessment hypotheses and assessment endpoints.

SWMU 50. The food chain assessment suggests potential adverse impacts to terrestrial wildlife, especially shrews, robins, and voles for modeled contact with the hazard drivers (primarily selenium and TCDD; and to a lesser extent Aroclor-1254, 4,4-DDT, and 4,4-DDE) in surface soil that are not statistically related to naturally-occurring surface soil concentrations (*Section 7.2.5*). Based on the Tier 2 Lowest-Observed-Adverse-Effect Level (LOAEL)-based approach, only selenium (vole, shrew, and robin), TCDD (shrew and robin), Aroclor-1254 (shrew), 4,4-DDT (robin), and 4,4-DDE (robin) had estimated environmental effects quotients (EEQs) greater than 1 when rounded to one significant figure. In addition, when alternative exposure and/or toxicity factors were used in the SLERA EEQ calculations, estimated EEQs would be expected to drop to 1 or less for all constituents except TCDD (shrew) and selenium (vole, shrew, and robin), which were slightly elevated above 1. The direct contact assessment results suggest a potential reduction in wildlife food supply due to mercury and lead in surface

soil; however, due to the small size of the Site (2.06 acres), this potential reduction in food is not considered biologically significant.

Based on uncertainties of toxicity, the fact that no wildlife rare, threatened, or endangered (RTE) species have been confirmed at the SWMU study area, alternative exposure and/or toxicity factors that could be used, and the relatively small size of the SWMU (2.06 acres), remedial measures solely to address ecological concerns are not warranted for soil. The scientific/management decision point (SMDP) reached for this SLERA is that the information collected and presented indicates that a more thorough assessment is not warranted. As the HHRA has identified some COPCs potentially associated with adverse health effects (*Section 6.1.2*), the corrective measures study should consider if attainment of human health PRGs would result in TCDD and selenium EEQs dropping to 1 or lower, or would result in a significant reduction of estimated ecological hazard for SWMU 50.

Migration of COPECs in groundwater to surface waters and sediment of the New River was determined unlikely due to the distance of this receptor area from the Site and therefore was not deemed to be an ecological concern.

The assessment results may serve as the focus of discussions with risk managers and regulatory agencies. It is very important to note that many conservative assumptions and modeling approaches were used in the assessment, and actual hazards to wildlife may be orders of magnitude lower than predicted herein.

SWMU 59. The food chain assessment suggests potential adverse impacts to terrestrial wildlife, especially shrews, robins, and voles for modeled contact with the hazard drivers (primarily selenium; and to a lesser extent TCDD and dieldrin) in surface soil that are not statistically related to naturally occurring surface soil concentrations (*Section 7.3.5*). Based on the Tier 2 LOAEL-based approach, only selenium (vole, shrew, and robin), TCDD (shrew), and dieldrin (shrew) had estimated EEQs greater than 1 when rounded to one significant figure. In addition, when alternative exposure and/or toxicity factors were used in the SLERA EEQ calculations, estimated EEQs would be expected to drop to 1 or less for all constituents except selenium (vole and shrew), which were slightly elevated above 1. The direct contact assessment results suggest that no additional action is required at the site, as direct contact benchmark exceedances 1) are either only for potential plant toxicity (not an overriding concern at the site), or 2) do not exceed more than 50 percent of the available direct contact benchmarks.

Based on uncertainties of toxicity, the fact that no wildlife RTE species have been confirmed at the SWMU study area, alternative exposure and/or toxicity factors that could be used, and the relatively small size of the SWMU (0.57 acres), remedial measures solely to address ecological concerns are not warranted for soil. The SMDP reached for this SLERA is that the information collected and presented indicates that a more thorough assessment is not warranted. As the HHRA has identified some COPCs potentially associated with adverse health effects (*Section 6.1.2*), the corrective measures study should consider if attainment of human health preliminary remediation goals (PRGs) would result in selenium EEQs dropping to 1 or lower, or would result in a significant reduction of estimated ecological hazard for SWMU 59.

Migration of COPECs in groundwater to surface waters and sediment of the New River was determined unlikely due to the distance of this receptor area from the Site and therefore was not deemed to be an ecological concern.

The assessment results may serve as the focus of discussions with risk managers and regulatory agencies. It is very important to note that many conservative assumptions and modeling approaches were used in the assessment, and actual hazards to wildlife may be orders of magnitude lower than predicted herein.

Summary and Conclusions

Risks and hazards to current workers associated with exposure to soil at the site are within or below acceptable limits. In addition, risks and hazards were within acceptable limits for hypothetical future residential soil receptors. The SLERA concluded that based on uncertainties of toxicity, the fact that no wildlife RTE species have been confirmed at the SWMU study area, alternative exposure and/or toxicity factors that could be used, and the relatively small size of the SWMU (0.57 acres), remedial measures solely to address ecological concerns are not warranted for soil.

The results of the contamination assessment indicate that contaminants of interest in groundwater in the area of SMWUs 49, 48, 50 and 59 are associated with SWMU 49; therefore, groundwater remediation for these four SWMUs is to be addressed as part of any SWMU 49 effort. As the current and future risks and hazards for human and ecological receptors associated with soil at SWMUs 50 and 59 are within acceptable ranges and any groundwater effort is deferred to SWMU 49, the soil at SWMUs 50 and 59 will require no further action.

1.0 INTRODUCTION

Shaw Environmental, Inc. (Shaw) was tasked by the U.S. Army Corps of Engineers (USACE), Baltimore District, to perform a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) and Corrective Measures Study (CMS) at Solid Waste Management Unit (SWMU) 50 (RAAP-025) - the Calcium Sulfate ($CASO_4$) Treatment/Disposal Area and SWMU 59 (RAAP-028) – Bottom Ash Pile. The SWMUs are located adjacent to one another in the southeastern portion of the Horseshoe Area (HSA) of Radford Army Ammunition Plant (RFAAP), east of the main bridge over the New River (**Figure 1-1**). The work was performed in accordance with RFAAP's *Master Work Plan (MWP)* (URS, 2003) and *MWP Addendum 019* (Shaw, 2007) under Contract No. W912QR-04-D-0027.

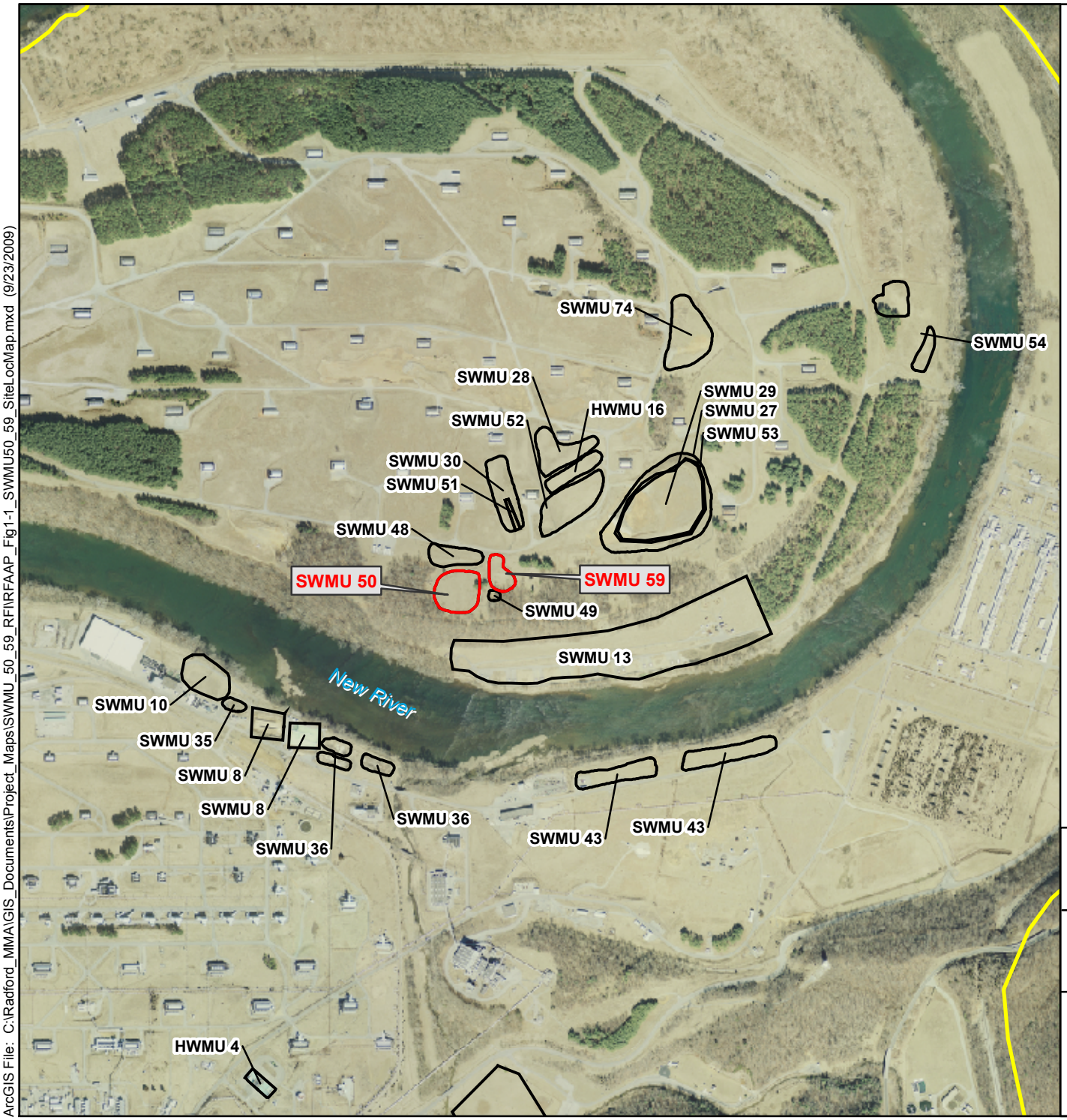
Previous investigations have been conducted as a collective effort at or adjacent to SWMUs 50 and 59 and are discussed in the following section of this report. A data review, including the development of a conceptual site model (CSM) and a data gap analysis, was performed in *MWP Addendum 019* (Shaw, 2007). Review of the data indicated that additional samples needed to be collected to characterize the current state of potentially impacted media, representing a data gap. Once the data needs were identified, sampling strategies were developed to complete the characterization of SWMUs 50 and 59.

The objectives of the recent field investigation at SWMUs 50 and 59 were designed to:

- Provide sufficient sample coverage for surface and subsurface soil for a statistical analysis of the on-site samples and the background dataset at SWMU 50.
- Characterize the subsurface and to delineate the extent of elevated arsenic in surface soil at SWMU 59.
- Assess the groundwater conditions at each SWMU and identify potential source areas.

Field activities were conducted in accordance with the *MWP, Master Quality Assurance Plan, Master Health and Safety Plan* (URS, 2003), *MWP Addendum 012* (IT, 2002a), and *MWP Addendum 019* (Shaw, 2007), as approved by U.S. Environmental Protection Agency (USEPA) Region III and the Virginia Department of Environmental Quality (VDEQ). Modifications to MWP Addendum 019 proposed sampling activities are presented in *Section 3.1.5*.

The data collected in 2007, in conjunction with existing data, was sufficient to complete a Nature and Extent of Contamination Assessment (*Section 4.0*), Fate and Transport Evaluation (*Section 5.0*), HHRA (*Section 6.0*), and Screening Level Ecological Risk Assessment (SLERA) (*Section 7.0*).



LEGEND

SWMU 50 and 59 Boundaries

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 50 and SWMU 59
Site Location Map
Radford Army Ammunition Plant,
Radford, VA

ArcGIS File: C:\Radford_MMA\GIS_Documents\Project_Maps\SWMU_50_59_RFI\RFAAP_Fig1-1_SWMU50_59_SiteLocMap.mxd (9/23/2009)

2.0 SITE BACKGROUND

2.1 Site Description

The combined study area (SWMUs 50 and 59) is located in the southeastern portion of the RFAAP HSA, east of the main bridge over the New River. As illustrated on **Figure 2-1**, the two SWMUs are adjacent, with SWMU 50 located approximately 81 feet (ft) southwest of SWMU 59.

The SWMU 50 study area is approximately 295 ft long (North to South) by 320 ft wide (East to West); whereas the SWMU 59 study area is 270 ft long by 145 ft wide. The combined study area is situated on a bluff approximately 120 ft above and overlooking SWMU 13 and the New River. The land surface in the combined study area gently slopes from approximately 1,830 feet above mean sea level (ft msl) on the north side of SWMU 59, to approximately 1,814 ft msl on the south side of SWMU 50. Based on topography, surface water runoff is expected to flow approximately 700 ft south to the New River.

The overall study area is grassy with wooded areas to the south, east, and west. The 2005 aerial photo shown on **Figure 2-2** portrays the sites' re-vegetation in the years since they were active.

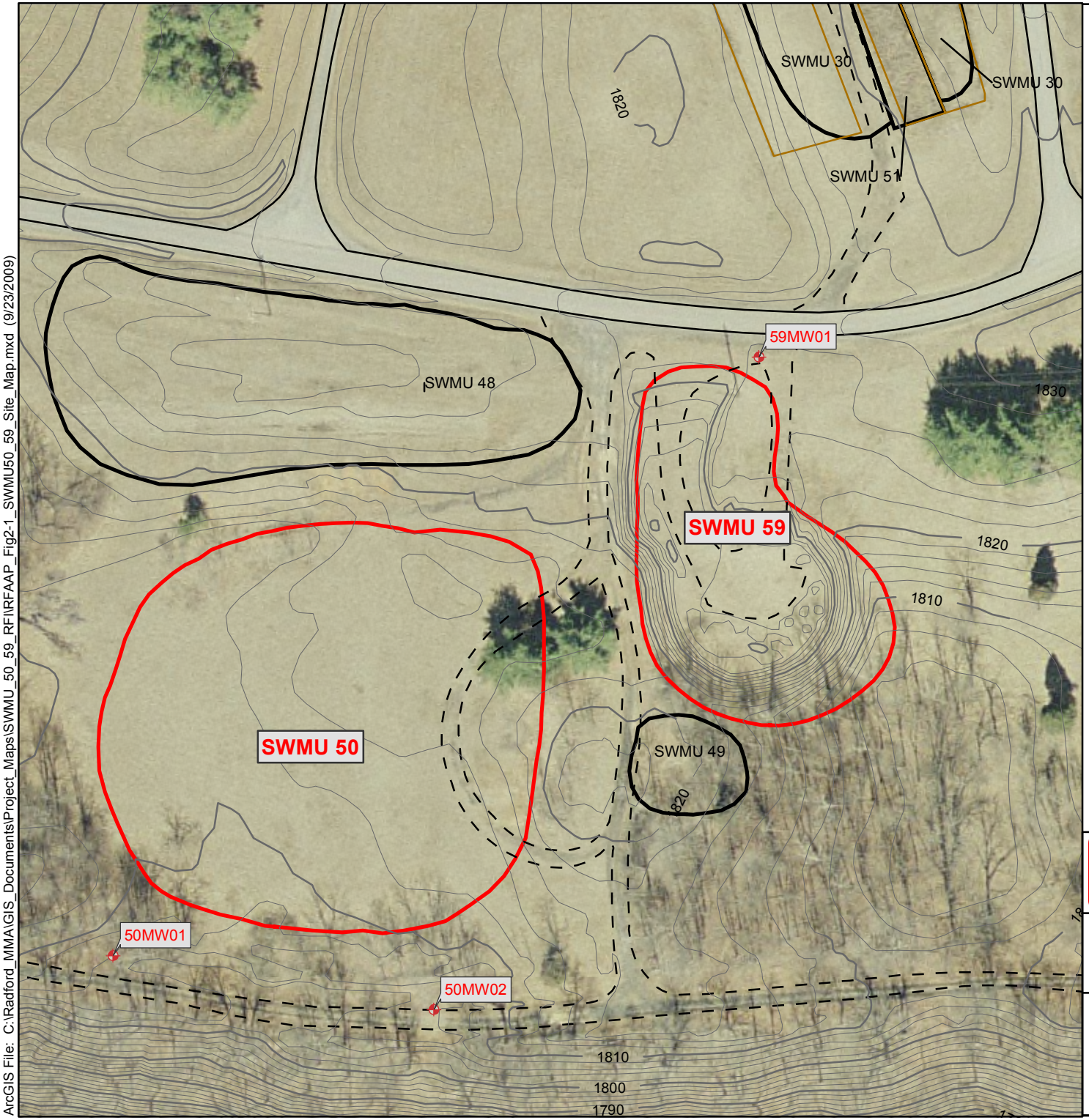
An east-west asphalt road, located at the northern edge of the study area, parallels SWMU 48 and provides access to the combined study area via a gravel and bottom ash covered dirt road that trends north-south in the middle of the study area. The dirt and gravel road connects to an east-west trending dirt road at the southern end of the area. There are no structures in the combined study area, and according to RFAAP utility maps, there are no manholes, catch basins, or storm drains located in the immediate vicinity of the area. There is also no sediment or surface water located on the sites.

2.2 Site History and Operations

The histories of the two SWMUs that comprise the combined study area are described separately in this section and the site figures depict the two SWMUs as separate and distinct areas. However, it is apparent from analytical testing of soil that the combined study area should be considered as one contiguous area with some degree of cross disposal occurring when operations at the SWMUs occurred concurrently.

SWMU 50, Calcium Sulfate Treatment/Disposal Area

The SWMU 50 study area was apparently used to manage material removed from calcium sulfate drying beds (SWMUs 35, 36, 37, 38, and Area of Concern Q) until 1982. Activity at SWMU 50 was first noted in a 1962 aerial photograph as disturbed ground (USEPA, 1992). Re-vegetation of the disturbed ground was noted in 1971; however, renewed activity was identified in a 1981 aerial photograph as a trench, a ground scar, disturbed ground, light-toned material, and mounded material. In 1986, the surface of the excavated features seen in the 1981 photograph appeared to have been filled. It should be noted that calcium sulfate and fly ash were permitted to be disposed of in nearby Solid Waste Permit 353 (aka Fly Ash Landfill No. 2, which incorporates SWMUs 27, 29, and 53). The site is no longer being used as a calcium sulfate treatment/disposal area.



LEGEND

- Monitoring Well
- Dirt Road
- Paved Road
- Fence
- 10 ft Contour Line
- SWMU 50 and SWMU 59 Boundaries
- Other SWMU Boundary

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

N

Scale:
0 50 100 200 Feet

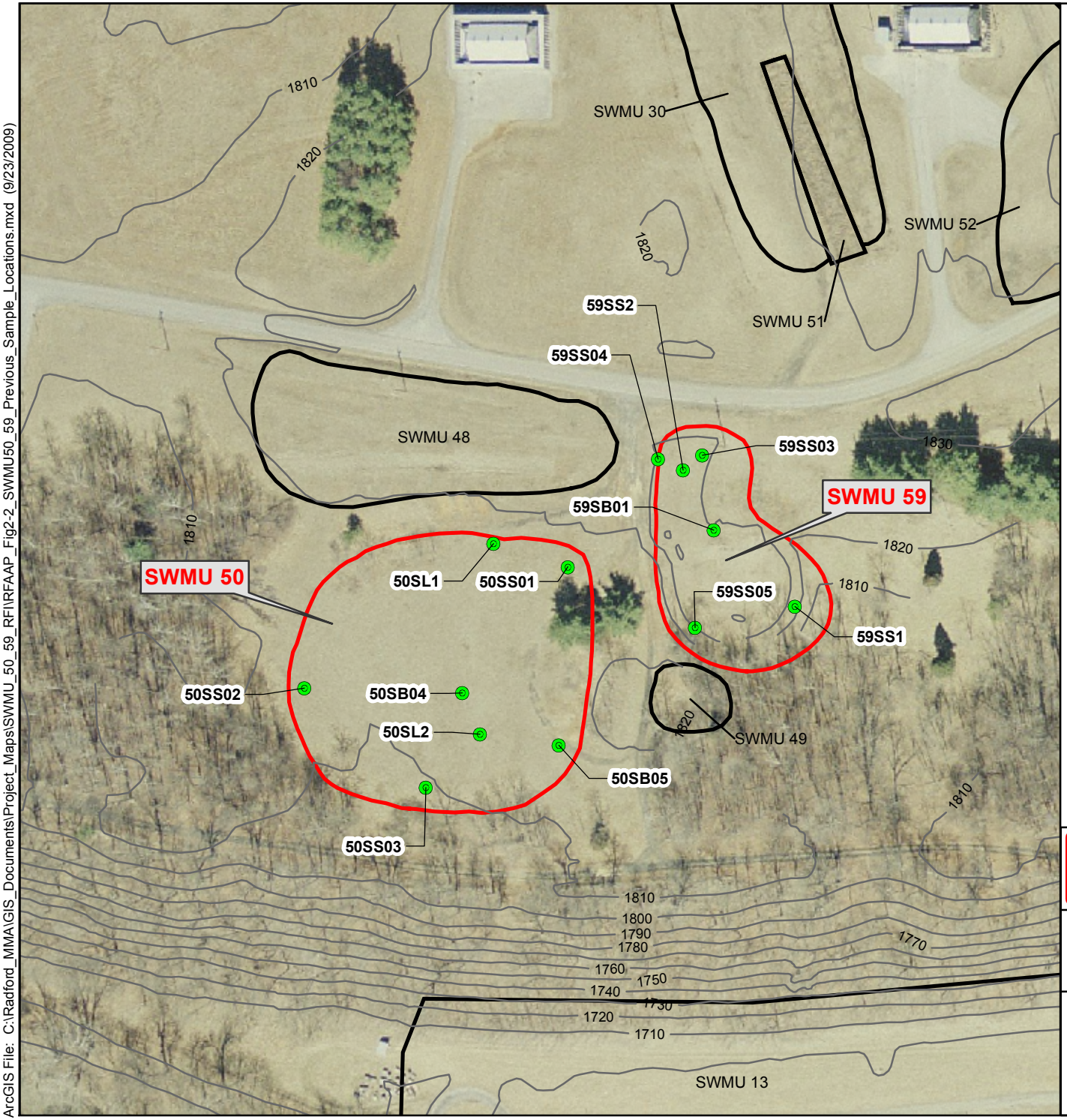
U.S. Army Corps of Engineers

Shaw® Shaw Environmental, Inc.

FIGURE 2-1
SWMU 50 and SWMU 59 Site Map

Radford Army Ammunition Plant,
Radford, VA

ArcGIS File: C:\Radford_MMA\GIS_Documents\Project_Maps\SWMU_50_59_RFI\RFAAP_Fig2-1_SWMU50_59_Site_Map.mxd (9/23/2009)



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LEGEND

- Previous Investigation Soil Sample Location
- 10 ft Contour Line
- SWMU 50 and SWMU 59 Boundaries
- Other SWMU Boundary

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

N

Scale:

0 75 150 300 Feet

U.S. Army Corps of Engineers

Shaw® Shaw Environmental, Inc.

FIGURE 2-2
SWMU 50 and SWMU 59
Previous Investigation Sample Locations
Radford Army Ammunition Plant,
Radford, VA

SWMU 59, Bottom Ash Pile

SWMU 59 was apparently used to manage ash generated from the coal-fired power plant in the HSA. It should be noted that calcium sulfate and fly ash were permitted to be disposed of in nearby Solid Waste Permit 353 (aka Fly Ash Landfill No. 2, which incorporates SWMUs 27, 29, and 53). Activity was first noted at the site in 1986 aerial photography, where a large area of dark toned material was visible (USEPA, 1992). The storage pile of ash was approximately 100 ft by 50 ft, and 20 ft high (USEPA, 1987). The ash pile is no longer visible at the site and the site is no longer being used in the same manner. It can be assumed that this pile or similar piles have existed at RFAAP since operation of the coal-fueled power plant began.

2.3 Site Soil

The U.S. Department of Agriculture has mapped Braddock loam soils as underlying SWMUs 50 and 59 with slope modifiers of 2 to 7 percent (**Figure 2-3**). A typical profile of Braddock loam has a dark yellowish-brown loam surface layer about 7 inches thick with yellowish-red and red clay subsoil extending to about 60 inches depth or more. It is a gently-sloping soil that is over 60 inches deep to bedrock and doesn't have a seasonal high water table within 6 ft of the surface. Permeability is moderate; natural fertility is low; organic matter is moderately low. This soil type is acidic or very strongly acidic (SCS, 1985).

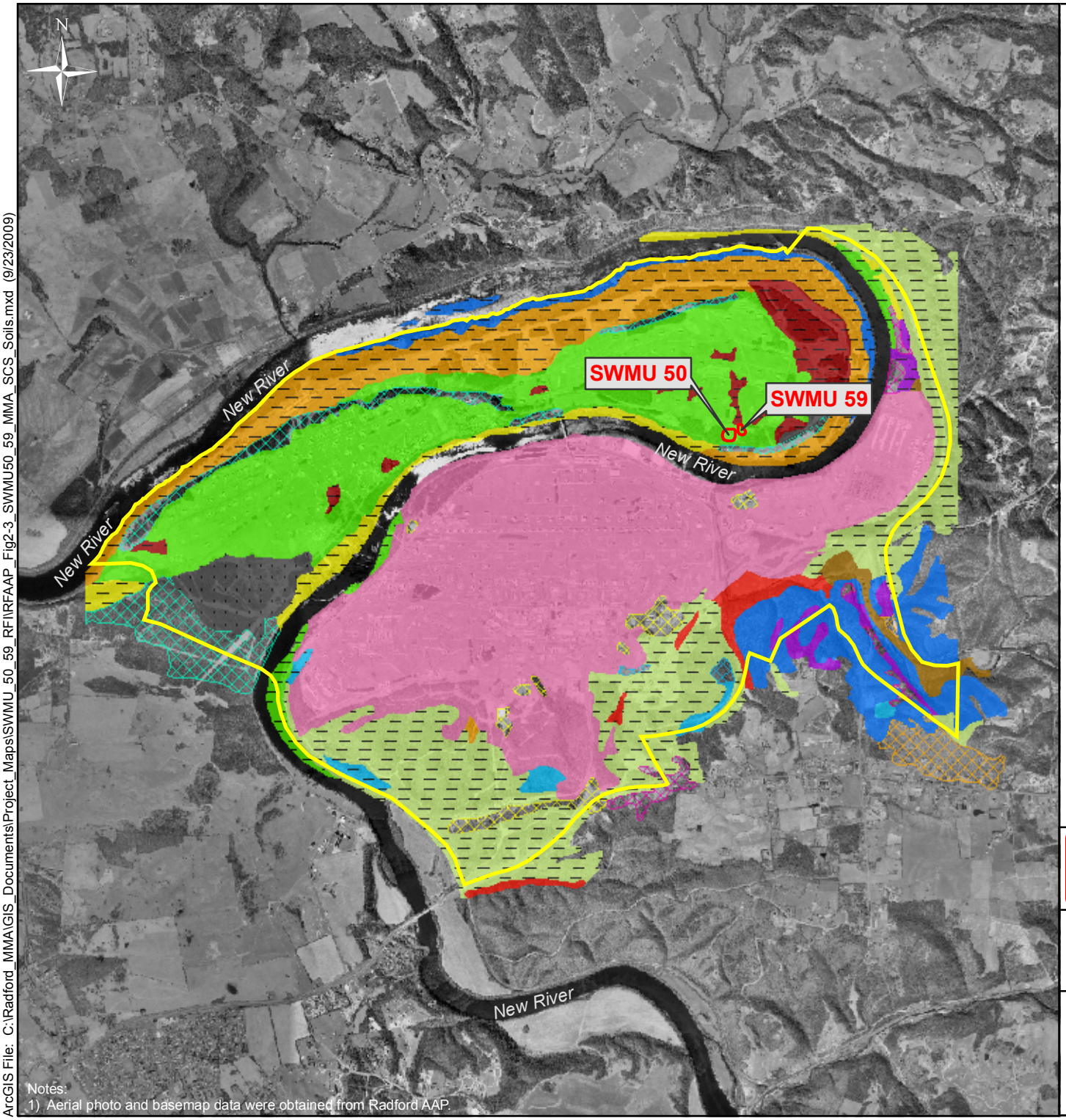
2.4 Site Geology

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

Stratigraphic characterization of the subsurface was performed during the advancement of soil and monitoring well borings at the sites. Geologic cross-sections were developed based on the logging descriptions (**Appendix B-1**). Plan view of cross-sectional lines A-A' and B-B' is presented on **Figure 2-4**. As depicted on **Figure 2-5 and 2-6**, the subsurface geology consists of alluvium and residual deposits comprised of clay and silt with some sand and gravel overlying bedrock. Depth to bedrock ranges from approximately 55 to 65 ft bgs. Bedrock consists of highly fractured interbedded siltstone, limestone, and dolostone of the Elbrook Formation. The Max Meadows Breccia is evident in outcrops along the slope leading to the river. In the outcrop along the slope, the tectonic breccia and the limestone and dolostone are highly weathered with many solution cavities.

2.5 Site Hydrogeology

The groundwater table was present below the sites in August 2007 at an elevation ranging from 1692 to 1886 ft msl (**Figure 2-7**). The water table slopes to the south, becoming steeper at the southern end of the sites near the cliff above SWMU 13 and the New River. Well 49MW01 on the figure does not show a water level because the well was practically dry at the time of measurement (August 2007). All wells for the four adjacent sites (SWMUs 48, 49, 50, and 59) were all analyzed together in the risk assessment because of their close proximity to one another. Groundwater conditions in the vicinity are controlled by the karstic nature of the Elbrook Formation. Based on topography and measured groundwater elevations (August 2007), groundwater flow in the combined study area is to the south towards the New River and appears



LEGEND

- SWMU 50 and SWMU 59 Boundaries
- Installation Boundary

SCS Soil Types

- BERKS AND WEIKERT SOILS
- BERKS AND WEIKERT, VERY STONEY SOILS
- BERKS-CLYMER COMPLEX
- BERKS-GROSECLOSE COMPLEX
- BERKS-WEIKERT COMPLEX
- BRADDOCK LOAM
- CANEYVILLE-OPEQUON-ROCK OUTCROP COMPLEX
- CARBO AND CHILHOWIE SOILS
- CARBO-ROCK OUTCROP COMPLEX
- COTACO LOAM
- CRAIGSVILLE SOIL
- FLUVAQUENTS
- FREDERICK AND VERTREES SILT LOAMS
- FRENCH SOILS
- GROSECLOSE AND POPLIMENTO
- GUERNSEY SILT LOAM
- HAYTER LOAM
- LOWELL SILT LOAM
- McGARY AND PURDY SOILS
- ROCK OUTCROP-NEWBERN-CARBO COMPLEX
- ROSS SOILS
- UDORTHENTS AND URBAN LAND
- UNISON AND BRADDOCK SOILS
- UNISON-URBAN LAND COMPLEX
- WEAVER SOILS
- WHEELING SANDY LOAM
- WURNO-NEWBERN-FAYWOOD SILT LOAMS

Scale:

0 1,750 3,500 7,000 Feet

Notes:
1) Aerial photo and basemap data were obtained from Radford AAP.

ArcGIS File: C:\Radford_MMA\GIS_Documents\Project_Maps\SWMU_50_59_RFI\RFAAP_Fig2-3_SWMU50_59_MMA_SCS_Soils.mxd (9/23/2009)

U.S. Army Corps of Engineers

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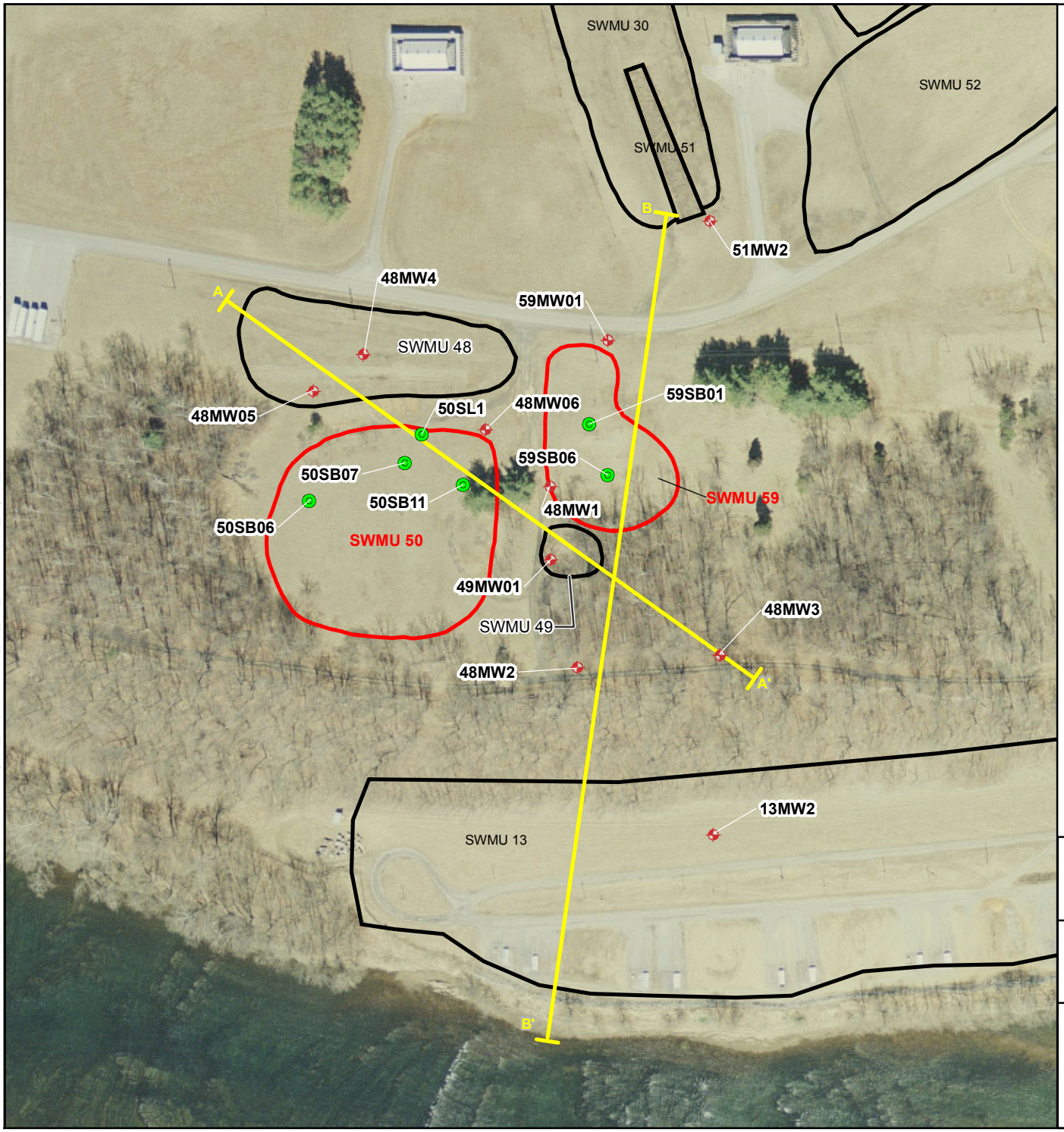
FIGURE 2-3

SCS Soil Types at RFAAP

Radford Army Ammunition Plant,
Radford, VA



LEGEND

- Monitoring Well
- Previous Investigation Soil Sample Location
- Geologic Cross Section Line
- SWMU 50 and SWMU 59 Boundaries
- Other SWMU Boundaries

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

N

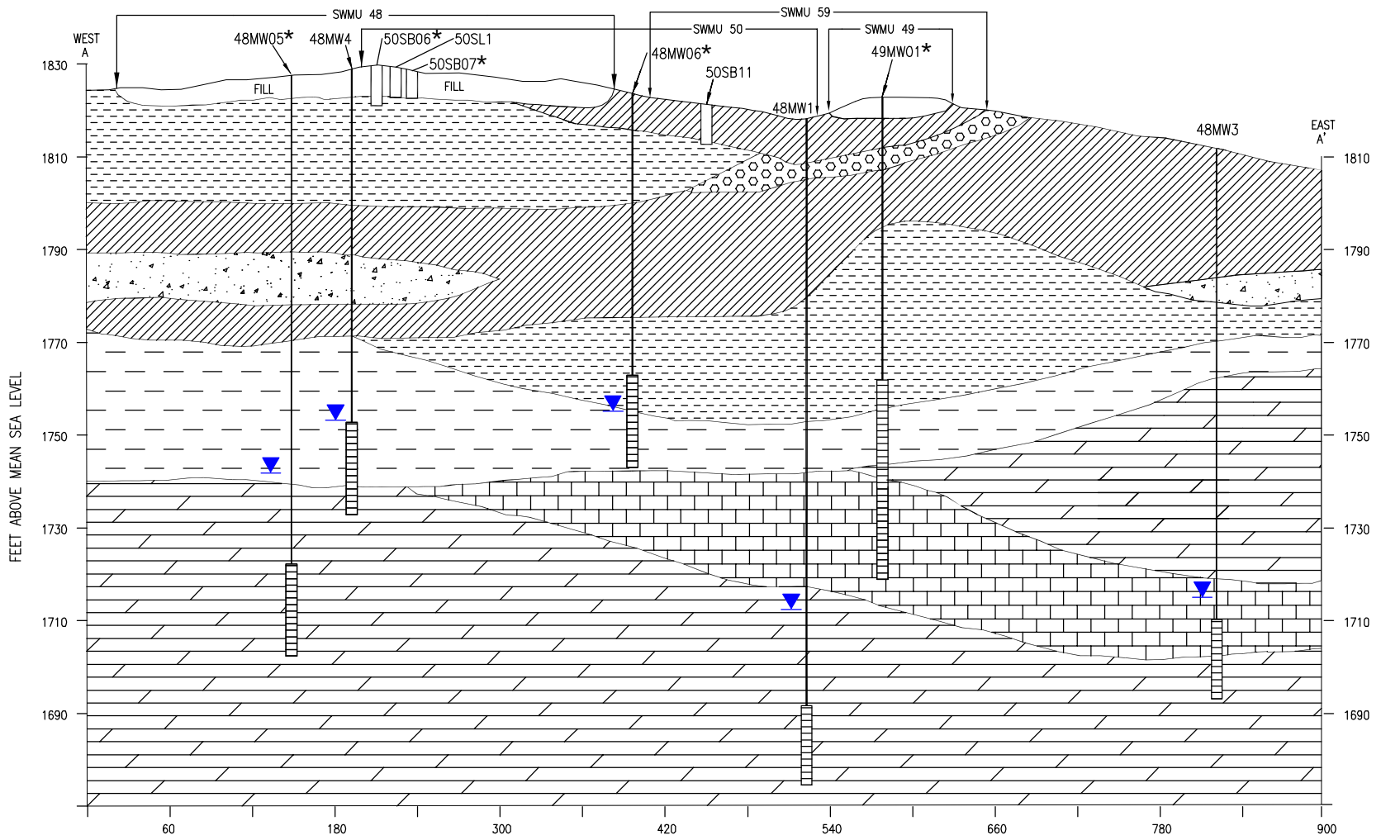
Scale:
0 80 160 320 Feet

U.S. Army Corps of Engineers

Shaw® Shaw Environmental, Inc.

FIGURE 2-4
SWMU 50 and SWMU 59
Geologic Cross Sections
Radford Army Ammunition Plant,
Radford, VA

ArcGIS File Path: C:\Radford_MMA\GIS_Documents\Project_Maps\SWMU_50_59_RFI\RFAAP_Fig2-4_SWMU50_59_XSect.mxd (joy.pasquarelli) (9/23/2009 3:16:36 PM)



LEGEND

- CLAY AND SILT, LITTLE SAND, RED–BROWN (CL)
- SILT, SOME SAND, SOME CLAY, ORANGE–BROWN (ML)
- SILT AND SAND, GRAVEL ORANGE–BROWN (CM/SM)
- SILT, SAND, AND GRAVEL, ORANGE–BROWN (GM)
- SILTSTONE, WEATHERED RED, GREEN, BROWN, INTERBEDDED DOLOMITE (SLSN)
- DOLOMITE, WEATHERED, GRAY, ARGILLACEOUS (DLMT)
- LIMESTONE, GRAY–BROWN, ARGILLACEOUS (LMSN)
- ▼ STATIC GROUNDWATER LEVEL (MEASURED AUGUST 2007)
- * PROJECTED LOCATION

NOTES

1) SOME DATA POINTS ARE PROJECTED ONTO PROFILE.
2) LITHOLOGY IS A COMPILATION FROM SWMUs 48 AND 49.
3) NO WATER LEVEL SHOWN FOR WELL 49MW01 BECAUSE IT WAS ESSENTIALLY DRY IN AUG. 2007.

HORIZ. SCALE: 0 60 120 VERT. SCALE: 0 20 40

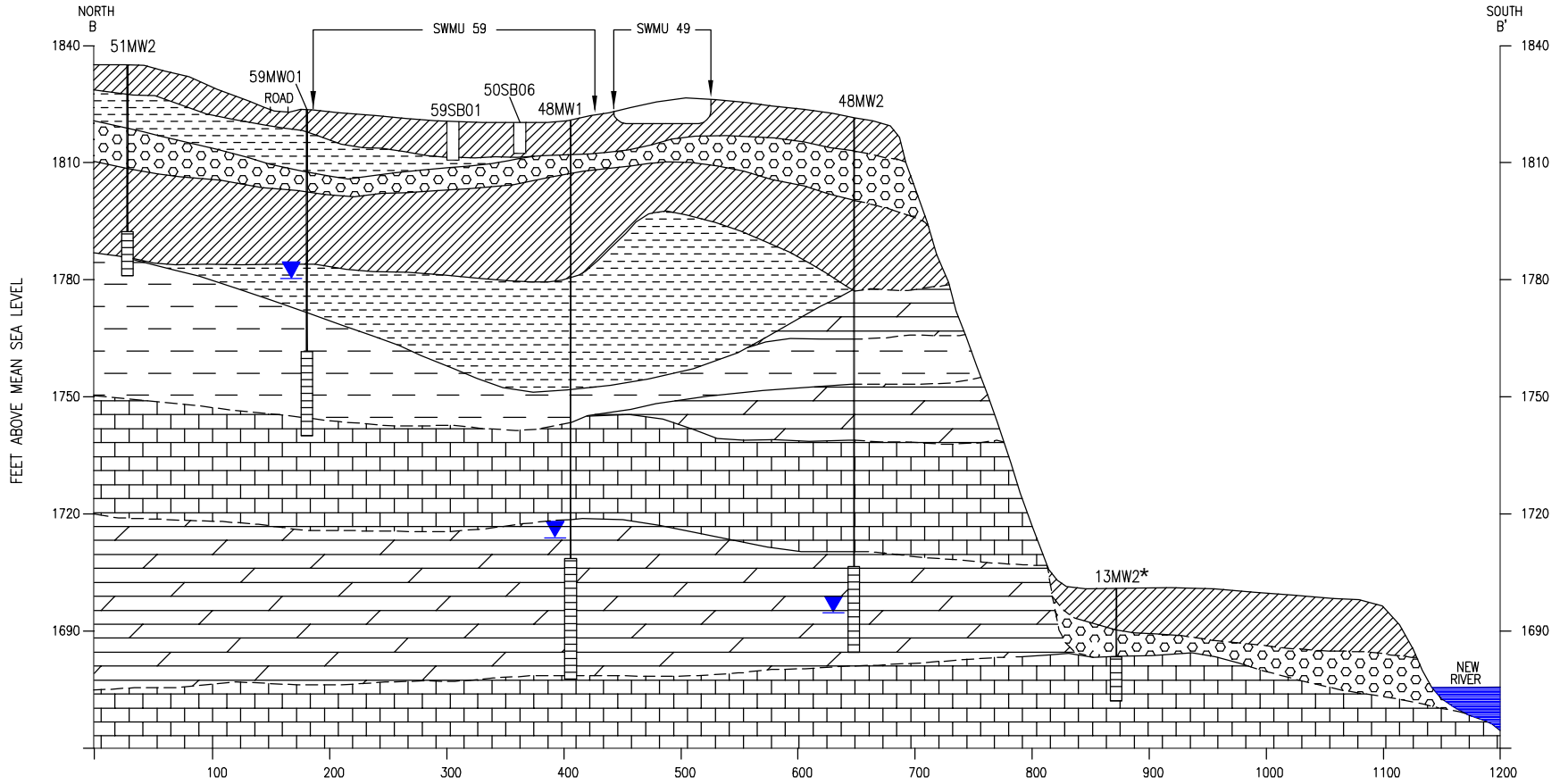
SOURCE: PARSONS ENGINEERING SCIENCE, INC.

RADFORD AAP

FIGURE 2–5

PREPARED BY: SHAW	TASK NO: 12346121003000
CHECKED BY: R. Sims	SHAW DWG NO: FIG2–5.dwg
DATE: REVISED MARCH 2009	

GEOLOGIC CROSS–SECTION A–A' SWMU 50 AND SWMU 59



HORIZ. SCALE: 0 100 200

VERT. SCALE: 0 30 60

LEGEND

- CLAY AND SILT, LITTLE SAND, RED–BROWN (CL)
- SILT, SOME SAND, SOME CLAY, ORANGE–BROWN (ML)
- SILT AND SAND, GRAVEL ORANGE–BROWN (CM/SM)
- SILTSTONE, WEATHERED RED, GREEN, BROWN, INTERBEDDED DOLOMITE (SLSN)
- DOLOMITE, WEATHERED, GRAY, ARGILLACEOUS (DLMT)
- LIMESTONE, GRAY–BROWN, ARGILLACEOUS (LMSN)
- STATIC GROUNDWATER LEVEL (MEASURED AUGUST 2007)
- * PROJECTED LOCATION

NOTES

1) SOME DATA POINTS ARE PROJECTED ONTO PROFILE.
2) 51MW2 AND 13MW2 LITHOLOGY FROM DAMES AND MOORE.
3) LITHOLOGY PATTERNS DO NOT MATCH DRILL LOG PATTERNS BECAUSE OF DIFFERING GRAPHICS SYSTEMS.
4) CONTACT LINES DASHED WHERE INFERRED.
5) ADDITIONAL WELLS SHOWN TO AID IN CROSS SECTION ACCURACY.
6) WELLS 51MW2 AND 13MW2 DID NOT HAVE WATER LEVELS TAKEN IN AUG. 2007.

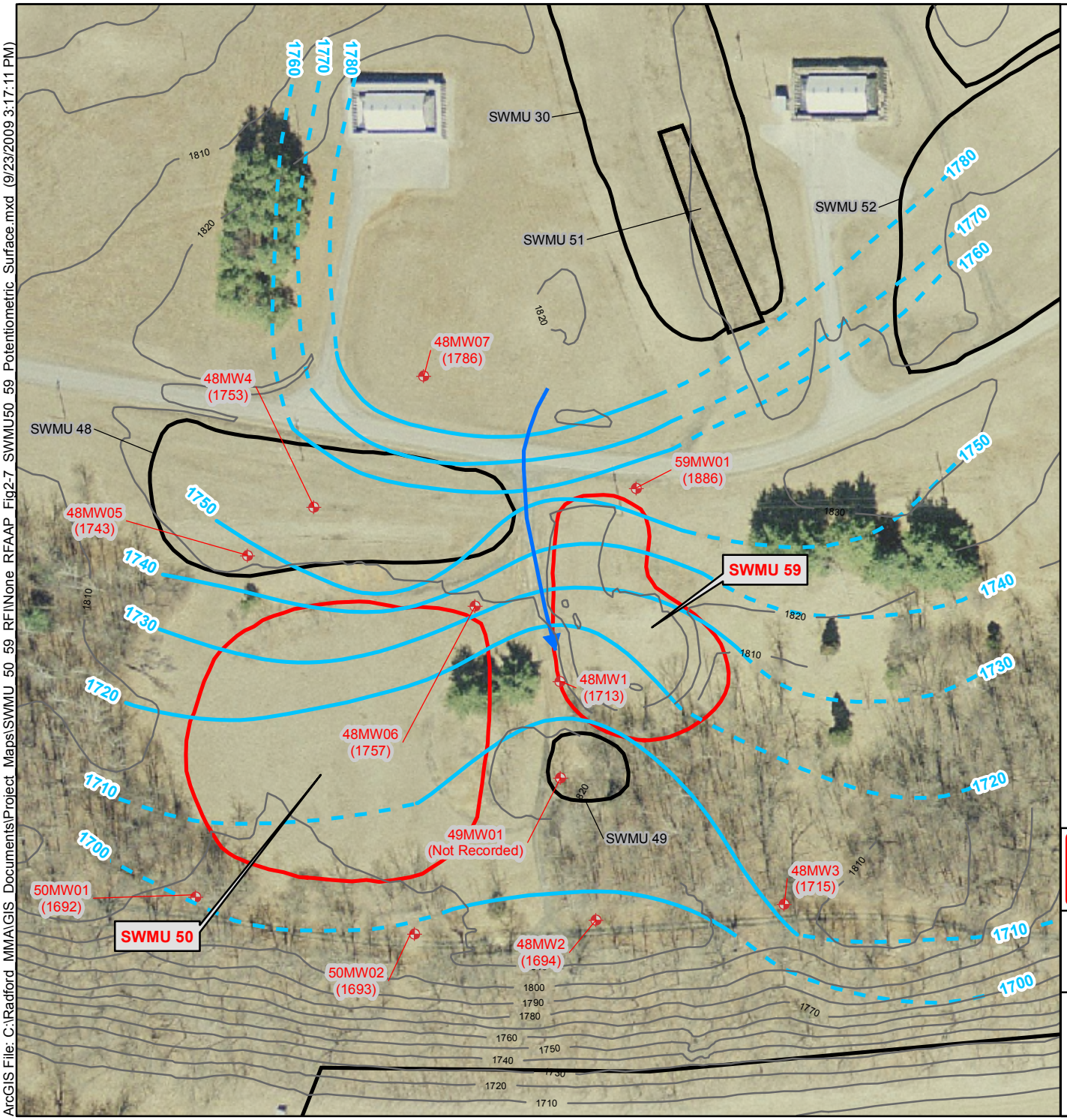
SOURCE: PARSONS ENGINEERING SCIENCE, INC.

RADFORD AAP

FIGURE 2–6

PREPARED BY: SHAW	TASK NO: 82987002300000
CHECKED BY: MT	SHAW DWG NO: FIG2–6.dwg
DATE: REVISED OCT. 2008	

GEOLOGIC CROSS–SECTION B–B' SWMU 50 AND SWMU 59



LEGEND

- Groundwater Sample Location
- Inferred Groundwater Contour
- Groundwater Contour
- Groundwater Flow Direction
- SWMU 50 and SWMU 59 Boundaries
- Other SWMU Boundary

Notes:
1) Aerial photo, dated 2005, was obtained from Montgomery County, VA Planning & GIS Services.
2) Water levels are expressed in feet above mean sea level.
3) All water levels were measured in August, 2007.

N

Scale:

0 75 150 300 Feet

U.S. Army Corps of Engineers

Shaw® Shaw Environmental, Inc.

FIGURE 2-7
SWMU 50 and SWMU 59
Potentiometric Surface Map
Radford Army Ammunition Plant,
Radford, VA

ArcGIS File: C:\Radford_MMA\GIS_Documents\Project_Maps\SWMU_50_59_RFI\None_RFAAP_Fig2-7_SWMU50_59_Potentiometric_Surface.mxd (9/23/2009 3:17:11 PM)

to follow topography. As discussed in *Section 2.1*, surface water is also expected to flow towards the New River.

2.6 Previous Investigations

Three previous investigations have been conducted at SWMUs 50 and 59. In 1987, the USEPA conducted a RCRA Facility Assessment (RFA) to evaluate potential hazardous waste or hazardous constituent releases and implement corrective actions, as necessary. In 1992, Dames and Moore performed a Verification Investigation (VI), which included surface and subsurface soil sampling and a soil gas survey to characterize the nature and extent of contamination. Additional sampling was conducted by IT Corporation/Shaw in 2002 to collect sufficient data to complete human health and ecological risk assessments. These investigations and results of the chemical data are summarized below.

2.6.1 RFA, USEPA, 1987

An installation-wide assessment was conducted for RFAAP to evaluate potential hazardous waste or hazardous constituent releases and implement corrective actions, as necessary. The assessment consisted of a preliminary review and evaluation of available site information, personnel interviews, and a visual site inspection. Environmental samples were not collected from SWMUs 50 or 59 as part of the inspection.

The assessment indicated that inactive SWMUs 48, 49, and 50 are contiguous, and no distinction can be made by visual observation. During a site inspection in April 1987, there were no visual signs of release; however, some residue of what appeared to be calcium sulfate was noted, likely associated with adjacent SWMU 50 – Calcium Sulfate Treatment/Disposal Area. For SWMU 59, the assessment indicated that active storage of bottom ash was occurring.

2.6.2 VI, Dames and Moore, 1992

The VI report was prepared for USATHAMA and covered many RFAAP SWMUs. The objective was to evaluate whether toxic or hazardous contaminants are present and are, or have the potential of, migrating beyond the boundaries of the identified SWMUs. Environmental samples were collected, analyzed for chemical constituents, and evaluated. Recommendations for further study or action (or no further action) were made. Environmental samples collected from the SWMU 50/59 combined study area included:

- Two samples of disposed sludge at SWMU 50, analyzed for TCLP metals, VOCs, and SVOCs.
- Two shallow soil samples collected from immediately below bottom ash at SWMU 59, analyzed for TAL metals and SVOCs.

A summary of VI sampling is included in **Table 2-1**. Positive detections for VI sampling and screening level (SL) exceedances for SWMUs 50 and 59 are identified in **Tables 2-2 and 2-3**, respectively. Detailed discussion of screening exceedances will be presented in *Section 4.0*. Soil sampling locations are depicted on **Figure 2-2**.

The VI report concluded that the contaminants of concern for SWMUs 50 and 59 were metals, specifically arsenic, in coal bottom ash and the underlying soil at SWMU 59.

The report recommended further sampling and/or an RFI to address the source and extent of the contaminants of concern identified.

Table 2-1
Previous Investigations Samples and Analyses

Media	Sample ID	Depth (ft bgs)	Analyses
SWMU 50			
1992 Verification Investigation, Dames & Moore			
Subsurface Soil	50SL1	0-5	VOCs, SVOCs, and pesticides/PCBs
	50SL2	0-5	VOCs, SVOCs, and pesticides/PCBs
2002 Site Characterization, IT Corporation			
Surface Soil	50SS01	0-0.5	TCL VOCs, SVOCs, pesticides/PCBs, herbicides, PAHs, explosives, TAL metals, TOC, and pH
	50SS02	0-0.5	TCL VOCs, SVOCs, PCBs, PAHs, explosives, and TAL metals
	50SS03	0-0.5	TCL VOCs, SVOCs, pesticides/PCBs, herbicides, PAHs, explosives, and TAL metals
	50SB04A	0-0.5	TCL VOCs, SVOCs, PCBs, PAHs, explosives, and TAL metals
	50SB05A	0-0.5	TCL VOCs, SVOCs, PCBs, PAHs, explosives, and TAL metals
Subsurface Soil	50SB04B	4-6	TCL VOCs, SVOCs, PCBs, PAHs, explosives, and TAL metals
	50SB04C	8-10	TCL VOCs, SVOCs, PCBs, PAHs, explosives, and TAL metals
	50SB05B	4-6	TCL VOCs, SVOCs, PCBs, PAHs, explosives, TAL metals
	50SB05C	8-10	TCL VOCs, SVOCs, PCBs, PAHs, explosives, TAL metals
SWMU 59			
1992 Verification Investigation, Dames and Moore			
Surface Soil	59SS1	0-1	SVOCs, pesticides/PCBs, and TAL metals
	59SS2	0-1	SVOCs, pesticides/PCBs, and TAL metals
2002 Site Characterization, IT Corporation			
Surface Soil	59SS03	0-0.5	TCL VOCs, SVOCs, pesticides/PCBs, herbicides, PAHs, explosives, TAL metals, dioxins/furans, TOC, and pH
	59SS04	0-0.5	TAL metals
	59SS05	0-0.5	TCL VOCs, SVOCs, pesticides/PCBs, herbicides, PAHs, explosives, TAL metals, and dioxins/furans
	59SB01A	0-0.5	TCL VOCs, SVOCs, pesticides/PCBs, herbicides, PAHs, explosives, TAL metals, and dioxins/furans
Subsurface Soil	59SB01B	4-6	TCL VOCs, SVOCs, PCBs, PAHs, explosives, TAL metals, and dioxins/furans
	59SB01C	8-10	TCL VOCs, SVOCs, PCBs, PAHs, explosives, TAL metals, and dioxins/furans

Table 2-2
Analytes Detected in SWMU 50 Soil Samples - 1992 VI

Analyte				Sample ID Sample Date Sample Depth	**50SL1 (RVFS*9)** **8/17/91** **0-5**		**50SL2 (RVFS*10)** **8/17/91** **0-5**	
	i-SL	**r-SL**	**Background**	Result	Lab Q	Result	Lab Q
VOCs (ug/kg)								
1,1,1-Trichloroethane	3900000	900000	na	5000		2000	U
Chloroform	1500	300	na	2000		400	U
SVOCs (ug/kg)								
2-Methylnaphthalene	410000	31000	na	470		49	U
Naphthalene	20000	3900	na	430		37	U
Phenanthrene	1700000	170000	na	150		33	U
Pesticides (ug/kg)	None detected						
PCBs (mg/kg)	None detected						

**Refer to legend immediately following this table for a list of definitions and tables notes.

Table 2-2
Legend

12	J	Shading and black font indicate an industrial SL exceedance.
12	J	Bold outline indicates a residential SL exceedance.
12	**J**	Bold, underlined font indicates a background exceedance.
12	*12*	Shading in the MDL/MRL columns indicates the MDL exceeds a criterion.

SLs for non-Carcinogenic compounds have been recalculated to an HI of 0.1.
The pyrene SLs were used for acenaphthylene, benzo(g,h,i)perylene, and phenanthrene.
Inorganic results below background UTLs are not indicated as exceedances on the table.
SL = Screening Level (Source: ORNL Regional Screening Table, September 2008).
SL values in table are for the more conservative chromium VI.
SL values for chromium III are 150,000 (ind) and 12,000 (res), which were not exceeded.
Lead screening values from Technical Review Workgroup for Lead: Guidance Document (April 1999).
mg/kg = milligrams per kilogram (parts per million).
ng/kg = nanograms per kilogram (parts per trillion).
µg/kg = micrograms per kilogram (parts per billion).
NA = not applicable.
NT = analyte not tested.

Lab Q = Lab Data Qualifiers

* = Laboratory duplicate not within control limits.
B = (organics) Blank contamination. Value detected in sample and associated blank.
A (Dioxins) = B = (metals) Value <MRL and >MDL and is considered estimated.
E (metals) = Reported value is estimated because of the presence of interferences.
EMPC (Dioxins) = The ion-abundance ratio between the two characteristic PCDD/PCDF ions was outside accepted ranges. The detected PCDD/PCDF was reported as an estimated maximum possible concentration (EMPC).
J = (organics) Value <MRL and >MDL and is considered estimated.
U = Analyte not-detected at the method reporting limit.
X = (dioxins) Ion abundance ratio outside acceptable range. Value reported is EMPC.

Val Q = Validation Data Qualifiers

B = blank contamination. Value detected in sample and associated blank.
J = estimated concentration.
K = estimated concentration bias high.
L = estimated concentration bias low.
N = presumptive evidence for tentatively identified compounds using a library search.
U = analyte not detected.
UJ = estimated concentration non-detect.
UL = estimated concentration non-detect bias low.

Table 2-3
Analytes Detected in SWMU 59 Soil Samples - 1992 VI

Analyte	Sample ID Sample Date Sample Depth			59SS1 (RVFS*110) 3/5/92 0-0.5		59SS2 (RVFS*108) 3/5/92 0-0.5	
	i-SL	r-SL	Background	Result	Lab Q	Result	Lab Q
SVOCs (ug/kg)							
Phenanthrene	1700000	170000	na	33	U	400	
Pesticides (ug/kg)	None detected						
PCBs (mg/kg)	None detected						
Metals (mg/kg)							
Aluminum	99000	7700	40041	11400		6270	
Arsenic	1.6	0.39	15.8	1.85		**34**	
Barium	19000	1500	209	190		181	
Beryllium	200	16	1.02	**1.23**		0.736	
Calcium	na	na	na	494		785	
Chromium	1400	280	65.3	22		14.4	
Cobalt	30	2.3	72.3	10.1		3.03	
Copper	4100	310	53.5	7.08		17	
Iron	72000	5500	50962	12700		20600	
Lead	800	400	26.8	15.3		**30.6**	
Magnesium	na	na	na	523		528	
Manganese	2300	180	2543	**2560**		38.9	
Nickel	2000	160	62.8	8.59		6.31	
Potassium	na	na	na	377		530	
Selenium	510	39	na	0.25	U	0.646	
Silver	510	39	na	0.589	U	0.701	
Sodium	na	na	na	167		231	
Vanadium	720	55	108	29.8		25.3	
Zinc	31000	2300	202	24.4		41.6	

**Refer to legend immediately following this table for a list of definitions and tables notes.

Table 2-3
Legend

12	J	Shading and black font indicate an industrial SL exceedance.
12	J	Bold outline indicates a residential SL exceedance.
12	**J**	Bold, underlined font indicates a background exceedance.
12	*12*	Shading in the MDL/MRL columns indicates the MDL exceeds a criterion.

SLs for non-Carcinogenic compounds have been recalculated to an HI of 0.1.
The pyrene SLs were used for acenaphthylene, benzo(g,h,i)perylene, and phenanthrene.
Inorganic results below background UTLs are not indicated as exceedances on the table.
SL = Screening Level (Source: ORNL Regional Screening Table, September 2008).
SL values in table are for the more conservative chromium VI.
SL values for chromium III are 150,000 (ind) and 12,000 (res), which were not exceeded.
Lead screening values from Technical Review Workgroup for Lead: Guidance Document (April 1999).
mg/kg = milligrams per kilogram (parts per million).
ng/kg = nanograms per kilogram (parts per trillion).
µg/kg = micrograms per kilogram (parts per billion).
NA = not applicable.
NT = analyte not tested.

Lab Q = Lab Data Qualifiers

* = Laboratory duplicate not within control limits.
B = (organics) Blank contamination. Value detected in sample and associated blank.
A (Dioxins) = B = (metals) Value <MRL and >MDL and is considered estimated.
E (metals) = Reported value is estimated because of the presence of interferences.
EMPC (Dioxins) = The ion-abundance ratio between the two characteristic PCDD/PCDF ions was outside accepted ranges. The detected PCDD/PCDF was reported as an estimated maximum possible concentration (EMPC).
J = (organics) Value <MRL and >MDL and is considered estimated.
U = Analyte not-detected at the method reporting limit.
X = (dioxins) Ion abundance ratio outside acceptable range. Value reported is EMPC.

Val Q = Validation Data Qualifiers

B = blank contamination. Value detected in sample and associated blank.
J = estimated concentration.
K = estimated concentration bias high.
L = estimated concentration bias low.
N = presumptive evidence for tentatively identified compounds using a library search.
U = analyte not detected.
UJ = estimated concentration non-detect.
UL = estimated concentration non-detect bias low.

2.6.3 RFI, Shaw, 2002

Additional RFI characterization of these sites continued in 2002, with the collection of additional soil samples. **Table 2-1** presents the depths and analyses for the 2002 soil samples. Results from these soil samples are presented in **Tables 2-4 and 2-5**.

The preliminary draft RFI utilized the combined data set from the 1992 and 2002 investigations to assess the two sites and perform an HHRA and a SLERA. At the time, RFAAP was considering a regional groundwater study and the groundwater component of the HHRA was not included. Subsequently, a site-specific approach to groundwater investigations was adopted and the preliminary draft RFI report was never submitted or finalized.

The soil results from this investigation are discussed in *Section 4.0* of this report, along with the other previous investigation data and data from the current (2007) investigation.

Table 2-4
Analytes Detected in SWMU 50 Soil Samples - 2002 Site Characterization
Page 1 of 4

Analyte	Sample ID			50SS01					50SS02					50SS03					50SB04A					50SB04B					50SB04C					
	Sample Date			6/25/02					6/25/02					6/25/02					6/25/02					6/25/02					6/25/02					
	Sample Depth			0-0.5					0-0.5					0-0.5					0-0.5					4-6					8-10					
	i-SL	r-SL	Background	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	Result	Lab Q	Val Q	MDL	MRL	Result
VOCs (ug/kg)																																		
Acetone	61000000	6100000	na	41		B	*2.5*	*5.6*	5.7	U	UJ	*2.6*	*5.7*	5.7	U	UJ	*2.6*	*5.7*	17		B	*2.5*	*5.5*	9.1	U	UJ	*4.1*	*9.1*	12	U	UJ	*5.4*	*12*	6
Carbon disulfide	300000	67000	na	5.6	U		*0.38*	*5.6*	5.7	U		*0.39*	*5.7*	5.7	U		*0.39*	*5.7*	5.5	U		*0.38*	*5.5*	1.1	J	B	*0.63*	*9.1*	12	U		*0.81*	*12*	0.64
PAHs (ug/kg)																																		
2-Methylnaphthalene	410000	31000	na	9.1			*0.71*	*2.1*	48			*0.74*	*2.2*	45			*0.74*	*2.2*	16			*0.69*	*2.1*	4.6	U		*1.6*	*4.6*	190			*2.2*	*6.7*	400
Acenaphthene	3300000	340000	na	2	J	B	*1.1*	*2.1*	2.4		B	*1.2*	*2.2*	1.9	J	B	*1.3*	*2.2*	3.8		B	*1.1*	*2.1*	7		B	*2.6*	*4.6*	6.2	J	B	*3.8*	*6.7*	16
Acenaphthylene	1700000	170000	na	2.2			*0.28*	*2.1*	10			*0.3*	*2.2*	3.1			*0.3*	*2.2*	4.4			*0.28*	*2.1*	2.8	J	J	*0.61*	*4.6*	3.6	J	J	*0.89*	*6.7*	20
Anthracene	17000000	1700000	na	2.1	U		*0.23*	*2.1*	6.2			*0.24*	*2.2*	3			*0.24*	*2.2*	9.5			*0.22*	*2.1*	2	J	J	*0.51*	*4.6*	6.3	J	J	*0.73*	*6.7*	11
Benz(a)anthracene	2100	150	na	3.6			*0.28*	*2.1*	42			*0.3*	*2.2*	14			*0.3*	*2.2*	15			*0.28*	*2.1*	8.2			*0.61*	*4.6*	23			*0.89*	*6.7*	36
Benzo(a)pyrene	210	15	na	3.3			*0.23*	*2.1*	54			*0.25*	*2.2*	12			*0.25*	*2.2*	12			*0.23*	*2.1*	5.7			*0.51*	*4.6*	17			*0.75*	*6.7*	19
Benzo(b)fluoranthene	2100	150	na	6.5			*0.4*	*2.1*	81			*0.42*	*2.2*	21			*0.42*	*2.2*	32			*0.4*	*2.1*	9.4			*0.88*	*4.6*	27			*1.3*	*6.7*	34
Benzo(g,h,i)perylene	1700000	170000	na	3.4		J	*0.75*	*2.1*	59			*0.77*	*2.2*	15			*0.77*	*2.2*	21			*0.73*	*2.1*	4.1	J	J	*1.6*	*4.6*	16			*2.4*	*6.7*	17
Benzo(k)fluoranthene	21000	1500	na	2	J	J	*0.37*	*2.1*	29			*0.39*	*2.2*	6.7			*0.39*	*2.2*	7.7			*0.36*	*2.1*	3.6	J	J	*0.81*	*4.6*	7.5			*1.2*	*6.7*	7.1
Chrysene	210000	15000	na	6.1			*0.33*	*2.1*	61			*0.35*	*2.2*	19			*0.35*	*2.2*	21			*0.33*	*2.1*	8.5			*0.74*	*4.6*	29			*1.1*	*6.7*	49
Dibenz(a,h)anthracene	210	15	na	1.6	J	J	*0.71*	*2.1*	14			*0.75*	*2.2*	3.5			*0.75*	*2.2*	2.3			*0.7*	*2.1*	4.6	U		*1.6*	*4.6*	3.4	J	J	*2.2*	*6.7*	3.3
Fluoranthene	2200000	230000	na	9			*0.37*	*2.1*	73			*0.37*	*2.2*	26			*0.38*	*2.2*	110			*0.35*	*2.1*	18			*0.79*	*4.6*	36			*1.2*	*6.7*	41
Fluorene	2200000	230000	na	1.1	J	J	*0.56*	*2.1*	5.4		J	*0.58*	*2.2*	3		J	*0.58*	*2.2*	8.4		J	*0.55*	*2.1*	1.3	J	J	*1.2*	*4.6*	10		J	*1.8*	*6.7*	18
Indeno(1,2,3-cd)pyrene	2100	150	na	2.3			*0.68*	*2.1*	40			*0.7*	*2.2*	9.7			*0.71*	*2.2*	15			*0.66*	*2.1*	3.5	J	J	*1.5*	*4.6*	11			*2.2*	*6.7*	6.9
Naphthalene	20000	3900	na	4.2		B	*0.81*	*2.1*	27			*0.84*	*2.2*	27			*0.85*	*2.2*	8.4			*0.79*	*2.1*	3.5	J	B	*1.8*	*4.6*	120			*2.6*	*6.7*	270
Phenanthrene	1700000	170000	na	11			*0.32*	*2.1*	65			*0.34*	*2.2*	38			*0.34*	*2.2*	70			*0.32*	*2.1*	11			*0.71*	*4.6*	120			*1*	*6.7*	260
Pyrene	1700000	170000	na	7.5			*0.48*	*2.1*	85			*0.49*	*2.2*	27			*0.5*	*2.2*	240			*0.46*	*2.1*	14			*1*	*4.6*	41			*1.5*	*6.7*	47
SVOCs (ug/kg)																																		
1,2-Dichlorobenzene	1000000	200000	na	190	U		*5.3*	*190*	11	J	J	*5.4*	*190*	190	U		*5.4*	*190*	190	U		*5.3*	*190*	280	U		*7.9*	*280*	16	J	J	*9.5*	*340*	370
1,3-Dichlorobenzene	na	na	na	190	U		*5.8*	*190*	8.6	J	J	*5.9*	*190*	190	U		*5.9*	*190*	190	U		*5.8*	*190*	280	U		*8.6*	*280*	16	J	J	*10*	*340*	370
1,4-Dichlorobenzene	13000	2600	na	190	U		*6.4*	*190*	11	J	J	*6.5*	*190*	190	U		*6.5*	*190*	190	U		*6.3*	*190*	280	U		*9.5*	*280*	16	J	J	*11*	*340*	370
2,4-Dinitrotoluene	120000	12000	na	190	U		*6.3*	*190*	43	J	J	*6.5*	*190*	190	J	J	*6.5*	*190*	2500			*6.3*	*190*	280	U		*9.4*	*280*	140	J	J	*11*	*340*	510
2,6-Dinitrotoluene	62000	6100	na	190	U		*4.7*	*190*	190	U		*4.8*	*190*	190	U		*4.8*	*190*	410			*4.6*	*190*	280	U		*6.9*	*280*	30	J	J	*8.3*	*340*	46
2-Methylnaphthalene	410000	31000	na	8.4	J	J	*7.2*	*190*	86	J	J	*7.3*	*190*	84	J	J	*7.3*	*190*	26	J	J	*7.1*	*190*	17	J	J	*11*	*280*	460			*13*	*340*	870
2-Methylphenol	3100000	310000	na	190	U	UL	*7.6*	*190*	190	U	UL	*7.7*	*190*	190	U	UL	*7.7*	*190*	190	U	UL	*7.5*	*190*	280	U	UL	*11*	*280*	21	J	B	*14*	*340*	370
4-Methylphenol	310000	31000	na	190	U	UL	*6.6*	*190*	190	U	UL	*6.7*	*190*	190	U	UL	*6.8*	*190*	190	U	UL	*6.5*	*190*	280	U	UL	*9.8*	*280*	29	J	B	*12*	*340*	370
Acenaphthene	3300000	340000	na	190	U		*5.2*	*190*	12	J	J	*5.3*	*190*	190	U		*5.3*	*190*	8.5	J	J	*5.1*	*190*	280	U		*7.7*	*280*	28	J	J	*9.3*	*340*	370
Acenaphthylene	1700000	170000	na	190	U		*5*	*190*	9.7	J	J	*5.1*	*190*	190	U		*5.2*	*190*	7.3	J	J	*5*	*190*	280	U		*7.5*	*280*	340	U		*9*	*340*	370
Anthracene	17000000	1700000	na	190	U		*5.5*	*190*	15	J	J	*5.6*	*190*	190	U		*5.6*	*190*	12	J	J	*5.4*	*190*	280	U		*8.1*	*280*	23	J	J	*9.8*	*340*	24
Benz(a)anthracene	2100	150	na	190	U		*5.4*	*190*	52	J	J	*5.5*	*190*	27	J	J	*5.5*	*190*	24	J	J	*5.3*	*190*	280	U		*8*	*280*	41	J	J	*9.6*	*340*	54
Benzo(a)pyrene	210	15	na	190	U		*4.6*	*190*	53	J	J	*4.7*	*190*	23	J	J	*4.7*	*190*	15	J	J	*4.6*	*190*	280	U		*6.9*	*280*	340	U		*8.3*	*340*	32
Benzo(b)fluoranthene	2100	150	na	190	U		*4*	*190*	70	J	J	*4.1*	*190*	39	J	J	*4.1*	*190*	38	J	J	*3.9*	*190*	280	U		*5.9*	*280*	340	U		*7.1*	*340*	53
Benzo(g,h,i)perylene	1700000	170000	na	190	U		*5.3*	*190*	43	J	J	*5.4*	*190*	190	U		*5.4*	*190*	190	U		*5.2*	*190*	280	U		*7.8*	*280*	340	U		*9.4*	*340*	370
Benzo(k)fluoranthene	21000	1500	na	190	U		*5.3*	*190*	29	J	J	*5.4*	*190*	11	J	J	*5.4*	*190*	8.8	J	J	*5.3*	*190*	280	U		*7.9*	*280*	340	U		*9.5*	*340*	370
bis(2-Ethylhexyl)phthalate	120000	35000	na	190	U		*13*	*190*	91	J	B	*13*	*190*	65	J	B	*13*	*190*	2500			*12*	*190*	280	U		*19*	*280*	200	J	B	*22*	*340*	120
Butylbenzylphthalate	910000	260000	na	190	U		*7.3*	*190*	190	U		*7.5*	*190*	39	J	B	*7.5*	*190*	190	U		*7.2*	*190*	280	U		*11*	*280*	340	U		*13*	*340*	370
Carbazole	na	na	na	190	U	UJ	*8.2*	*190*	17	J	J	*8.3*	*190*	11	J	J	*8.3*	*190*	30	J	J	*8.1*	*190*	280	U	UJ	*12*	*280*	23	J	J	*15*	*340*	28
Chrysene	210000	15000	na	190	U		*4.3*	*190*	83	J	J	*4.4*	*190*	37	J	J	*4.4*	*190*	31	J	J	*4.3*	*190*	280	U		*6.4*	*280*	32	J	J	*7.7*	*340*	100
Dibenzofuran	na	na	na	190	U		*5.4*	*190*	30	J	J	*5.5*	*190*	20	J	J	*5.5*	*190*	14	J	J	*5.3*	*190*	280	U		*8*	*280*	92	J	J	*9.5*	*340*	200
Diethylphthalate	49000000	4900000	na	190	U		*5.4*	*190*	12	J	B	*5.5*	*190*	8	J	B	*5.6*	*190*	7.7	J	B	*5.4*	*190*	280	U		*8.1*	*280*	340	U		*9.7*	*340*	88
Dimethylphthalate	na	na	na	190	U		*4.9*	*190*	190	U		*5*	*190*	190	U		*5*	*190*	1500			*4.9*	*190*	280	U		*7.3*	*280*	340	U		*8.8*	*340*	370
Di-n-butylphthalate	6200000	610000	na	190	U		*54*	*190*	63	J	B	*55*	*190*	420		B	*55*	*190*	61000		B	*1100*	*3700*	280	U		*80*	*280*	2200		B	*97*	*340*	5000
Di-n-octylphthalate	na	na	na	190	U		*8.4*	*190*	190	U		*8.5*	*190*	190	U		*8.6*	*190*	64	J	J	*8.3*	*190*	280	U		*12*	*280*	340	U		*15*	*340*	370
Fluoranthene	2200000	230000	na	11	J	J	*6.1*	*190*	83	J	J	*6.3*	*190*	48	J	J	*6.3*	*190*	120	J	J	*6.1*	*190*	18	J	J	*9.1*	*280*	45	J	J	*11*	*340*	64
Fluorene	2200000	230000	na	190	U		*6.1*	*190*	14	J	J	*6.2*	*190*	190	U		*6.3*	*190*	16	J	J	*6.1*	*190*	280	U		*9.1*	*280*	43	J	J	*11*	*340*	35
Indeno(1,2,3-cd)pyrene	2100	150	na	190	U		*7.2*	*190*	37	J	J	*7.4*	*190*	190	U		*7.4*	*190*	190	U		*7.1*	*190*	280	U		*11*	*280*	340	U		*13*	*340*	370
Naphthalene	20000	3900	na	7.2	J	J	*6.9*	*190*	57	J	J	*7*	*190*	44	J	J	*7*	*190*	18	J	J	*6.8*	*190*	11	J	J	*10*	*280*	340			*12*	*340*	490
N-nitrosodiphenylamine	350000	99000	na	190	U		*8.9*	*190*	21	J	J	*9.1*	*190*	170	J	J	*9.1*	*190*	1100			*8.8*	*190*	280	U		*13*	*280*	150	J	J	*16*	*340*	190
Phenanthrene	1700000	170000	na	14	J	J	*5.8*	*190*	100	J	J	*6*	*190*	73	J	J	*6*	*190*	81	J	J	*5.8*	*190*	14	J	J	*8.7*	*280*	190	J	J	*10*	*340*	470
Pyrene	1700000	170000	na	8.9	J	J	*5.7*	*190*	100	J	J	*5.8*	*190*	50	J	J	*5.9*	*190*	250			*5.7*	*190*	14	J	J	*8.5*	*280*	56	J	J	*10*	*340*	78

Table 2-4
Analytes Detected in SWMU 50 Soil Samples - 2002 Site Characterization
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Analyte	Sample ID			50SB05A				50SB05B					50SB05C				
	Sample Date			6/25/02				6/25/02					6/25/02				
	Sample Depth			0-0.5				4-6					8-10				
	i-SL	r-SL	Background	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
VOCs (ug/kg)																	
Acetone	61000000	6100000	na	U	UJ	*2.7*	*6*	5.7	U	UJ	*2.5*	*5.7*	6.4	U	UJ	*2.9*	*6.4*
Carbon disulfide	300000	67000	na	J	B	*0.42*	*6*	5.7	U		*0.39*	*5.7*	0.48	J	B	*0.44*	*6.4*
PAHs (ug/kg)																	
2-Methylnaphthalene	410000	31000	na			*0.69*	*2.1*	2.8	U		*0.93*	*2.8*	29			*0.93*	*2.8*
Acenaphthene	3300000	340000	na			*1.1*	*2.1*	2.8	U		*1.5*	*2.8*	2.8	U		*1.5*	*2.8*
Acenaphthylene	1700000	170000	na			*0.27*	*2.1*	5.1			*0.37*	*2.8*	2.8	U		*0.37*	*2.8*
Anthracene	17000000	1700000	na			*0.22*	*2.1*	2.8	U		*0.31*	*2.8*	2.8	U		*0.31*	*2.8*
Benz(a)anthracene	2100	150	na			*0.27*	*2.1*	2.8	U		*0.37*	*2.8*	1.6	J	J	*0.37*	*2.8*
Benzo(a)pyrene	210	15	na			*0.23*	*2.1*	2.8	U		*0.31*	*2.8*	2.8	U		*0.31*	*2.8*
Benzo(b)fluoranthene	2100	150	na			*0.38*	*2.1*	2.8	U		*0.52*	*2.8*	1.8	J	J	*0.52*	*2.8*
Benzo(g,h,i)perylene	1700000	170000	na			*0.71*	*2.1*	2.8	U		*0.97*	*2.8*	1.1	J	J	*0.97*	*2.8*
Benzo(k)fluoranthene	21000	1500	na			*0.35*	*2.1*	2.8	U		*0.48*	*2.8*	0.55	J	J	*0.48*	*2.8*
Chrysene	210000	15000	na			*0.33*	*2.1*	2.8	U		*0.43*	*2.8*	2.6	J	J	*0.45*	*2.8*
Dibenz(a,h)anthracene	210	15	na			*0.69*	*2.1*	2.8	U		*0.94*	*2.8*	2.8	U		*0.94*	*2.8*
Fluoranthene	2200000	230000	na			*0.35*	*2.1*	2.8	U		*0.47*	*2.8*	1.6	J	J	*0.47*	*2.8*
Fluorene	2200000	230000	na		J	*0.54*	*2.1*	2.8	U		*0.73*	*2.8*	1	J	J	*0.74*	*2.8*
Indeno(1,2,3-cd)pyrene	2100	150	na			*0.66*	*2.1*	2.8	U		*0.88*	*2.8*	2.8	U		*0.88*	*2.8*
Naphthalene	20000	3900	na			*0.79*	*2.1*	2.8	U		*1.1*	*2.8*	16			*1.1*	*2.8*
Phenanthrene	1700000	170000	na			*0.31*	*2.1*	2.8	U		*0.42*	*2.8*	13			*0.42*	*2.8*
Pyrene	1700000	170000	na			*0.46*	*2.1*	2.8	U		*0.62*	*2.8*	2.3	J	J	*0.63*	*2.8*
SVOCs (ug/kg)																	
1,2-Dichlorobenzene	1000000	200000	na	U		*10*	*370*	220	U		*6.1*	*220*	220	U		*6.1*	*220*
1,3-Dichlorobenzene	na	na	na	U		*11*	*370*	220	U		*6.7*	*220*	220	U		*6.7*	*220*
1,4-Dichlorobenzene	13000	2600	na	U		*13*	*370*	220	U		*7.3*	*220*	220	U		*7.3*	*220*
2,4-Dinitrotoluene	120000	12000	na			*12*	*370*	220	U		*7.2*	*220*	220	U		*7.3*	*220*
2,6-Dinitrotoluene	62000	6100	na	J	J	*9.2*	*370*	220	U		*5.3*	*220*	220	U		*5.3*	*220*
2-Methylnaphthalene	410000	31000	na			*14*	*370*	220	U		*8.2*	*220*	55	J	J	*8.2*	*220*
2-Methylphenol	3100000	310000	na	U	UL	*15*	*370*	220	U	UL	*8.7*	*220*	220	U	UL	*8.7*	*220*
4-Methylphenol	310000	31000	na	U	UL	*13*	*370*	220	U	UL	*7.6*	*220*	220	U	UL	*7.6*	*220*
Acenaphthene	3300000	340000	na	U		*10*	*370*	220	U		*5.9*	*220*	220	U		*6*	*220*
Acenaphthylene	1700000	170000	na	U		*9.9*	*370*	220	U		*5.8*	*220*	220	U		*5.8*	*220*
Anthracene	17000000	1700000	na	J	J	*11*	*370*	220	U		*6.3*	*220*	220	U		*6.3*	*220*
Benz(a)anthracene	2100	150	na	J	J	*11*	*370*	220	U		*6.2*	*220*	220	U		*6.2*	*220*
Benzo(a)pyrene	210	15	na	J	J	*9.1*	*370*	220	U		*5.3*	*220*	220	U		*5.3*	*220*
Benzo(b)fluoranthene	2100	150	na	J	J	*7.8*	*370*	220	U		*4.6*	*220*	220	U		*4.6*	*220*
Benzo(g,h,i)perylene	1700000	170000	na	U		*10*	*370*	220	U		*6*	*220*	220	U		*6*	*220*
Benzo(k)fluoranthene	21000	1500	na	U		*10*	*370*	220	U		*6.1*	*220*	220	U		*6.1*	*220*
bis(2-Ethylhexyl)phthalate	120000	35000	na	J	B	*25*	*370*	220	U		*14*	*220*	220	U		*14*	*220*
Butylbenzylphthalate	910000	260000	na	U		*14*	*370*	220	U		*8.4*	*220*	220	U		*8.4*	*220*
Carbazole	na	na	na	J	J	*16*	*370*	220	U	UJ	*9.3*	*220*	220	U	UJ	*9.3*	*220*
Chrysene	210000	15000	na	J	J	*8.5*	*370*	220	U		*4.9*	*220*	220	U		*5*	*220*
Dibenzofuran	na	na	na	J	J	*11*	*370*	220	U		*6.1*	*220*	12	J	J	*6.1*	*220*
Diethylphthalate	49000000	4900000	na	J	B	*11*	*370*	220	U		*6.2*	*220*	220	U		*6.2*	*220*
Dimethylphthalate	na	na	na	U		*9.7*	*370*	220	U		*5.6*	*220*	220	U		*5.7*	*220*
Di-n-butylphthalate	6200000	610000	na		B	*110*	*370*	220	U		*62*	*220*	220	U		*62*	*220*
Di-n-octylphthalate	na	na	na	U		*16*	*370*	220	U		*9.6*	*220*	220	U		*9.6*	*220*
Fluoranthene	2200000	230000	na	J	J	*12*	*370*	220	U		*7*	*220*	220	U		*7*	*220*
Fluorene	2200000	230000	na	J	J	*12*	*370*	220	U		*7*	*220*	220	U		*7*	*220*
Indeno(1,2,3-cd)pyrene	2100	150	na	U		*14*	*370*	220	U		*8.2*	*220*	220	U		*8.3*	*220*
Naphthalene	20000	3900	na			*13*	*370*	220	U		*7.8*	*220*	30	J	J	*7.9*	*220*
N-nitrosodiphenylamine	350000	99000	na	J	J	*17*	*370*	220	U		*10*	*220*	220	U		*10*	*220*
Phenanthrene	1700000	170000	na			*11*	*370*	220	U		*6.7*	*220*	27	J	J	*6.7*	*220*
Pyrene	1700000	170000	na	J	J	*11*	*370*	220	U		*6.6*	*220*	220	U		*6.6*	*220*

Table 2-4
Analytes Detected in SWMU 50 Soil Samples - 2002 Site Characterization
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Analyte	Sample ID / Sample Date / Sample Depth			50SS01 6/25/02 0-0.5					50SS02 6/25/02 0-0.5					50SS03 6/25/02 0-0.5					50SB04A 6/25/02 0-0.5					50SB04B 6/25/02 4-6					50SB04C 6/25/02 8-10					
	i-SL	r-SL	Background	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	Result	Lab Q	Val Q	MDL	MRL	Result
Pesticides (ug/kg)																																		
4,4'-DDD	7200	2000	na	0.41	J	J	*0.157*	*0.743*	NT					0.447	J	J	*0.16*	*0.759*	NT					NT					NT					NT
4,4'-DDE	5100	1400	na	0.657	J	B	*0.156*	*0.743*	NT					3.37			*0.159*	*0.759*	NT					NT					NT					NT
4,4'-DDT	7000	1700	na	0.743	U		*0.263*	*0.743*	NT					12.9			*0.268*	*0.759*	NT					NT					NT					NT
Endosulfan II	na	na	na	0.636	J	J	*0.265*	*0.743*	NT					2.24			*0.271*	*0.759*	NT					NT					NT					NT
Endrin	18000	1800	na	0.288	J	J	*0.178*	*0.743*	NT					0.759	U		*0.182*	*0.759*	NT					NT					NT					NT
Methoxychlor	310000	31000	na	0.743	U		*0.567*	*0.743*	NT					1.29			*0.579*	*0.759*	NT					NT					NT					NT
PCBs (mg/kg)																																		
PCB-1254	0.74	0.022	na	0.0254	J	J	*0.0109*	*0.0371*	0.467			*0.0112*	*0.0378*	0.0387			*0.0112*	*0.0379*	0.963			*0.0108*	*0.0366*	1.27			*0.0162*	*0.055*	0.75			*0.0195*	*0.0661*	0.376
Explosives (mg/kg)																																		
2,4,6-Trinitrotoluene	7.9	1.9	na	0.2	U		*0.0187*	*0.2*	0.4	U		*0.0374*	*0.4*	0.2	U		*0.0187*	*0.2*	0.075	J	J	*0.0187*	*0.2*	0.2	U		*0.0187*	*0.2*	0.2	U		*0.0187*	*0.2*	0.2
2,4-Dinitrotoluene	120	12	na	0.2	U		*0.0163*	*0.2*	0.4	U		*0.0326*	*0.4*	0.443			*0.0163*	*0.2*	1.96			*0.0163*	*0.2*	0.2	U		*0.0163*	*0.2*	0.094	J	J	*0.0163*	*0.2*	0.4
2,6-Dinitrotoluene	62	6.1	na	0.2	U		*0.0246*	*0.2*	0.4	U		*0.0492*	*0.4*	0.2	U		*0.0246*	*0.2*	0.375			*0.0246*	*0.2*	0.2	U		*0.0246*	*0.2*	0.2	U		*0.0246*	*0.2*	0.2
Herbicides (ug/kg)																																		
2,4,5-T	620000	61000	na	8.18	J	J	*3.1*	*11.1*	NT					114	U		*31.6*	*114*	NT					NT					NT					NT
2,4-D	770000	69000	na	22.3	U		*9.99*	*22.3*	NT					142	J	J	*102*	*228*	NT					NT					NT					NT
Dicamba	1800000	180000	na	6.29	J	B	*2.33*	*22.3*	NT					228	U		*23.8*	*228*	NT					NT					NT					NT
Metals (mg/kg)																																		
Aluminum	99000	7700	40041	11400			*6.2*	*22.3*	20100			*6.3*	*22.7*	24300			*6.3*	*22.8*	20900			*6.1*	*22*	16700			*9.1*	*33.1*	17500			*11*	*39.7*	13300
Antimony	41	3.1	na	0.19	B	B	*0.19*	*0.557*	0.691		L	*0.19*	*0.568*	0.25	B	B	*0.19*	*0.569*	0.55	U	UL	*0.19*	*0.55*	0.56	B	B	*0.28*	*0.826*	1.46		L	*0.33*	*0.992*	0.547
Arsenic	1.6	0.39	15.8	1.03		J	*0.39*	*0.557*	3.24		J	*0.4*	*0.568*	4.33		J	*0.4*	*0.569*	2.33		J	*0.38*	*0.55*	13.7		J	*0.58*	*0.826*	5.02		J	*0.69*	*0.992*	4.5
Barium	19000	1500	209	141			*0.37*	*2.23*	70.9			*0.38*	*2.27*	97.4			*0.38*	*2.28*	111			*0.37*	*2.2*	68			*0.55*	*3.31*	60.4			*0.66*	*3.97*	92.5
Beryllium	200	16	1.02	0.756		B	*0.0384*	*0.557*	0.885		B	*0.0392*	*0.568*	0.85		B	*0.0392*	*0.569*	0.74		B	*0.038*	*0.55*	0.77	B	B	*0.057*	*0.827*	0.97	B	B	*0.0685*	*0.992*	0.841
Cadmium	81	7	0.69	0.058	B	B	*0.053*	*0.111*	0.143			*0.054*	*0.114*	0.074	B	B	*0.054*	*0.114*	0.062	B	B	*0.052*	*0.11*	0.12	B	J	*0.079*	*0.165*	0.15	B	J	*0.094*	*0.198*	0.127
Calcium	na	na	na	484		J	*3.1*	*11.1*	28600		J	*3.2*	*11.4*	13700		J	*3.2*	*11.4*	1280		J	*3.1*	*11*	163000		J	*4.6*	*16.5*	136000		J	*5.5*	*19.8*	1720
Chromium	1400	280	65.3	18.6		J	*0.42*	*1.11*	28.5		J	*0.43*	*1.14*	43.7		J	*0.43*	*1.14*	43.5		J	*0.41*	*1.1*	50.8		J	*0.62*	*1.65*	**255**		**J**	*0.74*	*1.98*	22.5
Cobalt	30	2.3	72.3	6.4			*0.9*	*5.57*	9.73			*0.92*	*5.68*	11			*0.92*	*5.69*	16.7			*0.89*	*5.5*	7.7	B	J	*1.3*	*8.26*	13.7			*1.6*	*9.92*	10.5
Copper	4100	310	53.5	7.95			*0.69*	*2.23*	31.5			*0.7*	*2.27*	22.7			*0.7*	*2.28*	9.96			*0.68*	*2.2*	**120**			*1*	*3.31*	**163**			*1.2*	*3.97*	22.6
Iron	72000	5500	50962	9580			*3.7*	*5.57*	20600			*3.8*	*5.68*	28300			*3.8*	*5.69*	22200			*3.7*	*5.5*	13600			*5.6*	*8.26*	23800			*6.7*	*9.92*	17800
Lead	800	400	26.8	21.7			*0.034*	*0.334*	**148**			*0.034*	*0.341*	**98.1**			*0.034*	*0.341*	19.8			*0.033*	*0.33*	**138**			*0.0499*	*0.496*	**585**			*0.0599*	*0.595*	**31.9**
Magnesium	na	na	na	525			*2.6*	*11.1*	20200			*2.7*	*11.4*	9430			*2.7*	*11.4*	1080			*2.6*	*11*	3100			*3.9*	*16.5*	4110			*4.7*	*19.8*	1630
Manganese	2300	180	2543	1320			*0.062*	*1.11*	372			*0.064*	*1.14*	558			*0.064*	*1.14*	1580			*0.062*	*1.1*	199			*0.092*	*1.65*	223			*0.11*	*1.98*	553
Mercury	2.8	0.67	0.13	0.041	B	J	*0.022*	*0.0557*	0.0837			*0.0225*	*0.0568*	0.0984			*0.0225*	*0.0569*	0.0987			*0.0218*	*0.055*	**0.16**			*0.0327*	*0.0826*	**0.524**			*0.0393*	*0.0992*	**0.816**
Nickel	2000	160	62.8	7.09			*1*	*4.45*	16.3			*1*	*4.54*	14.9			*1*	*4.55*	9.89			*1*	*4.4*	24.7			*1.5*	*6.61*	**181**			*1.8*	*7.94*	13
Potassium	na	na	na	465			*37*	*334*	2050			*38*	*341*	1550			*38*	*341*	966			*37*	*330*	631			*55*	*496*	1070			*66*	*595*	923
Selenium	510	39	na	1.11	U	UL	*0.36*	*1.11*	1.14	U	UL	*0.37*	*1.14*	1.14	U	UL	*0.37*	*1.14*	1.1	U	UL	*0.36*	*1.1*	0.57	B	L	*0.54*	*1.65*	1.98	U	UL	*0.65*	*1.98*	1.09
Silver	510	39	na	1.11	U		*0.55*	*1.11*	0.61	B	J	*0.56*	*1.14*	0.58	B	J	*0.56*	*1.14*	1.1	U		*0.54*	*1.1*	1.65	U		*0.81*	*1.65*	1.1	B	J	*0.98*	*1.98*	0.89
Sodium	na	na	na	13	B	B	*4.2*	*22.3*	61.7		J	*4.2*	*22.7*	72.5		J	*4.2*	*22.8*	28.8		B	*4.1*	*22*	75.8		J	*6.2*	*33.1*	78.7		J	*7.4*	*39.7*	64.9
Thallium	6.6	0.51	2.11	0.24	B	B	*0.034*	*0.334*	0.18	B	B	*0.034*	*0.341*	0.15	B	B	*0.034*	*0.341*	0.15	B	B	*0.033*	*0.33*	0.25	B	B	*0.05*	*0.496*	0.595	U		*0.06*	*0.595*	0.13
Vanadium	720	55	108	24			*0.64*	*5.57*	41.2			*0.66*	*5.68*	47			*0.66*	*5.69*	46.7			*0.64*	*5.5*	21.5			*0.96*	*8.26*	24.5			*1.2*	*9.92*	33.9
Zinc	31000	2300	202	23.9		J	*0.4*	*2.23*	93.3		J	*0.41*	*2.27*	54.8		J	*0.41*	*2.28*	88.1		J	*0.39*	*2.2*	50.9		J	*0.59*	*3.31*	79.2		J	*0.71*	*3.97*	42.8
Misc.																																		
Total Organic Carbon	na	na	na	18900			*188*	*1110*	NT					NT					NT					NT					NT					NT
pH	na	na	na	5.33		J	*+/-0.1*	*+/-0.1*	NT					NT					NT					NT					NT					NT

**Refer to legend

Table 2-4
Analytes Detected in SWMU 50 Soil Samples - 2002 Site Characterization
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Analyte	Sample ID			50SB05A				50SB05B					50SB05C				
	Sample Date			6/25/02				6/25/02					6/25/02				
	Sample Depth			0-0.5				4-6					8-10				
	i-SL	r-SL	Background	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Pesticides (ug/kg)																	
4,4'-DDD	7200	2000	na					NT					NT				
4,4'-DDE	5100	1400	na					NT					NT				
4,4'-DDT	7000	1700	na					NT					NT				
Endosulfan II	na	na	na					NT					NT				
Endrin	18000	1800	na					NT					NT				
Methoxychlor	310000	31000	na					NT					NT				
PCBs (mg/kg)																	
PCB-1254	0.74	0.022	na			*0.0108*	*0.0364*	0.0424	U		*0.0125*	*0.0424*	0.0425	U		*0.0125*	*0.0425*
Explosives (mg/kg)																	
2,4,6-Trinitrotoluene	7.9	1.9	na	U		*0.0187*	*0.2*	0.2	U		*0.0187*	*0.2*	0.2	U		*0.0187*	*0.2*
2,4-Dinitrotoluene	120	12	na			*0.0163*	*0.2*	0.2	U		*0.0163*	*0.2*	0.2	U		*0.0163*	*0.2*
2,6-Dinitrotoluene	62	6.1	na	U		*0.0246*	*0.2*	0.2	U		*0.0246*	*0.2*	0.2	U		*0.0246*	*0.2*
Herbicides (ug/kg)																	
2,4,5-T	620000	61000	na					NT					NT				
2,4-D	770000	69000	na					NT					NT				
Dicamba	1800000	180000	na					NT					NT				
Metals (mg/kg)																	
Aluminum	99000	7700	40041			*6*	*21.9*	37900			*7*	*25.4*	38400			*7*	*25.5*
Antimony	41	3.1	na	U	UL	*0.18*	*0.547*	0.636	U	UL	*0.21*	*0.636*	0.22	B	B	*0.21*	*0.638*
Arsenic	1.6	0.39	15.8		J	*0.38*	*0.547*	2.78		J	*0.44*	*0.636*	1.67		J	*0.45*	*0.638*
Barium	19000	1500	209			*0.37*	*2.19*	66.8			*0.43*	*2.54*	60.6			*0.43*	*2.55*
Beryllium	200	16	1.02		B	*0.0377*	*0.547*	0.877		B	*0.0439*	*0.636*	0.816		B	*0.0439*	*0.638*
Cadmium	81	7	0.69			*0.052*	*0.109*	0.127	U		*0.06*	*0.127*	0.128	U		*0.061*	*0.128*
Calcium	na	na	na		J	*3.1*	*10.9*	27.3		B	*3.6*	*12.7*	59.5		J	*3.6*	*12.8*
Chromium	1400	280	65.3		J	*0.41*	*1.09*	29.4		J	*0.48*	*1.27*	33.1		J	*0.48*	*1.28*
Cobalt	30	2.3	72.3			*0.89*	*5.47*	13.6			*1*	*6.36*	6.1	B	J	*1*	*6.38*
Copper	4100	310	53.5			*0.68*	*2.19*	14.5			*0.79*	*2.54*	18.6			*0.79*	*2.55*
Iron	72000	5500	50962			*3.7*	*5.47*	32800			*4.3*	*6.36*	40900			*4.3*	*6.38*
Lead	800	400	26.8			*0.033*	*0.328*	14.2			*0.038*	*0.382*	15.8			*0.039*	*0.383*
Magnesium	na	na	na			*2.6*	*10.9*	967			*3*	*12.7*	1150			*3*	*12.8*
Manganese	2300	180	2543			*0.061*	*1.09*	375			*0.071*	*1.27*	104			*0.071*	*1.28*
Mercury	2.8	0.67	0.13			*0.0217*	*0.0547*	0.061	B	J	*0.0252*	*0.0636*	**0.205**			*0.0253*	*0.0638*
Nickel	2000	160	62.8			*1*	*4.38*	12.2			*1.2*	*5.09*	12.6			*1.2*	*5.1*
Potassium	na	na	na			*37*	*328*	1380			*43*	*382*	1450			*43*	*383*
Selenium	510	39	na	U	UL	*0.36*	*1.09*	1.27	U	UL	*0.42*	*1.27*	1.28	U	UL	*0.42*	*1.28*
Silver	510	39	na	B	J	*0.54*	*1.09*	1.27	U		*0.63*	*1.27*	0.74	B	J	*0.63*	*1.28*
Sodium	na	na	na		J	*4.1*	*21.9*	35.2		J	*4.8*	*25.4*	29.2		B	*4.8*	*25.5*
Thallium	6.6	0.51	2.11	B	B	*0.033*	*0.328*	0.18	B	B	*0.038*	*0.382*	0.16	B	B	*0.038*	*0.383*
Vanadium	720	55	108			*0.63*	*5.47*	56.7			*0.74*	*6.36*	77			*0.74*	*6.38*
Zinc	31000	2300	202		J	*0.39*	*2.19*	47.1		J	*0.46*	*2.54*	47.7		J	*0.46*	*2.55*
Misc.																	
Total Organic Carbon	na	na	na					NT					NT				
pH	na	na	na					NT					NT				

immediately following this table for a list of definitions and tables note

Table 2-4
Legend

12	J	Shading and black font indicate an industrial SL exceedance.
12	J	Bold outline indicates a residential SL exceedance.
12	**J**	Bold, underlined font indicates a background exceedance.
12	*12*	Shading in the MDL/MRL columns indicates the MDL exceeds a criterion.

SLs for non-Carcinogenic compounds have been recalculated to an HI of 0.1.
The pyrene SLs were used for acenaphthylene, benzo(g,h,i)perylene, and phenanthrene.
Inorganic results below background UTLs are not indicated as exceedances on the table.
SL = Screening Level (Source: ORNL Regional Screening Table, September 2008).
SL values in table are for the more conservative chromium VI.
SL values for chromium III are 150,000 (ind) and 12,000 (res), which were not exceeded.
Lead screening values from Technical Review Workgroup for Lead: Guidance Document (April 1999).
mg/kg = milligrams per kilogram (parts per million).
ng/kg = nanograms per kilogram (parts per trillion).
µg/kg = micrograms per kilogram (parts per billion).
NA = not applicable.
NT = analyte not tested.

Lab Q = Lab Data Qualifiers

* = Laboratory duplicate not within control limits.
B = (organics) Blank contamination. Value detected in sample and associated blank.
A (Dioxins) = B = (metals) Value <MRL and >MDL and is considered estimated.
E (metals) = Reported value is estimated because of the presence of interferences.
EMPC (Dioxins) = The ion-abundance ratio between the two characteristic PCDD/PCDF ions was outside accepted ranges. The detected PCDD/PCDF was reported as an estimated maximum possible concentration (EMPC).
J = (organics) Value <MRL and >MDL and is considered estimated.
U = Analyte not-detected at the method reporting limit.
X = (dioxins) Ion abundance ratio outside acceptable range. Value reported is EMPC.

Val Q = Validation Data Qualifiers

B = blank contamination. Value detected in sample and associated blank.
J = estimated concentration.
K = estimated concentration bias high.
L = estimated concentration bias low.
N = presumptive evidence for tentatively identified compounds using a library search.
U = analyte not detected.
UJ = estimated concentration non-detect.
UL = estimated concentration non-detect bias low.

Table 2-5
Analytes Detected in SWMU 59 Soil Samples - 2002 Site Characterization
Page 1 of 2

Analyte	Sample ID			59SS03					59SS04					59SS05					59SB01A					59SB01B					59SB01C				
	Sample Date			6/27/02					6/27/02					6/27/02					6/27/02					6/27/02					6/27/02				
	Sample Depth			0-0.5					0-0.5					0-0.5					0-0.5					4-6					8-10				
	i-SL	r-SL	Background	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	Result	Lab Q	Val Q	MDL	MRL
VOCs (ug/kg)																																	
Acetone	61000000	6100000	na	5.4	U		*2.4*	*5.4*	NT					17		B	*3.1*	*7*	8.5	U	UJ	*3.9*	*8.5*	6	U		*2.7*	*6*	6.1	U		*2.8*	*6.1*
Carbon disulfide	300000	67000	na	5.4	U		*0.37*	*5.4*	NT					7	U		*0.48*	*7*	2.2	J	B	*0.58*	*8.5*	6	U		*0.42*	*6*	6.1	U		*0.42*	*6.1*
m- & p-Xylene	na	na	na	11	U		*1.1*	*11*	NT					14	U		*1.4*	*14*	6.3	J	J	*1.8*	*17*	12	U		*1.3*	*12*	12	U		*1.3*	*12*
o-Xylene	2300000	530000	na	5.4	U		*1.1*	*5.4*	NT					7	U		*1.4*	*7*	2.5	J	J	*1.8*	*8.5*	6	U		*1.3*	*6*	6.1	U		*1.3*	*6.1*
Toluene	4600000	500000	na	5.4	U		*0.35*	*5.4*	NT					7	U		*0.45*	*7*	15		J	*0.56*	*8.5*	6	U		*0.39*	*6*	6.1	U		*0.4*	*6.1*
PAHs (ug/kg)																																	
2-Methylnaphthalene	410000	31000	na	3.7		B	*0.69*	*2*	NT					110			*0.67*	*2*	210			*0.65*	*1.9*	6			*0.77*	*2.3*	2.1	U		*0.7*	*2.1*
Acenaphthene	3300000	340000	na	6.5		B	*1.1*	*2*	NT					3.1		B	*1.1*	*2*	4		B	*1.1*	*1.9*	2.3	U		*1.3*	*2.3*	2.1	U		*1.1*	*2.1*
Acenaphthylene	1700000	170000	na	2	U		*0.27*	*2*	NT					2			*0.26*	*2*	2.9			*0.26*	*1.9*	2.3	U		*0.3*	*2.3*	2.1	U		*0.27*	*2.1*
Anthracene	17000000	1700000	na	20			*0.22*	*2*	NT					3.5			*0.22*	*2*	4.4			*0.21*	*1.9*	2.3	U		*0.25*	*2.3*	2.1	U		*0.23*	*2.1*
Benz(a)anthracene	2100	150	na	60			*0.27*	*2*	NT					12			*0.26*	*2*	13			*0.26*	*1.9*	2.3	U		*0.3*	*2.3*	2.1	U		*0.27*	*2.1*
Benzo(a)pyrene	210	15	na	46			*0.23*	*2*	NT					7.3			*0.22*	*2*	6.6			*0.22*	*1.9*	2.3	U		*0.26*	*2.3*	2.1	U		*0.23*	*2.1*
Benzo(b)fluoranthene	2100	150	na	63			*0.39*	*2*	NT					12			*0.38*	*2*	13			*0.37*	*1.9*	2.3	U		*0.43*	*2.3*	2.1	U		*0.39*	*2.1*
Benzo(g,h,i)perylene	1700000	170000	na	25		J	*0.72*	*2*	NT					8.2		J	*0.7*	*2*	15		J	*0.68*	*1.9*	2.3	U		*0.8*	*2.3*	2.1	U		*0.73*	*2.1*
Benzo(k)fluoranthene	21000	1500	na	33			*0.35*	*2*	NT					2.3			*0.34*	*2*	3			*0.34*	*1.9*	2.3	U		*0.4*	*2.3*	2.1	U		*0.36*	*2.1*
Chrysene	210000	15000	na	57			*0.32*	*2*	NT					16			*0.32*	*2*	18			*0.31*	*1.9*	2.3	U		*0.36*	*2.3*	2.1	U		*0.33*	*2.1*
Dibenz(a,h)anthracene	210	15	na	6.4			*0.69*	*2*	NT					1.8	J	J	*0.67*	*2*	1.9			*0.66*	*1.9*	2.3	U		*0.78*	*2.3*	2.1	U		*0.71*	*2.1*
Fluoranthene	2200000	230000	na	110			*0.35*	*2*	NT					13			*0.34*	*2*	15			*0.33*	*1.9*	2.3	U		*0.39*	*2.3*	2.1	U		*0.36*	*2.1*
Fluorene	2200000	230000	na	9.1		J	*0.54*	*2*	NT					4.3		J	*0.53*	*2*	5.8		J	*0.51*	*1.9*	2.3	U		*0.61*	*2.3*	2.1	U		*0.55*	*2.1*
Indeno(1,2,3-cd)pyrene	2100	150	na	23			*0.65*	*2*	NT					3.7			*0.63*	*2*	3.6			*0.62*	*1.9*	2.3	U		*0.73*	*2.3*	2.1	U		*0.66*	*2.1*
Naphthalene	20000	3900	na	4.5		B	*0.78*	*2*	NT					60			*0.76*	*2*	130			*0.75*	*1.9*	4.7		B	*0.88*	*2.3*	2.1	U		*0.8*	*2.1*
Phenanthrene	1700000	170000	na	83			*0.31*	*2*	NT					71			*0.3*	*2*	97			*0.3*	*1.9*	2.4			*0.35*	*2.3*	2.1	U		*0.32*	*2.1*
Pyrene	1700000	170000	na	92			*0.46*	*2*	NT					16			*0.45*	*2*	20			*0.44*	*1.9*	2.3	U		*0.51*	*2.3*	2.1	U		*0.47*	*2.1*
SVOCs (ug/kg)																																	
2-Methylnaphthalene	410000	31000	na	200	U		*7.7*	*200*	NT					120	J	J	*7.5*	*200*	95	J	J	*7.3*	*190*	230	U		*8.7*	*230*	210	U		*7.9*	*210*
Acenaphthene	3300000	340000	na	24	J	J	*5.6*	*200*	NT					200	U		*5.4*	*200*	190	U		*5.3*	*190*	230	U		*6.3*	*230*	210	U		*5.7*	*210*
Anthracene	17000000	1700000	na	61	J	J	*5.9*	*200*	NT					200	U		*5.7*	*200*	190	U		*5.6*	*190*	230	U		*6.6*	*230*	210	U		*6*	*210*
Benz(a)anthracene	2100	150	na	180	J	J	*5.8*	*200*	NT					19	J	J	*5.6*	*200*	190	U		*5.5*	*190*	230	U		*6.5*	*230*	210	U		*5.9*	*210*
Benzo(a)pyrene	210	15	na	140	J	J	*5*	*200*	NT					200	U		*4.8*	*200*	190	U		*4.7*	*190*	230	U		*5.6*	*230*	210	U		*5.1*	*210*
Benzo(b)fluoranthene	2100	150	na	210			*4.3*	*200*	NT					200	U		*4.2*	*200*	190	U		*4.1*	*190*	230	U		*4.8*	*230*	210	U		*4.4*	*210*
Benzo(g,h,i)perylene	1700000	170000	na	91	J	J	*5.7*	*200*	NT					200	U		*5.5*	*200*	190	U		*5.4*	*190*	230	U		*6.4*	*230*	210	U		*5.8*	*210*
Benzo(k)fluoranthene	21000	1500	na	60	J	J	*5.7*	*200*	NT					200	U		*5.6*	*200*	190	U		*5.4*	*190*	230	U		*6.4*	*230*	210	U		*5.8*	*210*
Carbazole	na	na	na	73	J	J	*8.8*	*200*	NT					200	U	UJ	*8.5*	*200*	190	U	UJ	*8.3*	*190*	230	U	UJ	*9.8*	*230*	210	U	UJ	*8.9*	*210*
Chrysene	210000	15000	na	150	J	J	*4.7*	*200*	NT					21	J	J	*4.5*	*200*	190	U		*4.4*	*190*	230	U		*5.2*	*230*	210	U		*4.7*	*210*
Dibenzofuran	na	na	na	16	J	J	*5.8*	*200*	NT					32	J	J	*5.6*	*200*	23	J	J	*5.5*	*190*	230	U		*6.5*	*230*	210	U		*5.9*	*210*
Fluoranthene	2200000	230000	na	320			*6.6*	*200*	NT					18	J	J	*6.4*	*200*	9.3	J	J	*6.3*	*190*	230	U		*7.4*	*230*	210	U		*6.7*	*210*
Fluorene	2200000	230000	na	37	J	J	*6.6*	*200*	NT					200	U		*6.4*	*200*	190	U		*6.3*	*190*	230	U		*7.4*	*230*	210	U		*6.7*	*210*
Indeno(1,2,3-cd)pyrene	2100	150	na	96	J	J	*7.8*	*200*	NT					200	U		*7.6*	*200*	190	U		*7.4*	*190*	230	U		*8.7*	*230*	210	U		*7.9*	*210*
Naphthalene	20000	3900	na	9.6	J	J	*7.4*	*200*	NT					75	J	J	*7.2*	*200*	69	J	J	*7*	*190*	230	U		*8.3*	*230*	210	U		*7.5*	*210*
Phenanthrene	1700000	170000	na	290			*6.3*	*200*	NT					86	J	J	*6.1*	*200*	52	J	J	*6*	*190*	230	U		*7.1*	*230*	210	U		*6.4*	*210*
Pyrene	1700000	170000	na	240			*6.2*	*200*	NT					18	J	J	*6*	*200*	8.2	J	J	*5.9*	*190*	230	U		*6.9*	*230*	210	U		*6.3*	*210*
Pesticides (ug/kg)																																	
4,4'-DDD	7200	2000	na	0.676	J	J	*0.169*	*0.798*	NT					0.777	U		*0.164*	*0.777*	0.76	U		*0.161*	*0.76*	NT					NT				
4,4'-DDE	5100	1400	na	0.768	J	B	*0.167*	*0.798*	NT					0.777	U		*0.163*	*0.777*	0.76	U		*0.159*	*0.76*	NT					NT				
4,4'-DDT	7000	1700	na	4.41			*0.282*	*0.798*	NT					1.97			*0.275*	*0.777*	1.12		B	*0.269*	*0.76*	NT					NT				
Dieldrin	110	30	na	0.798	U		*0.49*	*0.798*	NT					4.52			*0.478*	*0.777*	0.76	U		*0.467*	*0.76*	NT					NT				
Endosulfan II	na	na	na	0.798	U		*0.285*	*0.798*	NT					3.33			*0.277*	*0.777*	3.94			*0.271*	*0.76*	NT					NT				
Endosulfan I	na	na	na	0.798	U		*0.124*	*0.798*	NT					0.777	U		*0.121*	*0.777*	0.961			*0.118*	*0.76*	NT					NT				
Endrin aldehyde	na	na	na	0.428	J	J	*0.403*	*0.798*	NT					0.777	U		*0.393*	*0.777*	0.76	U		*0.384*	*0.76*	NT					NT				
Endrin ketone	na	na	na	1.66			*0.644*	*0.798*	NT					2.9			*0.627*	*0.777*	2.43			*0.613*	*0.76*	NT					NT				
gamma-Chlordane	na	na	na	1.1			*0.185*	*0.798*	NT					0.777	U		*0.181*	*0.777*	0.76	U		*0.177*	*0.76*	NT					NT				
Heptachlor epoxide	190	53	na	0.798	U		*0.483*	*0.798*	NT					0.777	U		*0.471*	*0.777*	1.06			*0.46*	*0.76*	NT					NT				
Methoxychlor	310000	31000	na	2.82			*0.609*	*0.798*	NT					10.2			*0.593*	*0.777*	9.99			*0.58*	*0.76*	NT					NT				
PCBs (mg/kg)																																	
PCB-1254	0.74	0.022	na	0.061			*0.0118*	*0.0398*	NT					0.0388	U		*0.0115*	*0.0388*	0.0379	U		*0.0112*	*0.0379*	0.0448	U		*0.0132*	*0.0448*	0.0407	U		*0.012*	*0.0407*
Explosives (mg/kg)																																	
1,3,5-Trinitrobenzene	2700	220	na	0.1	U		*0.0246*	*0.1*	NT					0.138			*0.0246*	*0.1*	0.134			*0.0246*	*0.1*	0.1	U		*0.0246*	*0.1*	0.1	U		*0.0246*	*0.1*
Herbicides (ug/kg)																																	
2,4,5-T	620000	61000	na	120	U		*33.3*	*120*	NT					36.6		J	*3.24*	*11.7*	114	U		*31.7*	*114*	NT					NT				

Table 2-5
Analytes Detected in SWMU 59 Soil Samples - 2002 Site Characterization
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Analyte	Sample ID			59SS03					59SS04					59SS05					59SB01A					59SB01B					59SB01C				
	Sample Date			6/27/02					6/27/02					6/27/02					6/27/02					6/27/02					6/27/02				
	Sample Depth			0-0.5					0-0.5					0-0.5					0-0.5					4-6					8-10				
	i-SL	r-SL	Background	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	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																																
Aluminum	99000	7700	40041	14700		J	*6.6*	*23.9*	12200		J	*6.6*	*23.9*	3180		J	*6.4*	*23.3*	3120		J	*6.3*	*22.8*	38100		J	*7.4*	*26.9*	18800		J	*6.7*	*24.4*
Antimony	41	3.1	na	0.598	U	UL	*0.2*	*0.598*	0.21	B	B	*0.2*	*0.598*	0.583	U	UL	*0.2*	*0.583*	0.569	U	UL	*0.19*	*0.569*	0.672	U	UL	*0.23*	*0.672*	0.611	U	UL	*0.21*	*0.611*
Arsenic	1.6	0.39	15.8	2.58		J	*0.42*	*0.598*	4.52		J	*0.42*	*0.598*	5.51		J	*0.41*	*0.583*	3.04		J	*0.4*	*0.569*	2.94		J	*0.47*	*0.672*	1.81		J	*0.43*	*0.611*
Barium	19000	1500	209	88			*0.4*	*2.39*	71.1			*0.4*	*2.39*	57.1			*0.39*	*2.33*	133			*0.38*	*2.28*	68.4			*0.45*	*2.69*	35.7			*0.41*	*2.44*
Beryllium	200	16	1.02	0.748			*0.0413*	*0.598*	0.51	B	J	*0.0413*	*0.598*	0.54	B	J	*0.0402*	*0.583*	0.589			*0.0393*	*0.569*	0.673			*0.0464*	*0.0672*	0.43	B	J	*0.0421*	*0.611*
Cadmium	81	7	0.69	0.11	B	J	*0.057*	*0.12*	0.11	B	J	*0.057*	*0.12*	0.117	U		*0.055*	*0.117*	0.114	U		*0.054*	*0.114*	0.134	U		*0.064*	*0.134*	0.122	U		*0.058*	*0.122*
Calcium	na	na	na	2680			*3.3*	*12*	1660			*3.3*	*12*	437			*3.3*	*11.7*	432			*3.2*	*11.4*	781			*3.8*	*13.4*	162			*3.4*	*12.2*
Chromium	1400	280	65.3	23.2			*0.45*	*1.2*	21.1			*0.45*	*1.2*	8.89			*0.44*	*1.17*	8.82			*0.43*	*1.14*	30.9			*0.5*	*1.34*	33.6			*0.46*	*1.22*
Cobalt	30	2.3	72.3	9.18			*0.97*	*5.98*	6.36			*0.97*	*5.98*	6.22			*0.94*	*5.83*	7.22			*0.92*	*5.69*	4.3	B	J	*1.1*	*6.72*	5.9	B	J	*0.99*	*6.11*
Copper	4100	310	53.5	11		J	*0.74*	*2.39*	9.07		J	*0.74*	*2.39*	11.7		J	*0.72*	*2.33*	15.3		J	*0.7*	*2.28*	16.2		J	*0.83*	*2.69*	7.48		J	*0.75*	*2.44*
Iron	72000	5500	50962	19300			*4*	*5.98*	18700			*4*	*5.98*	4200			*3.9*	*5.83*	5790			*3.8*	*5.69*	38600			*4.5*	*6.72*	21900			*4.1*	*6.11*
Lead	800	400	26.8	**30.9**			*0.036*	*0.359*	22.6			*0.036*	*0.359*	5.37			*0.035*	*0.35*	6.84			*0.034*	*0.342*	14.2			*0.041*	*0.403*	8.52			*0.037*	*0.366*
Magnesium	na	na	na	2270			*2.8*	*12*	1320			*2.8*	*12*	272			*2.8*	*11.7*	227			*2.7*	*11.4*	1080			*3.2*	*13.4*	1020			*2.9*	*12.2*
Manganese	2300	180	2543	289			*0.067*	*1.2*	213			*0.067*	*1.2*	140			*0.065*	*1.17*	128			*0.064*	*1.14*	132			*0.075*	*1.34*	360			*0.068*	*1.22*
Mercury	2.8	0.67	0.13	**0.45**	**B**	**J**	*0.0237*	*0.0598*	**0.153**			*0.0237*	*0.0598*	0.109			*0.0231*	*0.0583*	**0.282**			*0.0226*	*0.0569*	0.0902			*0.0266*	*0.0672*	0.0611	U		*0.0242*	*0.0611*
Nickel	2000	160	62.8	12.8			*1.1*	*4.78*	5.74			*1.1*	*4.78*	8.65			*1.1*	*4.66*	10.3			*1*	*4.56*	12.9			*1.2*	*5.38*	7.11			*1.1*	*4.88*
Potassium	na	na	na	945			*40*	*359*	684			*40*	*359*	330	B	J	*39*	*350*	300	B	J	*38*	*342*	1230			*45*	*403*	773			*41*	*366*
Selenium	510	39	na	1.2	U	UL	*0.39*	*1.2*	0.39	B	J	*0.39*	*1.2*	0.72	B	J	*0.38*	*1.17*	1.14	U	UL	*0.37*	*1.14*	1.34	U	UL	*0.44*	*1.34*	1.22	U	UL	*0.4*	*1.22*
Sodium	na	na	na	30		B	*4.5*	*23.9*	35.4			*4.5*	*23.9*	60.6			*4.4*	*23.3*	72.8			*4.3*	*22.8*	40.5			*5*	*26.9*	17	B	B	*4.6*	*24.4*
Thallium	6.6	0.51	2.11	0.16	B	J	*0.036*	*0.359*	0.21	B	J	*0.036*	*0.359*	0.092	B	J	*0.035*	*0.35*	0.073	B	J	*0.034*	*0.342*	0.13	B	J	*0.041*	*0.403*	0.11	B	J	*0.037*	*0.366*
Vanadium	720	55	108	36.1			*0.69*	*5.98*	34.4			*0.69*	*5.98*	12.1			*0.67*	*5.83*	14.4			*0.66*	*5.69*	68.1			*0.78*	*6.72*	25.2			*0.71*	*6.11*
Zinc	31000	2300	202	76.3		J	*0.43*	*2.39*	38.3		J	*0.43*	*2.39*	7.74		J	*0.42*	*2.33*	7.23		J	*0.41*	*2.28*	56.2		J	*0.48*	*2.69*	23.2		J	*0.44*	*2.44*
Dioxins/Furans (ng/kg)																																
2,3,7,8-TCDF	130	37	na	0.235	U		*0.19*	*0.235*	NT					0.257	U		*0.19*	*0.257*	0.139	U		*0.19*	*0.139*	0.148	U		*0.19*	*0.148*	0.183	U		*0.19*	*0.183*
2,3,7,8-TCDD	18	4.5	na	0.18	U		*0.13*	*0.18*	NT					0.066	U		*0.13*	*0.066*	0.124	U		*0.13*	*0.124*	0.181	U		*0.13*	*0.181*	0.187	U		*0.13*	*0.187*
1,2,3,7,8-PECDD	na	na	na	1.158	X	J	*0.19*	*0.283*	NT					0.358	U		*0.19*	*0.358*	0.156	U		*0.19*	*0.156*	0.148	U		*0.19*	*0.148*	0.169	U		*0.19*	*0.169*
1,2,3,4,7,8-HXCDD	460	100	na	2.868			*0.53*	*0.275*	NT					0.252	U		*0.53*	*0.252*	0.158	U		*0.53*	*0.158*	0.343	U		*0.53*	*0.343*	0.158	U		*0.53*	*0.158*
1,2,3,6,7,8-HXCDD	460	100	na	6.39			*0.57*	*0.215*	NT					0.198	U		*0.57*	*0.198*	0.124	U		*0.57*	*0.124*	0.269	U		*0.57*	*0.269*	0.124	U		*0.57*	*0.124*
1,2,3,7,8,9-HXCDD	460	100	na	7.918			*0.68*	*0.209*	NT					0.191	U		*0.68*	*0.191*	0.12	U		*0.68*	*0.12*	0.26	U		*0.68*	*0.26*	0.12	U		*0.68*	*0.12*
1,2,3,4,6,7,8-HPCDD	na	na	na	213.5			*0.63*	*0.495*	NT					13.77		J	*0.63*	*0.248*	11.63			*0.63*	*0.254*	1.436			*0.63*	*0.146*	0.82			*0.63*	*0.174*
OCDD	61000	15000	na	2768	B		*6.86*	*0.288*	NT					260.2	B	J	*6.86*	*0.355*	111	B		*6.86*	*0.201*	254.7	B		*6.86*	*0.246*	116.3	B		*6.86*	*0.262*
1,2,3,7,8-PECDF	440	120	na	0.221	U		*0.28*	*0.221*	NT					0.161	U		*0.28*	*0.161*	0.107	U		*0.28*	*0.107*	0.117	U		*0.28*	*0.117*	0.113	U		*0.28*	*0.113*
2,3,4,7,8-PECDF	44	12	na	0.231	U		*0.56*	*0.231*	NT					0.168	U		*0.56*	*0.168*	0.112	U		*0.56*	*0.112*	0.122	U		*0.56*	*0.122*	0.119	U		*0.56*	*0.119*
1,2,3,4,7,8-HXCDF	na	na	na	0.21	U		*0.34*	*0.21*	NT					0.168	U		*0.34*	*0.168*	0.13	U		*0.34*	*0.13*	0.119	U		*0.34*	*0.119*	0.11	U		*0.34*	*0.11*
1,2,3,6,7,8-HXCDF	na	na	na	0.205	U		*0.49*	*0.205*	NT					0.164	U		*0.49*	*0.164*	0.497	X	J	*0.49*	*0.127*	0.116	U		*0.49*	*0.116*	0.108	U		*0.49*	*0.108*
2,3,4,6,7,8-HXCDF	na	na	na	0.24	U		*0.47*	*0.24*	NT					0.192	U		*0.47*	*0.192*	0.148	U		*0.47*	*0.148*	0.135	U		*0.47*	*0.135*	0.126	U		*0.47*	*0.126*
1,2,3,7,8,9-HXCDF	na	na	na	0.241	U		*0.25*	*0.241*	NT					0.193	U		*0.25*	*0.193*	0.149	U		*0.25*	*0.149*	0.136	U		*0.25*	*0.136*	0.127	U		*0.25*	*0.127*
1,2,3,4,6,7,8-HPCDF	na	na	na	29.22			*0.33*	*0.139*	NT					1.896		J	*0.33*	*0.167*	1.952			*0.33*	*0.093*	0.096	U		*0.33*	*0.096*	0.112	U		*0.33*	*0.112*
1,2,3,4,7,8,9-HPCDF	na	na	na	1.229			*0.5*	*0.179*	NT					0.216	U		*0.5*	*0.216*	0.121	U		*0.5*	*0.121*	0.124	U		*0.5*	*0.124*	0.144	U		*0.5*	*0.144*
OCDF	44000	12000	na	71.1			*0.79*	*0.296*	NT					8.541		J	*0.79*	*0.347*	6.303			*0.79*	*0.245*	0.317	U		*0.79*	*0.317*	0.301	U		*0.79*	*0.301*
TOTAL TCDD	na	na	na	0.18	U			*0.18*	NT					0.066	U			*0.066*	0.124	U			*0.124*	0.181	U			*0.181*	0.187	U			*0.187*
TOTAL PECDD	18	4.5	na	0.283	U			*0.283*	NT					0.358	U			*0.358*	0.156	U			*0.156*	0.148	U			*0.148*	0.169	U			*0.169*
TOTAL HXCDD	180	45	na	35.79				*0.209*	NT					1.478		J		*0.191*	0.12	U			*0.12*	0.26	U			*0.26*	0.12	U			*0.12*
TOTAL HPCDD	1800	450	na	400				*0.495*	NT					24.69		J		*0.248*	19.15				*0.254*	3.33				*0.146*	1.867				*0.174*
TOTAL TCDF	na	na	na	0.235	U			*0.235*	NT					0.257	U			*0.257*	0.139	U			*0.139*	0.148	U			*0.148*	0.183	U			*0.183*
TOTAL PECDF	na	na	na	2.207				*0.221*	NT					0.161	U			*0.161*	0.107	U			*0.107*	0.117	U			*0.117*	0.113	U			*0.113*
TOTAL HXCDF	130	37	na	27.5				*0.205*	NT					0.164	U			*0.164*	1.468				*0.127*	0.116	U			*0.116*	0.108	U			*0.108*
TOTAL HPCDF	1300	370	na	86.5				*0.139*	NT					7.273		J		*0.167*	6.149				*0.093*	0.295				*0.096*	0.112	U			*0.112*
Misc.																																
Total Organic Carbon (mg/kg)	na	na	na	14000			*200*	*1200*	NT					NT					NT					NT					NT				
pH	na	na	na	7.24		J	*+/-0.1*	*+/-0.1*	NT					NT					NT					NT					NT				

**Refer to legend immediately following this table for a list of definitions and tables notes.

Table 2-5
Legend

12	J	Shading and black font indicate an industrial SL exceedance.
12	J	Bold outline indicates a residential SL exceedance.
12	**J**	Bold, underlined font indicates a background exceedance.
12	*12*	Shading in the MDL/MRL columns indicates the MDL exceeds a criterion.

SLs for non-Carcinogenic compounds have been recalculated to an HI of 0.1.
The pyrene SLs were used for acenaphthylene, benzo(g,h,i)perylene, and phenanthrene.
Inorganic results below background UTLs are not indicated as exceedances on the table.
SL = Screening Level (Source: ORNL Regional Screening Table, September 2008).
SL values in table are for the more conservative chromium VI.
SL values for chromium III are 150,000 (ind) and 12,000 (res), which were not exceeded.
Lead screening values from Technical Review Workgroup for Lead: Guidance Document (April 1999).
mg/kg = milligrams per kilogram (parts per million).
ng/kg = nanograms per kilogram (parts per trillion).
µg/kg = micrograms per kilogram (parts per billion).
NA = not applicable.
NT = analyte not tested.

Lab Q = Lab Data Qualifiers

* = Laboratory duplicate not within control limits.
B = (organics) Blank contamination. Value detected in sample and associated blank.
A (Dioxins) = B = (metals) Value <MRL and >MDL and is considered estimated.
E (metals) = Reported value is estimated because of the presence of interferences.
EMPC (Dioxins) = The ion-abundance ratio between the two characteristic PCDD/PCDF ions was outside accepted ranges. The detected PCDD/PCDF was reported as an estimated maximum possible concentration (EMPC).
J = (organics) Value <MRL and >MDL and is considered estimated.
U = Analyte not-detected at the method reporting limit.
X = (dioxins) Ion abundance ratio outside acceptable range. Value reported is EMPC.

Val Q = Validation Data Qualifiers

B = blank contamination. Value detected in sample and associated blank.
J = estimated concentration.
K = estimated concentration bias high.
L = estimated concentration bias low.
N = presumptive evidence for tentatively identified compounds using a library search.
U = analyte not detected.
UJ = estimated concentration non-detect.
UL = estimated concentration non-detect bias low.

3.0 FIELD INVESTIGATION PROGRAM

An additional field sampling event was conducted by Shaw in 2007 based on the USEPA/ VDEQ approved *MWP Addendum 019* (Shaw, 2007). This investigation was performed in order to obtain current analytical data for the sites to complete their characterization. Additional soil and groundwater samples were needed. In addition to re-sampling the existing groundwater wells, three new wells were installed at the combined study area in order to refine the delineation of elevated constituents detected in previous investigations at the study area [specifically, carbon tetrachloride (CT) and trichloroethene (TCE)]. The data was used to perform human health and ecological risk assessments that serve as the basis for the proposed remediation for the site. Details of the investigation are presented in *Section 3.1*. Samples and chemical analyses performed in support of the investigation are presented in **Table 3-1**. Results from the investigation are discussed in *Section 4.0*.

3.1 RFI, Shaw, 2007

3.1.1 Soil

As presented in **Table 3-1**, ten surface samples (50SB06A, 50SB07A, 50SB08A, 50SB09A, 50SB10A, 50SB11A, 50SB12A, 50SB13A, 50SB14A, and 50SB15A) and ten subsurface soil samples (50SB06B, 50SB07B, 50SB08B, 50SB09B, 50SB10B, 50SB11B, 50SB12B, 50SB13B, 50SB14B, and 50SB15B) were collected for chemical analysis at SWMU 50. At SWMU 59, ten surface soil samples (59SS06, 59SS07, 59SS08, 59SS09, 59SS10, 59SB02A, 59SB03A, 59SB04A, 59SB05A, and 59SB06A) and ten subsurface samples (59SB02B, 59SB02C, 59SB03B, 59SB03C, 59SB04B, 59SB04C, 59SB05B, 59SB05C, 59SB06B, and 59SB06C) were collected for chemical analysis. The ten subsurface samples at SWMU 59 were collected from five borings, with two samples per boring at depth. The five borings were located at five of the ten surface soil sample locations. These samples were intended to characterize the subsurface and to delineate the extent of elevated arsenic in surface soil. Sample locations are depicted on **Figure 3-1**. As shown in **Table 3-1**, the soil samples were analyzed for TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans. Soil exceedances are illustrated on **Figure 3-2**.

3.1.2 Groundwater

Three groundwater samples (50MW01, 50MW02, and 59MW01) were collected for chemical analysis from newly-installed wells at SWMU 50 and 59 (**Figure 3-1**). As shown in **Table 3-1**, groundwater samples were analyzed for TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, and perchlorate.

Boring logs and well construction diagrams for the newly-installed wells are presented in **Appendix B-1**. The well purging/field water quality measurement forms for the 2007 sampling event are included in **Appendix B-2**. Groundwater sample locations are illustrated on **Figure 3-1** and the exceedances are illustrated on **Figure 3-2**.

3.1.3 Global Positioning System Activities

Sample location coordinates and elevations were obtained for soil samples 50SB06, 50SB07, 50SB08, 50SB09, 50SB10, 50SB11, 50SB12, 50SB13, 50SB14, 50SB15, 59SS02, 59SS06, 59SS07, 59SS08, 59SS09, 59SS10, 59SB03, 59SB04, 59SB05, and 59SB06 and wells 50MW01, 50MW02, and 59MW01 using a Trimble Geo XH Global Positioning System. The Geo XH

system was used to obtain real-time position information with sub-meter accuracy and elevations at 1.5 to 2 times the horizontal accuracy. Horizontal position information was recorded in the U.S. State [Virginia (South)] Plane Coordinate System (measured in U.S. survey feet) using the North American Datum of 1983. The vertical control was measured in feet using the National Geodetic Vertical Datum of 1988. Position information will be entered into the Environmental Restoration Information System database. Sample location coordinates and elevations are presented in **Appendix C**.

3.1.4 Quality Assurance

The accuracy and integrity of 2007 RFI data were ensured through the implementation of internal quality control (QC) measures in accordance with *MWP Addendum 019* (Shaw, 2007), as approved by USEPA Region III and the VDEQ. Quality assurance (QA) and QC activities, including field QC, laboratory QC, data management, and data validation were integrated into the investigation program to meet data quality objectives (DQOs) established for the RFI. The data were evaluated for each of the DQO indicators in **Appendix A-2, Table A-3** and found to meet the pre-established goals. Qualified data did not impact the data quality of the RFI. Complete details of the RFI QA/QC analysis and activities are presented in **Appendix A-2**. Chemical data validation reports and analytical data are provided in **Appendix A-3**.

3.1.5 Modifications to the Sampling Plan

In some cases, modifications to the Work Plan are necessary to adjust for field conditions as they occur during field sampling. However, no adjustments to *MWP Addendum 019* (Shaw, 2007) were necessary during sampling activities at SWMUs 50 and 59.

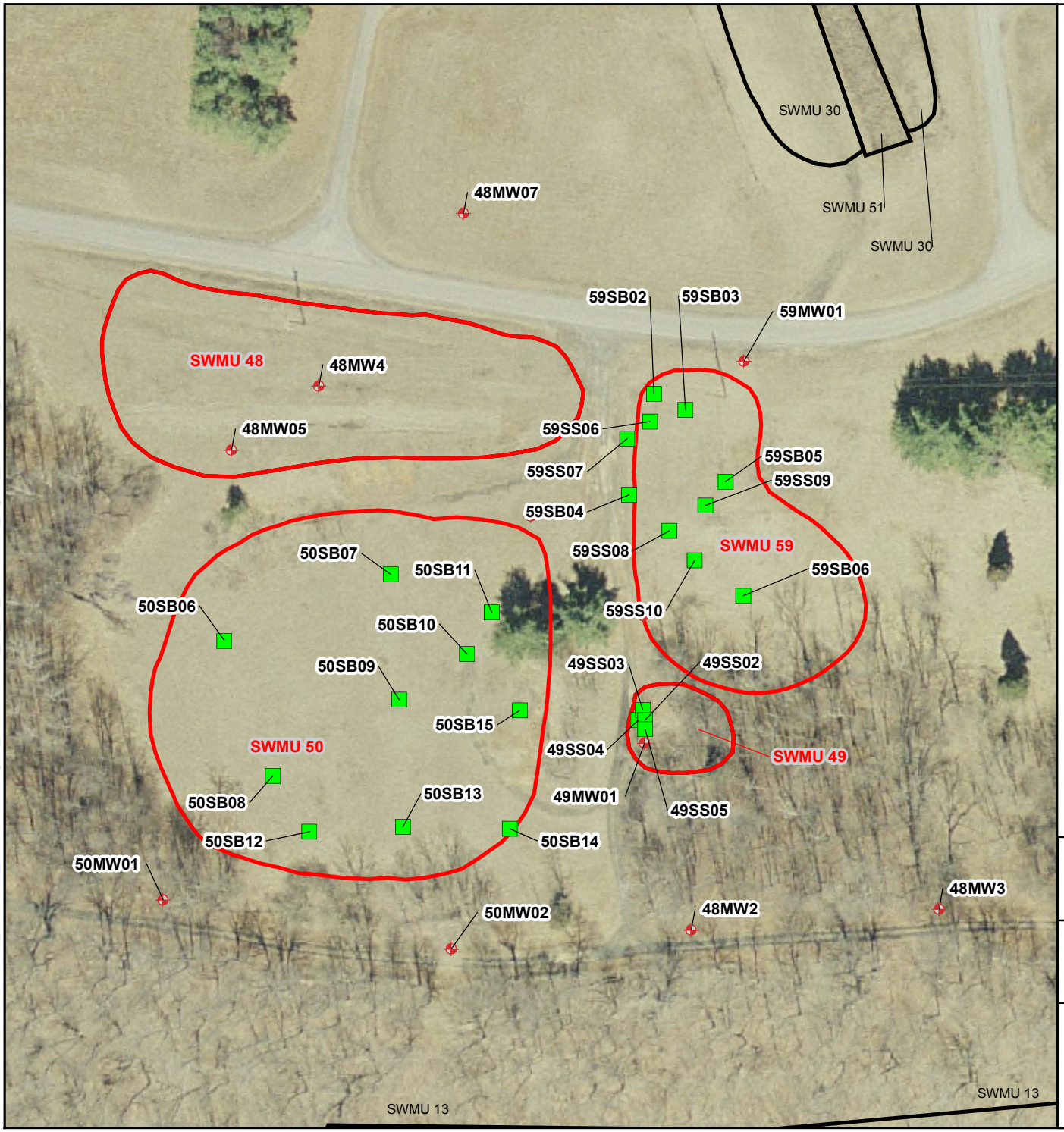
Table 3-1
2007 RFI Samples and Analyses

Media	Sampling ID	Depth (ft bgs)	Analytes
SWMU 50			
Surface Soil	50SB06A	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB07A	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB08A	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB09A	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB10A	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB11A	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB12A	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB13A	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB14A	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB15A	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
Subsurface Soil	50SB06B	4-6	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB07B	4-6	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB08B	4-6	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB09B	4-6	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB10B	4-6	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB11B	4-6	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB12B	4-6	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB13B	4-6	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB14B	4-6	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	50SB15B	4-6	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
Groundwater	50MW01	na	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, and perchlorate
	50MW02	na	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, and perchlorate

Table 3-1, Continued
2007 RFI Samples and Analyses

Media	Sampling ID	Depth (ft bgs)	Analytes
SWMU 59			
Surface Soil	59SS06	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SS07	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SS08	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SS09	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SS10	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SB02A	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SB03A	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SB04A	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SB05A	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SB06A	0-0.5	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
Subsurface Soil	59SB02B	4-6	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SB02C	8-10	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SB03B	4-6	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SB03C	8-10	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SB04B	4-6	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SB04C	8-10	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SB05B	4-6	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SB05C	8-10	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SB06B	4-6	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
	59SB06C	8-10	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans
Groundwater	59MW01	na	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, and perchlorate

Refer to **Appendix A-1, Table A-1** for the preparation and analytical methodologies used.



LEGEND

- Monitoring Well
- Soil Sample Location
- SWMU 48, 49, 50, and 59 Boundaries
- Other SWMU Boundary

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

N

Scale:
0 57.5 115 230 Feet

U.S. Army Corps of Engineers

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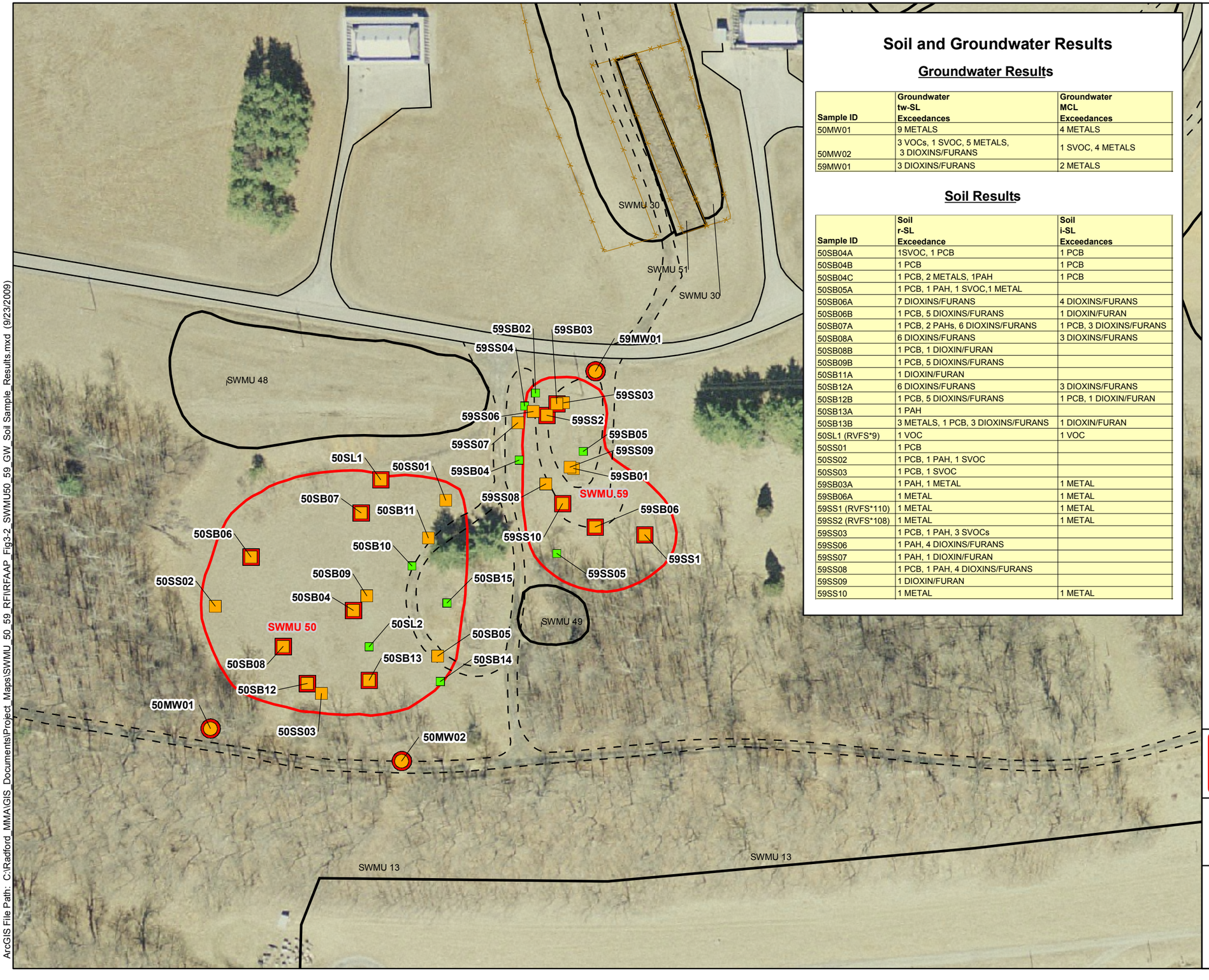
FIGURE 3-1
2007 Sample Locations
at SWMU 50 and SWMU 59
Radford Army Ammunition Plant,
Radford, VA

ArcGIS File Path: C:\Radford_MMA\GIS_Documents\Project_Maps\SWMU_50_59_RFI\RFAAP_Fig3-1_SWMU50_59_Sample_Locations.mxd (9/23/2009)



Soil and Groundwater Results

Groundwater Results

Sample ID	Groundwater tw-SL Exceedances	Groundwater MCL Exceedances
50MW01	9 METALS	4 METALS
50MW02	3 VOCs, 1 SVOC, 5 METALS, 3 DIOXINS/FURANS	1 SVOC, 4 METALS
59MW01	3 DIOXINS/FURANS	2 METALS

Soil Results

Sample ID	Soil r-SL Exceedance	Soil i-SL Exceedances
50SB04A	1SVOC, 1 PCB	1 PCB
50SB04B	1 PCB	1 PCB
50SB04C	1 PCB, 2 METALS, 1PAH	1 PCB
50SB05A	1 PCB, 1 PAH, 1 SVOC,1 METAL	
50SB06A	7 DIOXINS/FURANS	4 DIOXINS/FURANS
50SB06B	1 PCB, 5 DIOXINS/FURANS	1 DIOXIN/FURAN
50SB07A	1 PCB, 2 PAHs, 6 DIOXINS/FURANS	1 PCB, 3 DIOXINS/FURANS
50SB08A	6 DIOXINS/FURANS	3 DIOXINS/FURANS
50SB08B	1 PCB, 1 DIOXIN/FURAN	
50SB09B	1 PCB, 5 DIOXINS/FURANS	
50SB11A	1 DIOXIN/FURAN	
50SB12A	6 DIOXINS/FURANS	3 DIOXINS/FURANS
50SB12B	1 PCB, 5 DIOXINS/FURANS	1 PCB, 1 DIOXIN/FURAN
50SB13A	1 PAH	
50SB13B	3 METALS, 1 PCB, 3 DIOXINS/FURANS	1 DIOXIN/FURAN
50SL1 (RVFS*9)	1 VOC	1 VOC
50SS01	1 PCB	
50SS02	1 PCB, 1 PAH, 1 SVOC	
50SS03	1 PCB, 1 SVOC	
59SB03A	1 PAH, 1 METAL	1 METAL
59SB06A	1 METAL	1 METAL
59SS1 (RVFS*110)	1 METAL	1 METAL
59SS2 (RVFS*108)	1 METAL	1 METAL
59SS03	1 PCB, 1 PAH, 3 SVOCs	
59SS06	1 PAH, 4 DIOXINS/FURANS	
59SS07	1 PAH, 1 DIOXIN/FURAN	
59SS08	1 PCB, 1 PAH, 4 DIOXINS/FURANS	
59SS09	1 DIOXIN/FURAN	
59SS10	1 METAL	1 METAL

LEGEND

- Groundwater Sample Location Result < MCL and tw-SL
- Groundwater Sample Location Result >= tw-SL
- Groundwater Sample Location Result >= MCL
- Soil Sample Location Result < r-SL and i-SL
- Soil Sample Location Result >= r-SL
- Soil Sample Location Result >= i-SL
- Dirt Road
- Paved Road
- Fence
- SWMU 50 and 59 Boundaries
- Other SWMU Boundary

Notes:
1) Aerial photo, dated 2005, was obtained from Montgomery County, VA GIS & Planning Services.
2) Groundwater MCL values were obtained from the 2006 Edition of the Drinking Water Standards and Health Advisories, USEPA, August 2006. Groundwater tw-RBC values were obtained from the October 2008 USEPA Region III RBC table.

N

Scale:

0 57.5 115 230 Feet

U.S. Army Corps of Engineers

Shaw® Shaw Environmental, Inc.

FIGURE 3-2
Groundwater and Soil Results at SWMU 50 and SWMU 59
Radford Army Ammunition Plant, Radford, VA

ArcGIS File Path: C:\Radford_MMA\GIS_Documents\Project_Maps\SWMU_50_59_RFI\RFAAP_Fig3-2_SWMU50_59_GW_Soil Sample_Results.mxd (9/23/2009)

4.0 NATURE AND EXTENT OF CONTAMINATION

The following sections provide a discussion of the site conditions and the nature and extent of chemicals found in site media at SWMUs 50 and 59. The 2007 RFI sampling locations are illustrated on **Figure 3-1**. A summary of the results from the samples are portrayed on **Figure 3-2**. The distribution and concentrations of chemicals and parameter groups (i.e., VOCs, SVOCs, etc.) are evaluated for source locations, migration pathways, and potential hotspots.

Soil Screening. Chemical results from soil samples are compared to adjusted ORNL Regional industrial SLs (i-SLs) and residential soil SLs (r-SLs) (USEPA, 2008), as well as facility-wide background inorganic concentrations (IT, 2001), and other regulatory criteria. I-SLs and r-SLs were adjusted downward to a hazard index (HI) of 0.1 for non-carcinogenic compounds to ensure that chemicals with additive effects are not prematurely eliminated during screening.

Current (September 2008) SL screening values and background 95 percent upper tolerance limits for analytes detected in soil at SWMU 50 and SWMU 59 are respectively presented for comparison in **Tables 4-1 and 4-2**. Analytical results for inorganic compounds in soil are indicated in the tables and figures as exceedances when they exceed both the background value and a screening value. Eliminating SL exceedances in soil that are below the background value allows site-specific constituents to be more clearly indicated in the tables and figures.

Groundwater Screening. Groundwater sampling results are compared to the 2006 Edition of the Drinking Water Standards and Health Advisories (i.e., MCLs and secondary MCLs) (USEPA, 2006) and adjusted tw-SLs (USEPA, 2008). Analytes detected in SWMU 50 and SWMU 59 groundwater samples are presented and summarized for comparison against screening criteria in **Table 4-3**. Soil and groundwater results from the 2007 RFI are presented in *Section 4.1*.

4.1 RFI, Shaw, 2007

4.1.1 Soil Analytical Results

At SWMU 50, ten surface soil samples (50SB06A, 50SB07A, 50SB08A, 50SB09A, 50SB10A, 50SB11A, 50SB12A, 50SB13A, 50SB14A, and 50SB15A) and ten subsurface soil samples (50BSB06B, 50SB07B, 50SB08B, 50SB09B, 50SB10B, 50SB11B, 50SB12B, 50SB13B, 50SB14B, 50SB15B) were collected and analyzed for TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans. Detected results are presented in **Table 4-1**. At SWMU 59, ten surface soil samples (59SS06, 59SS07, 59SS08, 59SS09, 59SS10, 59SB02A, 59SB03A, 59SB04A, 59SB05A, and 59SB06A) and ten subsurface soil samples (59SB02B, 59SB02C, 59SB03B, 59SB03C, 59SB04B, 59SB04C, 59SB05B, 59SB05C, 59SB06B, and 59SB06C) were collected and analyzed for TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans. At SWMU 50, two PAHs, one PCB, three metals, and seven dioxins/furans were found above their SLs. At SWMU 59, one PAH, one PCB, one metal, and five dioxins/furans were detected at concentrations higher than their SLs.

VOCs. VOCs were detected in the SWMU 50 and SWMU 59 samples. However, all concentrations were below the adjusted i-SLs and r-SLs. The VOCs detected in SWMU 50 soil were acetone and m- & p-Xylene in two samples. Acetone was also detected in three SWMU 59 soil samples.

Table 4-1
Analytes Detected in SWMU 50 Soil Samples - 2007 RFI

Analyte	Sample ID			50SB06A					50SB06B					50SB07A					50SB07B					50SB08A					50SB08B					50SB09A				
	Sample Date			7/23/07					7/23/07					7/23/07					7/23/07					7/23/07					7/23/07					7/23/07				
	Sample Depth			0-0.5					4-6					0-0.5					4-6					0-0.5					4-6					0-0.5				
	i-SL	r-SL	Background	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	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
VOCs (ug/kg)																																						
Acetone	61000000	6100000	na	49	U	UJ	*25*	*49*	110	U	UJ	*55*	*110*	90	U	UJ	*45*	*90*	97	U	UJ	*48*	*97*	74.5		J	*31*	*61*	95	U	UJ	*48*	*95*	73	U	UJ	*37*	*73*
m- & p-Xylene	20000000	1600000	na	9.8	U		*2.9*	*9.8*	22	U		*6.6*	*22*	18	U		*5.4*	*18*	19	U		*5.8*	*19*	12	U		*3.7*	*12*	19	U		*5.7*	*19*	15	U		*4.4*	*15*
PAHs (ug/kg)																																						
Benz(a)anthracene	2100	150	na	59	U		*15*	*59*	180	U	UL	*45*	*180*	137	J	L	*75*	*300*	90	U		*22*	*90*	60	U		*15*	*60*	410	U		*100*	*410*	63	U		*16*	*63*
Benzo(a)pyrene	210	15	na	59	U		*15*	*59*	180	U	UL	*45*	*180*	150	J	L	*75*	*300*	90	U		*22*	*90*	60	U		*15*	*60*	410	U		*100*	*410*	63	U		*16*	*63*
Benzo(b)fluoranthene	2100	150	na	59	U		*15*	*59*	180	U	UL	*45*	*180*	152	J	L	*75*	*300*	90	U		*22*	*90*	60	U		*15*	*60*	410	U		*100*	*410*	63	U		*16*	*63*
Benzo(g,h,i)perylene	3100000	230000	na	59	U		*15*	*59*	180	U	UL	*45*	*180*	300	U	UL	*75*	*300*	90	U		*22*	*90*	60	U		*15*	*60*	410	U		*100*	*410*	63	U		*16*	*63*
Benzo(k)fluoranthene	21000	1500	na	59	U		*15*	*59*	180	U	UL	*45*	*180*	98.9	J	L	*75*	*300*	90	U		*22*	*90*	60	U		*15*	*60*	410	U		*100*	*410*	63	U		*16*	*63*
Chrysene	210000	15000	na	59	U		*15*	*59*	180	U	UL	*45*	*180*	119	J	L	*75*	*300*	90	U		*22*	*90*	60	U		*15*	*60*	410	U		*100*	*410*	63	U		*16*	*63*
Indeno(1,2,3-cd)pyrene	2100	150	na	59	U		*15*	*59*	180	U	UL	*45*	*180*	84.1	J	L	*75*	*300*	90	U		*22*	*90*	60	U		*15*	*60*	410	U		*100*	*410*	63	U		*16*	*63*
SVOCs (ug/kg)																																						
2,4-Dinitrotoluene	120000	12000	na	190	U		*37*	*190*	1400	U	UL	*280*	*1400*	331	J	L	*150*	*750*	280	U		*56*	*280*	63	J	J	*37*	*190*	1000	U		*210*	*1000*	200	U		*39*	*200*
Dimethylphthalate	na	na	na	370	U		*93*	*370*	2800	U	UL	*700*	*2800*	1500	U	UL	*370*	*1500*	560	U		*140*	*560*	716			*93*	*370*	2100	U		*520*	*2100*	390	U		*98*	*390*
Di-n-butylphthalate	6200000	610000	na	129	J	J	*93*	*370*	2800	U	UL	*700*	*2800*	1500	U	UL	*370*	*1500*	560	U		*140*	*560*	777			*93*	*370*	1270	J	J	*520*	*2100*	390	U		*98*	*390*
Pesticides (ug/kg)		None detected																																				
PCBs (mg/kg)																																						
PCB-1254	0.74	0.022	na	0.018	U		*0.0092*	*0.018*	0.323			*0.07*	*0.14*	1.48			*0.19*	*0.38*	0.027	U		*0.014*	*0.027*	0.019	U		*0.0096*	*0.019*	0.343			*0.065*	*0.13*	0.02	U		*0.0098*	*0.02*
Explosives (mg/kg)																																						
2,4,6-Trinitrotoluene	79	19	na	0.24	U		*0.048*	*0.24*	0.0923	J	J	*0.046*	*0.23*	0.22	U		*0.043*	*0.22*	0.25	U		*0.049*	*0.25*	0.24	U		*0.049*	*0.24*	0.22	U		*0.043*	*0.22*	0.23	U		*0.047*	*0.23*
2,4-Dinitrotoluene	120	12	na	0.24	U		*0.048*	*0.24*	0.23	U		*0.046*	*0.23*	0.888			*0.043*	*0.22*	0.25	U		*0.049*	*0.25*	0.101	J	J	*0.049*	*0.24*	0.0779	J	J	*0.043*	*0.22*	0.23	U		*0.047*	*0.23*
2,6-Dinitrotoluene	62	6.1	na	0.24	U		*0.085*	*0.24*	0.23	U		*0.082*	*0.23*	0.22	U		*0.077*	*0.22*	0.25	U		*0.088*	*0.25*	0.24	U		*0.087*	*0.24*	0.22	U		*0.077*	*0.22*	0.23	U		*0.083*	*0.23*
Herbicides (ug/kg)																																						
Dicamba	1800000	180000	na	7.4	U		*5.6*	*7.4*	11	U		*8.4*	*11*	7.5	U		*5.6*	*7.5*	11	U		*8.2*	*11*	7.7	U		*5.7*	*7.7*	10	U		*7.8*	*10*	7.9	U		*5.9*	*7.9*
Metals (mg/kg)																																						
Aluminum	99000	7700	40041	15300		J	*1.2*	*11*	11400		J	*1.8*	*16*	11800		J	*1.2*	*11*	3100		J	*1.8*	*16*	18400		J	*1.2*	*11*	11900		J	*1.7*	*15*	17900		J	*1.3*	*12*
Antimony	41	3.1	na	1.1	J	L	*0.28*	*3.2*	0.43	U	UL	*0.43*	*4.8*	1.4	J	L	*0.3*	*3.4*	0.43	U	UL	*0.43*	*4.8*	1.4	J	L	*0.3*	*3.4*	1.1	J	L	*0.4*	*4.5*	1.1	J	L	*0.31*	*3.5*
Arsenic	1600	390	15.8	6.9		J	*0.21*	*0.43*	3.7		J	*0.31*	*0.65*	3.5		J	*0.22*	*0.45*	1.5		J	*0.31*	*0.64*	5.7		J	*0.22*	*0.45*	11.2		J	*0.29*	*0.6*	7.4		J	*0.23*	*0.47*
Barium	19000000	1500000	209	95		J	*0.27*	*11*	39.8		J	*0.4*	*16*	92.7		J	*0.28*	*11*	12	J	J	*0.4*	*16*	123		J	*0.28*	*11*	61.6		J	*0.38*	*15*	79.9		J	*0.29*	*12*
Beryllium	200000	16000	1.02	0.72			*0.054*	*0.27*	0.45			*0.081*	*0.4*	0.6			*0.057*	*0.28*	0.13	J	J	*0.08*	*0.4*	0.9			*0.056*	*0.28*	0.61			*0.076*	*0.38*	0.58			*0.058*	*0.29*
Calcium	na	na	na	4050		J	*3.1*	*270*	187000		J	*81*	*4000*	13400		J	*3.2*	*280*	230000		J	*80*	*4000*	1290		J	*3.2*	*280*	193000		J	*76*	*3800*	1340		J	*3.3*	*290*
Chromium	1400	280	65.3	37		J	*0.048*	*0.54*	**165**		**J**	*0.073*	*0.81*	**116**		**J**	*0.051*	*0.57*	42.5		J	*0.072*	*0.8*	33.4		J	*0.05*	*0.56*	29.8		J	*0.068*	*0.76*	29.9		J	*0.053*	*0.58*
Cobalt	30000	2300	72.3	10.9		J	*0.054*	*2.7*	3.4	J	J	*0.081*	*4*	7.6		J	*0.057*	*2.8*	1.3	J	J	*0.08*	*4*	17.1		J	*0.056*	*2.8*	4.4		J	*0.076*	*3.8*	10.3		J	*0.058*	*2.9*
Copper	4100	310	53.5	12.2			*0.048*	*1.3*	**85.6**			*0.073*	*2*	**56.4**			*0.051*	*1.4*	8.6			*0.072*	*2*	12.9			*0.05*	*1.4*	**216**			*0.068*	*1.9*	8.9			*0.053*	*1.5*
Iron	72000	5500	50962	20300		J	*0.64*	*5.4*	9930		J	*0.97*	*8.1*	20700		J	*0.68*	*5.7*	3060		J	*0.96*	*8*	22700		J	*0.67*	*5.6*	23900		J	*0.91*	*7.6*	21900		J	*0.7*	*5.8*
Lead	800	400	26.8	19.9		J	*0.11*	*5.4*	**234**		**J**	*0.16*	*8.1*	**178**		**J**	*0.11*	*5.7*	16.6		J	*0.16*	*8*	18.9		J	*0.11*	*5.6*	**69.2**		**J**	*0.15*	*7.6*	17.7		J	*0.12*	*5.8*
Magnesium	na	na	na	2990		J	*0.4*	*270*	2150		J	*0.6*	*400*	2420		J	*0.42*	*280*	966		J	*0.59*	*400*	2030		J	*0.41*	*280*	1820		J	*0.56*	*380*	1160		J	*0.43*	*290*
Manganese	2300	180	2543	776		J	*0.54*	*8*	179		J	*0.048*	*1.2*	518		J	*0.57*	*8.5*	25.1		J	*0.048*	*1.2*	1130		J	*0.56*	*8.4*	172		J	*0.045*	*1.1*	1180		J	*0.58*	*8.8*
Mercury	2.8	0.67	0.13	0.057	J	J	*0.006*	*0.084*	0.11	J	J	*0.011*	*0.14*	**0.15**			*0.006*	*0.086*	0.012	J	J	*0.011*	*0.14*	0.052	J	J	*0.007*	*0.089*	0.12			*0.009*	*0.12*	0.1			*0.007*	*0.092*
Nickel	2000	160	62.8	9.7		J	*0.054*	*2.1*	30.4		J	*0.081*	*3.2*	50.1		J	*0.057*	*2.3*	15.9		J	*0.08*	*3.2*	12		J	*0.056*	*2.2*	22.8		J	*0.076*	*3*	8.9		J	*0.058*	*2.3*
Potassium	na	na	na	1170		J	*5.4*	*540*	523	J	B	*8.1*	*810*	654		B	*5.7*	*570*	307	J	B	*8*	*800*	1620		J	*5.6*	*560*	590	J	B	*7.6*	*760*	759		B	*5.8*	*580*
Selenium	510	39	na	5.8		J	*0.11*	*5.4*	16	U	UL	*16*	*32*	4.8	J	J	*0.11*	*5.7*	32	U	UL	*32*	*40*	6.5		J	*0.11*	*5.6*	15	U	UL	*15*	*30*	6.8		J	*0.12*	*5.8*
Silver	510	39	na	0.048	U		*0.048*	*0.54*	0.076	J	J	*0.073*	*0.81*	0.17	J	J	*0.051*	*0.57*	0.072	U		*0.072*	*0.8*	0.05	U		*0.05*	*0.56*	0.069	J	J	*0.068*	*0.76*	0.053	U		*0.053*	*0.58*
Sodium	na	na	na	44	U		*44*	*540*	152	J	B	*67*	*810*	54.8	J	B	*47*	*570*	180	J	B	*66*	*800*	46	U		*46*	*560*	138	J	B	*62*	*760*	52.7	J	B	*48*	*580*
Vanadium	720	55	108	40.6		J	*0.032*	*2.7*	16.7		J	*0.048*	*4*	29		J	*0.034*	*2.8*	6.4		J	*0.048*	*4*	48.9		J	*0.034*	*2.8*	13.8		J	*0.045*	*3.8*	46.1		J	*0.035*	*2.9*
Zinc	31000	2300	202	62		J	*0.07*	*1.1*	44.1		J	*0.1*	*1.6*	78.8		J	*0.074*	*1.1*	5		J	*0.1*	*1.6*	77.1		J	*0.073*	*1.1*	33.4		J	*0.098*	*1.5*	33.6		J	*0.076*	*1.2*
Dioxins/Furans (ng/kg)																																						
2,3,7,8-TCDF	130	37	na	0.599	A	B	*NA*	*NA*	3.81			*NA*	*NA*	7.79			*NA*	*NA*	0.37	A	B	*NA*	*NA*	0.302	A, EMPC	J	*NA*	*NA*	1.1	A	J	*NA*	*NA*	0.267	A	B	*NA*	*NA*
2,3,7,8-TCDD	18	4.5	na	0.454	A	J	*NA*	*NA*	0.314	A, EMPC	J	*NA*	*NA*	0.563	A	J	*NA*	*NA*	0.265	U		*0.265*	*0.265*	0.321	U		*0.321*	*0.321*	0.351	A, EMPC	J	*NA*	*NA*	0.13	A	J	*NA*	*NA*
1,2,3,7,8-PECDD	na	na	na	5.88			*NA*	*NA*	2.1	A	J	*NA*	*NA*	6.68			*NA*	*NA*	0.798	U		*0.798*	*0.798*	2.22	A	J	*NA*	*NA*	0.794	A	J	*NA*	*NA*	0.411	A	J	*NA*	*NA*
1,2,3,4,7,8-HXCDD	460	100	na	13.8			*NA*	*NA*	5.35	A	J	*NA*	*NA*	14.6			*NA*	*NA*	0.798	U		*0.798*	*0.798*	6.02			*NA*	*NA*	1.37	A	J	*NA*	*NA*	0.712	A	J	*NA*	*NA*
1,2,3,6,7,8-HXCDD	460	100	na	122			*NA*	*NA*	24			*NA*	*NA*	48.7			*NA*	*NA*	0.798	U		*0.798*	*0.798*	55.6			*NA*	*NA*	4.95	A	J	*NA*	*NA*	1.87	A	J	*NA*	*NA*
1,2,3,7,8,9-HXCDD	460	100	na	41.2			*NA*	*NA*	15.1			*NA*	*NA*	38.7			*NA*	*NA*	0.798	U		*0.798*	*0.798*	21.4			*NA*	*NA*	3.9	A	J	*NA*	*NA*	1.76	A	J	*NA*	*NA*
1,2,3,4,6,7,8-HPCDD	na	na	na	4610	E	J	*NA*	*NA*	889			*NA*	*NA*	1580			*NA*	*NA*	14.5			*NA*	*NA*	1850			*NA*	*NA*	205			*NA*	*NA*	84.9			*NA*	*NA*
OCDD	61000	15000	na	50200	E	J	*NA*	*NA*	7920	E	J	*NA*	*NA*	16200	E	J	*NA*	*NA*	472			*NA*	*NA*	19500	E	J	*NA*	*NA*	2150			*NA*	*NA*	4740	E	J	*NA*	*NA*
1,2,3,7,8-PECDF	440	120	na	1.76	A	J	*NA*	*NA*	1.53	A	J	*NA*	*NA*	4.08	A	J	*NA*	*NA*	0.798	U		*0.798*	*0.798*	0.615	A, EMPC	J	*NA*	*NA*	0.487	A	J	*NA*	*NA*	0.0999	A	J	*NA*	*NA*
2,3,4,7,8-PECDF	44	12	na	2.73	A	J	*NA*	*NA*	3.48	A	J	*NA*	*NA*	9.63			*NA*	*NA*	0.798	U		*0.798*	*0.798*	1.35	A	J	*NA*	*NA*	1.36	A	J	*NA*	*NA*	0.187	A	B	*NA*	*NA*
1,2,3,4,7,8-HXCDF	na	na	na	15.3			*NA*	*NA*	14.7	A	J	*NA*	*NA*	37			*NA*	*NA*	0.399	A	J	*NA*	*NA*	12.1			*NA*	*NA*	4.55	A	J	*NA*	*NA*	0.658	A	J	*NA*	*NA*
1,2,3,6,7,8-HXCDF	na	na	na	7.4			*NA*	*NA*	5.43			*NA*	*NA*	16.6			*NA*	*NA*	0.798	U		*0.798*	*0.798*	6.12			*NA*	*NA*	1.97	A	J	*NA*	*NA*	0.365	A, EMPC	J	*NA*	*NA*
2,3,4,6,7,8-HXCDF	na	na	na	12.8	A	J	*NA*	*NA*	6.97			*NA*	*NA*	15.3			*NA*	*NA*	0.798	U		*0.798*	*0.798*	9.24			*NA*	*NA*	1.63	A	J	*NA*	*NA*	0.463	A	J	*NA*	*NA*
1,2,3,7,8,9-HXCDF	na	na	na	2.79			*NA*	*NA*	1.73	A	J	*NA*	*NA*	4.27	A	J	*NA*	*NA*	0.798	U		*0.798*	*0.798*	2.71	A	J	*NA*	*NA*	0.819	A	J	*NA*	*NA*	0.543	U		*0.543*	*0.543*
1,2,3,4,6,7,8-HPCDF	na	na	na	519			*NA*	*NA*	212			*NA*	*NA*	385			*NA*	*NA*	2.87	A	B	*NA*	*NA*	280			*NA*	*NA*	43.3			*NA*	*NA*	14.1			*NA*	*NA*
1,2,3,4,7,8,9-HPCDF	na	na	na	29.7			*NA*	*NA*	10.3			*NA*	*NA*	21.9			*NA*	*NA*	0.798	U		*0.798*	*0.798*	23.2			*NA*	*NA*	2.68	A	J	*NA*	*NA*	0.615	A	J	*NA*	*NA*
OCDF	44000	12000	na	2090			*NA*	*NA*	716			*NA*	*NA*	1160			*NA*	*NA*	11.8	A	B	*NA*	*NA*	1150			*NA*	*NA*	155			*NA*	*NA*	40.4			*NA*	*NA*
TOTAL TCDD	na	na	na	0.454			*NA*	*NA*	0.971	A, EMPC	J	*NA*	*NA*	3.41	A, EMPC	J	*NA*	*NA*	0.182			*NA*	*NA*	0.97	A, EMPC	J	*NA*	*NA*	1.58	A, EMPC	J	*NA*	*NA*	0.413			*NA*	*NA*
TOTAL PECDD	18	4.5	na	16.9	AQ, EMPC	J	*NA*	*NA*	6.35	AQ, EMPC	J	*NA*	*NA*	17.8	AQ, EMPC	J	*NA*	*NA*	0.798	U		*0.798*	*0.798*	10.6			*NA*	*NA*	2.71			*NA*	*NA*	1.68			*NA*	*NA*
TOTAL HXCDD	180	45	na	404			*NA*	*NA*	110			*NA*	*NA*	256			*NA*	*NA*	1.19			*NA*	*NA*	200			*NA*	*NA*	26.3	A, EMPC	J	*NA*	*NA*	12.5	A, EMPC	J	*NA*	*NA*
TOTAL HPCDD	1800	450	na	7350			*NA*	*NA*	1420			*NA*	*NA*	2540			*NA*	*NA*	28.7			*NA*	*NA*	3580			*NA*	*NA*	329			*NA*	*NA*	152			*NA*	*NA*
TOTAL TCDF	na	na	na	2.42			*NA*	*NA*	25.2	A, EMPC	J	*NA*	*NA*	56.2	A, EMPC	J	*NA*	*NA*	0.779	A, EMPC	B	*NA*	*NA*	1.93	A, EMPC	J	*NA*	*NA*	7.55	A, EMPC	J	*NA*	*NA*	0.901	A, EMPC	J	*NA*	*NA*
TOTAL PECDF	na	na	na	48.2			*NA*	*NA*	42	A, EMPC	J	*NA*	*NA*	109	AQ, EMPC	J	*NA*	*NA*	0.207	A, EMPC	B	*NA*	*NA*	15.2	A, EMPC	J	*NA*	*NA*	11.7			*NA*	*NA*	2.44	A, EMPC	J	*NA*	*NA*
TOTAL HXCDF	130	37	na	518			*NA*	*NA*	224			*NA*	*NA*	415			*NA*	*NA*	2.11	A, EMPC	J	*NA*	*NA*	206			*NA*	*NA*	46.7			*NA*	*NA*	10.8	A, EMPC	J	*NA*	*NA*
TOTAL HPCDF	1300	370	na	2040	A, EMPC	J	*NA*	*NA*	731			*NA*	*NA*	1140			*NA*	*NA*	7.8			*NA*	*NA*	1160	A, EMPC	J	*NA*	*NA*	148	A, EMPC	J	*NA*	*NA*	35.1			*NA*	*NA*

Table 4-1
Analytes Detected in SWMU 50 Soil Samples - 2007 RFI
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Analyte	Sample ID			50SB09B					50SB10A					50SB10B					50SB11A					50SB11B					50SB12A					50SB12B				
	Sample Date			7/23/07					7/23/07					7/23/07					7/23/07					7/23/07					7/23/07					7/23/07				
	Sample Depth			4-6					0-0.5					4-6					0-0.5					4-6					0-0.5					4-6				
	i-SL	r-SL	Background	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	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
VOCs (ug/kg)																																						
Acetone	61000000	6100000	na	99	U	UJ	*50*	99	55	U	UJ	*27*	*55*	60	U	UJ	*30*	*60*	55	U	UJ	*28*	*55*	49	U	UJ	*25*	*49*	63	U	UJ	*31*	*63*	101		J	*38*	*76*
m- & p-Xylene	20000000	1600000	na	20	U		*5.9*	*20*	11	U		*3.3*	*11*	12	U		*3.6*	*12*	11	U		*3.3*	*11*	9.9	U		*3*	*9.9*	13	U		*3.8*	*13*	5.8	J	K	*1.7*	*15*
PAHs (ug/kg)																																						
Benz(a)anthracene	2100	150	na	85	U		*21*	*85*	56	U		*14*	*56*	68	U	UL	*17*	*68*	57	U		*14*	*57*	61	U		*15*	*61*	61	U		*15*	*61*	78	U	UL	*20*	*78*
Benzo(a)pyrene	210	15	na	85	U		*21*	*85*	56	U		*14*	*56*	68	U	UL	*17*	*68*	57	U		*14*	*57*	61	U		*15*	*61*	61	U		*15*	*61*	78	U	UL	*20*	*78*
Benzo(b)fluoranthene	2100	150	na	85	U		*21*	*85*	56	U		*14*	*56*	68	U	UL	*17*	*68*	57	U		*14*	*57*	61	U		*15*	*61*	61	U		*15*	*61*	78	U	UL	*20*	*78*
Benzo(g,h,i)perylene	3100000	230000	na	85	U		*21*	*85*	56	U		*14*	*56*	68	U	UL	*17*	*68*	57	U		*14*	*57*	61	U		*15*	*61*	61	U		*15*	*61*	78	U	UL	*20*	*78*
Benzo(k)fluoranthene	21000	1500	na	85	U		*21*	*85*	56	U		*14*	*56*	68	U	UL	*17*	*68*	57	U		*14*	*57*	61	U		*15*	*61*	61	U		*15*	*61*	78	U	UL	*20*	*78*
Chrysene	210000	15000	na	85	U		*21*	*85*	56	U		*14*	*56*	68	U	UL	*17*	*68*	57	U		*14*	*57*	61	U		*15*	*61*	61	U		*15*	*61*	78	U	UL	*20*	*78*
Indeno(1,2,3-cd)pyrene	2100	150	na	85	U		*21*	*85*	56	U		*14*	*56*	68	U	UL	*17*	*68*	57	U		*14*	*57*	61	U		*15*	*61*	61	U		*15*	*61*	78	U	UL	*20*	*78*
SVOCs (ug/kg)																																						
2,4-Dinitrotoluene	120000	12000	na	54	J	J	*53*	*270*	170	U		*35*	*170*	220	U	UL	*43*	*220*	180	U		*35*	*180*	190	U		*38*	*190*	770	U		*150*	*770*	1200	U	UL	*240*	*1200*
Dimethylphthalate	na	na	na	530	U		*130*	*530*	350	U		*87*	*350*	430	U	UL	*110*	*430*	350	U		*88*	*350*	380	U		*95*	*380*	1500	U		*380*	*1500*	2400	U	UL	*600*	*2400*
Di-n-butylphthalate	6200000	610000	na	355	J	J	*130*	*530*	350	U		*87*	*350*	430	U	UL	*110*	*430*	350	U		*88*	*350*	380	U		*95*	*380*	1500	U		*380*	*1500*	3540		L	*600*	*2400*
Pesticides (ug/kg)	None detected																																					
PCBs (mg/kg)																																						
PCB-1254	0.74	0.022	na	0.706			*0.13*	*0.27*	0.0104	J	J	*0.009*	*0.018*	0.022	U		*0.011*	*0.022*	0.018	U		*0.0089*	*0.018*	0.019	U		*0.0096*	*0.019*	0.019	U		*0.0097*	*0.019*	0.939			*0.12*	*0.24*
Explosives (mg/kg)																																						
2,4,6-Trinitrotoluene	79	19	na	0.24	U		*0.047*	*0.24*	0.25	U		*0.05*	*0.25*	0.23	U		*0.047*	*0.23*	0.23	U		*0.047*	*0.23*	0.24	U		*0.047*	*0.24*	0.23	U		*0.047*	*0.23*	0.24	U		*0.048*	*0.24*
2,4-Dinitrotoluene	120	12	na	0.24	U		*0.047*	*0.24*	0.25	U		*0.05*	*0.25*	0.23	U		*0.047*	*0.23*	0.23	U		*0.047*	*0.23*	0.24	U		*0.047*	*0.24*	0.23	U		*0.047*	*0.23*	0.645			*0.048*	*0.24*
2,6-Dinitrotoluene	62	6.1	na	0.24	U		*0.084*	*0.24*	0.25	U		*0.088*	*0.25*	0.23	U		*0.083*	*0.23*	0.23	U		*0.083*	*0.23*	0.24	U		*0.084*	*0.24*	0.23	U		*0.083*	*0.23*	0.179	J	J	*0.085*	*0.24*
Herbicides (ug/kg)																																						
Dicamba	1800000	180000	na	11	U		*8*	*11*	7.1	U		*5.3*	*7.1*	13.9		J	*6.5*	*8.6*	7.2	U		*5.4*	*7.2*	7.7	U		*5.8*	*7.7*	7.7	U		*5.8*	*7.7*	9.8	U		*7.4*	*9.8*
Metals (mg/kg)																																						
Aluminum	99000	7700	40041	6700		J	*1.7*	*15*	6590		J	*1.2*	*10*	31000		J	*1.4*	*13*	13300		J	*1.2*	*11*	15000		J	*1.3*	*11*	18100		J	*1.2*	*11*	8010		J	*1.6*	*14*
Antimony	41	3.1	na	0.41	U	UL	*0.41*	*4.6*	0.33	J	L	*0.28*	*3.1*	2.5	J	L	*0.34*	*3.8*	1	J	L	*0.28*	*3.2*	0.75	J	L	*0.3*	*3.4*	1.3	J	L	*0.3*	*3.3*	0.38	U	UL	*0.38*	*4.3*
Arsenic	1600	390	15.8	2.3		J	*0.3*	*0.61*	2.3		J	*0.2*	*0.42*	1.6		J	*0.25*	*0.51*	1.9		J	*0.21*	*0.42*	3.3		J	*0.22*	*0.46*	6.2		J	*0.22*	*0.45*	6		J	*0.28*	*0.58*
Barium	19000000	1500000	209	28		J	*0.38*	*15*	94.4		J	*0.26*	*10*	43.4		J	*0.32*	*13*	68.7		J	*0.26*	*11*	42.5		J	*0.29*	*11*	109		J	*0.28*	*11*	53		J	*0.36*	*14*
Beryllium	200000	16000	1.02	0.2	J	J	*0.077*	*0.38*	0.57			*0.052*	*0.26*	0.61			*0.064*	*0.32*	0.47			*0.053*	*0.26*	0.22	J	J	*0.057*	*0.29*	0.85			*0.056*	*0.28*	0.44			*0.072*	*0.36*
Calcium	na	na	na	237000		J	*77*	*3800*	563		J	*3*	*260*	332		J	*3.6*	*320*	706		J	*3*	*260*	523		J	*3.3*	*290*	855		J	*3.2*	*280*	188000		J	*72*	*3600*
Chromium	1400	280	65.3	27.7		J	*0.069*	*0.77*	12.2		J	*0.047*	*0.52*	25		J	*0.058*	*0.64*	16		J	*0.047*	*0.53*	22.4		J	*0.052*	*0.57*	34.6		J	*0.05*	*0.56*	33.3		J	*0.065*	*0.72*
Cobalt	30000	2300	72.3	1.4	J	J	*0.077*	*3.8*	4.8		J	*0.052*	*2.6*	3.7		J	*0.064*	*3.2*	3.4		J	*0.053*	*2.6*	9.8		J	*0.057*	*2.9*	14.5		J	*0.056*	*2.8*	3.3	J	J	*0.072*	*3.6*
Copper	4100	310	53.5	28.8			*0.069*	*1.9*	4			*0.047*	*1.3*	13.8			*0.058*	*1.6*	7.5			*0.047*	*1.3*	6.7			*0.052*	*1.4*	11.4			*0.05*	*1.4*	41.5			*0.065*	*1.8*
Iron	72000	5500	50962	3060		J	*0.92*	*7.7*	7510		J	*0.63*	*5.2*	47200		J	*9*	*64*	17500		J	*0.63*	*5.3*	16200		J	*0.69*	*5.7*	23400		J	*0.67*	*5.6*	7500		J	*0.87*	*7.2*
Lead	800	400	26.8	**56.5**		**J**	*0.15*	*7.7*	13.2		J	*0.1*	*5.2*	11.7		J	*0.13*	*6.4*	9.3		J	*0.11*	*5.3*	22.6		J	*0.11*	*5.7*	14.9		J	*0.11*	*5.6*	**115**		**J**	*0.14*	*7.2*
Magnesium	na	na	na	1820		J	*0.57*	*380*	312		J	*0.39*	*260*	778		J	*0.47*	*320*	651		J	*0.39*	*260*	514		J	*0.42*	*290*	1710		J	*0.41*	*280*	2680		J	*0.54*	*360*
Manganese	2300	180	2543	83.9		J	*0.046*	*1.2*	933		J	*0.52*	*7.9*	107		J	*0.038*	*0.96*	175		J	*0.032*	*0.79*	697		J	*0.57*	*8.6*	785		J	*0.56*	*8.4*	107		J	*0.043*	*1.1*
Mercury	2.8	0.67	0.13	0.031	J	J	*0.009*	*0.12*	0.048	J	J	*0.006*	*0.081*	**0.15**			*0.007*	*0.099*	0.057	J	J	*0.006*	*0.08*	0.12			*0.007*	*0.09*	0.07	J	J	*0.007*	*0.089*	**0.22**			*0.009*	*0.12*
Nickel	2000	160	62.8	10.4		J	*0.077*	*3.1*	4.1		J	*0.052*	*2.1*	10.8		J	*0.064*	*2.6*	6.1		J	*0.053*	*2.1*	5.6		J	*0.057*	*2.3*	11.2		J	*0.056*	*2.2*	16.9		J	*0.072*	*2.9*
Potassium	na	na	na	372	J	B	*7.7*	*770*	292	J	B	*5.2*	*520*	924		B	*6.4*	*640*	587		B	*5.3*	*530*	564	J	B	*5.7*	*570*	1280		J	*5.6*	*560*	1820		J	*7.2*	*720*
Selenium	510	39	na	30	U	UL	*30*	*38*	2.5	J	B	*0.1*	*5.2*	13.5		J	*0.13*	*6.4*	5.6		J	*0.11*	*5.3*	5.3	J	J	*0.11*	*5.7*	7.4		J	*0.11*	*5.6*	14	U	UL	*14*	*36*
Silver	510	39	na	0.069	U		*0.069*	*0.77*	0.047	U		*0.047*	*0.52*	0.058	U		*0.058*	*0.64*	0.047	U		*0.047*	*0.53*	0.052	U		*0.052*	*0.57*	0.05	U		*0.05*	*0.56*	0.065	U		*0.065*	*0.72*
Sodium	na	na	na	198	J	B	*63*	*770*	84.4	J	B	*43*	*520*	53	U		*53*	*640*	58	J	B	*43*	*530*	71.8	J	B	*47*	*570*	46	U		*46*	*560*	92.8	J	B	*60*	*720*
Vanadium	720	55	108	6.8		J	*0.046*	*3.8*	17.2		J	*0.031*	*2.6*	84.2		J	*0.038*	*3.2*	37.5		J	*0.032*	*2.6*	36.4		J	*0.034*	*2.9*	49.1		J	*0.033*	*2.8*	12.2		J	*0.043*	*3.6*
Zinc	31000	2300	202	18.2		J	*0.1*	*1.5*	17		J	*0.068*	*1*	33.5		J	*0.083*	*1.3*	26		J	*0.069*	*1.1*	20.1		J	*0.074*	*1.1*	80.7		J	*0.072*	*1.1*	26.9		J	*0.094*	*1.4*
Dioxins/Furans (ng/kg)																																						
2,3,7,8-TCDF	130	37	na	5.49			*NA*	*NA*	0.483	A, EMPC	B	*NA*	*NA*	0.244	A	B	*NA*	*NA*	0.216	A	B	*NA*	*NA*	0.141	A	B	*NA*	*NA*	0.291	A	B	*NA*	*NA*	2			*NA*	*NA*
2,3,7,8-TCDD	18	4.5	na	0.248	A, EMPC	J	*NA*	*NA*	0.166	U		*0.166*	*0.166*	0.187	U		*0.187*	*0.187*	0.139	U		*0.139*	*0.139*	0.148	U		*0.148*	*0.148*	0.159	U		*0.159*	*0.159*	0.505	A	J	*NA*	*NA*
1,2,3,7,8-PECDD	na	na	na	1.22	A	J	*NA*	*NA*	0.353	A	J	*NA*	*NA*	0.609	U		*0.609*	*0.609*	0.346	A	J	*NA*	*NA*	0.502	U		*0.502*	*0.502*	1.85	A	J	*NA*	*NA*	2.56	A	J	*NA*	*NA*
1,2,3,4,7,8-HXCDD	460	100	na	2.79	A	J	*NA*	*NA*	0.512	A, EMPC	J	*NA*	*NA*	0.609	U		*0.609*	*0.609*	0.478	A	J	*NA*	*NA*	0.693	U		*0.693*	*0.693*	5.48	A	J	*NA*	*NA*	5.34	A	J	*NA*	*NA*
1,2,3,6,7,8-HXCDD	460	100	na	11.2			*NA*	*NA*	1.02	A	J	*NA*	*NA*	0.3	A, EMPC	J	*NA*	*NA*	0.659	A	J	*NA*	*NA*	0.705	U		*0.705*	*0.705*	54.9			*NA*	*NA*	24.9			*NA*	*NA*
1,2,3,7,8,9-HXCDD	460	100	na	7.89	A	J	*NA*	*NA*	1.09	A	J	*NA*	*NA*	0.293	A, EMPC	J	*NA*	*NA*	0.76	A	J	*NA*	*NA*	0.715	U		*0.715*	*0.715*	18.2			*NA*	*NA*	15.4			*NA*	*NA*
1,2,3,4,6,7,8-HPCDD	na	na	na	541			*NA*	*NA*	52.7			*NA*	*NA*	64.4			*NA*	*NA*	162			*NA*	*NA*	35.4			*NA*	*NA*	2350	E	J	*NA*	*NA*	957			*NA*	*NA*
OCDD	61000	15000	na	5540			*NA*	*NA*	3810			*NA*	*NA*	10900	E	J	*NA*	*NA*	23800	E	J	*NA*	*NA*	6300	E	J	*NA*	*NA*	28300	E	J	*NA*	*NA*	8430	E	J	*NA*	*NA*
1,2,3,7,8-PECDF	440	120	na	2	A	J	*NA*	*NA*	0.173	A	J	*NA*	*NA*	0.609	U		*0.609*	*0.609*	0.122	A, EMPC	J	*NA*	*NA*	0.502	U		*0.502*	*0.502*	0.428	A	J	*NA*	*NA*	1.35	A	J	*NA*	*NA*
2,3,4,7,8-PECDF	44	12	na	4.76	AQ	J	*NA*	*NA*	0.232	A	B	*NA*	*NA*	0.107	A, EMPC	B	*NA*	*NA*	0.146	A, EMPC	B	*NA*	*NA*	0.502	U		*0.502*	*0.502*	0.721	A	J	*NA*	*NA*	8.49			*NA*	*NA*
1,2,3,4,7,8-HXCDF	na	na	na	12.9			*NA*	*NA*	0.324	A	J	*NA*	*NA*	1.2	A	J	*NA*	*NA*	0.435	A	J	*NA*	*NA*	0.914	A	J	*NA*	*NA*	6.87			*NA*	*NA*	46			*NA*	*NA*
1,2,3,6,7,8-HXCDF	na	na	na	5.72	A	J	*NA*	*NA*	0.12	A	J	*NA*	*NA*	0.21	A	J	*NA*	*NA*	0.167	A	J	*NA*	*NA*	0.183	, EMP	J	*NA*	*NA*	4.41	A	J	*NA*	*NA*	10.6			*NA*	*NA*
2,3,4,6,7,8-HXCDF	na	na	na	5.25	A	J	*NA*	*NA*	0.183	A	J	*NA*	*NA*	0.609	U		*0.609*	*0.609*	0.181	A, EMPC	J	*NA*	*NA*	0.502	U		*0.502*	*0.502*	6.16			*NA*	*NA*	10.6			*NA*	*NA*
1,2,3,7,8,9-HXCDF	na	na	na	1.48	A	J	*NA*	*NA*	0.51	U		*0.51*	*0.51*	0.609	U		*0.609*	*0.609*	0.486	U		*0.486*	*0.486*	0.502	U		*0.502*	*0.502*	0.777	A	J	*NA*	*NA*	5.74	A	J	*NA*	*NA*
1,2,3,4,6,7,8-HPCDF	na	na	na	124			*NA*	*NA*	2.44	A	B	*NA*	*NA*	4.48	A	B	*NA*	*NA*	1.86	A	B	*NA*	*NA*	4.01	A	B	*NA*	*NA*	317			*NA*	*NA*	196			*NA*	*NA*
1,2,3,4,7,8,9-HPCDF	na	na	na	7.15	A	J	*NA*	*NA*	0.51	U		*0.51*	*0.51*	0.609	U		*0.609*	*0.609*	0.486	U		*0.486*	*0.486*	0.502	U		*0.502*	*0.502*	18.2			*NA*	*NA*	18.5			*NA*	*NA*
OCDF	44000	12000	na	416			*NA*	*NA*	6.53	A	B	*NA*	*NA*	4.89	A	B	*NA*	*NA*	3.06	A	B	*NA*	*NA*	3.35	A	B	*NA*	*NA*	1220			*NA*	*NA*	628			*NA*	*NA*
TOTAL TCDD	na	na	na	0.626			*NA*	*NA*	0.838			*NA*	*NA*	0.187	U		*0.187*	*0.187*	0.371	A, EMPC	J	*NA*	*NA*	0.148	U		*0.148*	*0.148*	0.159	U		*0.159*	*0.159*	10	A, EMPC	J	*NA*	*NA*
TOTAL PECDD	18	4.5	na	4.52	Q	J	*NA*	*NA*	2.04			*NA*	*NA*	0.609	U		*0.609*	*0.609*	0.87	A, EMPC	J	*NA*	*NA*	0.502	U		*0.502*	*0.502*	6.43	A, EMPC	J	*NA*	*NA*	8.86	A, EMPC	J	*NA*	*NA*
TOTAL HXCDD	180	45	na	58.8	A, EMPC	J	*NA*	*NA*	9.86	A, EMPC	J	*NA*	*NA*	2.35	A, EMPC	J	*NA*	*NA*	7.23	A, EMPC	J	*NA*	*NA*	1.56			*NA*	*NA*	190			*NA*	*NA*	113			*NA*	*NA*
TOTAL HPCDD	1800	450	na	864			*NA*	*NA*	110	A, EMPC	J	*NA*	*NA*	140			*NA*	*NA*	363	A, EMPC	J	*NA*	*NA*	82			*NA*	*NA*	3670			*NA*	*NA*	1520			*NA*	*NA*
TOTAL TCDF	na	na	na	27.5	A, EMPC	J	*NA*	*NA*	2.49	A, EMPC	J	*NA*	*NA*	0.244			*NA*	*NA*	0.604	A, EMPC	B	*NA*	*NA*	0.141		B	*NA*	*NA*	1.82	A, EMPC	J	*NA*	*NA*	20.2	A, EMPC	J	*NA*	*NA*
TOTAL PECDF	na	na	na	40.2	AQ, EMPC	J	*NA*	*NA*	2.05			*NA*	*NA*	0.478	A, EMPC	J	*NA*	*NA*	0.882	A, EMPC	J	*NA*	*NA*	0.147	, EMP	B	*NA*	*NA*	22.1	A, EMPC	J	*NA*	*NA*	68	A, EMPC	J	*NA*	*NA*
TOTAL HXCDF	130	37	na	129			*NA*	*NA*	2.64			*NA*	*NA*	2.53	A, EMPC	J	*NA*	*NA*	1.77			*NA*	*NA*	1.73	, EMP	J	*NA*	*NA*	238			*NA*	*NA*	261			*NA*	*NA*
TOTAL HPCDF	1300	370	na	376			*NA*	*NA*	6.17			*NA*	*NA*	5.45			*NA*	*NA*	3.06		B	*NA*	*NA*	4.35	, EMP	B	*NA*	*NA*	1140	A, EMPC	J	*NA*	*NA*	630	A, EMPC	J	*NA*	*NA*

Table 4-1
Analytes Detected in SWMU 50 Soil Samples - 2007 RFI

Analyte	Sample ID			50SB13A					50SB13B					50SB14A					50SB14B					50SB15A					50SB15B				
	Sample Date			7/23/07					7/23/07					7/23/07					7/23/07					7/23/07					7/23/07				
	Sample Depth			0-0.5					4-6					0-0.5					4-6					0-0.5					4-6				
	i-SL	r-SL	Background	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	Result	Lab Q	Val Q	MDL	MRL
VOCs (ug/kg)																																	
Acetone	61000000	6100000	na	58	U	UJ	*29*	*58*	80	U	UJ	*40*	*80*	68	U	UJ	*34*	*68*	63	U	UJ	*32*	*63*	52	U	UJ	*26*	*52*	79	U	UJ	*39*	*79*
m- & p-Xylene	20000000	1600000	na	12	U		*3.5*	*12*	16	U		*1.7*	*16*	14	U		*4.1*	*14*	13	U		*3.8*	*13*	10	U		*3.1*	*10*	16	U		*1.7*	*16*
PAHs (ug/kg)																																	
Benz(a)anthracene	2100	150	na	60	U		*15*	*60*	81	U		*20*	*81*	58	U		*14*	*58*	64	U		*16*	*64*	61	U		*15*	*61*	62	U		*16*	*62*
Benzo(a)pyrene	210	15	na	18.7	J	J	*15*	*60*	81	U		*20*	*81*	58	U		*14*	*58*	64	U		*16*	*64*	61	U		*15*	*61*	62	U		*16*	*62*
Benzo(b)fluoranthene	2100	150	na	20.2	J	J	*15*	*60*	81	U		*20*	*81*	58	U		*14*	*58*	64	U		*16*	*64*	61	U		*15*	*61*	62	U		*16*	*62*
Benzo(g,h,i)perylene	3100000	230000	na	16.9	J	J	*15*	*60*	24.5	J	J	*20*	*81*	58	U		*14*	*58*	64	U		*16*	*64*	61	U		*15*	*61*	62	U		*16*	*62*
Benzo(k)fluoranthene	21000	1500	na	16	J	J	*15*	*60*	81	U		*20*	*81*	58	U		*14*	*58*	64	U		*16*	*64*	61	U		*15*	*61*	62	U		*16*	*62*
Chrysene	210000	15000	na	15.8	J	J	*15*	*60*	81	U		*20*	*81*	58	U	UL	*14*	*58*	64	U		*16*	*64*	61	U		*15*	*61*	62	U		*16*	*62*
Indeno(1,2,3-cd)pyrene	2100	150	na	19.1	J	J	*15*	*60*	21	J	J	*20*	*81*	58	U		*14*	*58*	64	U		*16*	*64*	61	U		*15*	*61*	62	U		*16*	*62*
SVOCs (ug/kg)																																	
2,4-Dinitrotoluene	120000	12000	na	190	U		*37*	*190*	250	U		*51*	*250*	180	U		*36*	*180*	200	U		*40*	*200*	190	U		*38*	*190*	190	U		*39*	*190*
Dimethylphthalate	na	na	na	370	U		*94*	*370*	510	U		*130*	*510*	360	U		*90*	*360*	400	U		*100*	*400*	380	U		*96*	*380*	390	U		*97*	*390*
Di-n-butylphthalate	6200000	610000	na	370	U		*94*	*370*	366	J	J	*130*	*510*	229	J	J	*90*	*360*	400	U		*100*	*400*	380	U		*96*	*380*	390	U		*97*	*390*
Pesticides (ug/kg)	None detected																																
PCBs (mg/kg)																																	
PCB-1254	0.74	0.022	na	0.0126	J	J	*0.0095*	*0.019*	0.0283		J	*0.013*	*0.025*	0.018	U		*0.009*	*0.018*	0.02	U		*0.01*	*0.02*	0.019	U		*0.0095*	*0.019*	0.019	U		*0.0096*	*0.019*
Explosives (mg/kg)																																	
2,4,6-Trinitrotoluene	79	19	na	0.23	U		*0.046*	*0.23*	0.24	U		*0.048*	*0.24*	0.25	U		*0.05*	*0.25*	0.24	U		*0.048*	*0.24*	0.25	U		*0.049*	*0.25*	0.24	U		*0.049*	*0.24*
2,4-Dinitrotoluene	120	12	na	0.23	U		*0.046*	*0.23*	0.24	U		*0.048*	*0.24*	0.134	J	J	*0.05*	*0.25*	0.24	U		*0.048*	*0.24*	0.25	U		*0.049*	*0.25*	0.24	U		*0.049*	*0.24*
2,6-Dinitrotoluene	62	6.1	na	0.23	U		*0.081*	*0.23*	0.24	U		*0.085*	*0.24*	0.25	U		*0.089*	*0.25*	0.24	U		*0.085*	*0.24*	0.25	U		*0.088*	*0.25*	0.24	U		*0.087*	*0.24*
Herbicides (ug/kg)																																	
Dicamba	1800000	180000	na	7.6	U		*5.7*	*7.6*	10	U		*7.7*	*10*	7.3	U		*5.5*	*7.3*	8	U		*6*	*8*	7.6	U		*5.7*	*7.6*	7.8	U		*5.8*	*7.8*
Metals (mg/kg)																																	
Aluminum	99000	7700	40041	18800		J	*1.2*	*11*	10500		J	*1.7*	*15*	11300		J	*1.2*	*11*	26800		J	*1.3*	*12*	14600		J	*1.3*	*11*	23500		J	*1.3*	*12*
Antimony	41	3.1	na	1.3	J	L	*0.29*	*3.3*	1.8	J	L	*0.4*	*4.5*	1	J	L	*0.29*	*3.3*	1.5	J	L	*0.32*	*3.6*	1.2	J	L	*0.3*	*3.4*	1	J	L	*0.31*	*3.5*
Arsenic	1600	390	15.8	2.5		J	*0.21*	*0.44*	13.1		J	*0.29*	*0.6*	4.1		J	*0.22*	*0.44*	1.8		J	*0.24*	*0.48*	1.8		J	*0.22*	*0.46*	1.9		J	*0.23*	*0.47*
Barium	19000000	1500000	209	75.9		J	*0.27*	*11*	68.4		J	*0.38*	*15*	74.1		J	*0.28*	*11*	47.5		J	*0.3*	*12*	33.9		J	*0.29*	*11*	101		J	*0.29*	*12*
Beryllium	200000	16000	1.02	0.75			*0.055*	*0.27*	0.74			*0.075*	*0.38*	0.35			*0.055*	*0.28*	0.5			*0.06*	*0.3*	0.7			*0.057*	*0.29*	0.59			*0.059*	*0.29*
Calcium	na	na	na	12900		J	*3.1*	*270*	129000		J	*75*	*3800*	1390		J	*3.2*	*280*	844		J	*3.4*	*300*	512		J	*3.3*	*290*	25.4	J	J	*3.3*	*290*
Chromium	1400	280	65.3	23.5		J	*0.049*	*0.55*	**513**		**J**	*1.1*	*7.5*	26.6		J	*0.05*	*0.55*	32.3		J	*0.054*	*0.6*	14.4		J	*0.052*	*0.57*	27.5		J	*0.053*	*0.59*
Cobalt	30000	2300	72.3	8.3		J	*0.055*	*2.7*	6.1		J	*0.075*	*3.8*	8.2		J	*0.055*	*2.8*	3.3		J	*0.06*	*3*	4.1		J	*0.057*	*2.9*	44.9		J	*0.059*	*2.9*
Copper	4100	310	53.5	21.2			*0.049*	*1.4*	**438**			*1.4*	*19*	6.2			*0.05*	*1.4*	12.2			*0.054*	*1.5*	11.5			*0.052*	*1.4*	10			*0.053*	*1.5*
Iron	72000	5500	50962	25000		J	*0.66*	*5.5*	16300		J	*0.9*	*7.5*	18300		J	*0.66*	*5.5*	30500		J	*0.72*	*6*	19500		J	*0.69*	*5.7*	22400		J	*0.7*	*5.9*
Lead	800	400	26.8	17.4		J	*0.11*	*5.5*	**128**		**J**	*0.15*	*7.5*	17.8		J	*0.11*	*5.5*	11.1		J	*0.12*	*6*	6.6		J	*0.11*	*5.7*	7.3		J	*0.12*	*5.9*
Magnesium	na	na	na	8820		J	*0.41*	*270*	1550		J	*0.56*	*380*	933		J	*0.41*	*280*	863		J	*0.45*	*300*	607		J	*0.42*	*290*	820		J	*0.43*	*290*
Manganese	2300	180	2543	496		J	*0.55*	*8.2*	199		J	*0.045*	*1.1*	888		J	*0.55*	*8.3*	46.8		J	*0.036*	*0.91*	62.8		J	*0.034*	*0.86*	1440		J	*0.59*	*8.8*
Mercury	2.8	0.67	0.13	**0.18**			*0.006*	*0.087*	**0.15**			*0.009*	*0.12*	**0.22**			*0.006*	*0.081*	**0.22**			*0.007*	*0.088*	0.051	J	J	*0.007*	*0.088*	0.059	J	J	*0.007*	*0.092*
Nickel	2000	160	62.8	13.6		J	*0.055*	*2.2*	**160**		**J**	*0.075*	*3*	4.7		J	*0.055*	*2.2*	8.4		J	*0.06*	*2.4*	9.3		J	*0.057*	*2.3*	10.6		J	*0.059*	*2.3*
Potassium	na	na	na	1140		J	*5.5*	*550*	1360		J	*7.5*	*750*	511	J	B	*5.5*	*550*	935		B	*6*	*600*	649		B	*5.7*	*570*	814		B	*5.9*	*590*
Selenium	510	39	na	5.6		J	*0.11*	*5.5*	0.15	U	UL	*0.15*	*7.5*	5.7		J	*0.11*	*5.5*	10.1		J	*0.12*	*6*	6.6		J	*0.11*	*5.7*	7		J	*0.12*	*5.9*
Silver	510	39	na	0.049	U		*0.049*	*0.55*	0.068	U		*0.068*	*0.75*	0.05	U		*0.05*	*0.55*	0.054	U		*0.054*	*0.6*	0.052	U		*0.052*	*0.57*	0.053	U		*0.053*	*0.59*
Sodium	na	na	na	100	J	B	*45*	*550*	594	J	B	*62*	*750*	75.1	J	B	*46*	*550*	50.6	J	B	*50*	*600*	47	U		*47*	*570*	48.8	J	B	*48*	*590*
Vanadium	720	55	108	37.3		J	*0.033*	*2.7*	21.7		J	*0.045*	*3.8*	38.9		J	*0.033*	*2.8*	77.8		J	*0.036*	*3*	42.2		J	*0.034*	*2.9*	31.1		J	*0.035*	*2.9*
Zinc	31000	2300	202	40		J	*0.071*	*1.1*	33.1		J	*0.098*	*1.5*	17.7		J	*0.072*	*1.1*	23.4		J	*0.079*	*1.2*	19.4		J	*0.075*	*1.1*	26.1		J	*0.076*	*1.2*
Dioxins/Furans (ng/kg)																																	
2,3,7,8-TCDF	130	37	na	0.394	A	B	*NA*	*NA*	0.762	A	B	*NA*	*NA*	0.393	U		*0.393*	*0.393*	0.41	A, EMPC	J	*NA*	*NA*	0.239	A	J	*NA*	*NA*	0.274	A	J	*NA*	*NA*
2,3,7,8-TCDD	18	4.5	na	0.175	U		*0.175*	*0.175*	0.435	U		*0.435*	*0.435*	0.497	U		*0.497*	*0.497*	0.679	U		*0.679*	*0.679*	0.192	U		*0.192*	*0.192*	0.203	U		*0.203*	*0.203*
1,2,3,7,8-PECDD	na	na	na	0.279	A, EMPC	J	*NA*	*NA*	1.08	A, EMPC	J	*NA*	*NA*	0.575	U		*0.575*	*0.575*	0.834	U		*0.834*	*0.834*	0.554	U		*0.554*	*0.554*	0.539	U		*0.539*	*0.539*
1,2,3,4,7,8-HXCDD	460	100	na	0.457	A	J	*NA*	*NA*	1.07	A, EMPC	J	*NA*	*NA*	0.89	A, EMPC	J	*NA*	*NA*	0.816	U		*0.816*	*0.816*	0.202	A, EMPC	J	*NA*	*NA*	0.539	U		*0.539*	*0.539*
1,2,3,6,7,8-HXCDD	460	100	na	1.4	A	J	*NA*	*NA*	2.65	A	J	*0.695*	*0.695*	3.38	A	J	*NA*	*NA*	0.83	U		*0.83*	*0.83*	0.334	A, EMPC	J	*NA*	*NA*	0.539	U		*0.539*	*0.539*
1,2,3,7,8,9-HXCDD	460	100	na	1.55	A	J	*NA*	*NA*	1.81	A	J	*NA*	*NA*	1.72	A	J	*NA*	*NA*	0.842	U		*0.842*	*0.842*	0.357	A, EMPC	J	*NA*	*NA*	0.539	U		*0.539*	*0.539*
1,2,3,4,6,7,8-HPCDD	na	na	na	97.4			*NA*	*NA*	66.8			*NA*	*NA*	159			*NA*	*NA*	12.5			*NA*	*NA*	58.1			*NA*	*NA*	33.6			*NA*	*NA*
OCDD	61000	15000	na	5960	E	J	*NA*	*NA*	999			*NA*	*NA*	9060	E	J	*NA*	*NA*	2660			*NA*	*NA*	11400	E	J	*NA*	*NA*	4630	E	J	*NA*	*NA*
1,2,3,7,8-PECDF	440	120	na	0.586	U		*0.586*	*0.586*	1.99	A, EMPC	J	*NA*	*NA*	0.387	A	J	*NA*	*NA*	0.599	U		*0.599*	*0.599*	0.554	U		*0.554*	*0.554*	0.539	U		*0.539*	*0.539*
2,3,4,7,8-PECDF	44	12	na	0.199	A	B	*NA*	*NA*	8.02			*NA*	*NA*	0.357	A	J	*NA*	*NA*	0.599	U		*0.599*	*0.599*	0.554	U		*0.554*	*0.554*	0.539	U		*0.539*	*0.539*
1,2,3,4,7,8-HXCDF	na	na	na	0.57	A	J	*NA*	*NA*	120			*NA*	*NA*	1.16	A	J	*NA*	*NA*	0.669	U		*0.669*	*0.669*	0.554	U		*0.554*	*0.554*	0.539	U		*0.539*	*0.539*
1,2,3,6,7,8-HXCDF	na	na	na	0.368	A	J	*NA*	*NA*	18.2			*NA*	*NA*	0.743	A	J	*NA*	*NA*	0.63	U		*0.63*	*0.63*	0.554	U		*0.554*	*0.554*	0.539	U		*0.539*	*0.539*
2,3,4,6,7,8-HXCDF	na	na	na	0.443	A	J	*NA*	*NA*	6.61	A	J	*NA*	*NA*	0.865	A	J	*NA*	*NA*	0.665	U		*0.665*	*0.665*	0.554	U		*0.554*	*0.554*	0.539	U		*0.539*	*0.539*
1,2,3,7,8,9-HXCDF	na	na	na	0.586	U		*0.586*	*0.586*	2.09	A	J	*NA*	*NA*	0.682	U		*0.682*	*0.682*	0.774	U		*0.774*	*0.774*	0.554	U		*0.554*	*0.554*	0.539	U		*0.539*	*0.539*
1,2,3,4,6,7,8-HPCDF	na	na	na	9.77			*NA*	*NA*	559			*NA*	*NA*	20.6			*NA*	*NA*	1.56	A	B	*NA*	*NA*	1.01	A	B	*NA*	*NA*	0.891	A	B	*NA*	*NA*
1,2,3,4,7,8,9-HPCDF	na	na	na	0.588	A	J	*NA*	*NA*	11.1			*NA*	*NA*	1.11	A	J	*NA*	*NA*	1.02	U		*1.02*	*1.02*	0.554	U		*0.554*	*0.554*	0.539	U		*0.539*	*0.539*
OCDF	44000	12000	na	23.2			*NA*	*NA*	1110			*NA*	*NA*	55			*NA*	*NA*	2.8	A	B	*NA*	*NA*	1.7	A	B	*NA*	*NA*	1.28	A	B	*NA*	*NA*
TOTAL TCDD	na	na	na	0.175	U		*0.175*	*0.175*	4.22	A, EMPC	J	*NA*	*NA*	0.497	U		*0.497*	*0.497*	1.24			*NA*	*NA*	0.192	U		*0.192*	*0.192*	0.203	U		*0.203*	*0.203*
TOTAL PECDD	18	4.5	na	0.788	A, EMPC	J	*NA*	*NA*	10.2	A, EMPC	J	*NA*	*NA*	0.575	U		*0.575*	*0.575*	0.834	U		*0.834*	*0.834*	0.554	U		*0.554*	*0.554*	0.539	U		*0.539*	*0.539*
TOTAL HXCDD	180	45	na	13.1			*NA*	*NA*	27.6	A, EMPC	J	*NA*	*NA*	16.7	A, EMPC	J	*NA*	*NA*	5.32			*NA*	*NA*	3.11	A, EMPC	J	*NA*	*NA*	0.63			*NA*	*NA*
TOTAL HPCDD	1800	450	na	201			*NA*	*NA*	125			*NA*	*NA*	294			*NA*	*NA*	35.1			*NA*	*NA*	134			*NA*	*NA*	71.7			*NA*	*NA*
TOTAL TCDF	na	na	na	1.57	A, EMPC	J	*NA*	*NA*	15.1	A, EMPC	J	*NA*	*NA*	0.393	U		*0.393*	*0.393*	0.41	A, EMPC	J	*NA*	*NA*	0.516			*NA*	*NA*	0.403			*NA*	*NA*
TOTAL PECDF	na	na	na	2.98	A, EMPC	J	*NA*	*NA*	62.7	A, EMPC	J	*NA*	*NA*	4.56			*NA*	*NA*	0.599	U		*0.599*	*0.599*	0.554	U		*0.554*	*0.554*	0.539	U		*0.539*	*0.539*
TOTAL HXCDF	130	37	na	8.92			*NA*	*NA*	250	A, EMPC	J	*NA*	*NA*	17.4			*NA*	*NA*	0.774	U		*0.774*	*0.774*	0.554	U		*0.554*	*0.554*	0.345			*NA*	*NA*
TOTAL HPCDF	1300	370	na	25.5			*NA*	*NA*	621			*NA*	*NA*	55.3			*NA*	*NA*	1.56		B	*NA*	*NA*	1.55		B	*NA*	*NA*	0.891		B	*NA*	*NA*

**Refer to legend immediately following this table for a list of definitions and tables notes.

Table 4-1
Legend

12	J	Shading and black font indicate an industrial SL exceedance.
12	J	Bold outline indicates a residential SL exceedance.
12	**J**	Bold, underlined font indicates a background exceedance.
12	*12*	Shading in the MDL/MRL columns indicates the MDL exceeds a criterion.

SLs for non-Carcinogenic compounds have been recalculated to an HI of 0.1.
The pyrene SLs were used for acenaphthylene, benzo(g,h,i)perylene, and phenanthrene.
Inorganic results below background UTLs are not indicated as exceedances on the table.
SL = Screening Level (Source: ORNL Regional Screening Table, September 2008).
SL values in table are for the more conservative chromium VI.
SL values for chromium III are 150,000 (ind) and 12,000 (res), which were not exceeded.
Lead screening values from Technical Review Workgroup for Lead: Guidance Document (April 1999).
mg/kg = milligrams per kilogram (parts per million).
ng/kg = nanograms per kilogram (parts per trillion).
µg/kg = micrograms per kilogram (parts per billion).
NA = not applicable.
NT = analyte not tested.
Lab Q = Lab Data Qualifiers
* = Laboratory duplicate not within control limits.
B = (organics) Blank contamination. Value detected in sample and associated blank.
A (Dioxins) = B = (metals) Value <MRL and >MDL and is considered estimated.
E (metals) = Reported value is estimated because of the presence of interferences.
EMPC (Dioxins) = The ion-abundance ratio between the two characteristic PCDD/PCDF ions was outside accepted ranges. The detected PCDD/PCDF was reported as an estimated maximum possible concentration (EMPC).
J = (organics) Value <MRL and >MDL and is considered estimated.
U = Analyte not-detected at the method reporting limit.
X = (dioxins) Ion abundance ratio outside acceptable range. Value reported is EMPC.
Val Q = Validation Data Qualifiers
B = blank contamination. Value detected in sample and associated blank.
J = estimated concentration.
K = estimated concentration bias high.
L = estimated concentration bias low.
N = presumptive evidence for tentatively identified compounds using a library search.
U = analyte not detected.
UJ = estimated concentration non-detect.
UL = estimated concentration non-detect bias low.

Table 4-2
Analytes Detected in SWMU 59 Soil Samples - 2007 RFI
Page 1 of 3

Analyte	Sample ID			59SB02A					59SB02B					59SB02C					59SB03A					59SB03B					59SB03C					59SB04A				
	Sample Date			7/25/07					7/25/07					7/25/07					7/24/07					7/24/07					7/24/07					7/25/07				
	Sample Depth			0-0.5					4-6					8-10					0-0.5					4-6					8-10					0-0.5				
	i-SL	r-SL	Background	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	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
VOCs (ug/kg)																																					
Acetone	61000000	6100000	na	56	U	UJ	*28*	*56*	52	U	UJ	*26*	*52*	61	U	UJ	*31*	*61*	65	U	UJ	*33*	*65*	59	U	UJ	*29*	*59*	57	U	UJ	*29*	*57*	57	U	UJ	*29*	*57*
PAHs (ug/kg)																																					
1-Methylnaphthalene	99000	22000	na	290	U	UJ	*44*	*290*	320	U	UJ	*48*	*320*	310	U	UJ	*47*	*310*	290	U	UJ	*43*	*290*	330	U	UJ	*49*	*330*	320	U	UJ	*47*	*320*	300	U	UJ	*45*	*300*
2-Methylnaphthalene	410000	31000	na	290	U		*44*	*290*	320	U		*48*	*320*	310	U		*47*	*310*	290	U		*43*	*290*	330	U		*49*	*330*	320	U		*47*	*320*	300	U		*45*	*300*
Benz(a)anthracene	2100	150	na	58	U		*15*	*58*	64	U		*16*	*64*	63	U		*16*	*63*	25.5	J	J	*14*	*57*	66	U		*16*	*66*	63	U		*16*	*63*	60	U		*15*	*60*
Benzo(a)pyrene	210	15	na	58	U		*15*	*58*	64	U		*16*	*64*	63	U		*16*	*63*	23.9	J	J	*14*	*57*	66	U		*16*	*66*	63	U		*16*	*63*	60	U		*15*	*60*
Benzo(b)fluoranthene	2100	150	na	16.6	J	J	*15*	*58*	64	U		*16*	*64*	63	U		*16*	*63*	30.9	J	J	*14*	*57*	66	U		*16*	*66*	63	U		*16*	*63*	60	U		*15*	*60*
Benzo(g,h,i)perylene	3100000	230000	na	58	U		*15*	*58*	64	U		*16*	*64*	63	U		*16*	*63*	15.1	J	J	*14*	*57*	66	U		*16*	*66*	63	U		*16*	*63*	60	U		*15*	*60*
Benzo(k)fluoranthene	21000	1500	na	58	U		*15*	*58*	64	U		*16*	*64*	63	U		*16*	*63*	21.8	J	J	*14*	*57*	66	U		*16*	*66*	63	U		*16*	*63*	60	U		*15*	*60*
Chrysene	210000	15000	na	19.4	J	J	*15*	*58*	64	U	UJ	*16*	*64*	63	U	UJ	*16*	*63*	37	J	J	*14*	*57*	66	U	UJ	*16*	*66*	63	U	UJ	*16*	*63*	60	U	UJ	*15*	*60*
Fluoranthene	2200000	230000	na	290	U		*51*	*290*	320	U		*56*	*320*	310	U		*55*	*310*	51.1	J	J	*50*	*290*	330	U		*58*	*330*	320	U		*55*	*320*	300	U		*53*	*300*
Indeno(1,2,3-cd)pyrene	2100	150	na	58	U		*15*	*58*	64	U		*16*	*64*	63	U		*16*	*63*	15.9	J	J	*14*	*57*	66	U		*16*	*66*	63	U		*16*	*63*	60	U		*15*	*60*
Naphthalene	20000	3900	na	290	U		*44*	*290*	320	U		*48*	*320*	310	U		*47*	*310*	290	U		*43*	*290*	330	U		*49*	*330*	320	U		*47*	*320*	300	U		*45*	*300*
Phenanthrene	3100000	230000	na	290	U		*44*	*290*	320	U		*48*	*320*	310	U		*47*	*310*	53	J	J	*43*	*290*	330	U		*49*	*330*	320	U		*47*	*320*	300	U		*45*	*300*
Pyrene	1700000	170000	na	290	U		*51*	*290*	320	U		*56*	*320*	310	U		*55*	*310*	290	U		*50*	*290*	330	U		*58*	*330*	320	U		*55*	*320*	300	U		*53*	*300*
SVOCs (ug/kg)		None detected																																			
Pesticides (ug/kg)																																					
4,4'-DDD	7200	2000	na	3.7	U		*0.74*	*3.7*	4	U		*0.8*	*4*	4	U		*0.8*	*4*	3.5	U		*0.7*	*3.5*	4.2	U		*0.83*	*4.2*	4	U		*0.8*	*4*	3.8	U		*0.75*	*3.8*
Dieldrin	110	30	na	1.8	U		*0.41*	*1.8*	2	U		*0.44*	*2*	2	U		*0.44*	*2*	1.8	U		*0.39*	*1.8*	2.1	U		*0.46*	*2.1*	2	U		*0.44*	*2*	1.9	U		*0.41*	*1.9*
Endosulfan sulfate	na	na	na	3.7	U		*1.2*	*3.7*	4	U		*1.3*	*4*	4	U		*1.3*	*4*	3.5	U		*1.2*	*3.5*	4.2	U		*1.4*	*4.2*	4	U		*1.3*	*4*	3.8	U		*1.2*	*3.8*
Heptachlor epoxide	190	53	na	1.8	U		*0.37*	*1.8*	2	U		*0.4*	*2*	2	U		*0.4*	*2*	1.8	U		*0.35*	*1.8*	2.1	U		*0.42*	*2.1*	2	U		*0.4*	*2*	1.9	U		*0.38*	*1.9*
PCBs (mg/kg)																																					
PCB-1254	0.74	0.022	na	0.018	U		*0.0092*	*0.018*	0.02	U		*0.0099*	*0.02*	0.019	U		*0.0097*	*0.019*	0.0161	J	J	*0.0088*	*0.018*	0.021	U		*0.01*	*0.021*	0.02	U		*0.01*	*0.02*	0.019	U		*0.0094*	*0.019*
Explosives (mg/kg)		None detected																																			
Herbicides (ug/kg)		None detected																																			
Metals (mg/kg)																																					
Aluminum	99000	7700	40041	7210		J	*1.2*	*11*	22900		J	*1.3*	*12*	19800		J	*1.3*	*12*	10400		J	*1.2*	*11*	27300		J	*1.4*	*12*	24200		J	*1.3*	*12*	17800		J	*1.2*	*11*
Antimony	41	3.1	na	0.37	J	B	*0.29*	*3.3*	0.76	J	B	*0.31*	*3.5*	0.86	J	B	*0.32*	*3.6*	0.74	J	L	*0.28*	*3.2*	1.5	J	L	*0.33*	*3.7*	1.8	J	L	*0.32*	*3.6*	0.72	J	B	*0.29*	*3.3*
Arsenic	1600	390	15.8	5.2		J	*0.21*	*0.44*	1.3		J	*0.23*	*0.47*	1.4		J	*0.23*	*0.48*	**30.3**		**J**	*0.21*	*0.42*	4.3		J	*0.24*	*0.49*	11		J	*0.24*	*0.49*	1.6		J	*0.22*	*0.44*
Barium	19000000	1500000	209	140		J	*0.27*	*11*	45.5		J	*0.29*	*12*	38.6		J	*0.3*	*12*	181		J	*0.26*	*11*	39.7		J	*0.31*	*12*	41.6		J	*0.3*	*12*	94.7		J	*0.28*	*11*
Beryllium	200000	16000	1.02	1			*0.055*	*0.27*	0.7		B	*0.059*	*0.29*	0.71			*0.06*	*0.3*	0.59			*0.053*	*0.26*	0.54			*0.062*	*0.31*	0.48			*0.061*	*0.3*	**1.1**			*0.056*	*0.28*
Calcium	na	na	na	192	J	J	*3.1*	*270*	539		J	*3.4*	*290*	323		J	*3.4*	*300*	1420		J	*3*	*260*	138	J	J	*3.5*	*310*	152	J	J	*3.5*	*300*	937		J	*3.2*	*280*
Chromium	1400	280	65.3	11.6		J	*0.049*	*0.55*	16.8		J	*0.053*	*0.59*	17.3		J	*0.054*	*0.6*	15.6		J	*0.047*	*0.53*	17.3		J	*0.055*	*0.62*	19.6		J	*0.055*	*0.61*	28.8		J	*0.05*	*0.56*
Cobalt	30000	2300	72.3	2.9		J	*0.055*	*2.7*	3.7		J	*0.059*	*2.9*	7.8		J	*0.06*	*3*	5.4		J	*0.053*	*2.6*	3.2		J	*0.062*	*3.1*	2.9	J	J	*0.061*	*3*	9.6		J	*0.056*	*2.8*
Copper	4100	310	53.5	10.9		J	*0.049*	*1.4*	12.1		J	*0.053*	*1.5*	9.7		J	*0.054*	*1.5*	13.2		J	*0.047*	*1.3*	19.1		J	*0.055*	*1.5*	17.3		J	*0.055*	*1.5*	12.8		J	*0.05*	*1.4*
Iron	72000	5500	50962	10800		J	*0.66*	*5.5*	26400		J	*0.71*	*5.9*	20000		J	*0.71*	*6*	15600		J	*0.63*	*5.3*	36400		J	*8.6*	*62*	36500		J	*8.5*	*61*	24400		J	*0.67*	*5.6*
Lead	800	400	26.8	9.9		J	*0.11*	*5.5*	10.1		J	*0.12*	*5.9*	6.6		J	*0.12*	*6*	20.3		J	*0.11*	*5.3*	9.7		J	*0.12*	*6.2*	9.3		J	*0.12*	*6.1*	8.3		J	*0.11*	*5.6*
Magnesium	na	na	na	382		J	*0.41*	*270*	1010		J	*0.44*	*290*	1060		J	*0.44*	*300*	1520		J	*0.39*	*260*	972		J	*0.46*	*310*	949		J	*0.45*	*300*	1830		J	*0.41*	*280*
Manganese	2300	180	2543	337		J	*0.27*	*4.1*	167		J	*0.035*	*0.88*	378		J	*0.3*	*4.5*	175		J	*0.032*	*0.79*	82.2		J	*0.037*	*0.92*	76.6		J	*0.036*	*0.91*	216		J	*0.033*	*0.83*
Mercury	2.8	0.67	0.13	**0.24**			*0.007*	*0.089*	0.1			*0.007*	*0.097*	0.066	J	J	*0.007*	*0.095*	**0.22**			*0.006*	*0.081*	0.093	J	J	*0.008*	*0.1*	0.029	J	J	*0.007*	*0.098*	0.082	J	J	*0.006*	*0.084*
Nickel	2000	160	62.8	5.3		J	*0.055*	*2.2*	9.5		J	*0.059*	*2.4*	8.6		J	*0.06*	*2.4*	8.9		J	*0.053*	*2.1*	10.6		J	*0.062*	*2.5*	9.6		J	*0.061*	*2.4*	11.5		J	*0.056*	*2.2*
Potassium	na	na	na	365	J	J	*5.5*	*550*	1080		J	*5.9*	*590*	948		J	*6*	*600*	757		J	*5.3*	*530*	1130		J	*6.2*	*620*	1020		J	*6.1*	*610*	935		J	*5.6*	*560*
Selenium	510	39	na	0.63	J	L	*0.11*	*5.5*	0.12	U	UL	*0.12*	*5.9*	0.29	J	L	*0.12*	*6*	6.4		J	*0.11*	*5.3*	10.7		J	*0.12*	*6.2*	11.7		J	*0.12*	*6.1*	0.11	U	UL	*0.11*	*5.6*
Sodium	na	na	na	187	J	B	*45*	*550*	366	J	L	*49*	*590*	315	J	L	*49*	*600*	43	U		*43*	*530*	51	U		*50*	*610*	50	U		*50*	*610*	370	J	L	*46*	*560*
Vanadium	720	55	108	20.5		J	*0.033*	*2.7*	63.4		J	*0.035*	*2.9*	42.3		J	*0.036*	*3*	25		J	*0.032*	*2.6*	56.9		J	*0.037*	*3.1*	49.5		J	*0.036*	*3*	50.6		J	*0.033*	*2.8*
Zinc	31000	2300	202	22.6		J	*0.071*	*1.1*	30.6		J	*0.077*	*1.2*	24.4		J	*0.077*	*1.2*	45.7		J	*0.068*	*1.1*	31.9		J	*0.08*	*1.2*	29.5		J	*0.079*	*1.2*	42.8		J	*0.072*	*1.1*
Dioxins/Furans (ng/kg)																																					
2,3,7,8-TCDF	130	37	na	0.157	A, EMPC	J	*0.148*	*0.148*	0.26	A, EMPC	J	*0.182*	*0.182*	0.54	U		*0.54*	*0.54*	0.502	A	J	*NA*	*NA*	0.29	A	J	*NA*	*NA*	0.188	U		*0.188*	*0.188*	0.378	A	J	*NA*	*NA*
2,3,7,8-TCDD	18	4.5	na	0.137	U		*0.137*	*0.137*	0.198	U		*0.198*	*0.198*	0.192	U		*0.192*	*0.192*	0.217	U		*0.217*	*0.217*	0.261	U		*0.261*	*0.261*	0.191	U		*0.191*	*0.191*	0.294	U		*0.294*	*0.294*
1,2,3,7,8-PECDD	na	na	na	0.119	A, EMPC	J	*0.446*	*0.446*	0.619	U		*0.619*	*0.619*	0.54	U		*0.54*	*0.54*	0.675	A	J	*NA*	*NA*	0.615	U		*0.615*	*0.615*	0.234	A, EMPC	J	*0.617*	*0.617*	0.528	U		*0.528*	*0.528*
1,2,3,4,7,8-HXCDD	460	100	na	0.148	A, EMPC	J	*0.446*	*0.446*	0.619	U		*0.619*	*0.619*	0.54	U		*0.54*	*0.54*	1.07	A	J	*NA*	*NA*	0.615	U		*0.615*	*0.615*	0.269	A, EMPC	J	*0.617*	*0.617*	0.528	U		*0.528*	*0.528*
1,2,3,6,7,8-HXCDD	460	100	na	0.31	A, EMPC	J	*0.446*	*0.446*	0.619	U		*0.619*	*0.619*	0.106	A, EMPC	J	*0.54*	*0.54*	3.07	A	J	*NA*	*NA*	0.615	U		*0.615*	*0.615*	0.383	A	J	*NA*	*NA*	0.558	A	J	*NA*	*NA*
1,2,3,7,8,9-HXCDD	460	100	na	0.308	A	J	*NA*	*NA*	0.619	U		*0.619*	*0.619*	0.54	U		*0.54*	*0.54*	2.89	A	J	*NA*	*NA*	0.615	U		*0.615*	*0.615*	0.496	A	J	*NA*	*NA*	0.682	A, EMPC	J	*0.543*	*0.543*
1,2,3,4,6,7,8-HPCDD	na	na	na	14.8		J	*NA*	*NA*	9.87		J	*NA*	*NA*	7.82		J	*NA*	*NA*	91.9			*NA*	*NA*	20.7			*NA*	*NA*	14.7			*NA*	*NA*	46.4		J	*NA*	*NA*
OCDD	61000	15000	na	736		J	*NA*	*NA*	1490		J	*NA*	*NA*	987		J	*NA*	*NA*	1750			*NA*	*NA*	3260			*NA*	*NA*	1170			*NA*	*NA*	5980	E	J	*NA*	*NA*
1,2,3,7,8-PECDF	440	120	na	0.291	A, EMPC	J	*0.446*	*0.446*	0.619	U		*0.619*	*0.619*	0.54	U		*0.54*	*0.54*	0.152	A, EMPC	J	*0.594*	*0.594*	0.615	U		*0.615*	*0.615*	0.617	U		*0.617*	*0.617*	0.528	U		*0.528*	*0.528*
2,3,4,7,8-PECDF	44	12	na	0.282	A	J	*NA*	*NA*	0.619	U		*0.619*	*0.619*	0.54	U		*0.54*	*0.54*	0.376	A	J	*NA*	*NA*	0.615	U		*0.615*	*0.615*	0.101	A, EMPC	J	*0.617*	*0.617*	0.528	U		*0.528*	*0.528*
1,2,3,4,7,8-HXCDF	na	na	na	1.92	A	J	*NA*	*NA*	0.144	A	B	*NA*	*NA*	0.177	A	B	*NA*	*NA*	1.11	A	B	*NA*	*NA*	0.615	U		*0.615*	*0.615*	0.239	A	B	*NA*	*NA*	0.528	U		*0.528*	*0.528*
1,2,3,6,7,8-HXCDF	na	na	na	0.683	A	B	*NA*	*NA*	0.619	U		*0.619*	*0.619*	0.54	U		*0.54*	*0.54*	0.616	A, EMPC	J	*0.594*	*0.594*	0.615	U		*0.615*	*0.615*	0.153	A, EMPC	J	*0.617*	*0.617*	0.528	U		*0.528*	*0.528*
2,3,4,6,7,8-HXCDF	na	na	na	0.246	A	J	*NA*	*NA*	0.619	U		*0.619*	*0.619*	0.54	U		*0.54*	*0.54*	0.899	A	J	*NA*	*NA*	0.615	U		*0.615*	*0.615*	0.0913	A, EMPC	J	*0.617*	*0.617*	0.528	U		*0.528*	*0.528*
1,2,3,7,8,9-HXCDF	na	na	na	0.121	A	J	*NA*	*NA*	0.619	U		*0.619*	*0.619*	0.54	U		*0.54*	*0.54*	0.594	U		*0.594*	*0.594*	0.615	U		*0.615*	*0.615*	0.617	U		*0.617*	*0.617*	0.528	U		*0.528*	*0.528*
1,2,3,4,6,7,8-HPCDF	na	na	na	3.51	A	B	*NA*	*NA*	0.617	A	B	*NA*	*NA*	0.984	A	B	*NA*	*NA*	18.9			*NA*	*NA*	0.963	A, EMPC	J	*0.615*	*0.615*	2.75	A	B	*NA*	*NA*	2.19	A	B	*NA*	*NA*
1,2,3,4,7,8,9-HPCDF	na	na	na	0.287	A	J	*NA*	*NA*	0.619	U		*0.619*	*0.619*	0.54	U		*0.54*	*0.54*	0.982	A	J	*NA*	*NA*	0.615	U		*0.615*	*0.615*	0.617	U		*0.617*	*0.617*	0.528	U		*0.528*	*0.528*
OCDF	44000	12000	na	6.93	A	B	*NA*	*NA*	1.3	A	B	*NA*	*NA*	1.7	A	B	*NA*	*NA*	50.7			*NA*	*NA*	1.23	U		*1.23*	*1.23*	5.74	A	B	*NA*	*NA*	5.17	A	B	*NA*	*NA*
TOTAL TCDD	na	na	na	0.137	U		*0.137*	*0.137*	0.198	U		*0.198*	*0.198*	0.192	U		*0.192*	*0.192*	0.418			*NA*	*NA*	0.261	U		*0.261*	*0.261*	0.074			*NA*	*NA*	0.294	U		*0.294*	*0.294*
TOTAL PECDD	18	4.5	na	0.504			*NA*	*NA*	0.619	U		*0.619*	*0.619*	0.54	U		*0.54*	*0.54*	2.19			*NA*	*NA*	0.615	U		*0.615*	*0.615*	0.617	U		*0.617*	*0.617*	0.714			*NA*	*NA*
TOTAL HXCDD	180	45	na	2.91			*NA*	*NA*	0.268			*NA*	*NA*	0.54	U		*0.54*	*0.54*	19.4			*NA*	*NA*	0.394			*NA*	*NA*	1.34			*NA*	*NA*	4.2			*NA*	*NA*
TOTAL HPCDD	1800	450	na	43.3			*NA*	*NA*	25.8			*NA*	*NA*	17.8			*NA*	*NA*	194			*NA*	*NA*	52.9			*NA*	*NA*	32.3			*NA*	*NA*	125			*NA*	*NA*
TOTAL TCDF	na	na	na	0.225			*NA*	*NA*	0.182	U		*0.182*	*0.182*	0.0669			*NA*	*NA*	1.5			*NA*	*NA*	0.29			*NA*	*NA*	0.17			*NA*	*NA*	0.378			*NA*	*NA*
TOTAL PECDF	na	na	na	0.877			*NA*	*NA*	0.619	U		*0.619*	*0.619*	0.041			*NA*	*NA*	1.67			*NA*	*NA*	0.615	U		*0.615*	*0.615*	0.104			*NA*	*NA*	0.528	U		*0.528*	*0.528*
TOTAL HXCDF	130	37	na	5.71			*NA*	*NA*	0.235			*NA*	*NA*	0.432			*NA*	*NA*	16.3			*NA*	*NA*	0.615	U		*0.615*	*0.615*	1.51			*NA*	*NA*	1.02			*NA*	*NA*
TOTAL HPCDF	1300	370	na	8.43			*NA*	*NA*	1.23			*NA*	*NA*	1.93			*NA*	*NA*	62			*NA*	*NA*	0.896			*NA*	*NA*	6.06			*NA*	*NA*	5.52			*NA*	*NA*

Table 4-2
Analytes Detected in SWMU 59 Soil Samples - 2007 RFI
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Analyte	Sample ID			59SB04B					59SB04C					59SB05A					59SB05B					59SB05C					59SB06A					59SB06B				
	Sample Date			7/25/07					7/25/07					7/25/07					7/25/07					7/25/07					7/25/07					7/25/07				
	Sample Depth			4-6					8-10					0-0.5					4-6					8-10					0-0.5					4-6				
	i-SL	r-SL	Background	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	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
VOCs (ug/kg)																																						
Acetone	61000000	6100000	na	52	U	UJ	*26*	*52*	49	U	UJ	*24*	*49*	56	U	UJ	*28*	*56*	59	U	UJ	*29*	*59*	51.3	J	J	*26*	*53*	46.3	J	J	*30*	*59*	47	U		*24*	*47*
PAHs (ug/kg)																																						
1-Methylnaphthalene	99000	22000	na	320	U	UJ	*48*	*320*	300	U	UJ	*46*	*300*	290	U	UJ	*44*	*290*	310	U	UJ	*46*	*310*	300	U	UJ	*46*	*300*	290	U	UJ	*43*	*290*	300	U	UJ	*44*	*300*
2-Methylnaphthalene	410000	31000	na	320	U		*48*	*320*	300	U		*46*	*300*	290	U		*44*	*290*	310	U		*46*	*310*	300	U		*46*	*300*	290	U		*43*	*290*	300	U		*44*	*300*
Benz(a)anthracene	2100	150	na	64	U		*16*	*64*	61	U		*15*	*61*	59	U		*15*	*59*	61	U		*15*	*61*	61	U		*15*	*61*	57	U		*14*	*57*	59	U		*15*	*59*
Benzo(a)pyrene	210	15	na	64	U		*16*	*64*	61	U		*15*	*61*	59	U		*15*	*59*	61	U		*15*	*61*	61	U		*15*	*61*	57	U		*14*	*57*	59	U		*15*	*59*
Benzo(b)fluoranthene	2100	150	na	64	U		*16*	*64*	61	U		*15*	*61*	59	U		*15*	*59*	61	U		*15*	*61*	61	U		*15*	*61*	57	U		*14*	*57*	59	U		*15*	*59*
Benzo(g,h,i)perylene	3100000	230000	na	64	U		*16*	*64*	61	U		*15*	*61*	59	U		*15*	*59*	61	U		*15*	*61*	61	U		*15*	*61*	57	U		*14*	*57*	59	U		*15*	*59*
Benzo(k)fluoranthene	21000	1500	na	64	U		*16*	*64*	61	U		*15*	*61*	59	U		*15*	*59*	61	U		*15*	*61*	61	U		*15*	*61*	57	U		*14*	*57*	59	U		*15*	*59*
Chrysene	210000	15000	na	64	U	UJ	*16*	*64*	61	U	UJ	*15*	*61*	59	U	UJ	*15*	*59*	61	U	UJ	*15*	*61*	61	U	UJ	*15*	*61*	57	U	UJ	*14*	*57*	59	U	UJ	*15*	*59*
Fluoranthene	2200000	230000	na	320	U		*56*	*320*	300	U		*53*	*300*	290	U		*51*	*290*	310	U		*54*	*310*	300	U		*53*	*300*	290	U		*50*	*290*	300	U		*52*	*300*
Indeno(1,2,3-cd)pyrene	2100	150	na	64	U		*16*	*64*	61	U		*15*	*61*	59	U		*15*	*59*	61	U		*15*	*61*	61	U		*15*	*61*	57	U		*14*	*57*	59	U		*15*	*59*
Naphthalene	20000	3900	na	320	U		*48*	*320*	300	U		*46*	*300*	290	U		*44*	*290*	310	U		*46*	*310*	300	U		*46*	*300*	290	U		*43*	*290*	300	U		*44*	*300*
Phenanthrene	3100000	230000	na	320	U		*48*	*320*	300	U		*46*	*300*	290	U		*44*	*290*	310	U		*46*	*310*	300	U		*46*	*300*	290	U		*43*	*290*	300	U		*44*	*300*
Pyrene	1700000	170000	na	320	U		*56*	*320*	300	U		*53*	*300*	290	U		*51*	*290*	310	U		*54*	*310*	300	U		*53*	*300*	290	U		*50*	*290*	300	U		*52*	*300*
SVOCs (ug/kg)	None detected																																					
Pesticides (ug/kg)																																						
4,4'-DDD	7200	2000	na	4	U		*0.8*	*4*	3.9	U		*0.77*	*3.9*	3.7	U		*0.74*	*3.7*	3.9	U		*0.78*	*3.9*	3.8	U		*0.76*	*3.8*	3.5	U	UJ	*0.71*	*3.5*	3.8	U		*0.75*	*3.8*
Dieldrin	110	30	na	2	U		*0.44*	*2*	1.9	U		*0.42*	*1.9*	1.9	U		*0.41*	*1.9*	2	U		*0.43*	*2*	1.9	U		*0.42*	*1.9*	1.8	U	UJ	*0.39*	*1.8*	1.9	U		*0.41*	*1.9*
Endosulfan sulfate	na	na	na	4	U		*1.3*	*4*	3.9	U		*1.3*	*3.9*	3.7	U		*1.2*	*3.7*	3.9	U		*1.3*	*3.9*	3.8	U		*1.3*	*3.8*	3.5	U	UJ	*1.2*	*3.5*	3.8	U		*1.2*	*3.8*
Heptachlor epoxide	190	53	na	2	U		*0.4*	*2*	1.9	U		*0.39*	*1.9*	1.9	U		*0.37*	*1.9*	2	U		*0.39*	*2*	1.9	U		*0.38*	*1.9*	1.8	U	UJ	*0.35*	*1.8*	1.9	U		*0.38*	*1.9*
PCBs (mg/kg)																																						
PCB-1254	0.74	0.022	na	0.02	U		*0.01*	*0.02*	0.019	U		*0.0096*	*0.019*	0.019	U		*0.0093*	*0.019*	0.02	U		*0.0098*	*0.02*	0.019	U		*0.0095*	*0.019*	0.018	U		*0.0089*	*0.018*	0.019	U		*0.0094*	*0.019*
Explosives (mg/kg)	None detected																																					
Herbicides (ug/kg)	None detected																																					
Metals (mg/kg)																																						
Aluminum	99000	7700	40041	25900		J	*1.3*	*12*	17100		J	*1.3*	*11*	15500		J	*1.2*	*11*	24800		J	*1.3*	*12*	18600		J	*1.2*	*11*	7210		J	*1.2*	*11*	12200		J	*1.2*	*11*
Antimony	41	3.1	na	0.84	J	B	*0.32*	*3.6*	0.61	J	B	*0.3*	*3.4*	1	J	B	*0.29*	*3.3*	1.1	J	B	*0.31*	*3.6*	0.63	J	B	*0.3*	*3.4*	0.29	U	UJ	*0.29*	*3.2*	0.83	J	B	*0.29*	*3.3*
Arsenic	1600	390	15.8	1.2		J	*0.23*	*0.48*	1.3		J	*0.22*	*0.46*	2.4		J	*0.21*	*0.44*	1.2		J	*0.23*	*0.48*	0.97		J	*0.22*	*0.45*	2.3		J	*0.21*	*0.43*	2.7		J	*0.22*	*0.44*
Barium	19000000	1500000	209	43.6		J	*0.3*	*12*	44.6		J	*0.29*	*11*	88.6		J	*0.27*	*11*	38.7		J	*0.3*	*12*	31.6		J	*0.28*	*11*	178		J	*0.27*	*11*	56.4		J	*0.28*	*11*
Beryllium	200000	16000	1.02	0.66		B	*0.06*	*0.3*	0.67		B	*0.057*	*0.29*	0.6		B	*0.055*	*0.27*	0.63		B	*0.059*	*0.3*	0.61		B	*0.056*	*0.28*	**1.3**			*0.054*	*0.27*	0.45		B	*0.055*	*0.28*
Calcium	na	na	na	530		J	*3.4*	*300*	184	J	J	*3.3*	*290*	596		J	*3.1*	*270*	245	J	J	*3.4*	*300*	40.7	J	J	*3.2*	*280*	411		J	*3.1*	*270*	531		J	*3.2*	*280*
Chromium	1400	280	65.3	21		J	*0.054*	*0.6*	16.7		J	*0.051*	*0.57*	21.5		J	*0.049*	*0.55*	20		J	*0.053*	*0.59*	22.9		J	*0.051*	*0.56*	9.2		J	*0.048*	*0.54*	33		J	*0.05*	*0.55*
Cobalt	30000	2300	72.3	2.9	J	J	*0.06*	*3*	8.2		J	*0.057*	*2.9*	7.2		J	*0.055*	*2.7*	3.3		J	*0.059*	*3*	6.2		J	*0.056*	*2.8*	6.6		J	*0.054*	*2.7*	7		J	*0.055*	*2.8*
Copper	4100	310	53.5	12.8		J	*0.054*	*1.5*	7.3		J	*0.051*	*1.4*	8.3		J	*0.049*	*1.4*	13.6		J	*0.053*	*1.5*	10.3		J	*0.051*	*1.4*	3.3		J	*0.048*	*1.3*	6.3		J	*0.05*	*1.4*
Iron	72000	5500	50962	37000		J	*1.7*	*12*	14900		J	*0.69*	*5.7*	19200		J	*0.66*	*5.5*	27800		J	*0.71*	*5.9*	14600		J	*0.67*	*5.6*	6270		J	*0.65*	*5.4*	13800		J	*0.66*	*5.5*
Lead	800	400	26.8	8.4		J	*0.12*	*6*	4.7	J	J	*0.11*	*5.7*	9.7		J	*0.11*	*5.5*	7.6		J	*0.12*	*5.9*	3.8	J	J	*0.11*	*5.6*	15.1		J	*0.11*	*5.4*	11.6		J	*0.11*	*5.5*
Magnesium	na	na	na	806		J	*0.44*	*300*	714		J	*0.42*	*290*	609		J	*0.41*	*270*	983		J	*0.44*	*300*	648		J	*0.42*	*280*	295		J	*0.4*	*270*	563		J	*0.41*	*280*
Manganese	2300	180	2543	112		J	*0.036*	*0.89*	452		J	*0.29*	*4.3*	446		J	*0.27*	*4.1*	119		J	*0.036*	*0.89*	296		J	*0.11*	*1.7*	**3630**		**J**	*1.1*	*16*	1320		J	*0.55*	*8.3*
Mercury	2.8	0.67	0.13	0.087	J	J	*0.007*	*0.094*	0.03	J	J	*0.007*	*0.096*	0.12			*0.006*	*0.085*	0.068	J	J	*0.007*	*0.097*	0.039	J	J	*0.007*	*0.089*	0.041	J	J	*0.007*	*0.088*	0.1			*0.007*	*0.091*
Nickel	2000	160	62.8	9.6		J	*0.06*	*2.4*	8.1		J	*0.057*	*2.3*	6.8		J	*0.055*	*2.2*	9.8		J	*0.059*	*2.4*	8.1		J	*0.056*	*2.2*	5.2		J	*0.054*	*2.2*	6.1		J	*0.055*	*2.2*
Potassium	na	na	na	1050		J	*6*	*600*	813		J	*5.7*	*570*	656		J	*5.5*	*550*	1250		J	*5.9*	*590*	718		J	*5.6*	*560*	302	J	J	*5.4*	*540*	607		J	*5.5*	*550*
Selenium	510	39	na	0.12	U	UL	*0.12*	*6*	0.2	J	L	*0.11*	*5.7*	0.26	J	L	*0.11*	*5.5*	0.12	U	UL	*0.12*	*5.9*	0.19	J	L	*0.11*	*5.6*	0.7	J	L	*0.11*	*5.4*	0.39	J	L	*0.11*	*5.5*
Sodium	na	na	na	396	J	L	*49*	*600*	225	J	B	*47*	*570*	230	J	B	*45*	*550*	383	J	L	*49*	*590*	227	J	B	*46*	*560*	109	J	B	*44*	*540*	162	J	B	*46*	*550*
Vanadium	720	55	108	74.5		J	*0.036*	*3*	27.4		J	*0.034*	*2.9*	47.2		J	*0.033*	*2.7*	64.9		J	*0.036*	*3*	24.3		J	*0.034*	*2.8*	15.1		J	*0.032*	*2.7*	34.6		J	*0.033*	*2.8*
Zinc	31000	2300	202	32.5		J	*0.077*	*1.2*	18.9		J	*0.074*	*1.1*	22.9		J	*0.071*	*1.1*	32.3		J	*0.077*	*1.2*	20		J	*0.073*	*1.1*	12.9		J	*0.07*	*1.1*	19.6		J	*0.072*	*1.1*
Dioxins/Furans (ng/kg)																																						
2,3,7,8-TCDF	130	37	na	0.328	A	J	*NA*	*NA*	0.272	A, EMPC	J	*0.23*	*0.23*	0.243	U		*0.243*	*0.243*	0.32	A, EMPC	J	*0.264*	*0.264*	0.181	A, EMPC	J	*0.212*	*0.212*	0.34	A	J	*NA*	*NA*	0.379	U		*0.379*	*0.379*
2,3,7,8-TCDD	18	4.5	na	0.22	U		*0.22*	*0.22*	0.166	A, EMPC	J	*0.231*	*0.231*	0.24	U		*0.24*	*0.24*	0.219	U		*0.219*	*0.219*	0.199	U		*0.199*	*0.199*	0.369	U		*0.369*	*0.369*	0.532	U		*0.532*	*0.532*
1,2,3,7,8-PECDD	na	na	na	0.515	U		*0.515*	*0.515*	0.531	U		*0.531*	*0.531*	0.548	U		*0.548*	*0.548*	0.559	U		*0.559*	*0.559*	0.525	U		*0.525*	*0.525*	0.475	U		*0.475*	*0.475*	0.637	U		*0.637*	*0.637*
1,2,3,4,7,8-HXCDD	460	100	na	0.515	U		*0.515*	*0.515*	0.531	U		*0.531*	*0.531*	0.235	A, EMPC	J	*0.548*	*0.548*	0.559	U		*0.559*	*0.559*	0.525	U		*0.525*	*0.525*	0.475	U		*0.475*	*0.475*	0.859	U		*0.859*	*0.859*
1,2,3,6,7,8-HXCDD	460	100	na	0.515	U		*0.515*	*0.515*	0.531	U		*0.531*	*0.531*	0.318	A	J	*NA*	*NA*	0.559	U		*0.559*	*0.559*	0.525	U		*0.525*	*0.525*	0.475	U		*0.475*	*0.475*	0.874	U		*0.874*	*0.874*
1,2,3,7,8,9-HXCDD	460	100	na	0.233	A, EMPC	J	*0.515*	*0.515*	0.531	U		*0.531*	*0.531*	0.432	A, EMPC	J	*0.548*	*0.548*	0.559	U		*0.559*	*0.559*	0.525	U		*0.525*	*0.525*	0.475	U		*0.475*	*0.475*	0.887	U		*0.887*	*0.887*
1,2,3,4,6,7,8-HPCDD	na	na	na	21.2		J	*NA*	*NA*	1.14	A	B	*NA*	*NA*	51			*NA*	*NA*	11.8		J	*NA*	*NA*	7.69		J	*NA*	*NA*	9.48		J	*NA*	*NA*	26.7		J	*NA*	*NA*
OCDD	61000	15000	na	2990		J	*NA*	*NA*	56.8		J	*NA*	*NA*	5350	E	J	*NA*	*NA*	1830		J	*NA*	*NA*	894		J	*NA*	*NA*	441		J	*NA*	*NA*	4990	E	J	*NA*	*NA*
1,2,3,7,8-PECDF	440	120	na	0.515	U		*0.515*	*0.515*	0.0807	A, EMPC	J	*0.531*	*0.531*	0.548	U		*0.548*	*0.548*	0.559	U		*0.559*	*0.559*	0.525	U		*0.525*	*0.525*	0.475	U		*0.475*	*0.475*	0.552	U		*0.552*	*0.552*
2,3,4,7,8-PECDF	44	12	na	0.515	U		*0.515*	*0.515*	0.531	U		*0.531*	*0.531*	0.548	U		*0.548*	*0.548*	0.559	U		*0.559*	*0.559*	0.525	U		*0.525*	*0.525*	0.475	U		*0.475*	*0.475*	0.552	U		*0.552*	*0.552*
1,2,3,4,7,8-HXCDF	na	na	na	0.515	U		*0.515*	*0.515*	0.159	A, EMPC	B	*0.531*	*0.531*	0.423	A, EMPC	B	*0.548*	*0.548*	0.137	A	B	*NA*	*NA*	0.525	U		*0.525*	*0.525*	0.475	U		*0.475*	*0.475*	0.568	U		*0.568*	*0.568*
1,2,3,6,7,8-HXCDF	na	na	na	0.515	U		*0.515*	*0.515*	0.0807	A	B	*NA*	*NA*	0.125	A	B	*NA*	*NA*	0.559	U		*0.559*	*0.559*	0.525	U		*0.525*	*0.525*	0.475	U		*0.475*	*0.475*	0.552	U		*0.552*	*0.552*
2,3,4,6,7,8-HXCDF	na	na	na	0.515	U		*0.515*	*0.515*	0.531	U		*0.531*	*0.531*	0.548	U		*0.548*	*0.548*	0.559	U		*0.559*	*0.559*	0.525	U		*0.525*	*0.525*	0.475	U		*0.475*	*0.475*	0.565	U		*0.565*	*0.565*
1,2,3,7,8,9-HXCDF	na	na	na	0.515	U		*0.515*	*0.515*	0.531	U		*0.531*	*0.531*	0.548	U		*0.548*	*0.548*	0.559	U		*0.559*	*0.559*	0.525	U		*0.525*	*0.525*	0.475	U		*0.475*	*0.475*	0.658	U		*0.658*	*0.658*
1,2,3,4,6,7,8-HPCDF	na	na	na	0.389	A, EMPC	B	*0.515*	*0.515*	0.593	A	B	*NA*	*NA*	2	A	B	*NA*	*NA*	0.723	A	B	*NA*	*NA*	0.525	U	UJ	*0.525*	*0.525*	0.838	A	B	*NA*	*NA*	0.845	A	B	*NA*	*NA*
1,2,3,4,7,8,9-HPCDF	na	na	na	0.515	U		*0.515*	*0.515*	0.531	U		*0.531*	*0.531*	0.548	U		*0.548*	*0.548*	0.559	U		*0.559*	*0.559*	0.525	U		*0.525*	*0.525*	0.475	U		*0.475*	*0.475*	1.14	U		*1.14*	*1.14*
OCDF	44000	12000	na	0.661	A, EMPC	B	*0.515*	*0.515*	1.06	U	UJ	*1.06*	*1.06*	2.83	A	B	*NA*	*NA*	1.12	U	UJ	*1.12*	*1.12*	0.963	A	B	*NA*	*NA*	2.11	A	B	*NA*	*NA*	2.69	U	UJ	*2.69*	*2.69*
TOTAL TCDD	na	na	na	0.515	U		*0.515*	*0.515*	0.231	U		*0.231*	*0.231*	0.24	U		*0.24*	*0.24*	0.219	U		*0.219*	*0.219*	0.199	U		*0.199*	*0.199*	0.369	U		*0.369*	*0.369*	0.532	U		*0.532*	*0.532*
TOTAL PECDD	18	4.5	na	0.515	U		*0.515*	*0.515*	0.531	U		*0.531*	*0.531*	0.548	U		*0.548*	*0.548*	0.559	U		*0.559*	*0.559*	0.525	U		*0.525*	*0.525*	0.475	U		*0.475*	*0.475*	0.637	U		*0.637*	*0.637*
TOTAL HXCDD	180	45	na	1.26			*NA*	*NA*	0.531	U		*0.531*	*0.531*	2.68			*NA*	*NA*	0.559	U		*0.559*	*0.559*	0.525	U		*0.525*	*0.525*	0.927			*NA*	*NA*	1.81			*NA*	*NA*
TOTAL HPCDD	1800	450	na	61.3			*NA*	*NA*	2.45			*NA*	*NA*	133			*NA*	*NA*	31.9			*NA*	*NA*	19.3			*NA*	*NA*	29.5			*NA*	*NA*	53.6			*NA*	*NA*
TOTAL TCDF	na	na	na	0.328			*NA*	*NA*	0.23	U		*0.23*	*0.23*	0.243	U		*0.243*	*0.243*	0.255			*NA*	*NA*	0.174			*NA*	*NA*	0.34			*NA*	*NA*	0.379	U		*0.379*	*0.379*
TOTAL PECDF	na	na	na	0.515	U		*0.515*	*0.515*	0.531	U		*0.531*	*0.531*	0.548	U		*0.548*	*0.548*	0.559	U		*0.559*	*0.559*	0.525	U		*0.525*	*0.525*	0.475	U		*0.475*	*0.475*	0.552	U		*0.552*	*0.552*
TOTAL HXCDF	130	37	na	0.103			*NA*	*NA*	0.198			*NA*	*NA*	0.316			*NA*	*NA*	0.137			*NA*	*NA*	0.172			*NA*	*NA*	0.475	U		*0.475*	*0.475*	0.658	U		*0.658*	*0.658*
TOTAL HPCDF	1300	370	na	0.515	U		*0.515*	*0.515*	0.807			*NA*	*NA*	2			*NA*	*NA*	0.985			*NA*	*NA*	0.525	U		*0.525*	*0.525*	2.03			*NA*	*NA*	0.845			*NA*	*NA*

Table 4-2
Analytes Detected in SWMU 59 Soil Samples - 2007 RFI
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Analyte	Sample ID			59SB06C					59SS06					59SS07					59SS08					59SS09					59SS10				
	Sample Date			7/25/07					7/19/07					7/19/07					7/19/07					7/19/07					7/19/07				
	Sample Depth			8-10					0-0.5					0-0.5					0-0.5					0-0.5					0-0.5				
	i-SL	r-SL	Background	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	Result	Lab Q	Val Q	MDL	MRL
VOCs (ug/kg)																																	
Acetone	61000000	6100000	na	47	U	UJ	*23*	*47*	61	U	UJ	*31*	*61*	66	U	UJ	*33*	*66*	100	U	UJ	*51*	*100*	120	U	UJ	*60*	*120*	65.8	J	J	*63*	*130*
PAHs (ug/kg)																																	
1-Methylnaphthalene	99000	22000	na	310	U	UJ	*46*	*310*	290	U		*43*	*290*	280	U		*43*	*280*	300	U		*44*	*300*	92	J	J	*42*	*280*	51.4	J	J	*42*	*280*
2-Methylnaphthalene	410000	31000	na	310	U		*46*	*310*	290	U		*43*	*290*	280	U		*43*	*280*	300	U		*44*	*300*	115	J	J	*42*	*280*	56.4	J	J	*42*	*280*
Benz(a)anthracene	2100	150	na	61	U		*15*	*61*	38.2	J	J	*14*	*58*	21	J	J	*14*	*57*	39.2	J	J	*15*	*59*	56	U		*14*	*56*	56	U		*14*	*56*
Benzo(a)pyrene	210	15	na	61	U		*15*	*61*	35.6	J	J	*14*	*58*	19.6	J	J	*14*	*57*	40	J	J	*15*	*59*	56	U		*14*	*56*	56	U		*14*	*56*
Benzo(b)fluoranthene	2100	150	na	61	U		*15*	*61*	42.4	J	J	*14*	*58*	22.6	J	J	*14*	*57*	45	J	J	*15*	*59*	56	U		*14*	*56*	56	U		*14*	*56*
Benzo(g,h,i)perylene	3100000	230000	na	61	U		*15*	*61*	18.9	J	J	*14*	*58*	57	U		*14*	*57*	23.5	J	J	*15*	*59*	56	U		*14*	*56*	56	U		*14*	*56*
Benzo(k)fluoranthene	21000	1500	na	61	U		*15*	*61*	31.1	J	J	*14*	*58*	18	J	J	*14*	*57*	32.3	J	J	*15*	*59*	56	U		*14*	*56*	56	U		*14*	*56*
Chrysene	210000	15000	na	61	U	UJ	*15*	*61*	40.1	J	J	*14*	*58*	22.7	J	J	*14*	*57*	41.7	J	J	*15*	*59*	56	U		*14*	*56*	56	U		*14*	*56*
Fluoranthene	2200000	230000	na	310	U		*54*	*310*	90.6	J	J	*51*	*290*	280	U		*50*	*280*	81.7	J	J	*52*	*300*	280	U		*49*	*280*	280	U		*49*	*280*
Indeno(1,2,3-cd)pyrene	2100	150	na	61	U		*15*	*61*	21.3	J	J	*14*	*58*	57	U		*14*	*57*	26.3	J	J	*15*	*59*	56	U		*14*	*56*	56	U		*14*	*56*
Naphthalene	20000	3900	na	310	U		*46*	*310*	290	U		*43*	*290*	280	U		*43*	*280*	300	U		*44*	*300*	82.2	J	J	*42*	*280*	280	U		*42*	*280*
Phenanthrene	3100000	230000	na	310	U		*46*	*310*	67	J	J	*43*	*290*	280	U		*43*	*280*	48.8	J	J	*44*	*300*	65.4	J	J	*42*	*280*	45.3	J	J	*42*	*280*
Pyrene	1700000	170000	na	310	U		*54*	*310*	83.8	J	J	*51*	*290*	280	U		*50*	*280*	74.7	J	J	*52*	*300*	280	U		*49*	*280*	280	U		*49*	*280*
SVOCs (ug/kg)		None detected																															
Pesticides (ug/kg)																																	
4,4'-DDD	7200	2000	na	3.8	U		*0.75*	*3.8*	3.5	U		*0.71*	*3.5*	3.5	U		*0.71*	*3.5*	1	J	J	*0.75*	*3.7*	3.4	U		*0.69*	*3.4*	3.4	U		*0.68*	*3.4*
Dieldrin	110	30	na	1.9	U		*0.41*	*1.9*	1.8	U		*0.39*	*1.8*	0.75	J	J	*0.39*	*1.8*	0.44	J	J	*0.41*	*1.9*	1.7	U		*0.38*	*1.7*	1.7	U		*0.37*	*1.7*
Endosulfan sulfate	na	na	na	3.8	U		*1.2*	*3.8*	3.5	U		*1.2*	*3.5*	3.5	U		*1.2*	*3.5*	3.7	U		*1.2*	*3.7*	7.1			*1.1*	*3.4*	2.1	J	J	*1.1*	*3.4*
Heptachlor epoxide	190	53	na	1.9	U		*0.38*	*1.9*	0.48	J	J	*0.35*	*1.8*	0.46	J	J	*0.35*	*1.8*	1.9	U		*0.37*	*1.9*	1.7	U		*0.34*	*1.7*	1.7	U		*0.34*	*1.7*
PCBs (mg/kg)																																	
PCB-1254	0.74	0.022	na	0.019	U		*0.0094*	*0.019*	0.0111	J	J	*0.0088*	*0.018*	0.021		J	*0.0089*	*0.018*	0.0247		J	*0.0093*	*0.019*	0.017	U		*0.0086*	*0.017*	0.017	U		*0.0085*	*0.017*
Explosives (mg/kg)		None detected																															
Herbicides (ug/kg)		None detected																															
Metals (mg/kg)																																	
Aluminum	99000	7700	40041	12900		J	*1.2*	*11*	13100			*1.2*	*11*	12300			*1.1*	*10*	16200			*1.2*	*11*	4430			*1.1*	*10*	5020		K	*1.1*	*10*
Antimony	41	3.1	na	0.87	J	B	*0.29*	*3.3*	1.2	J	B	*0.28*	*3.2*	0.73	J	B	*0.28*	*3.1*	0.98	J	B	*0.3*	*3.4*	0.39	J	B	*0.27*	*3.1*	0.64	J	B	*0.27*	*3.1*
Arsenic	1600	390	15.8	1.9		J	*0.22*	*0.44*	2.9			*0.21*	*0.43*	2.8			*0.2*	*0.42*	4.4			*0.22*	*0.45*	5.6			*0.2*	*0.41*	**24.1**		**J**	*0.2*	*0.41*
Barium	19000000	1500000	209	56.6		J	*0.28*	*11*	62.8			*0.27*	*11*	67.5			*0.26*	*10*	71.9			*0.28*	*11*	160			*0.26*	*10*	99.7			*0.26*	*10*
Beryllium	200000	16000	1.02	0.42		B	*0.055*	*0.28*	0.61			*0.053*	*0.27*	0.63			*0.052*	*0.26*	0.63			*0.056*	*0.28*	0.85			*0.051*	*0.26*	0.85			*0.051*	*0.26*
Calcium	na	na	na	545		J	*3.1*	*280*	2550			*3*	*270*	2270			*3*	*260*	1100			*3.2*	*280*	718			*2.9*	*260*	730		J	*2.9*	*260*
Chromium	1400	280	65.3	25.9		J	*0.05*	*0.55*	21.1			*0.048*	*0.53*	14.3			*0.047*	*0.52*	18.8			*0.051*	*0.56*	7.5			*0.046*	*0.51*	9.5		J	*0.046*	*0.51*
Cobalt	30000	2300	72.3	7.5		J	*0.055*	*2.8*	5.1			*0.053*	*2.7*	5.5			*0.052*	*2.6*	5			*0.056*	*2.8*	4.8			*0.051*	*2.6*	3.6		J	*0.051*	*2.6*
Copper	4100	310	53.5	6.6		J	*0.05*	*1.4*	7.5			*0.048*	*1.3*	7.7			*0.047*	*1.3*	10.5			*0.051*	*1.4*	15.3			*0.046*	*1.3*	10.6			*0.046*	*1.3*
Iron	72000	5500	50962	13700		J	*0.66*	*5.5*	18500			*0.64*	*5.3*	15000			*0.62*	*5.2*	19700			*0.67*	*5.6*	6660			*0.61*	*5.1*	9530		J	*0.61*	*5.1*
Lead	800	400	26.8	10.6		J	*0.11*	*5.5*	17		K	*0.11*	*5.3*	17.3		K	*0.1*	*5.2*	17.1		K	*0.11*	*5.6*	5.9		K	*0.1*	*5.1*	9.2		J	*0.1*	*5.1*
Magnesium	na	na	na	503		J	*0.41*	*280*	1910			*0.39*	*270*	1640			*0.38*	*260*	1230			*0.42*	*280*	410			*0.38*	*260*	334		J	*0.38*	*260*
Manganese	2300	180	2543	943		J	*0.55*	*8.3*	367			*0.16*	*4*	473			*0.16*	*3.9*	276			*0.17*	*4.2*	104			*0.031*	*0.77*	414		J	*0.15*	*3.8*
Mercury	2.8	0.67	0.13	0.12			*0.006*	*0.084*	0.047	J	B	*0.006*	*0.082*	0.027	J	B	*0.007*	*0.091*	0.068	J	J	*0.006*	*0.081*	**0.4**			*0.006*	*0.086*	**0.34**			*0.006*	*0.083*
Nickel	2000	160	62.8	6		J	*0.055*	*2.2*	5.8			*0.053*	*2.1*	6.2			*0.052*	*2.1*	7.7			*0.056*	*2.2*	8.5			*0.051*	*2*	6.6		J	*0.051*	*2*
Potassium	na	na	na	586		J	*5.5*	*550*	693		B	*5.3*	*530*	735		B	*5.2*	*520*	1070			*5.6*	*560*	441	J	B	*5.1*	*510*	431	J	B	*5.1*	*510*
Selenium	510	39	na	0.38	J	L	*0.11*	*5.5*	6.3		K	*0.11*	*5.3*	5	J	K	*0.1*	*5.2*	7		K	*0.11*	*5.6*	2.7	J	B	*0.1*	*5.1*	4.8	J	K	*0.1*	*5.1*
Sodium	na	na	na	195	J	B	*46*	*550*	76.5	J	B	*44*	*530*	74.5	J	B	*43*	*520*	56.8	J	B	*46*	*560*	42	U		*42*	*510*	69.8	J	B	*42*	*510*
Vanadium	720	55	108	34.2		J	*0.033*	*2.8*	35.8			*0.032*	*2.7*	30.5			*0.031*	*2.6*	39.3			*0.034*	*2.8*	17.6			*0.031*	*2.6*	18.3		J	*0.031*	*2.6*
Zinc	31000	2300	202	20.3		J	*0.072*	*1.1*	34.3			*0.069*	*1.1*	33.2			*0.068*	*1*	44.9			*0.073*	*1.1*	15.9			*0.066*	*1*	13		J	*0.067*	*1*
Dioxins/Furans (ng/kg)																																	
2,3,7,8-TCDF	130	37	na	0.357	U		*0.357*	*0.357*	0.424	A	B			0.413	A	B			0.566	A	B			0.424	A	B			0.442	A, EMPC	B	*0.184*	*0.184*
2,3,7,8-TCDD	18	4.5	na	0.528	U		*0.528*	*0.528*	0.236	A, EMPC	J	*0.178*	*0.178*	0.21	U		*0.21*	*0.21*	0.231	A	J			0.248	A, EMPC	J	*0.184*	*0.184*	0.204	U		*0.204*	*0.204*
1,2,3,7,8-PECDD	na	na	na	0.579	U		*0.579*	*0.579*	1.09	A	J			1.23	A	J			2.03	A	J			0.0934	A	J			0.341	A	J		
1,2,3,4,7,8-HXCDD	460	100	na	0.852	U		*0.852*	*0.852*	2.05	A	J			1.95	A	J			3.47	A	J			1.66	A	J			0.657	A	J		
1,2,3,6,7,8-HXCDD	460	100	na	0.867	U		*0.867*	*0.867*	5.92					5.26					8.25					3.73	A	J			1.56	A	J		
1,2,3,7,8,9-HXCDD	460	100	na	0.88	U		*0.88*	*0.88*	5.3					5.44					9.49					4.39	A	J			1.49	A	J		
1,2,3,4,6,7,8-HPCDD	na	na	na	11		J	*NA*	*NA*	274					204					269					122					54.1				
OCDD	61000	15000	na	2120		J	*NA*	*NA*	17400	E	J			7200	E	J			9970	E	J			1410					1030				
1,2,3,7,8-PECDF	440	120	na	0.508	U		*0.508*	*0.508*	0.302	A	J			0.254	A, EMPC	J	*0.496*	*0.496*	0.275	A, EMPC	J	*0.56*	*0.56*	0.286	A, EMPC	J	*0.484*	*0.484*	0.196	A	J		
2,3,4,7,8-PECDF	44	12	na	0.508	U		*0.508*	*0.508*	0.473	A	J			0.437	A	J			0.537	A	J			0.292	A, EMPC	B	*0.484*	*0.484*	0.184	A, EMPC	B	*0.517*	*0.517*
1,2,3,4,7,8-HXCDF	na	na	na	0.575	U		*0.575*	*0.575*	2.03	A	J			2.11	A	J			2.1	A	J			1.04	A	J			0.81	A	J		
1,2,3,6,7,8-HXCDF	na	na	na	0.542	U		*0.542*	*0.542*	0.963	A	J			0.84	A	J			1.38	A	J			0.619	A	J			0.358	A	J		
2,3,4,6,7,8-HXCDF	na	na	na	0.571	U		*0.571*	*0.571*	1.4	A	J			1.11	A	J			1.95	A	J			0.745	A	J			0.335	A	J		
1,2,3,7,8,9-HXCDF	na	na	na	0.665	U		*0.665*	*0.665*	0.581	A	J			0.391	A	J			0.56	U		*0.56*	*0.56*	0.484	U		*0.484*	*0.484*	0.517	U		*0.517*	*0.517*
1,2,3,4,6,7,8-HPCDF	na	na	na	0.821	A, EMPC	B	*0.959*	*0.959*	46.1					33.2					49.2					21.5					10.6				
1,2,3,4,7,8,9-HPCDF	na	na	na	1.22	U		*1.22*	*1.22*	2.02	A	J			1.39	A	J			2.09	A	J			0.83	A	J			0.451	A	J		
OCDF	44000	12000	na	3.09	U	UJ	*3.09*	*3.09*	150					79.3					136					57.6					26				
TOTAL TCDD	na	na	na	0.528	U		*0.528*	*0.528*	1.84	A, EMPC	J			1.26					1.67					3.6	A, EMPC	J			13.3				
TOTAL PECDD	18	4.5	na	0.579	U		*0.579*	*0.579*	5	A, EMPC	J			5.17	A, EMPC	J			7.45					5.46	A, EMPC	J			2.2	A, EMPC	J		
TOTAL HXCDD	180	45	na	0.88	U		*0.88*	*0.88*	41.5					41.3	A, EMPC	J			55.3					30.9					11.8				
TOTAL HPCDD	1800	450	na	25.3			*NA*	*NA*	490					385					461					222					99.1				
TOTAL TCDF	na	na	na	0.357	U		*0.357*	*0.357*	2.42	A, EMPC	J			2.52	A, EMPC	J			3.91	A, EMPC	J			5.3	AQ, EMPC	J			2.82	A, EMPC	J		
TOTAL PECDF	na	na	na	0.508	U		*0.508*	*0.508*	7.31	A, EMPC	J			6.13	A, EMPC	J			8.48	A, EMPC	J			4.74	A, EMPC	J			2.57	A, EMPC	J		
TOTAL HXCDF	130	37	na	0.665	U		*0.665*	*0.665*	49.4					36.2					48.5	A, EMPC	J			17.8	A, EMPC	J			7.8	A, EMPC	J		
TOTAL HPCDF	1300	370	na	1.53			*NA*	*NA*	154					93.8	A, EMPC	J			143					57.9					26.4				

**Refer to legend immediately following this table for a list of definitions and tables notes.

Table 4-2
Legend

12	J	Shading and black font indicate an industrial SL exceedance.
12	J	Bold outline indicates a residential SL exceedance.
12	**J**	Bold, underlined font indicates a background exceedance.
12	*12*	Shading in the MDL/MRL columns indicates the MDL exceeds a criterion.

SLs for non-Carcinogenic compounds have been recalculated to an HI of 0.1.
The pyrene SLs were used for acenaphthylene, benzo(g,h,i)perylene, and phenanthrene.
Inorganic results below background UTLs are not indicated as exceedances on the table.
SL = Screening Level (Source: ORNL Regional Screening Table, September 2008).
SL values in table are for the more conservative chromium VI.
SL values for chromium III are 150,000 (ind) and 12,000 (res), which were not exceeded.
Lead screening values from Technical Review Workgroup for Lead: Guidance Document (April 1999).
mg/kg = milligrams per kilogram (parts per million).
ng/kg = nanograms per kilogram (parts per trillion).
µg/kg = micrograms per kilogram (parts per billion).
NA = not applicable.
NT = analyte not tested.

Lab Q = Lab Data Qualifiers

* = Laboratory duplicate not within control limits.
B = (organics) Blank contamination. Value detected in sample and associated blank.
A (Dioxins) = B = (metals) Value <MRL and >MDL and is considered estimated.
E (metals) = Reported value is estimated because of the presence of interferences.
EMPC (Dioxins) = The ion-abundance ratio between the two characteristic PCDD/PCDF ions was outside accepted ranges. The detected PCDD/PCDF was reported as an estimated maximum possible concentration (EMPC).
J = (organics) Value <MRL and >MDL and is considered estimated.
U = Analyte not-detected at the method reporting limit.
X = (dioxins) Ion abundance ratio outside acceptable range. Value reported is EMPC.

Val Q = Validation Data Qualifiers

B = blank contamination. Value detected in sample and associated blank.
J = estimated concentration.
K = estimated concentration bias high.
L = estimated concentration bias low.
N = presumptive evidence for tentatively identified compounds using a library search.
U = analyte not detected.
UJ = estimated concentration non-detect.
UL = estimated concentration non-detect bias low.

Table 4-3
Analytes Detected in SWMU 50 and SWMU 59 Groundwater Samples - 2007 RFI

Analyte	Sample ID		50MW01					50MW02					59MW01				
	Sample Date		8/30/07					8/30/07					8/29/07				
	MCL	tw-SL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
VOCs (ug/L)																	
Carbon tetrachloride	5	0.2	1	U		*0.29*	*1*	2.7			*0.29*	*1*	1	U		*0.29*	*1*
Tetrachloroethene	5	0.11	1	U		*0.25*	*1*	0.84	J	J	*0.25*	*1*	1	U		*0.25*	*1*
Trichloroethene	5	1.7	1	U		*0.38*	*1*	3.4			*0.38*	*1*	1	U		*0.38*	*1*
PAHs (ug/L)		None detected															
SVOCs (ug/L)																	
bis(2-Ethylhexyl)phthalate	6	4.8	5.1	U		*2*	*5.1*	8			*2*	*4.9*	5	U		*2*	*5*
Pesticides (ug/L)		None detected															
PCBs (ug/L)		None detected															
Explosives (ug/L)		None detected															
Herbicides (ug/L)		None detected															
Metals (ug/L)																	
Aluminum	50	3700	38600			*79*	*200*	8210			*79*	*200*	725			*79*	*200*
Arsenic	10	0.045	9.1	J	J	*3.7*	*10*	3.7	U		*3.7*	*10*	3.7	U		*3.7*	*10*
Barium	2000	730	357			*5*	*200*	191	J	J	*5*	*200*	214			*5*	*200*
Beryllium	4	7.3	1.8	J	K	*1*	*4*	1	U		*1*	*4*	1	U		*1*	*4*
Cadmium	5	1.8	3	J	J	*1*	*5*	1	U		*1*	*5*	1	U		*1*	*5*
Calcium	na	na	2770000			*1000*	*10000*	146000			*100*	*1000*	30700			*100*	*1000*
Chromium	100	11	78.7			*0.92*	*10*	18.2			*0.92*	*10*	9.8	J	J	*0.92*	*10*
Cobalt	na	1.1	19.6	J	J	*1*	*50*	3.8	J	J	*1*	*50*	1	U		*1*	*50*
Copper	1300	150	17.8	J	B	*1.2*	*25*	9.3	J	B	*1.2*	*25*	1.2	U		*1.2*	*25*
Iron	300	2600	40900			*15*	*300*	8850			*15*	*300*	801			*15*	*300*
Lead	15	na	237			*2.1*	*5*	65.7			*2.1*	*5*	2.1	U		*2.1*	*5*
Magnesium	na	na	1720000			*1000*	*50000*	59100			*100*	*5000*	23800			*100*	*5000*
Manganese	50	88	1230			*1*	*15*	245			*1*	*15*	20.5			*1*	*15*
Mercury	2	0.063	0.13	J	J	*0.11*	*1*	0.11	U		*0.11*	*1*	0.11	U		*0.11*	*1*
Nickel	na	73	49.8			*1*	*40*	22.3	J	J	*1*	*40*	5.8	J	J	*1*	*40*
Potassium	na	na	19300			*100*	*10000*	6940	J	B	*100*	*10000*	2090	J	B	*100*	*10000*
Sodium	na	na	19900			*500*	*10000*	14500			*500*	*10000*	1460	J	J	*500*	*10000*
Vanadium	na	26	138			*1.1*	*50*	18.5	J	J	*1.1*	*50*	1.8	J	J	*1.1*	*50*
Zinc	5000	1100	223			*5*	*20*	137			*5*	*20*	5	U		*5*	*20*
Dioxins/Furans (ug/L)																	
2,3,7,8-TCDF	na	0.0052	0.00165	U		*0.00165*	*0.00165*	0.00337	A	J	*NA*	*NA*	0.00248	U		*0.00248*	*0.00248*
2,3,7,8-TCDD	0.03	0.00052	0.00222	U		*0.00222*	*0.00222*	0.00389	U		*0.00389*	*0.00389*	0.00314	U		*0.00314*	*0.00314*
1,2,3,7,8-PECDD	na	na	0.00544	U		*0.00544*	*0.00544*	0.00546	U		*0.00546*	*0.00546*	0.00302	A	J	*NA*	*NA*
1,2,3,4,7,8-HXCDD	na	0.011	0.00544	U		*0.00544*	*0.00544*	0.00546	U		*0.00546*	*0.00546*	0.0056	U		*0.0056*	*0.0056*
1,2,3,6,7,8-HXCDD	na	0.011	0.00544	U		*0.00544*	*0.00544*	0.00546	U		*0.00546*	*0.00546*	0.0056	U		*0.0056*	*0.0056*
1,2,3,7,8,9-HXCDD	na	0.011	0.00544	U		*0.00544*	*0.00544*	0.00501	A, EMPC	J	*0.00548*	*0.00548*	0.0056	U		*0.0056*	*0.0056*

Table 4-3
Analytes Detected in SWMU 50 and SWMU 59 Groundwater Samples - 2007 RFI

Analyte	Sample ID		50MW01					50MW02					59MW01				
	Sample Date		8/30/07					8/30/07					8/29/07				
	MCL	tw-SL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
1,2,3,4,6,7,8-HPCDD	na	na	0.00544	U		*0.00544*	*0.00544*	0.0338	A	J	*NA*	*NA*	0.0056	U		*0.0056*	*0.0056*
OCDD	na	1.7	0.0184	A	J	*NA*	*NA*	1.1			*NA*	*NA*	0.00703	A	J	*NA*	*NA*
1,2,3,7,8-PECDF	na	0.017	0.00544	U		*0.00544*	*0.00544*	0.00546	U		*0.00546*	*0.00546*	0.0037	A	J	*NA*	*NA*
2,3,4,7,8-PECDF	na	0.0017	0.00544	U		*0.00544*	*0.00544*	0.00546	U		*0.00546*	*0.00546*	0.00298	A	J	*NA*	*NA*
1,2,3,4,7,8-HXCDF	na	na	0.00544	U		*0.00544*	*0.00544*	0.00376	A	J	*NA*	*NA*	0.00307	A	J	*NA*	*NA*
1,2,3,6,7,8-HXCDF	na	na	0.00544	U		*0.00544*	*0.00544*	0.00546	U		*0.00546*	*0.00546*	0.00271	A	J	*NA*	*NA*
2,3,4,6,7,8-HXCDF	na	na	0.00544	U		*0.00544*	*0.00544*	0.00546	U		*0.00546*	*0.00546*	0.0019	A, EMPC	J	*0.0056*	*0.0056*
1,2,3,7,8,9-HXCDF	na	na	0.00544	U		*0.00544*	*0.00544*	0.00546	U		*0.00546*	*0.00546*	0.00253	A	J	*NA*	*NA*
1,2,3,4,6,7,8-HPCDF	na	na	0.00544	U		*0.00544*	*0.00544*	0.0238	A	J	*NA*	*NA*	0.00309	A	J	*NA*	*NA*
1,2,3,4,7,8,9-HPCDF	na	na	0.00544	U		*0.00544*	*0.00544*	0.00691	U		*0.00691*	*0.00691*	0.0056	U		*0.0056*	*0.0056*
OCDF	na	1.7	0.0109	U		*0.0109*	*0.0109*	0.0513	A	J	*NA*	*NA*	0.0112	U		*0.0112*	*0.0112*
TOTAL TCDD	na	na	0.00222	U		*0.00222*	*0.00222*	0.00389	U		*0.00389*	*0.00389*	0.00314	U		*0.00314*	*0.00314*
TOTAL PECDD	na	0.00052	0.00544	U		*0.00544*	*0.00544*	0.00546	U		*0.00546*	*0.00546*	0.00302			*NA*	*NA*
TOTAL HXCDD	na	0.0052	0.00544	U		*0.00544*	*0.00544*	0.0197			*NA*	*NA*	0.0056	U		*0.0056*	*0.0056*
TOTAL HPCDD	na	0.052	0.00544	U		*0.00544*	*0.00544*	0.0802			*NA*	*NA*	0.0056	U		*0.0056*	*0.0056*
TOTAL TCDF	na	na	0.00165	U		*0.00165*	*0.00165*	0.00509			*NA*	*NA*	0.00248	U		*0.00248*	*0.00248*
TOTAL PECDF	na	na	0.00544	U		*0.00544*	*0.00544*	0.00546	U		*0.00546*	*0.00546*	0.00667			*NA*	*NA*
TOTAL HXCDF	na	0.0052	0.00544	U		*0.00544*	*0.00544*	0.00704			*NA*	*NA*	0.0102			*NA*	*NA*
TOTAL HPCDF	na	0.052	0.00544	U		*0.00544*	*0.00544*	0.0238			*NA*	*NA*	0.00309			*NA*	*NA*
Misc. (ug/L)																	
Perchlorate	na	2.6	0.203		J	*0.0663*	*0.2*	0.288		J	*0.0663*	*0.2*	0.283		J	*0.0663*	*0.2*

**Refer to legend immediately following this table for a list of definitions and tables notes.

Table 4-3
Legend

12	J	Shading and black font indicate an MCL exceedance.
12	J	Bold outline indicates a tw-SL exceedance.
12	*12*	Shading in the MDL/MRL columns indicates the MDL exceeds a criterion.

tw-SLs for non-Carcinogenic compounds have been recalculated to an HI of 0.1.
The pyrene tw-SLs were used for acenaphthylene, benzo(g,h,i)perylene, and phenanthrene.
The 2-methylnaphthalene tw-SL was used for 1-methylnaphthalene.
Secondary MCLs were used for aluminum, iron, manganese, silver, and zinc.
MCL Action Levels were used for copper and lead.
MCL = Maximum Contaminant Level (Source: 2006 Edition of the Drinking Water Standards and Health Advisories. USEPA, August 2006).
tw-SL = Tap Water Screening Level (Source: ORNL Regional Screening Table, September 2008).
tw-SL value in table is for the more conservative chromium VI.
tw-SL value for chromium III is 5,500, which was not exceeded.
ng/L = nanograms per liter (parts per trillion).
µg/L = micrograms per liter (parts per billion).
NA = not applicable.
NT = analyte not tested.

Lab Q = Lab Data Qualifiers

B = (organics) Blank contamination. Value detected in sample and associated blank.
A (Dioxins) = B = (metals) Value <MRL and >MDL and is considered estimated.
E (metals) = Reported value is estimated because of the presence of interferences.
EMPC (Dioxins) = The ion-abundance ratio between the two characteristic PCDD/PCDF ions was outside accepted ranges. The detected PCDD/PCDF was reported as an estimated maximum possible concentration (EMPC).
J = (organics) Value <MRL and >MDL and is considered estimated.
U = Analyte not-detected at the method reporting limit.
X = (dioxins) Ion abundance ratio outside acceptable range. Value reported is EMPC.

Val Q = Validation Data Qualifiers

B = blank contamination. Value detected in sample and associated blank.
J = estimated concentration.
K = estimated concentration bias high.
L = estimated concentration bias low.
N = presumptive evidence for tentatively identified compounds using a library search.
U = analyte not detected.
UJ = estimated concentration non-detect.
UL = estimated concentration non-detect bias low.

PAHs. In 2007, seven PAHs were detected in three SWMU 50 soil samples. However, only two of those PAHs [benzo(a)pyrene and benzo(b)fluoranthene] were detected above r-SLs in two SWMU 50 soil samples (50SB07A and 50SB13A). In SWMU 59 soil samples, 13 PAHs were detected. However, only one [benzo(a)pyrene] was detected at levels greater than its r-SL in four surface soil samples (59SB03A, 59SS06, 59SS07, and 59SS08).

SVOCs. Three SVOCs were detected in SWMU 50 and SWMU 59 soil samples in 2007. However, the concentrations were well below the adjusted i-SLs and r-SLs. SVOCs were not detected in any of the SWMU 59 soil samples.

Pesticides. Pesticides were not detected in the 2007 SWMU 50 soil samples. At SWMU 59, four pesticides were detected in two soil samples. However, all concentrations were well below the adjusted i-SLs and r-SLs.

PCBs. One PCB (PCB-1254) was detected in the 2007 SWMU 50 soil samples. At SWMU 50, PCB-1254 was detected above its i-SL in three samples and above its r-SL in five samples. At SWMU 59, PCB-1254 was found to be greater than its r-SL in only one sample (59SS08).

Explosives. Three explosives (2,4,6-TNT; 2,4-DNT; and 2,6-DNT) were detected in the 2007 SWMU 50 soil samples. However, they were not detected above their SLs. Explosives were not detected in any of the SWMU 59 soil samples.

Herbicides. At SWMU 50 in 2007, one herbicide (dicamba) was detected in one soil sample (50SB10B) at a concentration well below the adjusted SLs. At SWMU 59, herbicides were not detected in any of the soil samples.

TAL Inorganics. Twenty-one metals were detected in the 2007 SWMU 50 soil samples. Three of those metals (chromium, copper, and nickel) were detected above r-SL and background levels in one SWMU 50 soil sample (50SB13B). Twenty metals were detected in SWMU 59 soil samples. One of those metals (manganese) was detected above its r-SL, i-SL, and background SL in one sample (59SB06A).

Dioxins/Furans. Twenty-five dioxins/furans (total and congeners) were detected in the 2007 SWMU 50 and SWMU 59 soil samples. Seven dioxins/furans (total and congeners) (1,2,3,6,7,8-HXCDD; OCDD; total PECDD; total HXCDD; total HPCDD; total HXCDF; and total HPCDF) were detected at concentrations above their SLs in SWMU 50 soil samples. Five dioxins/furans (total and congeners) (OCDD, total PECDD, total HXCDD, total HPCDD, and total HXCDF) were detected at levels above their r-SLs in SWMU 59 soil samples. Calculated TCDD Toxicity Equivalents (TE) values are discussed in *Section 6.1.1* of the HHRA.

4.1.2 Groundwater Analytical Results

Three groundwater samples (50MW01, 50MW02, and 59MW01) were collected, from three newly-installed wells at SWMU 50 and SWMU 59, and analyzed for TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, and perchlorate (see **Table 3-1**). 2007 detected groundwater results for SWMUs 50 and 59 are presented in **Table 4-3**. In the SWMU 50 and SWMU 59 groundwater samples, three VOCs, one SVOC, ten metals, and five dioxins/furans were found above their SLs.

VOCs. Three VOCs [CT, tetrachloroethene (PCE), and TCE] were detected in SWMU 50 and SWMU 59 groundwater samples at levels greater than their tw-SLs in sample 50MW02.

PAHs. PAHs were not detected in the SWMU 50 and SWMU 59 groundwater samples.

SVOCs. One non-PAH SVOC [bis(2-ethylhexyl)phthalate] was detected in the SWMU 48 and SWMU 49 groundwater samples at a level above its MCL and tw-SL in sample 50MW02.

Pesticides. Pesticides were not detected in the SWMU 50 and SWMU 59 groundwater samples.

PCBs. PCBs were not detected in the SWMU 50 and SWMU 59 groundwater samples.

Explosives. Explosives were not detected in the SWMU 50 and SWMU 59 groundwater samples.

Herbicides. Herbicides were not detected in the SWMU 50 and SWMU 59 groundwater samples.

Metals. Nineteen metals were detected in the SWMU 50 and SWMU 59 groundwater samples. Ten of these metals (aluminum, arsenic, cadmium, chromium, cobalt, iron, lead, manganese, mercury, and vanadium) were detected at concentrations exceeding their SLs. Three metals (aluminum, iron, and manganese) were detected above both their MCLs and tw-SLs. Four metals (arsenic, cadmium, chromium, and mercury) were only detected above their tw-SLs. One metal without a tw-SL (lead) was detected above its MCL. Two metals without MCLs, cobalt and vanadium, were detected at concentrations exceeding their tw-SLs.

Dioxin/Furans. Twenty dioxins/furans were detected in site groundwater samples. Five of those dioxins/furans (total and congeners) were detected above their tw-SLs in the SWMU 50 and SWMU 59 groundwater samples. Those five dioxins/furans were 2,3,4,7,8-PECDF; total PECDD; total HXCDD; total HPCDD; and total HXCDF. None of the detected dioxins/furans have an associated MCL. Calculated TCDD TE values are discussed in *Section 6.1.1*, HHRA.

Misc. Perchlorate was detected in the three groundwater samples. However, concentrations did not exceed its tw-SL in any of the samples. It should be noted that perchlorate has consistently been detected at low levels throughout Radford since the adoption of the new LC/MS analytical method.

4.2 Soil Screening Level Comparison

Tables 4-4 and 4-5 present the chemical results from all the investigations soil sampling events for SWMUs 50 and 59, respectively, compared with the current (September 2008) ORNL Regional SSL soil transfer to groundwater values, using a dilution attenuation factor of 20 (USEPA, 2008). There were a total of 31 soil samples collected at SWMU 50 and a total of 28 collected at SWMU 59.

At SWMU 50, five VOCs (1,1,1-TCE; acetone; carbon disulfide; chloroform; and m- & p-xylene) were detected in soil samples. However, only one VOC (chloroform) was detected above its respective SSL in 1992 sample 50SL1 (RVFS*9). At SWMU 59, five VOCs (acetone, carbon disulfide, m- & p-xylene, o-xylene, and toluene) were detected in all the collected soil samples. However, none of those VOCs were detected at concentrations greater than their SSLs. The low frequency of detection (FOD) suggests that these compounds are not a concern in soil at SWMU 50 or SWMU 59.

Table 4-4
Overall SWMU 50 SSL Transfer to Groundwater Exceedance Summary
Page 1 of 3

Analyte	Background	SSL Transfer	# of Background Exceedances	# of SSL Transfer Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
VOCs (ug/kg)									
1,1,1-Trichloroethane	na	66000	na	0	1	31	5000	5000	50SL1 (RVFS*9)
Acetone	na	88000	na	0	4	31	17	101	50SB12B
Carbon disulfide	na	5400	na	0	3	31	0.48	1.1	50SB04B
Chloroform	na	1.1	na	1	1	31	2000	2000	50SL1 (RVFS*9)
m- & p-Xylene	na	na	na	na	1	29	5.8	5.8	50SB12B
PAHs (ug/kg)									
2-Methylnaphthalene	na	18000	na	0	7	29	9.1	400	50SB05A
Acenaphthene	na	540000	na	0	7	29	1.9	16	50SB05A
Acenaphthylene	na	3000000	na	0	8	29	2.2	20	50SB05A
Anthracene	na	9000000	na	0	6	29	2	11	50SB05A
Benz(a)anthracene	na	280	na	0	9	29	1.6	137	50SB07A
Benzo(a)pyrene	na	92	na	1	9	29	18.7	150	50SB07A
Benzo(b)fluoranthene	na	940	na	0	10	29	1.8	152	50SB07A
Benzo(g,h,i)perylene	na	3000000	na	0	10	29	1.1	59	50SS02
Benzo(k)fluoranthene	na	9200	na	0	10	29	0.55	98.9	50SB07A
Chrysene	na	28000	na	0	10	29	2.6	119	50SB07A
Dibenz(a,h)anthracene	na	300	na	0	6	29	1.6	14	50SS02
Fluoranthene	na	4200000	na	0	8	29	1.6	110	50SB04A
Fluorene	na	660000	na	0	8	29	1	18	50SB05A
Indeno(1,2,3-cd)pyrene	na	3200	na	0	10	29	2.3	84.1	50SB07A
Naphthalene	na	11	na	5	8	29	3.5	270	50SB05A
Phenanthrene	na	3000000	na	0	8	29	11	260	50SB05A
Pyrene	na	3000000	na	0	8	29	2.3	240	50SB04A
SVOCs (ug/kg)									
1,2-Dichlorobenzene	na	8000	na	0	2	31	11	16	50SB04C
1,3-Dichlorobenzene	na	na	na	na	2	31	8.6	16	50SB04C
1,4-Dichlorobenzene	na	9.2	na	2	2	31	11	16	50SB04C
2,4-Dinitrotoluene	na	1360	na	1	8	31	43	2500	50SB04A
2,6-Dinitrotoluene	na	680	na	0	3	31	30	410	50SB04A
2-Methylnaphthalene	na	18000	na	0	9	31	8.4	870	50SB05A
2-Methylphenol	na	40000	na	0	1	31	21	21	50SB04C
4-Methylphenol	na	3800	na	0	1	11	29	29	50SB04C
Acenaphthene	na	540000	na	0	3	11	8.5	28	50SB04C
Acenaphthylene	na	3000000	na	0	2	11	7.3	9.7	50SS02
Anthracene	na	9000000	na	0	4	11	12	24	50SB05A
Benz(a)anthracene	na	280	na	0	5	11	24	54	50SB05A
Benzo(a)pyrene	na	92	na	0	4	11	15	53	50SS02
Benzo(b)fluoranthene	na	940	na	0	4	11	38	70	50SS02
Benzo(g,h,i)perylene	na	3000000	na	0	1	11	43	43	50SS02
Benzo(k)fluoranthene	na	9200	na	0	3	11	8.8	29	50SS02
bis(2-Ethylhexyl)phthalate	na	32000	na	0	5	31	65	2500	50SB04A
Butylbenzylphthalate	na	13400	na	0	1	31	39	39	50SS03
Carbazole	na	na	na	na	5	29	11	30	50SB04A

Table 4-4
Overall SWMU 50 SSL Transfer to Groundwater Exceedance Summary
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Analyte	Background	SSL Transfer	# of Background Exceedances	# of SSL Transfer Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
Chrysene	na	28000	na	0	5	11	31	100	50SB05A
Dibenzofuran	na	na	na	na	6	31	12	200	50SB05A
Diethylphthalate	na	260000	na	0	4	31	7.7	88	50SB05A
Dimethylphthalate	na	na	na	na	2	31	716	1500	50SB04A
Di-n-butylphthalate	na	220000	na	0	12	31	63	61000	50SB04A
Di-n-octylphthalate	na	9.8E+10	na	0	1	31	64	64	50SB04A
Fluoranthene	na	4200000	na	0	7	11	11	120	50SB04A
Fluorene	na	660000	na	0	4	11	14	43	50SB04C
Indeno(1,2,3-cd)pyrene	na	3200	na	0	1	11	37	37	50SS02
Naphthalene	na	11	na	8	9	11	7.2	490	50SB05A
N-nitrosodiphenylamine	na	3400	na	0	5	31	21	1100	50SB04A
Phenanthrene	na	3000000	na	0	9	11	14	470	50SB05A
Pyrene	na	3000000	na	0	7	11	8.9	250	50SB04A
Pesticides (ug/kg)									
4,4'-DDD	na	1720	na	0	2	24	0.41	0.447	50SS03
4,4'-DDE	na	1200	na	0	2	24	0.657	3.37	50SS03
4,4'-DDT	na	1740	na	0	1	24	12.9	12.9	50SS03
Endosulfan II	na	na	na	na	2	24	0.636	2.24	50SS03
Endrin	na	4600	na	0	1	24	0.288	0.288	50SS01
Methoxychlor	na	3200	na	0	1	24	1.29	1.29	50SS03
PCBs (mg/kg)									
PCB-1254	na	0.102	na	10	15	31	0.0104	1.48	50SB07A
Explosives (mg/kg)									
2,4,6-Trinitrotoluene	na	0.174	na	0	2	29	0.075	0.0923	50SB06B
2,4-Dinitrotoluene	na	1.36	na	1	9	29	0.0779	1.96	50SB04A
2,6-Dinitrotoluene	na	0.68	na	0	2	29	0.179	0.375	50SB04A
Herbicides (ug/kg)									
2,4,5-T	na	2200	na	0	1	22	8.18	8.18	50SS01
2,4-D	na	1880	na	0	1	22	142	142	50SS03
Dicamba	na	5600	na	0	2	22	6.29	13.9	50SB10B
Metals (mg/kg)									
Aluminum	40041	1100000	0	0	29	29	0.0112	38400	50SB05C
Antimony	na	13.2	na	0	22	29	0.0056	2.5	50SB10B
Arsenic	15.8	0.026	0	0	29	29	0.00309	13.7	50SB04B
Barium	209	6000	0	0	29	29	0.0056	141	50SS01
Beryllium	1.02	1160	0	0	29	29	0.0102	0.97	50SB04C
Cadmium	0.69	28	0	0	7	29	0.058	0.15	50SB04C
Calcium	na	na	na	na	29	29	25.4	237000	50SB09B
Chromium	65.3	42	4	4	29	29	12.2	513	50SB13B
Cobalt	72.3	9.8	0	0	29	29	1.3	44.9	50SB15B
Copper	53.5	1020	6	0	29	29	4	438	50SB13B
Iron	50962	12800	0	0	29	29	3060	47200	50SB10B
Lead	26.8	na	11	na	29	29	6.6	234	50SB06B
Magnesium	na	na	na	na	29	29	312	20200	50SS02

Table 4-4
Overall SWMU 50 SSL Transfer to Groundwater Exceedance Summary

Analyte	Background	SSL Transfer	# of Background Exceedances	# of SSL Transfer Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
Manganese	2543	1140	0	0	29	29	25.1	1580	50SB04A
Mercury	0.13	0.66	11	1	29	29	0.012	0.816	50SB05A
Nickel	62.8	960	2	0	29	29	4.1	181	50SB04C
Potassium	na	na	na	na	29	29	292	2050	50SS02
Selenium	na	19	na	0	15	29	0.57	13.5	50SB10B
Silver	na	32	na	0	8	29	0.069	1.1	50SB04C
Sodium	na	na	na	na	24	29	13	594	50SB13B
Thallium	2.11	3.4	0	0	8	29	0.13	0.25	50SB04B
Vanadium	108	5200	0	0	29	29	6.4	84.2	50SB10B
Zinc	202	13600	0	0	29	29	5	93.3	50SS02
Dioxins/Furans (ng/kg)									
2,3,7,8-TCDF	na	16.8	na	0	19	20	0.141	7.79	50SB07A
2,3,7,8-TCDD	na	3	na	0	7	20	0.13	0.563	50SB07A
1,2,3,7,8-PECDD	na	na	na	na	13	20	0.279	6.68	50SB07A
1,2,3,4,7,8-HXCDD	na	na	na	na	15	20	0.202	14.6	50SB07A
1,2,3,6,7,8-HXCDD	na	na	na	na	16	20	0.3	122	50SB06A
1,2,3,7,8,9-HXCDD	na	na	na	na	16	20	0.293	41.2	50SB06A
1,2,3,4,6,7,8-HPCDD	na	na	na	na	20	20	12.5	4610	50SB06A
OCDD	na	82000	na	0	20	20	472	50200	50SB06A
1,2,3,7,8-PECDF	na	94	na	0	13	20	0.0999	4.08	50SB07A
2,3,4,7,8-PECDF	na	9.4	na	1	15	20	0.107	9.63	50SB07A
1,2,3,4,7,8-HXCDF	na	na	na	na	17	20	0.324	120	50SB13B
1,2,3,6,7,8-HXCDF	na	na	na	na	16	20	0.12	18.2	50SB13B
2,3,4,6,7,8-HXCDF	na	na	na	na	14	20	0.181	15.3	50SB07A
1,2,3,7,8,9-HXCDF	na	na	na	na	9	20	0.777	5.74	50SB12B
1,2,3,4,6,7,8-HPCDF	na	na	na	na	20	20	0.891	559	50SB13B
1,2,3,4,7,8,9-HPCDF	na	na	na	na	12	20	0.588	29.7	50SB06A
OCDF	na	46000	na	0	20	20	1.28	2090	50SB06A
TOTAL TCDD	na	na	na	na	13	20	0.182	10	50SB12B
TOTAL PECDD	na	5.4	na	7	13	20	0.788	17.8	50SB07A
TOTAL HXCDD	na	86	na	6	20	20	0.63	404	50SB06A
TOTAL HPCDD	na	1460	na	5	20	20	28.7	7350	50SB06A
TOTAL TCDF	na	na	na	na	19	20	0.141	56.2	50SB07A
TOTAL PECDF	na	na	na	na	17	20	0.147	109	50SB07A
TOTAL HXCDF	na	48	na	8	18	20	0.345	518	50SB06A
TOTAL HPCDF	na	800	na	4	20	20	0.891	2040	50SB06A
Misc.									
Total Organic Carbon (mg/kg)	na	na	na	na	1	1	18900	18900	50SS01
pH	na	na	na	na	1	1	5.33	5.33	50SS01

SSL = Soil Screening Level (USEPA, September 2008).
mg/kg = milligrams per kilogram (parts per million).
ng/kg = nanograms per kilogram (parts per trillion).
ug/kg = micrograms per kilogram (parts per billion).
na = not applicable.

Table 4-5
Overall SWMU 59 SSL Transfer to Groundwater Exceedance Summary

Analyte	Background	SSL Transfer	# of Background Exceedances	# of SSL Transfer Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
VOCs (ug/kg)									
Acetone	na	88000	na	0	4	25	17	65.8	59SS10
Carbon disulfide	na	5400	na	0	1	25	2.2	2.2	59SB01A
m- & p-Xylene	na	na	na	na	1	25	6.3	6.3	59SB01A
o-Xylene	na	32000	na	0	1	25	2.5	2.5	59SB01A
Toluene	na	34000	na	0	1	25	15	15	59SB01A
PAHs (ug/kg)									
1-Methylnaphthalene	na	300	na	0	2	20	51.4	92	59SS09
2-Methylnaphthalene	na	18000	na	0	6	25	3.7	210	59SB01A
Acenaphthene	na	540000	na	0	3	25	3.1	6.5	59SS03
Acenaphthylene	na	3000000	na	0	2	25	2	2.9	59SB01A
Anthracene	na	9000000	na	0	3	25	3.5	20	59SS03
Benz(a)anthracene	na	280	na	0	7	25	12	60	59SS03
Benzo(a)pyrene	na	92	na	0	7	25	6.6	46	59SS03
Benzo(b)fluoranthene	na	940	na	0	8	25	12	63	59SS03
Benzo(g,h,i)perylene	na	3000000	na	0	6	25	8.2	25	59SS03
Benzo(k)fluoranthene	na	9200	na	0	7	25	2.3	33	59SS03
Chrysene	na	28000	na	0	8	25	16	57	59SS03
Dibenz(a,h)anthracene	na	300	na	0	3	25	1.8	6.4	59SS03
Fluoranthene	na	4200000	na	0	6	25	13	110	59SS03
Fluorene	na	660000	na	0	3	25	4.3	9.1	59SS03
Indeno(1,2,3-cd)pyrene	na	3200	na	0	6	25	3.6	26.3	59SS08
Naphthalene	na	11	na	3	5	25	4.5	130	59SB01A
Phenanthrene	na	3000000	na	0	9	25	2.4	97	59SB01A
Pyrene	na	3000000	na	0	5	25	16	92	59SS03

Table 4-5
Overall SWMU 59 SSL Transfer to Groundwater Exceedance Summary

Analyte	Background	SSL Transfer	# of Background Exceedances	# of SSL Transfer Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
SVOCs (ug/kg)									
2-Methylnaphthalene	na	18000	na	0	2	7	95	120	59SS05
Acenaphthene	na	540000	na	0	1	7	24	24	59SS03
Anthracene	na	9000000	na	0	1	7	61	61	59SS03
Benz(a)anthracene	na	280	na	0	2	7	19	180	59SS03
Benzo(a)pyrene	na	92	na	1	1	7	140	140	59SS03
Benzo(b)fluoranthene	na	940	na	0	1	7	210	210	59SS03
Benzo(g,h,i)perylene	na	3000000	na	0	1	7	91	91	59SS03
Benzo(k)fluoranthene	na	9200	na	0	1	7	60	60	59SS03
Carbazole	na	na	na	na	1	25	73	73	59SS03
Chrysene	na	28000	na	0	2	7	21	150	59SS03
Dibenzofuran	na	na	na	na	3	27	16	32	59SS05
Fluoranthene	na	4200000	na	0	3	7	9.3	320	59SS03
Fluorene	na	660000	na	0	1	7	37	37	59SS03
Indeno(1,2,3-cd)pyrene	na	3200	na	0	1	7	96	96	59SS03
Naphthalene	na	11	na	2	3	7	9.6	75	59SS05
Phenanthrene	na	3000000	na	0	4	7	52	400	59SS2 (RVFS*108)
Pyrene	na	3000000	na	0	3	7	8.2	240	59SS03
Pesticides (ug/kg)									
4,4'-DDD	na	1720	na	0	2	25	0.676	1	59SS08
4,4'-DDE	na	1200	na	0	1	25	0.768	0.768	59SS03
4,4'-DDT	na	1740	na	0	3	25	1.12	4.41	59SS03
Dieldrin	na	1.8	na	1	3	25	0.44	4.52	59SS05
Endosulfan II	na	na	na	na	2	25	3.33	3.94	59SB01A
Endosulfan I	na	na	na	na	1	25	0.961	0.961	59SB01A
Endosulfan sulfate	na	na	na	na	2	22	2.1	7.1	59SS09
Endrin aldehyde	na	na	na	na	1	25	0.428	0.428	59SS03
Endrin ketone	na	na	na	na	3	25	1.66	2.9	59SS05
gamma-Chlordane	na	na	na	na	1	5	1.1	1.1	59SS03
Heptachlor epoxide	na	1.58	na	0	3	25	0.46	1.06	59SB01A
Methoxychlor	na	3200	na	0	3	25	2.82	10.2	59SS05

Table 4-5
Overall SWMU 59 SSL Transfer to Groundwater Exceedance Summary

Analyte	Background	SSL Transfer	# of Background Exceedances	# of SSL Transfer Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
PCBs (mg/kg)									
PCB-1254	na	0.102	na	0	5	27	0.0111	0.061	59SS03
Explosives (mg/kg)									
1,3,5-Trinitrobenzene	na	52	na	0	2	25	0.134	0.138	59SS05
Herbicides (ug/kg)									
2,4,5-T	na	2200	na	0	1	23	36.6	36.6	59SS05
Metals (mg/kg)									
Aluminum	40041	1100000	0	0	28	28	3120	38100	59SB01B
Antimony	na	13.2	na	0	20	28	0.21	1.8	59SB03C
Arsenic	15.8	0.026	3	3	28	28	0.97	34	59SS2 (RVFS*108)
Barium	209	6000	0	0	28	28	31.6	190	59SS1 (RVFS*110)
Beryllium	1.02	1160	2	0	28	28	0.42	1.3	59SB06A
Cadmium	0.69	28	0	0	2	28	0.11	0.11	59SS03
Calcium	na	na	na	na	28	28	40.7	2680	59SS03
Chromium	65.3	42	0	0	28	28	7.5	33.6	59SB01C
Cobalt	72.3	9.8	0	0	28	28	2.9	10.1	59SS1 (RVFS*110)
Copper	53.5	1020	0	0	28	28	3.3	19.1	59SB03B
Iron	50962	12800	0	0	28	28	4200	38600	59SB01B
Lead	26.8	na	1	na	28	28	3.8	30.9	59SS03
Magnesium	na	na	na	na	28	28	227	2270	59SS03
Manganese	2543	1140	2	2	28	28	38.9	3630	59SB06A
Mercury	0.13	0.66	7	0	25	26	0.027	0.45	59SS03
Nickel	62.8	960	0	0	28	28	5.2	12.9	59SB01B
Potassium	na	na	na	na	28	28	300	1250	59SB05B
Selenium	na	19	na	0	19	28	0.19	11.7	59SB03C
Silver	na	32	na	0	1	28	0.701	0.701	59SS2 (RVFS*108)
Sodium	na	na	na	na	24	28	17	396	59SB04B
Thallium	2.11	3.4	0	0	6	28	0.073	0.21	59SS04
Vanadium	108	5200	0	0	28	28	12.1	74.5	59SB04B
Zinc	202	13600	0	0	28	28	7.23	76.3	59SS03

Table 4-5
Overall SWMU 59 SSL Transfer to Groundwater Exceedance Summary

Analyte	Background	SSL Transfer	# of Background Exceedances	# of SSL Transfer Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
Dioxins/Furans (ng/kg)									
2,3,7,8-TCDF	na	16.8	na	0	15	26	0.157	0.566	59SS08
2,3,7,8-TCDD	na	3	na	0	4	26	0.166	0.248	59SS09
1,2,3,7,8-PECDD	na	na	na	na	9	26	0.0934	2.03	59SS08
1,2,3,4,7,8-HXCDD	na	na	na	na	10	26	0.148	3.47	59SS08
1,2,3,6,7,8-HXCDD	na	na	na	na	12	26	0.106	8.25	59SS08
1,2,3,7,8,9-HXCDD	na	na	na	na	12	26	0.233	9.49	59SS08
1,2,3,4,6,7,8-HPCDD	na	na	na	na	26	26	0.82	274	59SS06
OCDD	na	82000	na	0	26	26	56.8	17400	59SS06
1,2,3,7,8-PECDF	na	94	na	0	8	26	0.0807	0.302	59SS06
2,3,4,7,8-PECDF	na	9.4	na	0	8	26	0.101	0.537	59SS08
1,2,3,4,7,8-HXCDF	na	na	na	na	13	26	0.137	2.11	59SS07
1,2,3,6,7,8-HXCDF	na	na	na	na	11	26	0.0807	1.38	59SS08
2,3,4,6,7,8-HXCDF	na	na	na	na	8	26	0.0913	1.95	59SS08
1,2,3,7,8,9-HXCDF	na	na	na	na	3	26	0.121	0.581	59SS06
1,2,3,4,6,7,8-HPCDF	na	na	na	na	22	26	0.389	49.2	59SS08
1,2,3,4,7,8,9-HPCDF	na	na	na	na	8	26	0.287	2.09	59SS08
OCDF	na	46000	na	0	18	26	0.661	150	59SS06
TOTAL HXCDD	na	86	na	0	17	26	0.268	55.3	59SS08
TOTAL HPCDD	na	1460	na	0	26	26	1.867	490	59SS06
TOTAL PECDF	na	na	na	na	10	26	0.041	8.48	59SS08
TOTAL HXCDF	na	48	na	2	18	26	0.103	49.4	59SS06
TOTAL HPCDF	na	800	na	0	22	26	0.295	154	59SS06
Misc.									
Total Organic Carbon (mg/kg)	na	na	na	na	1	1	14000	14000	59SS03
pH	na	na	na	na	1	1	7.24	7.24	59SS03

SSL = Soil Screening Level (USEPA, September 2008).
mg/kg = milligrams per kilogram (parts per million).
ng/kg = nanograms per kilogram (parts per trillion).
ug/kg = micrograms per kilogram (parts per billion).
na = not applicable.

At SWMU 50, 17 PAHs were detected in soil samples. However, only two of those [benzo(a)pyrene and naphthalene] were detected at concentrations above their SSLs. At SWMU 59, 18 PAHs were detected in soil samples. However, only one of those (naphthalene) was detected at a concentration greater than its SSL in three samples. The low FOD suggests that these compounds are not a concern in soil at SWMU 50 or SWMU 59.

Thirty-two non-PAH SVOCs were detected in all the soil samples collected from SWMU 50 (**Table 4-4**). However, only two of those (1,4-dichlorobenzene; and 2,4-dinitrotoluene) were detected above their SSLs. 2,4-DNT and 1,4-dichlorobenzene were only detected above their SSLs in one and two samples, respectively, out of 31 samples analyzed for them. In all soil samples collected at SWMU 59, 17 SVOCs were detected. Only two of those SVOCs [benzo(a)pyrene and naphthalene] were detected above their SSLs in one and two samples, respectively. Once again, the low FOD and relatively low concentrations suggest that these compounds are not a concern in soil at SWMU 50 or SWMU 59.

Six pesticides were detected in either one or two of the SWMU 50 soil samples. However, none of them were detected at concentrations above their SSLs. At SWMU 59, 12 pesticides were detected in up to three of the soil samples. However, only one of them (dieldrin) was detected at concentration greater than its SSL in sample 59SS05.

One PCB (PCB-1254) was detected in 15 out of 31 SWMU 50 soil samples. It was detected above its SSL in 10 out of 31 samples. It should be noted, however, that PCB-1254 was not detected in groundwater. Similarly, at SWMU 59, only PCB-1254 was detected in 5 out of 27 samples. However, it was never detected above its SSL.

Three explosives were detected in the 29 SWMU 50 soil samples tested for it. Only one of those explosives (2,4-DNT) was detected above its SSL in one sample (50SB04A). In SWMU 59 samples, only one explosive (1,3,5-trinitrobenzene) was detected in 2 out of 25 samples. However, it was not detected above its SSL in any sample.

Three herbicides (2,4,5-T; 2,4-D; and dicamba) were detected in one or two of 22 SWMU 50 soil samples. However, none of them were detected above their SSLs. One herbicide (2,4,5-T) was detected in 1 out of 23 SWMU 59 samples, but not above its SSL.

In the SWMU 50 soil samples, 23 metals were detected. Three of those metals (copper, lead, and nickel) were detected only above their background SLs. Two of those metals (chromium and mercury) were detected above their SSLs and background levels. In the SWMU 59 soil samples, 23 metals were detected. Two of those metals (arsenic and manganese) were detected above SSLs only. The majority of these detections were only slightly above the background 95 percent upper confidence limit (UCL) and are likely within the range of naturally-occurring metal concentrations for this area.

In the SWMU 50 soil samples, 25 dioxins/furans were detected. Six of those dioxins/furans (2,3,4,7,8-PECDF; total PECDD; total HXCDD; total HPCDD; total HXCDF; and total HPCDF) were detected above SSLs. In the SWMU 59 soil samples, 22 dioxins/furans were detected. Only one of those (total HXCDF) was detected above its SSL in 2 out of 26 samples analyzed for it.

4.3 Nature and Extent Summary and Conclusions

4.3.1 Soil

4.3.1.1 SWMU 50

The soil at SWMU 50 was investigated during the 1991 sampling event and then again in 2002 and 2007 in support of draft RFIs. A summary of all analytes detected in soil during all investigations of SWMU 50 can be found in **Table 4-6**.

The SWMU 50 data set from all investigations indicates that one VOC (chloroform), two PAHs [benzo(a)pyrene and benzo(b)fluoranthene], one PCB (PCB-1254), five metals (chromium, copper, lead, mercury, and nickel), and seven dioxins/furans (1,2,3,6,7,8-HXCDD; OCDD; total PECDD; total HXCDD; total HPCDD; total HXCDF; and total HPCDF) were detected above their SLs in soil samples collected for this site.

Prior to the 2002 sampling event, PCBs were not detected. Also, in 1992 only two VOCs and three SVOCs were detected at the site. Only one of those VOCs was detected at a concentration above its SL. However, only VOCs, SVOCs, pesticides, and PCBs were analyzed for in 1992. When comparing the 2002 and 2007 sampling events, the only analytes that were detected above their SLs in both events were one PAH [benzo(a)pyrene] and one PCB (PCB-1254). In 2002, benzo(a)pyrene was detected above its r-SL in samples 50SS02, 50SB04C, and 50SB05A at respective concentrations of 54, 17, and 19 micrograms per kilogram (µg/kg) when its r-SL was 15 µg/kg. In 2007, benzo(a)pyrene was detected in samples 50SB07A and 50SB13A at concentrations of 150 and 18.7 µg/kg, above its r-SL of 15 µg/kg. The highest concentration was 150 µg/kg in sample 50SB07A, which was above its r-SL. In 2002, PCB-1254 was detected above its SL in samples 50SS01, 50SS02, 50SS03, 50SB04A, 50SB04B, and 50SB04C. In 2007, PCB-1254 was detected above its SL in samples 50SB06B, 50SB07A, 50SB08B, 50SB09B, 50SB12B, and 50SB13B. The highest concentration was 1.48 milligrams per kilogram (mg/kg) in sample 50SB07A, when the i-SL is 0.74 and the r-SL is 0.022 mg/kg.

The only analytes with concentrations greater than SLs in previous SWMU 50 soil investigations that were also detected in 2007 groundwater samples were five metals (chromium, copper, lead, mercury, and nickel). However, the groundwater copper detections were “B” flagged during data validation, indicating that copper was also detected in associated laboratory blanks. The “B” flags suggest that the copper is not site-related. Therefore, this finding suggests that mobility from soils into groundwater is very low.

Results from the investigations at SWMUs 50 indicate that any negative impacts to soil resulting from the waste burial areas have been mitigated during the years since the waste was deposited.

4.3.1.2 SWMU 59

The soil at SWMU 59 was investigated during the 1991 sampling event and then again in 2002 and 2007 in support of draft RFIs. Finally in 2007, the soil was investigated in support of completing this RFI. A summary of all analytes detected in soil during all investigations of SWMU 59 can be found in **Table 4-7**.

The SWMU 59 data set from all previous investigations indicates that three PAHs [benzo(a)pyrene, benzo(a)anthracene, and benzo(b)fluoranthene], one PCB (PCB-1254), two metals (arsenic and manganese), and two dioxins/furans (OCDD and total HPCDD) exceeded their screening limits in soil samples collected for this site.

Table 4-6
Overall SWMU 50 Soil Summary

Analyte	i-SL	r-SL	Background	# of i-SL Exceedances	# of r-SL Exceedances	# of Background Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
VOCs (ug/kg)											
1,1,1-Trichloroethane	3900000	900000	na	0	0	na	1	31	5000	5000	50SL1 (RVFS*9)
Acetone	61000000	6100000	na	0	0	na	4	31	17	101	50SB12B
Carbon disulfide	300000	67000	na	0	0	na	3	31	0.48	1.1	50SB04B
Chloroform	1500	300	na	1	1	na	1	31	2000	2000	50SL1 (RVFS*9)
m- & p-Xylene	20000000	1600000	na	0	0	na	1	29	5.8	5.8	50SB12B
PAHs (ug/kg)											
2-Methylnaphthalene	410000	31000	na	0	0	na	7	29	9.1	400	50SB05A
Acenaphthene	3300000	340000	na	0	0	na	7	29	1.9	16	50SB05A
Acenaphthylene	3100000	230000	na	0	0	na	8	29	2.2	20	50SB05A
Anthracene	17000000	1700000	na	0	0	na	6	29	2	11	50SB05A
Benz(a)anthracene	2100	150	na	0	0	na	9	29	1.6	137	50SB07A
Benzo(a)pyrene	210	15	na	0	5	na	9	29	3.3	150	50SB07A
Benzo(b)fluoranthene	2100	150	na	0	1	na	10	29	1.8	152	50SB07A
Benzo(g,h,i)perylene	3100000	230000	na	0	0	na	10	29	1.1	59	50SS02
Benzo(k)fluoranthene	21000	1500	na	0	0	na	10	29	0.55	98.9	50SB07A
Chrysene	210000	15000	na	0	0	na	10	29	2.6	119	50SB07A
Dibenz(a,h)anthracene	210	15	na	0	0	na	6	29	1.6	14	50SS02
Fluoranthene	2200000	230000	na	0	0	na	8	29	1.6	110	50SB04A
Fluorene	2200000	230000	na	0	0	na	8	29	1	18	50SB05A
Indeno(1,2,3-cd)pyrene	2100	150	na	0	0	na	10	29	2.3	84.1	50SB07A
Naphthalene	20000	3900	na	0	0	na	8	29	3.5	270	50SB05A
Phenanthrene	3100000	230000	na	0	0	na	8	29	11	260	50SB05A
Pyrene	1700000	170000	na	0	0	na	8	29	2.3	240	50SB04A
SVOCs (ug/kg)											
1,2-Dichlorobenzene	1000000	200000	na	0	0	na	2	29	11	16	50SB04C
1,3-Dichlorobenzene	310000	23000	na	0	0	na	2	29	8.6	16	50SB04C
1,4-Dichlorobenzene	13000	2600	na	0	0	na	2	29	11	16	50SB04C
2,4-Dinitrotoluene	120000	12000	na	0	0	na	8	29	43	2500	50SB04A
2,6-Dinitrotoluene	62000	6100	na	0	0	na	3	29	30	410	50SB04A
2-Methylnaphthalene	410000	31000	na	0	0	na	9	11	8.4	870	50SB05A
2-Methylphenol	3100000	310000	na	0	0	na	1	29	21	21	50SB04C

Table 4-6
Overall SWMU 50 Soil Summary

Analyte	i-SL	r-SL	Background	# of i-SL Exceedances	# of r-SL Exceedances	# of Background Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
4-Methylphenol	310000	31000	na	0	0	na	1	9	29	29	50SB04C
Acenaphthene	3300000	340000	na	0	0	na	3	9	8.5	28	50SB04C
Acenaphthylene	1700000	170000	na	0	0	na	2	9	7.3	9.7	50SS02
Anthracene	17000000	1700000	na	0	0	na	4	9	12	24	50SB05A
Benz(a)anthracene	2100	150	na	0	0	na	5	9	24	54	50SB05A
Benzo(a)pyrene	210	15	na	0	4	na	4	9	15	53	50SS02
Benzo(b)fluoranthene	2100	150	na	0	0	na	4	9	38	70	50SS02
Benzo(g,h,i)perylene	1700000	170000	na	0	0	na	1	9	43	43	50SS02
Benzo(k)fluoranthene	21000	1500	na	0	0	na	3	9	8.8	29	50SS02
bis(2-Ethylhexyl)phthalate	120000	35000	na	0	0	na	5	29	65	2500	50SB04A
Butylbenzylphthalate	910000	260000	na	0	0	na	1	29	39	39	50SS03
Carbazole	140000	32000	na	0	0	na	5	29	11	30	50SB04A
Chrysene	210000	15000	na	0	0	na	5	9	31	100	50SB05A
Dibenzofuran	100000	7800	na	0	0	na	6	29	12	200	50SB05A
Diethylphthalate	49000000	4900000	na	0	0	na	4	29	7.7	88	50SB05A
Dimethylphthalate	na	na	na	na	na	na	2	29	716	1500	50SB04A
Di-n-butylphthalate	6200000	610000	na	0	0	na	12	29	63	61000	50SB04A
Di-n-octylphthalate	na	na	na	na	na	na	1	29	64	64	50SB04A
Fluoranthene	2200000	230000	na	0	0	na	7	9	11	120	50SB04A
Fluorene	2200000	230000	na	0	0	na	4	9	14	43	50SB04C
Indeno(1,2,3-cd)pyrene	2100	150	na	0	0	na	1	9	37	37	50SS02
Naphthalene	20000	3900	na	0	0	na	9	11	7.2	490	50SB05A
N-nitrosodiphenylamine	350000	99000	na	0	0	na	5	29	21	1100	50SB04A
Phenanthrene	1700000	170000	na	0	0	na	9	11	14	470	50SB05A
Pyrene	1700000	170000	na	0	0	na	7	9	8.9	250	50SB04A
Pesticides (ug/kg)											
4,4'-DDD	7200	2000	na	0	0	na	2	24	0.41	0.447	50SS03
4,4'-DDE	5100	1400	na	0	0	na	2	24	0.657	3.37	50SS03
4,4'-DDT	7000	1700	na	0	0	na	1	24	12.9	12.9	50SS03
Endosulfan II	610000	47000	na	0	0	na	2	24	0.636	2.24	50SS03
Endrin	18000	1800	na	0	0	na	1	24	0.288	0.288	50SS01
Methoxychlor	310000	31000	na	0	0	na	1	24	1.29	1.29	50SS03

Table 4-6
Overall SWMU 50 Soil Summary

Analyte	i-SL	r-SL	Background	# of i-SL Exceedances	# of r-SL Exceedances	# of Background Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
PCBs (mg/kg)											
PCB-1254	0.74	0.022	na	5	12	na	15	31	0.0104	1.48	50SB07A
Explosives (mg/kg)											
2,4,6-Trinitrotoluene	79	19	na	0	0	na	2	29	0.075	0.0923	50SB06B
2,4-Dinitrotoluene	120	12	na	0	0	na	9	29	0.0779	1.96	50SB04A
2,6-Dinitrotoluene	62	6.1	na	0	0	na	2	29	0.179	0.375	50SB04A
Herbicides (ug/kg)											
2,4,5-T	620000	61000	na	0	0	na	1	22	8.18	8.18	50SS01
2,4-D	770000	69000	na	0	0	na	1	22	142	142	50SS03
Dicamba	1800000	180000	na	0	0	na	2	22	6.29	13.9	50SB10B
Metals (mg/kg)											
Aluminum	99000	7700	40041	0	0	0	29	29	3100	38400	50SB05C
Antimony	41	3.1	na	0	0	na	22	29	0.19	2.5	50SB10B
Arsenic	1600	390	15.8	0	0	0	29	29	1.03	13.7	50SB04B
Barium	19000000	1500000	209	0	0	0	29	29	12	141	50SS01
Beryllium	200000	16000	1.02	0	0	0	29	29	0.13	0.97	50SB04C
Cadmium	81	7	0.69	0	0	0	7	29	0.058	0.15	50SB04C
Calcium	na	na	na	na	na	na	29	29	25.4	237000	50SB09B
Chromium	1400	280	65.3	0	1	4	29	29	12.2	513	50SB13B
Cobalt	30000	2300	72.3	0	0	0	29	29	1.3	44.9	50SB15B
Copper	4100	310	53.5	0	1	6	29	29	4	438	50SB13B
Iron	72000	5500	50962	0	0	0	29	29	3060	47200	50SB10B
Lead	800	400	26.8	0	1	11	29	29	6.6	585	50SB04C
Magnesium	na	na	na	na	na	na	29	29	312	20200	50SS02
Manganese	2300	180	2543	0	0	0	29	29	25.1	1580	50SB04A
Mercury	2.8	0.67	0.13	0	1	11	29	29	0.012	0.816	50SB05A
Nickel	2000	160	62.8	0	2	2	29	29	4.1	181	50SB04C
Potassium	na	na	na	na	na	na	29	29	292	2050	50SS02
Selenium	510	39	na	0	0	na	15	29	0.57	13.5	50SB10B
Silver	510	39	na	0	0	na	8	29	0.069	1.1	50SB04C
Sodium	na	na	na	na	na	na	24	29	13	594	50SB13B
Thallium	6.6	0.51	2.11	0	0	0	8	29	0.13	0.25	50SB04B
Vanadium	720	55	108	0	0	0	29	29	6.4	84.2	50SB10B
Zinc	31000	2300	202	0	0	0	29	29	5	93.3	50SS02

Table 4-6
Overall SWMU 50 Soil Summary

Analyte	i-SL	r-SL	Background	# of i-SL Exceedances	# of r-SL Exceedances	# of Background Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
Dioxins/Furans (ng/kg)											
2,3,7,8-TCDF	130	37	na	0	0	na	19	20	0.141	7.79	50SB07A
2,3,7,8-TCDD	18	4.5	na	0	0	na	7	20	0.13	0.563	50SB07A
1,2,3,7,8-PECDD	na	na	na	na	na	na	13	20	0.279	6.68	50SB07A
1,2,3,4,7,8-HXCDD	460	100	na	0	0	na	15	20	0.202	14.6	50SB07A
1,2,3,6,7,8-HXCDD	460	100	na	0	1	na	16	20	0.3	122	50SB06A
1,2,3,7,8,9-HXCDD	460	100	na	0	0	na	16	20	0.293	41.2	50SB06A
1,2,3,4,6,7,8-HPCDD	na	na	na	na	na	na	20	20	12.5	4610	50SB06A
OCDD	61000	15000	na	0	5	na	20	20	472	50200	50SB06A
1,2,3,7,8-PECDF	440	120	na	0	0	na	13	20	0.0999	4.08	50SB07A
2,3,4,7,8-PECDF	44	12	na	0	0	na	15	20	0.107	9.63	50SB07A
1,2,3,4,7,8-HXCDF	na	na	na	na	na	na	17	20	0.324	120	50SB13B
1,2,3,6,7,8-HXCDF	na	na	na	na	na	na	16	20	0.12	18.2	50SB13B
2,3,4,6,7,8-HXCDF	na	na	na	na	na	na	14	20	0.181	15.3	50SB07A
1,2,3,7,8,9-HXCDF	na	na	na	na	na	na	9	20	0.777	5.74	50SB12B
1,2,3,4,6,7,8-HPCDF	na	na	na	na	na	na	20	20	0.891	559	50SB13B
1,2,3,4,7,8,9-HPCDF	na	na	na	na	na	na	12	20	0.588	29.7	50SB06A
OCDF	44000	12000	na	0	0	na	20	20	1.28	2090	50SB06A
TOTAL TCDD	na	na	na	na	na	na	13	20	0.182	10	50SB12B
TOTAL PECDD	18	4.5	na	0	8	na	13	20	0.788	17.8	50SB07A
TOTAL HXCDD	180	45	na	4	7	na	20	20	0.63	404	50SB06A
TOTAL HPCDD	1800	450	na	4	7	na	20	20	28.7	7350	50SB06A
TOTAL TCDF	na	na	na	na	na	na	19	20	0.141	56.2	50SB07A
TOTAL PECDF	na	na	na	na	na	na	17	20	0.147	109	50SB07A
TOTAL HXCDF	130	37	na	7	9	na	18	20	0.345	518	50SB06A
TOTAL HPCDF	1300	370	na	1	8	na	20	20	0.891	2040	50SB06A
Misc.											
Total Organic Carbon (mg/kg)	na	na	na	na	na	na	1	1	18900	18900	50SS01
pH	na	na	na	na	na	na	1	1	5.33	5.33	50SS01

Table 4-7
Overall SWMU 59 Soil Summary

Analyte	i-SL	r-SL	Background	# of i-SL Exceedances	# of r-SL Exceedances	# of Background Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
VOCs (ug/kg)											
Acetone	61000000	6100000	na	0	0	na	4	25	17	65.8	59SS10
Carbon disulfide	300000	67000	na	0	0	na	1	25	2.2	2.2	59SB01A
m- & p-Xylene	20000000	1600000	na	0	0	na	1	25	6.3	6.3	59SB01A
o-Xylene	2300000	530000	na	0	0	na	1	25	2.5	2.5	59SB01A
Toluene	4600000	500000	na	0	0	na	1	25	15	15	59SB01A
PAHs (ug/kg)											
1-Methylnaphthalene	99000	22000	na	0	0	na	2	20	51.4	92	59SS09
2-Methylnaphthalene	410000	31000	na	0	0	na	6	25	3.7	210	59SB01A
Acenaphthene	3300000	340000	na	0	0	na	3	25	3.1	6.5	59SS03
Acenaphthylene	3100000	230000	na	0	0	na	2	25	2	2.9	59SB01A
Anthracene	17000000	1700000	na	0	0	na	3	25	3.5	20	59SS03
Benz(a)anthracene	2100	150	na	0	0	na	7	25	12	60	59SS03
Benzo(a)pyrene	210	15	na	0	5	na	7	25	6.6	46	59SS03
Benzo(b)fluoranthene	2100	150	na	0	0	na	8	25	12	63	59SS03
Benzo(g,h,i)perylene	3100000	230000	na	0	0	na	6	25	8.2	25	59SS03
Benzo(k)fluoranthene	21000	1500	na	0	0	na	7	25	2.3	33	59SS03
Chrysene	210000	15000	na	0	0	na	8	25	16	57	59SS03
Dibenz(a,h)anthracene	210	15	na	0	0	na	3	25	1.8	6.4	59SS03
Fluoranthene	2200000	230000	na	0	0	na	6	25	13	110	59SS03
Fluorene	2200000	230000	na	0	0	na	3	25	4.3	9.1	59SS03
Indeno(1,2,3-cd)pyrene	2100	150	na	0	0	na	6	25	3.6	26.3	59SS08
Naphthalene	20000	3900	na	0	0	na	5	25	4.5	130	59SB01A
Phenanthrene	3100000	230000	na	0	0	na	9	25	2.4	97	59SB01A
Pyrene	1700000	170000	na	0	0	na	5	25	16	92	59SS03

Table 4-7
Overall SWMU 59 Soil Summary

Analyte	i-SL	r-SL	Background	# of i-SL Exceedances	# of r-SL Exceedances	# of Background Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
SVOCs (ug/kg)											
2-Methylnaphthalene	410000	31000	na	0	0	na	2	7	95	120	59SS05
Acenaphthene	3300000	340000	na	0	0	na	1	7	24	24	59SS03
Anthracene	17000000	1700000	na	0	0	na	1	7	61	61	59SS03
Benz(a)anthracene	2100	150	na	0	1	na	2	7	19	180	59SS03
Benzo(a)pyrene	210	15	na	0	1	na	1	7	140	140	59SS03
Benzo(b)fluoranthene	2100	150	na	0	1	na	1	7	210	210	59SS03
Benzo(g,h,i)perylene	1700000	170000	na	0	0	na	1	7	91	91	59SS03
Benzo(k)fluoranthene	21000	1500	na	0	0	na	1	7	60	60	59SS03
Carbazole	140000	32000	na	0	0	na	1	25	73	73	59SS03
Chrysene	210000	15000	na	0	0	na	2	7	21	150	59SS03
Dibenzofuran	100000	7800	na	0	0	na	3	27	16	32	59SS05
Fluoranthene	2200000	230000	na	0	0	na	3	7	9.3	320	59SS03
Fluorene	2200000	230000	na	0	0	na	1	7	37	37	59SS03
Indeno(1,2,3-cd)pyrene	2100	150	na	0	0	na	1	7	96	96	59SS03
Naphthalene	20000	3900	na	0	0	na	3	7	9.6	75	59SS05
Phenanthrene	1700000	170000	na	0	0	na	3	7	52	290	59SS03
Pyrene	1700000	170000	na	0	0	na	3	7	8.2	240	59SS03
Pesticides (ug/kg)											
4,4'-DDD	7200	2000	na	0	0	na	2	25	0.676	1	59SS08
4,4'-DDE	5100	1400	na	0	0	na	1	25	0.768	0.768	59SS03
4,4'-DDT	7000	1700	na	0	0	na	3	25	1.12	4.41	59SS03
Dieldrin	110	30	na	0	0	na	3	25	0.44	4.52	59SS05
Endosulfan II	610000	47000	na	0	0	na	2	25	3.33	3.94	59SB01A
Endosulfan I	610000	47000	na	0	0	na	1	25	0.961	0.961	59SB01A
Endosulfan sulfate	na	na	na	na	na	na	2	25	2.1	7.1	59SS09
Endrin aldehyde	na	na	na	na	na	na	1	25	0.428	0.428	59SS03
Endrin ketone	na	na	na	na	na	na	3	25	1.66	2.9	59SS05
gamma-Chlordane	na	na	na	na	na	na	1	5	1.1	1.1	59SS03
Heptachlor epoxide	190	53	na	0	0	na	3	25	0.46	1.06	59SB01A
Methoxychlor	310000	31000	na	0	0	na	3	25	2.82	10.2	59SS05

Table 4-7
Overall SWMU 59 Soil Summary

Analyte	i-SL	r-SL	Background	# of i-SL Exceedances	# of r-SL Exceedances	# of Background Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
PCBs (mg/kg)											
PCB-1254	0.74	0.022	na	0	2	na	5	27	0.0111	0.061	59SS03
Explosives (mg/kg)											
1,3,5-Trinitrobenzene	2700	220	na	0	0	na	2	25	0.134	0.138	59SS05
Herbicides (ug/kg)											
2,4,5-T	620000	61000	na	0	0	na	1	23	36.6	36.6	59SS05
Metals (mg/kg)											
Aluminum	99000	7700	40041	0	0	0	28	28	3120	38100	59SB01B
Antimony	41	3.1	na	0	0	na	20	28	0.21	0.21	59SS04
Arsenic	1600	390	15.8	1	1	3	28	28	0.97	34	59SS2 (RVFS*108)
Barium	19000000	1500000	209	0	0	0	28	28	31.6	190	59SS1 (RVFS*110)
Beryllium	200000	16000	1.02	0	0	3	28	28	0.42	1.3	59SB06A
Cadmium	81	7	0.69	0	0	0	2	28	0.11	0.11	59SS03
Calcium	na	na	na	na	na	na	28	28	40.7	2680	59SS03
Chromium	1400	280	65.3	0	0	0	28	28	7.5	33.6	59SB01C
Cobalt	30000	2300	72.3	0	0	0	28	28	2.9	10.1	59SS1 (RVFS*110)
Copper	4100	310	53.5	0	0	0	28	28	3.3	19.1	59SB03B
Iron	72000	5500	50962	0	0	0	28	28	4200	38600	59SB01B
Lead	800	400	26.8	0	0	2	28	28	3.8	30.9	59SS03
Magnesium	na	na	na	na	na	na	28	28	227	2270	59SS03
Manganese	2300	180	2543	2	2	2	28	28	38.9	3630	59SB06A
Mercury	2.8	0.67	0.13	0	0	7	25	26	0.027	0.45	59SS03
Nickel	2000	160	62.8	0	0	0	28	28	5.2	12.9	59SB01B
Potassium	na	na	na	na	na	na	28	28	300	1250	59SB05B
Selenium	510	39	na	0	0	na	19	28	0.19	11.7	59SB03C
Silver	510	39	na	0	0	na	1	28	0.701	0.701	59SS2 (RVFS*108)
Sodium	na	na	na	na	na	na	24	28	17	396	59SB04B
Thallium	6.6	0.51	2.11	0	0	0	6	28	0.073	0.21	59SS04
Vanadium	720	55	108	0	0	0	28	28	12.1	74.5	59SB04B
Zinc	31000	2300	202	0	0	0	28	28	7.23	76.3	59SS03

Table 4-7
Overall SWMU 59 Soil Summary

Analyte	i-SL	r-SL	Background	# of i-SL Exceedances	# of r-SL Exceedances	# of Background Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
Dioxins/Furans (ng/kg)											
2,3,7,8-TCDF	130	37	na	0	0	na	15	25	0.157	0.566	59SS08
2,3,7,8-TCDD	18	4.5	na	0	0	na	4	25	0.166	0.248	59SS09
1,2,3,7,8-PECDD	na	na	na	na	na	na	9	25	0.0934	2.03	59SS08
1,2,3,4,7,8-HXCDD	460	100	na	0	0	na	10	25	0.148	3.47	59SS08
1,2,3,6,7,8-HXCDD	460	100	na	0	0	na	12	25	0.106	8.25	59SS08
1,2,3,7,8,9-HXCDD	460	100	na	0	0	na	12	25	0.233	9.49	59SS08
1,2,3,4,6,7,8-HPCDD	na	na	na	na	na	na	25	25	0.82	274	59SS06
OCDD	61000	15000	na	0	1	na	25	25	56.8	17400	59SS06
1,2,3,7,8-PECDF	440	120	na	0	0	na	8	25	0.0807	0.302	59SS06
2,3,4,7,8-PECDF	44	12	na	0	0	na	8	25	0.101	0.537	59SS08
1,2,3,4,7,8-HXCDF	na	na	na	na	na	na	13	25	0.137	2.11	59SS07
1,2,3,6,7,8-HXCDF	na	na	na	na	na	na	11	25	0.0807	1.38	59SS08
2,3,4,6,7,8-HXCDF	na	na	na	na	na	na	8	25	0.0913	1.95	59SS08
1,2,3,7,8,9-HXCDF	na	na	na	na	na	na	3	25	0.121	0.581	59SS06
1,2,3,4,6,7,8-HPCDF	na	na	na	na	na	na	22	25	0.389	49.2	59SS08
1,2,3,4,7,8,9-HPCDF	na	na	na	na	na	na	8	25	0.287	2.09	59SS08
OCDF	44000	12000	na	0	0	na	18	25	0.661	150	59SS06
TOTAL TCDD	na	na	na	na	na	na	7	25	0.074	13.3	59SS10
TOTAL PECDD	18	4.5	na	0	0	na	8	25	0.504	7.45	59SS08
TOTAL HXCDD	180	45	na	0	0	na	17	25	0.268	55.3	59SS08
TOTAL HPCDD	1800	450	na	0	2	na	25	25	1.867	490	59SS06
TOTAL TCDF	na	na	na	na	na	na	15	25	0.0669	5.3	59SS09
TOTAL PECDF	na	na	na	na	na	na	10	25	0.041	8.48	59SS08
TOTAL HXCDF	130	37	na	0	0	na	18	25	0.103	49.4	59SS06
TOTAL HPCDF	1300	370	na	0	0	na	22	25	0.295	154	59SS06
Misc.											
Total Organic Carbon (mg/kg)	na	na	na	na	na	na	1	1	14000	14000	59SS03
pH	na	na	na	na	na	na	1	1	7.24	7.24	59SS03

Prior to the 2002 sampling event, only one SVOC (phenanthrene) and metals were detected at all at SWMU 59. However, the only analyte groups tested for were SVOCs, pesticides, PCBs, and metals. The only analytes detected above SLs in 1992 samples were two metals (arsenic and manganese).

Before the 2007 sampling event, dioxins/furans were not detected in soil at SWMU 59. There were no constituents that were detected above SLs in all sampling events. However, one SVOC [benzo(a)pyrene] and one PCB (PCB-1254) were detected above screening levels in both 2002 and 2007. In 2002, benzo(a)pyrene was detected above its r-SL only in one surface soil sample (59SS03) at a concentration of 46 µg/kg, when its r-SL was 15 µg/kg. In 2007, benzo(a)pyrene was only detected in surface soil samples at concentrations of 23.9, 35.6, 19.6, and 40 µg/kg, above its previously-listed r-SL, in samples 59SB03A, 59SS06, 59SS07, and 59SS08, respectively. PCB-1254 was only detected in 2002 sample 59SS03 at a concentration of 0.061 mg/kg, above its r-SL of 0.022 mg/kg. In 2007, PCB-1254 was only detected above its r-SL in surface soil sample 59SS08 at a concentration of 0.0247 mg/kg. These detections above screening levels were in surface soil samples and were not able to be duplicated at such high concentrations in subsurface samples collected beneath them.

The only analytes that were SL exceedances in previous SWMU 50 soil investigations that were also detected in 2007 groundwater samples were two metals (arsenic and manganese) and two dioxins/furans (OCDD and total HPCDD). Therefore, this finding suggests that mobility from soils into groundwater is very low.

Results from the investigations at SWMUs 59 indicate that most negative impacts to soil resulting from the waste burial areas have been mitigated during the years since the waste was deposited.

4.3.2 Groundwater

Groundwater for the two sites is assessed together in this section due to the proximity of the two sites and the similarity of constituents in groundwater at the two sites. It should be noted that groundwater remediation in this area has been recommended for SWMU 49. The remediation at SWMU 49 is intended to address VOC constituents in groundwater throughout the SWMUs 48, 49, 50, and 59 area. The distribution of elevated soil constituents in groundwater is discussed for the two sites at the end of the section.

Groundwater at SWMUs 50 and 59 was first investigated during the 2007 investigation. In 2007, two groundwater monitoring wells were installed at SWMU 50 and one at SWMU 59 intending to assess the groundwater conditions at these individual SWMUs and to identify potential source areas. The wells were also installed to assess impacts to groundwater from the analytes detected in site soil.

Groundwater results from the 2007 sampling event indicated that VOCs (CT, PCE, and TCE), one SVOC [bis(2-ethylhexyl)phthalate], TAL metals (aluminum, arsenic, cadmium, chromium, cobalt, iron, lead, manganese, mercury, and vanadium), and dioxins/furans (2,3,4,7,8-PECDF; total PECDD; total HXCDD; total HPCDD; and total HXCDF) exceeded their SLs in site samples. The only VOC concentrations of CT, TCE, and PCE were found in well 50MW2 above their tw-SLs but under their MCLs. Vinyl chloride (a breakdown product of TCE and PCE) was analyzed for and not found in any of the samples. The only SVOC detection of bis(2-ethylhexyl)phthalate was detected in well 50MW02 at only 2 micrograms per liter (µg/L)

over the MCL. In wells 50MW01 and 50MW02, aluminum, iron, and manganese were detected above their MCL and tw-SLs. In well 50MW01, arsenic, cadmium, chromium, cobalt, and mercury were also detected above their tw-SLs only. Lead was detected above its MCL only in wells 50MW01 and 50MW02, because it does not have a tw-SL. In well 50MW02, chromium and cobalt were detected only above their tw-SLs. In well 59MW01, only aluminum and iron were detected above their MCLs. One total dioxin/furan (total HXCDF) was detected above its tw-SL in wells 50MW02 and 59MW01. Two other total dioxins/furans (total HXCDD and total HPCDD) were detected in well 50MW02 at levels above their tw-SLs. Two other dioxins/furans (2,3,4,7,8-PECDF and total PECDD) were also detected in well 59MW01 at levels above their tw-SLs.

In addition, nine other metals (barium, beryllium, calcium, copper, magnesium, nickel, potassium, sodium, and zinc), perchlorate, and 15 dioxins/furans (2,3,7,8-TCDF; 1,2,3,7,8-PECDD; 1,2,3,7,8,9-HXCDD; 1,2,3,4,6,7,8-HPCDD; OCDD; 1,2,3,7,8-PECDF; 1,2,3,4,7,8-HXCDF; 1,2,3,6,7,8-HXCDF; 2,3,4,6,7,8-HXCDF; 1,2,3,7,8,9-HXCDF; 1,2,3,4,6,7,8-HPCDF; OCDF; total TCDF; total PECDF; and total HPCDF) were detected, but did not exceed their SLs. However, the groundwater copper detections were "B" flagged during data validation, indicating that copper was also detected in associated laboratory blanks. The "B" flags suggest that the copper is not site-related. PAHs, pesticides, PCBs, explosives, and herbicides were not detected in 2007 site groundwater samples. A summary of all analytes detected in SWMU 50 and SWMU 59 groundwater during the 2007 investigation can be found in **Table 4-8**.

Table 4-8
Overall SWMU 50 and SWMU 59 Groundwater Summary

Analyte	MCL	tw-SL	# of MCL Exceedances	# of tw-SL Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
VOCs (ug/L)									
Carbon tetrachloride	5	0.2	0	1	1	3	2.7	2.7	50MW02
Tetrachloroethene	5	0.11	0	1	1	3	0.84	0.84	50MW02
Trichloroethene	5	1.7	0	1	1	3	3.4	3.4	50MW02
PAHs (ug/L)		None detected							
SVOCs (ug/L)									
bis(2-Ethylhexyl)phthalate	6	4.8	1	1	1	3	8	8	50MW02
Pesticides (ug/L)		None detected							
PCBs (ug/L)		None detected							
Explosives (ug/L)		None detected							
Herbicides (ug/L)		None detected							
Metals (ug/L)									
Aluminum	50	3700	3	2	3	3	725	38600	50MW01
Arsenic	10	0.045	0	1	1	3	9.1	9.1	50MW01
Barium	2000	730	0	0	3	3	191	357	50MW01
Beryllium	4	7.3	0	0	1	3	1.8	1.8	50MW01
Cadmium	5	1.8	0	1	1	3	3	3	50MW01
Calcium	na	na	na	na	3	3	30700	2770000	50MW01
Chromium	100	11	0	2	3	3	9.8	78.7	50MW01
Cobalt	na	1.1	na	2	2	3	3.8	19.6	50MW01
Copper	1300	150	0	0	2	3	9.3	17.8	50MW01
Iron	300	2600	3	2	3	3	801	40900	50MW01
Lead	15	na	2	na	2	3	65.7	237	50MW01
Magnesium	na	na	na	na	3	3	23800	1720000	50MW01
Manganese	50	88	2	2	3	3	20.5	1230	50MW01
Mercury	2	0.063	0	1	1	3	0.13	0.13	50MW01
Nickel	na	73	na	0	3	3	5.8	49.8	50MW01
Potassium	na	na	na	na	3	3	2090	19300	50MW01
Sodium	na	na	na	na	3	3	1460	19900	50MW01
Vanadium	na	26	na	1	3	3	1.8	138	50MW01
Zinc	5000	1100	0	0	2	3	137	223	50MW01

Table 4-8
Overall SWMU 50 and SWMU 59 Groundwater Summary

Analyte	MCL	tw-SL	# of MCL Exceedances	# of tw-SL Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
Dioxins/Furans (ug/L)									
2,3,7,8-TCDF	na	0.0052	na	0	1	3	0.00337	0.00337	50MW02
1,2,3,7,8-PECDD	na	na	na	na	1	3	0.00302	0.00302	59MW01
1,2,3,7,8,9-HXCDD	na	0.011	na	0	1	3	0.00501	0.00501	50MW02
1,2,3,4,6,7,8-HPCDD	na	na	na	na	1	3	0.0338	0.0338	50MW02
OCDD	na	1.7	na	0	3	3	0.00703	1.1	50MW02
1,2,3,7,8-PECDF	na	0.017	na	0	1	3	0.0037	0.0037	59MW01
2,3,4,7,8-PECDF	na	0.0017	na	1	1	3	0.00298	0.00298	59MW01
1,2,3,4,7,8-HXCDF	na	na	na	na	2	3	0.00307	0.00376	50MW02
1,2,3,6,7,8-HXCDF	na	na	na	na	1	3	0.00271	0.00271	59MW01
2,3,4,6,7,8-HXCDF	na	na	na	na	1	3	0.0019	0.0019	59MW01
1,2,3,7,8,9-HXCDF	na	na	na	na	1	3	0.00253	0.00253	59MW01
1,2,3,4,6,7,8-HPCDF	na	na	na	na	2	3	0.00309	0.0238	50MW02
OCDF	na	1.7	na	0	1	3	0.0513	0.0513	50MW02
TOTAL PECDD	na	0.00052	na	1	1	3	0.00302	0.00302	59MW01
TOTAL HXCDD	na	0.0052	na	1	1	3	0.0197	0.0197	50MW02
TOTAL HPCDD	na	0.052	na	1	1	3	0.0802	0.0802	50MW02
TOTAL TCDF	na	na	na	na	1	3	0.00509	0.00509	50MW02
TOTAL PECDF	na	na	na	na	1	3	0.00667	0.00667	59MW01
TOTAL HXCDF	na	0.0052	na	2	2	3	0.00704	0.0102	59MW01
TOTAL HPCDF	na	0.052	na	0	2	3	0.00309	0.0238	50MW02
Misc.									
Perchlorate	na	2.6	na	0	3	3	0.203	0.288	50MW02

5.0 CONTAMINANT FATE AND TRANSPORT

This section presents a discussion of the fate and transport mechanisms for chemicals of potential concern (COPCs) at SWMUs 50 and 59. Physical and chemical properties of the impacted media and of the contaminant(s) affect the fate and persistence of contamination in the environment (Rosenblatt et al., 1975). A general discussion of the physical properties and mechanisms which may govern the fate of contaminants in the environment, and a discussion of contaminant transport is presented in **Appendix D**. A discussion of the physical and chemical properties affecting soil conditions at SWMUs 50 and 59 is presented as *Section 5.1*.

In terms of the soil samples collected at SWMU 50 in 1992, one VOC (chloroform) was detected at a concentration of 2000 µg/kg, greater than its respective i-SL (1500 µg/kg) and r-SLs (300 µg/kg) in sample 50SL1 (RVFS*9). In SWMU 50 2002 soil samples, one PAH [benzo(a)pyrene] was detected above its r-SL in three samples (50SS02, 50SB04C, and 50SB05A). Additionally, one SVOC [benzo(a)pyrene], one PCB (PCB-1254), and three metals (lead, mercury, and nickel) were detected above their SLs. In 2007 SWMU 50 samples, two PAHs [benzo(a)pyrene and benzo(b)fluoranthene], PCB-1254, three metals (chromium, copper, and nickel), and seven dioxins/furans (1,2,3,6,7,8-HXCDD; OCDD; total PECDD; total HXCDD; total HPCDD; total HXCDF; and total HPCDF) were detected above SLs.

Detected above SLs and background levels in the 1992 SWMU 59 soil samples were two metals (arsenic and manganese), respectively in samples 59SS2 (RVFS*108) and 59SS1 (RVFS*110). In 2002 SWMU 59 soil samples, one PAH [benzo(a)pyrene], three SVOCs [benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene], and PCB-1254 were detected above their SLs. 2007 SWMU 59 soil samples showed that one PAH [benzo(a)pyrene], PCB-1254, manganese, and five dioxins/furans (OCDD; total PECDD; total HXCDD; total HPCDD; and total HXCDF) were detected above SLs.

A generalized fate and transport discussion for those constituents identified as risk drivers in the HHRA is presented in *Section 5.2*. A discussion of the fate of risk drivers by natural attenuation factors is presented in *Section 5.3*.

5.1 Soil Properties Affecting Fate and Transport

Chemical and physical properties of soil influence the fate and transport of constituents through the environment. Grain size distribution, pH, and TOC are commonly used to assess these chemical and physical characteristics of the soil. A summary of each follows.

Grain Size Distribution. The grain size distribution measures the amount of clay, silt, sand, and gravel in a sample based on the diameter of the material. Soil particles less than 0.002 millimeters are classified as clay and have a very large specific surface area, allowing them a significant capacity to adsorb water and other substances. Clay composition greatly influences soil fertility and the physical conditions of the soil. Clay directly affects the permeability and the plasticity of soil by generally lowering the soil's permeability and increasing the plasticity. Because pores between clay particles are very small and convoluted, movement of both water and air is very slow. Fate and transport of chemical compounds are hindered when passing through a soil with a high composition of clay due to clay's ability to adsorb cations and to retain soil moisture. The surface soil at SWMUs 50 and 59 is comprised of fill material. The site soil beneath the fill at SWMUs 50 and 59 is mostly clay and silt with little sand. Therefore, the site

soil beneath SWMUs 50 and 59 has a high percentage of soil and is a low permeability zone where it is more difficult for constituents to pass through the soil.

The grain size distribution is also used to assess the permeability of soil. Well-sorted sands and gravels have a smaller distribution of grain size and a higher permeability. Poorly sorted, clayey sands and gravels have a large range in grain size and lower permeability because the smaller clay and silt particles fill in the void spaces between the sand and gravel. The soils beneath the fill at SWMUs 50 and 59 were poorly sorted and therefore aided in a lower permeability rate.

Soil pH. Soil pH is a measure of acidity or alkalinity and is an important chemical property because it is an indication of soil reaction potential. Soil reaction influences the fate of many pollutants, affecting their breakdown and potential movement. For example, hydrolysis is the reaction of a compound with water. It usually involves the introduction of a hydroxyl (-OH) group into an organic compound, usually at a point of unbalanced charge distribution. The hydrolysis reaction can displace halogens and may be catalyzed by the presence of acids, bases, or metal ions. Therefore, the rate of hydrolysis is pH and metal-ion concentration dependent. The transport of some contaminants is also affected by pH. This is less significant for neutral and slightly polarized organic compounds, which are somewhat affected by pH, but is significant for chemicals that tend to ionize (Lyman et al., 1990). When the pH of the groundwater is approximately 1.0 to 1.5 units above the negative log of the acid dissociation constant (pK_a), adsorption becomes significant, retarding transport rates. pH also affects the rate of biodegradation that may occur at a site. Most bacteria find the optimum pH range to be 6.5 to 7.5 and are not able to survive at pH values greater than 9.5 or below 4.0 (Knox et al., 1993).

Soil at RFAAP generally ranges in pH from slightly less than 4.0 to slightly more than 9.61. A review of pH results during the *Facility-Wide Background Study Report* (IT, 2001) across soil types at the Main Manufacturing Area did not yield outstanding trends. Higher soil pH results were generally associated with limestone and shale parent material (IT, 2001).

pH groundwater measurements were taken at SWMUs 50 and 59 wells in August 2007. Those measurements ranged between 6.37 and 7.55. This means that the site groundwater has the optimum pH for bacteria to thrive and degradation to occur.

TOC. Organic matter content is expressed as a percentage, by weight, of the soil material that is a composition of plant and animal residues in the soil at various stages of decomposition. Available water capacity and infiltration rate are affected by organic matter content. Sorption and desorption are two major mechanisms affecting the fate of contaminants in the subsurface. Sorption is the process by which a compound is retained onto a solid particle rather than remaining dissolved in solution. The sorption of contaminants to the soil matrix is an important factor affecting their transport in terrestrial environments. Hydrophobic contaminants will accumulate at an interface or partition into a nonpolar phase (e.g., associate with the organic content of the subsurface medium) rather than partition into the water phase. For nonionic organic chemicals and aquifer materials, sorption is largely controlled by the clay and organic carbon content of the soil. The soil type in this area is the Braddock Loam, which is described as yellowish-brown grading into yellowish-red and red clay extending to a depth of 60 inches or more. So, there is a good percentage of clay in the soil beneath SWMUs 50 and 59 and therefore the permeability is moderate and sorption is low. In addition, this means that the amount of TOC present in the soil matrix has a large effect on the fate of both organic and inorganic compounds. The degree to which TOC affects the fate of a chemical varies dependent on the properties of the

chemical itself. Soil TOC concentrations at RFAAP range from 0.075 to 30.4 percent, with a median value of 0.5 percent.

5.2 Fate and Transport of Analytes Detected Above Screening Levels

As discussed in *Section 4.0*, the analytes that were detected above SLs at SWMU 50 between 1991 and 2007 were one VOC (chloroform), two PAHs [benzo(a)pyrene and benzo(b)fluoranthene], one SVOC [benzo(a)pyrene], PCB-1254, five metals (chromium, copper, lead, mercury, and nickel), and seven dioxins/furans (1,2,3,6,7,8-HXCDD; OCDD; total PECDD; total HXCDD; total HPCDD; total HXCDF; and total HPCDF). Constituents detected at concentrations above soil SLs at SWMU 59 between 1991 and 2007 were one PAH [benzo(a)pyrene], three SVOCs [benz(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene], PCB-1254, two metals (arsenic and manganese), and two dioxins/furans (OCDD and total HPCDD).

None of these exceedances were identified as risk drivers in the HHRA for SWMUs 50 and 59 (*Section 6.0*). Specific characteristics of the evaluated possible risk drivers are discussed in more detail in the following sections.

5.2.1 Arsenic

In all the 28 SWMU 59 soil samples, arsenic was detected above its r-SL (3.9 mg/kg) and its i-SL (16 mg/kg) in only one 1992 sample, 59SS2 (RVFS*108).

Arsenic is a naturally-occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds (ATSDR, 2007a).

Inorganic arsenic compounds are mainly used to preserve wood. Chromated copper arsenate (CCA) is used to make "pressure-treated" lumber. CCA is no longer used in the U.S. for residential uses; it is still used in industrial applications. Organic arsenic compounds are used as pesticides, primarily on cotton fields and orchards (ATSDR, 2007a).

Arsenic occurs naturally in soil and minerals and may enter the air, water, and land from wind-blown dust and may get into water from runoff and leaching. Arsenic cannot be destroyed in the environment. It can only change its form. Rain and snow remove arsenic dust particles from the air. Many common arsenic compounds can dissolve in water. Most of the arsenic in water will ultimately end up in soil or sediment (ATSDR, 2007a).

5.2.2 PCBs (Aroclor-1254)

PCB-1254 or Aroclor-1254 was detected above SLs in 12 out of 31 SWMU 50 soil samples tested. They were all relatively low detections, with the highest being 1.48 mg/kg whereas the i-SL is 0.74 mg/kg. It was also detected above its r-SL in only two surface soil samples out of 27 samples tested at SWMU 59, with the highest concentration there being 0.061 mg/kg, just above its r-SL of 0.022 mg/kg.

PCBs, which are also known by the trade name "Aroclor," were produced by the partial chlorination of biphenyl in the presence of a catalyst. The production of PCBs in large quantities began in 1929. PCBs were used as heat transfer liquids, hydraulic fluids, and lubricants, as well as plasticizers, surface coatings, inks, adhesives, and pesticide extenders. It is estimated that 77 percent of the total PCBs produced between 1930 and 1975 were used as coolants and

lubricants in transformers, capacitors, and other electrical equipment (Dames and Moore, 1992). The manufacture of PCBs in the United States ceased in 1977 because of evidence that PCBs were toxic and accumulated in the environment.

PCBs are distinguished by a four-digit code in which the first two digits (e.g., 12) indicate the production process and the second two digits indicate the weight percent of chlorine (e.g., 48). Thus, Aroclor-1254 is a PCB with an average chlorine content of 54 percent. The water solubility for this compound is approximately 10^{-2} milligrams per liter (mg/L). Therefore, this compound is not soluble in water. The vapor pressure of PCBs is approximately 10^{-5} mm Hg. As a result of the low vapor pressure, this PCB will not volatilize to the atmosphere. This point is further supported by Henry's Law Constant, which for this compound is on the order of 10^{-4} atm-m^3/mole.

PCBs are persistent in the environment and are resistant to oxidation and hydrolysis. The properties that made PCBs applicable for industrial use are the same properties that cause it to be persistent in the environment: chemical stability; thermal stability; resistance to hydrolysis by water, alkalis, and acids; and, low flammability. Aroclor-1254 will tend to remain in the soil once it is released into the environment.

5.2.3 PAHs [Benzo(a)pyrene]

Two PAHs [benzo(a)pyrene and benzo(b)fluoranthene] were detected above their r-SLs in SWMU 50 soil samples throughout all the investigations. Benzo(a)pyrene was also detected in five samples, at concentrations greater than its r-SL, among the 25 soil samples collected from SWMU 59.

The presence of benzo(a)pyrene is likely due to leachate from buried asphalt or treated wood generated during construction.

PAHs are a group of more than 100 organic compounds of two or more aromatic rings. As a general rule, when PAH compounds grow in molecular weight, their solubility in water decreases, solubility in fat tissues increases, and their melting and boiling points increase (Environment Canada, 1997). The solubility ranges of the PAHs detected at the site indicate that the present PAHs are not soluble in water. PAHs were not detected in groundwater site samples, indicating that PAHs have not migrated from soil to groundwater.

In addition, the vapor pressure ranges of the present PAHs indicate that these compounds do not readily volatilize into the atmosphere and this is further supported by the values of the Henry's law constants. The organic carbon/water partition coefficient (K_{oc}) is a measure of the tendency of a chemical to be sorbed to the organic fraction of soil. The logarithm ($\log_{10}$) of the K_{oc} values for the PAHs detected indicates that these PAHs have high sorption potentials and will not tend to leach into surface water runoff. This is further supported by the octanol/water partition coefficient, K_{ow}, which is an indication of whether a compound will dissolve in a solvent (i.e., n-octanol) or water. The PAHs detected at this site are nonpolar and hydrophobic and, as mentioned above, will tend to sorb to soil rather than partition into the polar water phase. In summary, the physical properties of benzo(a)pyrene and benzo(a)anthracene indicate they tend to have relatively low mobility and to be very persistent in the environment.

5.2.4 Dioxins/Furans

Seven dioxins/furans (1,2,3,6,7,8-HXCDD; OCDD; total PECDD; total HXCDD; total HPCDD; total HXCDF; and total HPCDF) were detected above SLs in samples collected from SWMU 50.

Two dioxins/furans (OCDD and total HPCDD) were detected above r-SLs in SWMU 59 samples.

Dioxins/furans make up a family of chemicals with related properties and toxicity. There are 75 different forms of dioxins, while there are 135 different furans. Dioxins/furans are not manufactured or used. Instead, these groups of chemicals are formed unintentionally in two ways: (1) as a chemical contaminant of industrial processes involving chlorine or bromine, or (2) by burning organic matter in the presence of chlorine. The principal sources of dioxins/furans in the environment are combustion and incineration, chemical manufacturing, pulp and paper mills, as well as metal refining and smelting.

Several research studies have indicated that dioxins/furans act like a hormone, with effects that include neurotoxicity; immunotoxicity; and reproductive, developmental, and endocrine toxicity, including diabetes. Additional evidence exists that exposure to dioxins/furans at high levels for long periods of time causes cancer in humans (Gibbs, 1995).

Dioxins and furans share many physical properties, several of which influence how these compounds will behave in the environment. Dioxin and dioxin-like chemicals are not very water soluble. For example, the water solubility of TCDD, the most toxic dioxin, is 2.0×10^{-4} mg/L at 25°C. Dioxins/furans also have low vapor pressures (e.g., 1.0×10^{-6} mm Hg for TCDD at 25°C), which means that these compounds do not readily volatilize to the atmosphere. Dioxins and furans have high K_{oc} values (i.e., $3.30 \times 10^{+6}$ for TCDD) indicating that dioxins and furans have high sorption potentials and will not tend to leach into groundwater or surface water runoff.

Chemicals with high K_{ow} values, such as dioxins and furans, are relatively hydrophobic and will tend to sorb to soil rather than partitioning into the polar water phase.

Dioxins and furans with four or more chlorine atoms (i.e., OCDD and HpCDF) are extremely stable, with photolysis as the single significant degradation process. In the photodecomposition process, lower chlorinated congeners are formed (Crosby et al., 1971; Miller et al., 1989). Higher chlorinated congeners will have lower rates of decomposition. In addition, in or on solid phases, photochemical transformation results in a preferential loss of chlorine on the 1, 4, 6, and 9 positions leading to the formation of more toxic compounds (Lamparski et al., 1980; Nestrick et al., 1980). Since sunlight penetration becomes restricted in subsurface soil, photolysis of dioxins and furans will predominantly occur in the top layer of soil.

In summary, dioxins and furans appear to be relatively immobile in soil due to their strong sorption behavior and limited water solubility. In soil systems, photolysis is the most significant degradation mechanism for dioxins/furans. However, degradation rates tend to be extremely slow and confined to the surface layer of the soil. Therefore, any dioxins/furans found in the trench sludge most likely did not degrade due to the lack of light at that depth.

6.0 HUMAN HEALTH RISK ASSESSMENT

These HHRAs evaluate the probability and magnitude of potential adverse effects on human health associated with exposure to site-related chemicals in soil, surface water, sediment, and groundwater. The HHRAs were conducted for each of the sites consistent with guidance included in USEPA's *Interim Final Risk Assessment Guidance for Superfund* (RAGS) and other current USEPA/USEPA Region III resources and guidance documents as noted throughout this section and on the RAGS Part D tables provided in **Appendices E-1 and E-2**. Additional information regarding the site background can be found in *Section 2.0*. This HHRA consists of the following six sections:

- **Section 6.1: Data Summary and Selection of COPCs:** Relevant site data are gathered, examined, and discussed. Basic constituent statistics and SLs are summarized. COPCs are identified by comparison to screening criteria as discussed in *Section 6.1.2*.
- **Section 6.2: Exposure Assessment:** Potentially exposed populations (e.g., receptors) and exposure routes are identified, and exposure point concentrations (EPCs) are calculated for COPCs. Standard exposure factors and health-protective assumptions are used to assess the magnitude, frequency, and duration of exposure for each exposure route and intakes are calculated.
- **Section 6.3: Toxicity Assessment:** Toxicity criteria for COPCs are compiled and presented.
- **Section 6.4: Risk Characterization:** Quantitative risks and hazards are estimated and summarized by combining toxicity criteria with intakes for each exposure route.
- **Section 6.5: Uncertainties Analysis:** Uncertainties, "including uncertainties in the physical setting definition for the site, in the models used, in the exposure parameters, and in the toxicity assessment" (USEPA, 1989a) are discussed.
- **Section 6.6: Summary and Conclusions:** The results of the HHRAs are summarized.

The tabulated risk assessment results are presented in accordance with USEPA guidance described in *RAGS: Volume I - Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments)* (USEPA, 2001a). RAGS D requires the risk assessment results to be presented in a series of standardized tables, which are presented in **Appendix E-1** for SWMU 50 and **Appendix E-2** for SWMU 59.

6.1 DATA SUMMARY AND SELECTION OF COPCS

6.1.1 Data Summary

Table 6-1 identifies the soil samples used in the HHRA for SWMUs 50 and 59. Although groundwater is present at these units, the groundwater for the combined study area of SWMUs 48, 49, 50, and 59 was evaluated as part of a separate RFI/CMS for SWMUs 48 and 49 (Shaw, 2008). For this HHRA, it assumed that the groundwater is being addressed and no duplicate evaluation of the groundwater is included. For completeness, the results of the groundwater evaluation will be summarized in *Section 6.4*. The complete data tables for detected analytes for each media are provided in *Section 4.0*. Additional information regarding the data used in the HHRAs is summarized below:

Table 6-1
SWMU 50 and SWMU 59
Sample Groupings

SWMU 50		
SURFACE SOIL[a]		
50SS01	50SS02	50SS03
50SB04A	50SB08A	50SB12A
50SB05A	50SB09A	50SB13A
50SB06A	50SB10A	50SB14A
50SB07A	50SB11A	50SB15A
TOTAL SOIL[b]		
50SB04A	50SB07A	50SB11A
50SB04B	50SB07B	50SB11B
50SB04C	50SB08A	50SB12A
50SB05A	50SB08B	50SB12B
50SB05B	50SB09A	50SB13A
50SB05C	50SB09B	50SB13B
50SB06A	50SB10A	50SB14A
50SB06B	50SB10B	50SB14B
50SS01	50SL1 (RVFS*9)	50SB15A
50SS02	50SL2 (RVFS*10)	50SB15B
50SS03		

SWMU 59		
SURFACE SOIL[a]		
59SB02A	59SS07	59SS2 (RVFS*109)
59SB03A	59SS08	59SB01A
59SB04A	59SS09	59SS03
59SB05A	59SS10	59SS04
59SB06A	59SS1 (RVFS*110)	59SS05
59SS06	59SS2 (RVFS*108)	
TOTAL SOIL[b]		
59SB02A	59SB05C	59SS1 (RVFS*110)
59SB02B	59SB06A	59SS2 (RVFS*108)
59SB02C	59SB06B	59SS2 (RVFS*109)
59SB03A	59SB06C	59SB01A
59SB03B	59SS06	59SB01B
59SB03C	59SS07	59SB01C
59SB04A	59SS08	59SS03
59SB04B	59SS09	59SS04
59SB04C	59SS10	59SS05
59SB05A	TMSB02B	TMSB01B
59SB05B	TMSB04C	

(a) Surface soil samples consist of samples collected at depths of 0 to 0.5 feet.

(b) Total soil sample group includes all surface soil and subsurface soil samples from 0 to 10 ft.

- Though several dioxins are known to be toxic, toxicity criteria are limited to 2,3,7,8-TCDD. Therefore, the HHRA uses the method outlined in Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-dioxins and Dibenzofurans (CDDs and CDFs) (USEPA, 1989b, 1994b; Van den Berg et al, 2006) to assess risks due to exposure to dioxins and/or furans. Each congener is assigned a TEF, which corresponds to its toxicity relative to 2,3,7,8-TCDD. Each congener detection is multiplied by its corresponding TEF; the adjusted concentrations are then summed to derive one total 2,3,7,8-TCDD equivalent concentration for each sample. This concentration is then compared with toxicity criteria for 2,3,7,8-TCDD to calculate risks. TEFs are presented and total 2,3,7,8-TCDD equivalents are calculated for surface soil and total soil in **Appendix E-3**.
- If a constituent was measured by two methods, results from the more sensitive analytical method were used. For example, PAHs were analyzed as part of the SVOC method, as well as by a PAH-specific method. Results from the specific method were used.
- J-flagged data (estimated concentration) are considered detections and are used without modification.
- The qualification and validation of the analytical data included a comparison of the site data to corresponding blank (laboratory, equipment rinse, field, and trip) concentration data. If the detected concentration in a site sample was less than ten times (for common laboratory contaminants) or five times (for other compounds) the concentration in the corresponding blank sample, the sample was qualified with a "B." According to USEPA Region III guidance (USEPA, 1995a, 2000b), it cannot be unequivocally stated that the result is not "non-detected" at that concentration. Therefore, B-qualified data are typically eliminated from the data set.
- Rejected results (R-flagged) are not used.
- Data from duplicate sample pairs are averaged and treated as one result. If an analyte is detected in one of the sample pair, one half the detection limit of the non-detect is averaged with the detected result and the result is considered detected.

Additional information regarding specific soil samples used in the HHRA is provided in *Section 6.1.1.1*. Groundwater sampling for SWMUs 48, 49, 50, and 59 is discussed in *Section 6.1.1.2*.

6.1.1.1 Surface Soil and Total Soil

The soil samples used for COPC screening of SWMU 50 were collected during sampling events in 1991, 2002, and 2007. The soil samples used for COPC screening of SWMU 59 were collected during sampling events in 1992, 2002, and 2007. As presented in **Table 6-1**, the soil samples for SWMUs 50 and 59 have been divided into surface soil (0 to 0.5 ft bgs) and subsurface soil (typically 4 to 10 ft bgs). The total soil data grouping was assembled by combining the surface and subsurface soil data sets to address mixing of potential soil contamination during construction or land development activities. A total of 15 surface soil samples and 16 subsurface soil samples were used in the HHRA for SWMU 50. A total of 17 surface soil samples and 15 subsurface soil samples were used in the HHRA for SWMU 59.

6.1.1.2 Groundwater

Groundwater samples representing the study area for SWMUs 48, 49, 50, and 59 were collected during sampling events in 1998 and 2007. A total of 16 samples and two duplicate samples were evaluated as part of a separate RFI/CMS for SWMU 48 and 49. As stated in *Section 6.1.1*, this HHRA is focused on the soil at SWMUs 50 and 59.

6.1.2 Identification of COPCs

COPCs were identified for the sites by comparing the maximum detected concentration (MDC) in surface soil and total soil with the USEPA Residential Soil SLs as presented in the September 2008 USEPA Regional Screening Tables (USEPA, 2008). In accordance with USEPA regional guidance, SLs for non-carcinogenic chemicals were adjusted downward to a hazard quotient (HQ) of 0.1 to ensure that chemicals with additive effects were not prematurely eliminated during screening. Although current and future land uses at SWMUs 50 and 59 are most likely to be industrial in nature, r-SLs (rather than industrial) were used for comparisons with soil concentrations. Because the residential scenario was evaluated for this HHRA, r-SLs were used to screen chemicals in soil as a conservative measure. In addition, lead action levels of 400 mg/kg for residential receptors were used in the COPC identification since toxicity criteria were not available for lead (USEPA, 1994a).

The maximum concentrations of the four essential human nutrients that do not have SLs (i.e., calcium, magnesium, potassium, and sodium) were compared with dietary Allowable Daily Intakes. The essential nutrients calcium, magnesium, potassium and sodium were eliminated as COPCs. Although iron is also an essential nutrient, there is an SL available for iron. If iron concentrations in soil resulted in an HQ of 1.0 or greater, a "margin of exposure" evaluation was also performed. Risks from exposure to iron were characterized by comparing estimated iron intake to the Recommended Daily Allowance (RDA) and concentrations known to cause effects in children (USEPA, 1996).

Analytes detected at a maximum concentration greater than the corresponding adjusted SL or screening values identified above for nutrients and lead were selected as COPCs. Analytes for which no screening criteria exist were also selected as COPCs. COPC screening tables for each area are presented in **Appendix E-1, Tables E.1-2** (COPC Determination Detects-Surface Soil) and **E.1-4** (COPC Determination Detects-Total Soil) for SWMU 50, and **Appendix E-2, Tables E.2-2** (COPC Determination Detects-Surface Soil) and **E.2-4** (COPC Determination Detects-Total Soil) for SWMU 59. The COPCs selected for each medium are summarized in **Table 6-2** for SWMU 50 and **Table 6-3** for SWMU 59.

Similarly, the reporting limits for those constituents that were not detected were compared with SLs for each medium. Chemicals that were not detected in at least one medium have not been included in the HHRA. The reporting limits for the non-detected constituents were screened against the SLs to ensure that the range of reporting limits was generally low enough to detect constituents that would exceed SLs. The maximum reporting limits for these constituents were compared with SLs. The results of these comparisons for SWMU 50 are shown in **Appendix E-1, Tables E.1-3** (Non-Detect Screening-Surface Soil) and **E.1-5** (Non-Detect Screening-Total Soil) and for SWMU 59 in **Appendix E-2, Tables E.2-3** (Non-Detect Screening- Surface Soil) and **E.2-5** (Non-Detect Screening-Total Soil). Detected constituents identified as COPCs were carried through the quantitative risk assessment. The reporting limits

Table 6-2
Summary of Chemicals of Potential Concern at SWMU 50

Chemical (a)	Surface Soil	Total Soil
Organics		
Aroclor 1254	X	X
Benzo(a)pyrene		X
Benzo(b)fluoranthene	X	X
Carbazole	X	X
Chloroform		X
Dibenzofuran	X	X
Dimethyl phthalate	X	X
2,4-Dinitrotoluene	X	X
TCDD-Toxicity Equivalent	X	X
Inorganics		
Aluminum	X	X
Arsenic	X	X
Chromium		X
Cobalt	X	X
Copper		X
Iron	X	X
Lead		X
Manganese	X	X
Nickel		X
Vanadium	X	X

(a) Chemicals detected in all media at SWMU 50.
Shaded cells indicate that the chemical lacks toxicity criteria and cannot be quantitatively evaluated.
X = Selected as a COPC in this media.

Table 6-3
Summary of Chemicals of Potential Concern at SWMU 59

Chemical (a)	Surface Soil	Total Soil
Organics		
Benzo(a)pyrene	X	X
Carbazole	X	X
Dibenzofuran	X	X
TCDD-Toxicity Equivalent	X	X
Inorganics		
Aluminum	X	X
Arsenic	X	X
Cobalt	X	X
Iron	X	X
Manganese	X	X
Vanadium	X	X

(a) Chemicals detected in all media at SWMU 59.
Shaded cells indicate that the chemical lacks toxicity criteria and cannot be quantitatively evaluated.
X = Selected as a COPC in this media.

for constituents that were not detected in surface soil or total soil are evaluated with respect to their screening criteria and discussed in the uncertainty section (*Section 6.5.2*).

6.2 EXPOSURE ASSESSMENT

The objective of the exposure assessment is to estimate "the type and magnitude of exposures to chemicals of potential concern" (USEPA, 1989a). When combined with chemical-specific toxicity information (summarized in the toxicity assessment), these exposures produce estimations of potential risks.

6.2.1 Conceptual Site Model/Receptor Characterization

Refined conceptual site models (CSMs) for SWMUs 50 and 59 are presented on **Figure 6-1** and **Figure 6-2** for current and future exposure scenarios, respectively. The combined study area for SWMUs 48, 49, 50, and 59 is located in the southeastern portion of the RFAAP Horseshoe Area, east of the main bridge over the New River. The area is situated on a bluff approximately 120 ft above and overlooking SWMU 13 and the New River. Based on topography, surface water runoff is expected to flow approximately 700 ft southwest to the New River. The SWMUs are co-located and the overall area is grassy with wooded areas to the south, east, and west. There are no structures, catch basins, or storm drains located in the immediate vicinity of the area.

SWMU 50, the Calcium Sulfate Treatment/Disposal Area was identified as the major disposal area at RFAAP, until 1982, for sludge removed from the calcium sulfate drying beds. It is approximately 2.06 acres in size.

SWMU 59 was used to store bottom ash generated from the coal-fired power plant used to supply steam to the buildings in the HSA. Bottom ash is permitted to be buried in landfills at the Installation. It is approximately 0.57 acres in size.

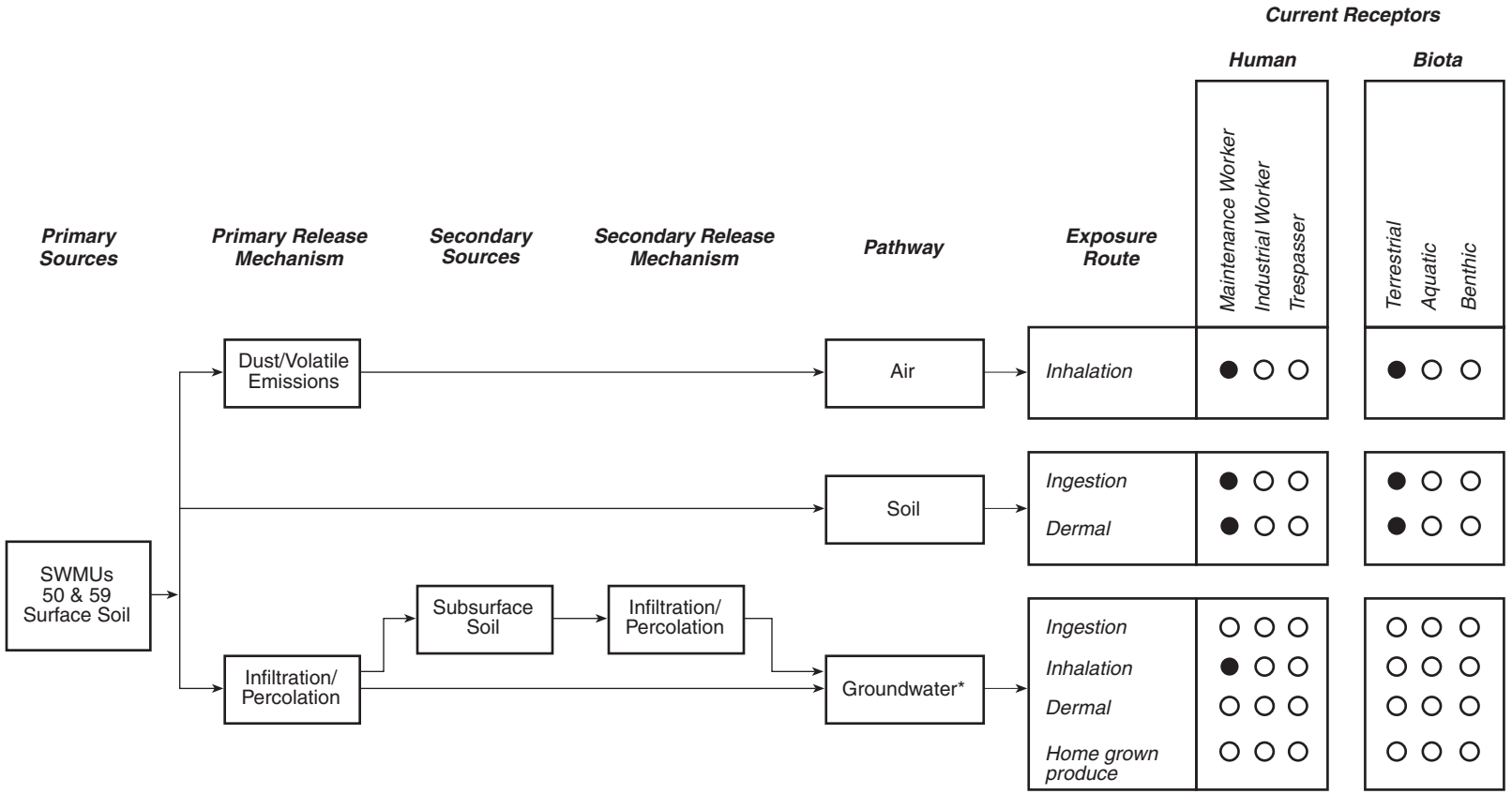
It was conservatively assumed that maintenance workers are the most likely receptors at these sites. Due to installation security, it is unlikely that trespassers could gain access to SWMUs 50 and 59; however, risks associated with the maintenance worker are considered protective of the limited exposure experienced by the trespasser.

If future development occurs, maintenance workers, industrial/commercial workers, and excavation workers could be exposed to surface and subsurface soil as a result of disturbing soil during construction/excavation activities. Therefore, maintenance worker, industrial worker, and excavation worker exposures at SWMUs 50 and 59 were evaluated for total soil in the HHRA. Although groundwater at SWMUs 50 and 59 is not expected to be used for potable purposes, industrial workers were evaluated for hypothetical exposures to groundwater in the RFI/CMS for SWMU 48 and 49 (Shaw, 2008).

RFAAP is likely to remain a military installation; therefore, a residential scenario is considered unlikely. However, the residential scenario was evaluated for exposures to total soil at both areas to assess clean closeout requirements under RCRA. As previously stated, the groundwater pathway for adult and child residents was addressed in the RFI/CMS for SWMUs 48 and 49 (Shaw, 2008).

6.2.2 Identification of Exposure Pathways

The potential receptors identified for the sites include maintenance workers, industrial workers, excavation workers, child residents, adult residents, and lifetime residents. **Appendix E-1, Table E.1-1** and **Appendix E-2, Table E.2-1** summarize the selection of exposure pathways for



*Groundwater pathway addressed in RCRA Facility Investigation for SWMUs 48 & 49

● Indicates pathway/receptor combinations to be evaluated

○ Indicates pathway/receptor combinations incomplete or no source

Figure 6-1. Current Land Use Conceptual Site Model for SWMUs 50 & 59 Radford Army Ammunition Plant, Virginia

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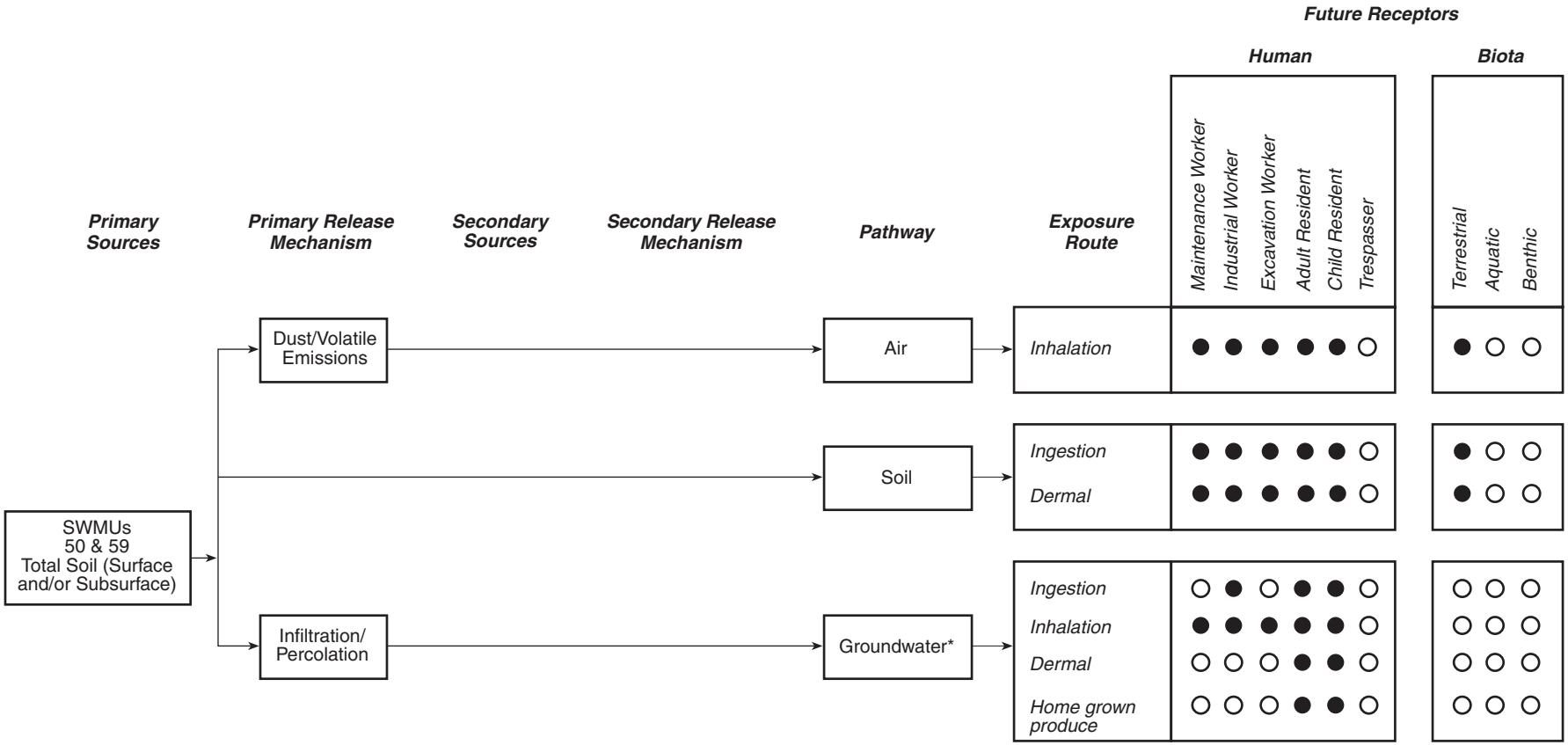
	3/16/09	APPROVED BY	CH	3/16/09	S-123461-1/07-w



*Groundwater pathway addressed in RCRA Facility Investigation for SWMUs 48 & 49

● Indicates pathway/receptor combinations to be evaluated

○ Indicates pathway/receptor combinations incomplete or no source

Figure 6-2. Future Land Use
Conceptual Site Model for SWMUs 50 & 59
Radford Army Ammunition Plant, Virginia

Shaw™ Shaw Environmental, Inc.

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	3/16/09	APPROVED BY	CH	3/16/09	

each receptor listing the rationale for the inclusion or exclusion of each pathway at SWMU 50 and SWMU 59, respectively.

6.2.3 Calculation of EPCs

To calculate intakes, a 95 percent upper confidence limit of the mean concentration (95% UCL) for each COPC is used as a conservative estimate of the average concentration in a given environmental medium to which a receptor would be exposed. The 95% UCL estimate is referred to as the Exposure Point Concentration (EPC). The 95% UCL is used rather than the mean concentration, to account for uncertainty when estimating EPCs from sample data (USEPA, 1989a). Methods used to calculate 95% UCLs are based on guidance provided in the documents *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (USEPA, 2002a) and ProUCL Version 4.0 Technical Guide (USEPA, 2007a).

In general, the method used to calculate a 95% UCL depends on: 1) the prevalence of non-detects, 2) the data distribution (e.g., normal, gamma, or lognormal), and 3) number of samples. Non-detects introduce uncertainty in the data set because the true concentration may be between zero to just below the detection limit. Therefore, distributional assumptions are difficult to ascertain for COPCs with a high rate of non-detects. USEPA's (2007a) ProUCL 4.00.02 statistical program was used to evaluate estimate 95% UCL values for nearly all the soil COPC data sets. For data sets with non-detects, ProUCL uses the Kaplan-Meier estimation method to derive a recommended 95% UCL (USEPA, 2007a). Where ProUCL recommends the results of more than one statistical approach, the most conservative (highest) 95% UCL value was used in the HHRA. Where fewer than 5 percent of samples had detected values, ProUCL does not recommend a 95% UCL value. In these cases, 95% UCL values were derived using a bootstrap-t statistical program, described by Efron (1982) and discussed in USEPA (1997a). Non-detect values are represented in this bootstrap-t program as random numbers between zero and the detection limit that are generated by the iterative process written into the program. EPCs for soil (surface and total) COPCs are presented in **Appendix E-1, Tables E.1-6 and E.1-7** for SWMU 50 and **Appendix E-2, Tables E.2-6 and E.2-7** for SWMU 59. The output from ProUCL 4.0 is provided in **Appendix E-4** for SWMU 50, **Appendix E-5** for SWMU 59, and **Appendix E-6** for 2,3,7,8-TCDD toxicity equivalents.

Models were also used to estimate concentrations of COPCs in air from soil. These models are discussed in *Section 6.2.4*.

6.2.4 Quantification of Exposure: Calculation of Daily Intakes

For each receptor and pathway, chronic daily intake (CDI, expressed as milligrams of COPC per kilogram body weight per day) for each COPC is estimated by combining the EPC with exposure parameters such as ingestion rate, frequency of contact, duration, and frequency of exposure. In addition, intake parameters are selected so the combination of intake variables results in an estimate of the reasonable maximum exposure for that pathway (USEPA, 1989a). Intake formulas, exposure parameters, and chemical-specific parameters for each of the receptors for SWMU 50 are provided in **Appendix E-1**, **Tables E.1-8 through E.1-14** and **Appendix E-2**, **Tables E.2-8 through E.2-14** for SWMU 59.

The particulate emission factors (PEFs) and volatilization factors (VFs) used to calculate inhalation daily intakes associated with soil were calculated in accordance with the

Supplemental Guidance for Developing Soil SLs for Superfund Sites (USEPA, 2002b), as provided in **Appendix E-1, Tables E.1-15 through E.1-22** and **Appendix E-2, Tables E.2-15 through E.2-17**.

6.3 TOXICITY ASSESSMENT

The methodology used for classifying health effects from exposure to chemicals is recommended by USEPA (2009). The health effects analysis considers chronic (long-term) exposures. Using the following hierarchy (USEPA, 2003b), the chronic toxicity criteria were obtained from:

- Tier 1 – Integrated Risk Information System (IRIS) (USEPA, 2009).
- Tier 2 – Provisional Peer Reviewed Toxicity Values (PPRTVs) - as developed on a chemical-specific basis by the Office of Research and Development/National Center for Environmental Assessment/Superfund Health Risk Technical Support Center (USEPA, 2003b). Because access to PPRTV is limited, these values were obtained directly from the USEPA Regional SL Table (USEPA, 2008).
- Tier 3 – Other Toxicity Values – including additional USEPA and non-USEPA sources of toxicity information, such as the Agency for Toxic Substances Disease Registry (ATSDR) Minimum Risk Levels (MRLs), California Environmental Protection Agency, and the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997b).

Toxicity criteria used to quantify non-carcinogenic hazards (risk reference doses - RfDs) and carcinogenic risks (slope factors - CSFs) are presented in **Appendix E-1, Tables E.1-23 through E.1-26** and **Appendix E-2, Tables E.2-18 through E.2-21**.

Lead was selected as a COPC in total soil SWMU 50 because the maximum detected concentration (MDC) of lead (585 mg/kg) exceeded the residential screening criterion of 400 mg/kg at one location (50SB04C). This sample was collected at a soil interval of 8 to 10 ft. The concentrations of the other 30 samples ranged from 10 mg/kg to 234 mg/kg. The arithmetic mean for lead in total soil was 72.8 mg/kg

Quantitative oral toxicity criteria were not available for lead. The USEPA's Adult Lead Model (USEPA, 2003a), is used to evaluate risks associated with nonresidential adult exposures to lead in soil. The potential risks associated with residential exposures to lead are addressed using the IEUBK Lead Model for Windows®, Version 1.0, Build 264 (USEPA, 1994a, 2002c, 2007b). The appropriate input concentration for each model is the arithmetic mean concentration of lead in soil. The arithmetic mean for lead in total soil was 72.8 mg/kg was well below the r-SL (400 mg/kg).

It is noted that lead was selected as a COPC in SWMUs 48, 49, 50, and 59 groundwater because the MDC of lead (237 µg/L) exceeded the MCL for lead of 15 µg/L. The details of this evaluation are provided in the RFI/CMS for SWMUs 48 and 49 (Shaw, 2008).

Chromium was identified as a COPC for total soil at SWMU 50. The toxic effects associated with chromium are dependent upon its valence state (USEPA, 1998). Two common forms of chromium are trivalent chromium (chromium III) and hexavalent chromium (chromium VI). Chromium III is the predominant form of chromium in nature and is the less toxic of the two forms. Hexavalent chromium is the more toxic form of chromium and is considered to be a Class A carcinogen via the route of inhalation. The speciation of hexavalent chromium (Cr VI) is not routinely performed during a sampling program due to the very short holding time and the

unique stability issues associated with hexavalent chromium (i.e., it tends to change valence states very easily after sample collection). Unless there is convincing evidence that hexavalent chromium may be present at a site (such as its for control of scale in non-contact cooling water piping for a power plant or a chromium plating operation), it is generally not included in an analytical program. Hexavalent chromium analyses were not performed for the environmental media samples at SWMU 50.

It was assumed that the majority of the chromium that was detected at the site would be in the trivalent form. Hexavalent chromium is relatively unstable in the environment and is typically converted to trivalent chromium. As stated in *Water-Related Environmental Fate of 129 Priority Pollutants* (USEPA, 1979), hexavalent chromium or Cr(VI) is a moderately strong oxidizing agent and reacts with reducing materials to form trivalent chromium or Cr(III). Chemical speciation is an important fate process for chromium and in aquatic environments. Cr(VI), if present, would be expected to remain in a soluble form, while trivalent chromium would be expected to hydrolyze and precipitate as $Cr(OH)_3$. Cr(III) the most stable form under reducing conditions normally found in natural waters and sediments, and when in solution at pH greater than 5, quickly precipitates due to formation of the insoluble hydroxide or oxide.

Cr (III) is the stable form of chromium in soil (FRTR, 2002). Cr (III) hydroxy compounds precipitate at pH 4.5 and complete precipitation of the hydroxy species occurs at pH 5.5. In contrast to Cr (VI), Cr (III) is relatively immobile in soil. Soil pH (pH = 5.33) was measured in Sample 50SS01. This sample indicates acidic soil conditions, with the total chromium concentration at 18.6 mg/kg. The pH value is within the optimal pH range for precipitation of Cr III. Because of its anionic nature, Cr (VI) associates with soil surfaces at positively charged exchange sites (FRTR, 2002). This association decreases with increasing soil pH. Regardless of pH and redox potential, most Cr(VI) in soil is reduced to Cr(III). Soil organic matter and iron (Fe II) minerals donate electrons in this reaction. The reduction reaction in the presence of organic matter proceeds at a slow rate under normal environmental pH and temperatures, but the rate of reaction increases with decreasing soil pH.

A number of studies have been conducted with respect to the fate and transport of chromium in soil. For example, the objectives of a study conducted by the Oak Ridge National Laboratory (Jardine et al., 1999) were to investigate the impact of coupled hydrologic and geochemical processes on the fate and transport of Cr(VI) in undisturbed soil cores. The reduction of Cr(VI) to Cr(III) was dramatically more significant on soil with higher levels of surface-bound natural organic matter. This indicated that natural organic matter was serving as a suitable reductant during Cr(VI) transport even in the presence of potentially competing geochemical oxidation reactions involving chromium. In another example, seven organic amendments (e.g., composts, manures) were investigated for their effects on the reduction of Cr(VI) in a mineral soil low in organic matter contact (Bolan et al., 2003). Addition of organic amendments enhanced the rate of reduction of Cr(VI) to Cr(III) in the soil. Finally, it was found that the distribution of metal contaminants such as chromium in soil can be strongly localized by transport limitations and redox gradients within soil aggregates (Tokunaga et al., 2001). Shifts in characteristic redox potential and the extent of Cr(VI) reduction to Cr(III) were related to organic matter availability.

Increasing chromium concentrations are typically associated with increasing levels of organic matter. The TOC measurement for 50SS01 was 18,900 micrograms per gram. Even if trace amounts of Cr(VI) were present at the site, the environmental conditions at RFAAP, including typical precipitation events over the years, would tend to favor the conversion of this form of

chromium to the more stable (less toxic) trivalent state. For these reasons, it was assumed that toxicity associated with chromium would be most accurately represented by the use of chromium III toxicity data. Therefore, the oral RfD for CrIII was used in the risk/hazard calculations for the oral and dermal pathways for total soil at SWMU 50. Because there is no inhalation toxicity value for CrIII, the inhalation unit risk (IUR) for total Cr was conservatively used to evaluate the inhalation pathway. The IUR is based on a 1:6 ratio of CrVI to CrIII.

Benzo(a)pyrene and benzo(b)fluoranthene were COPCs at SWMU 50 and benzo(a)pyrene was a COPC at SWMU 59. USEPA has determined that these compounds have a mutagenic mode of action (USEPA 2005, 2008). The lifetime cancer risks for benzo(a)pyrene and benzo(b)fluoranthene were calculated in accordance with USEPA guidance concerning carcinogens that act via a mutagenic mode of action (USEPA, 2005). Risks for these COPCs were estimated by applying age-dependent adjustment factors (ADAFs). The following ADAFs were applied to the following used: 10 for age 0-2, 3 for age 2-16, and 1 (i.e., no adjustment) for years 16 and older. In the following example, cancer risk associated with benzo(a)pyrene in total soil at SWMU 50 is calculated for the ingestion pathway:

Age 0-2

$$\frac{0.0331\,mg/kg\;x\,200\,mg/day\,x\,350\,days/yr\,x\,2\,yr\,x\,1\,x\,1E-6\,kg/mg}{365\,days/yr\,x\,70\,yr\,x\,15\,kg}\,x\,\frac{7.3}{mg/kg/day}\,x10=8.8\,x10^{-7}$$

Age 2-6

$$\frac{0.0331\,mg/kg\;x\,200\,mg/day\,x\,350\,days/yr\,x\,4\,yr\,x\,1E-6\,kg/mg}{365\,days/yr\,x\,70\,yr\,x\,15\,kg}\,x\,\frac{7.3}{mg/kg/day}\,x\,3=5.3\,x10^{-7}$$

Age 6-16

$$\frac{0.0331\,mg/kg\;x\,100\,mg/day\,x\,350\,days/yr\,x\,10\,yr\,x\,1E-6\,kg/mg}{365\,days/yr\,x\,70\,yr\,x\,70\,kg}\,x\,\frac{7.3}{mg/kg/day}\,x\,3=1.4\,x10^{-7}$$

Age 16-30

$$\frac{0.0331\,mg/kg\;x\,100\,mg/day\,x\,350\,days/yr\,x\,14\,yr\,x\,1E-6\,kg/mg}{365\,days/yr\,x\,70\,yr\,x\,70\,kg}\,x\,\frac{7.3}{mg/kg/day}\,x1=6.6\,x10^{-8}$$

Total Ingestion Risk

$(8.8 \times 10^{-7}) + (5.3 \times 10^{-7}) + (1.4 \times 10^{-7}) + (6.6 \times 10^{-8}) = 1.6 \times 10^{-6}$

Therefore, using ADAFs, the cancer risk for benzo(a)pyrene in total soil at SWMU 50 is (1.6×10^{-6}) for the ingestion pathway. Cancer risks for benzo(a)pyrene associated with the dermal absorption and inhalation pathways were calculated in a similar manner. In addition, cancer risks for benzo(b)fluoranthene associated with the ingestion, dermal absorption, and inhalation pathways were also calculated.

6.4 RISK CHARACTERIZATION

Quantitative risks and hazards due to exposure to COPCs are estimated and summarized by combining toxicity criteria (presented in the Toxicity Assessment) with CDIs (calculated in the Exposure Assessment). Methods used to calculate risks and hazards are taken from USEPA (1989a).

For exposures to potential carcinogens, the individual upper-bound excess lifetime cancer risk was calculated by multiplying the estimated CDI by the CSF. In order to assess the individual excess lifetime cancer risks associated with simultaneous exposure to COPCs, the risks derived from the individual chemicals are summed within each exposure pathway. For the residential scenario, carcinogenic risk was evaluated for the lifetime resident.

Non-carcinogenic adverse health effects are calculated by dividing the CDI of each COPC by its RfD, forming an HQ. HQs with a value greater than one (1.0) indicate the potential for adverse health effects. To estimate non-carcinogenic adverse health effects due to simultaneous exposure to several COPCs, HQs for individual COPCs are summed within each exposure pathway to form a Hazard Index (HI). As with HQs, HIs that are greater than 1.0 indicate potential adverse health effects. In such cases, COPCs are divided into categories based on the target organ affected (e.g., liver, kidney) and target organ-specific HIs are recalculated. Non-carcinogenic hazards were evaluated for both child and adult residents independently.

Excess lifetime cancer risks derived in this report are compared with USEPA's target risk range for Superfund sites of 1E-06 to 1E-04 (USEPA, 1989a). In addition, USEPA's Office of Solid Waste and Emergency Response has issued a directive (USEPA, 1991a) clarifying the role of HHRA in the Superfund process. The directive states that, if the cumulative carcinogenic risk to a receptor (based on reasonable maximum exposure for both current and future land use) is less than 1E-04 and the non-carcinogenic HI is equal to or less than 1, action generally is not warranted unless adverse environmental effects are likely.

Calculation of risks and hazards due to exposure to COPCs in soil are provided in **Appendix E-1, Tables E.1-27 through E.1-38** for SWMU 50 and **Appendix E-2, Tables E.2-22 through E.2-33** for SWMU 59. The risks and hazard indices for each receptor are presented in **Appendix E-l, Tables E.1-39 through E.1-44** (SWMU 50) and **Appendix E-2, Tables E.2-34 through E.2-39** (SWMU 59). These risks and hazards are summarized in **Table 6-4** (SWMU 50) and **Table 6-5** (SWMU 59). A refinement of the HIs based on target organs is conducted by calculating HIs on a target organ-specific basis. In addition, **Appendix E-1, Tables E.1-45 through E.1-50** (SWMU 50) and **Appendix E-2, Tables E.2-40 through E.2-45** (SWMU 59) summarize risks and hazards for risk/HI drivers (i.e., those COPCs contributing to a total risk greater than 1.E-04 or a total target organ hazard greater than 1.0). As stated in *Section 6.1.1*, risks and hazards associated with exposures to groundwater at SWMUs 48, 49, 50, and 59 have been addressed in the RFI/CMS for SWMUs 48 and 49 (Shaw, 2008).

6.4.1 Lead Exposure Models

Because concentrations of lead in total soil at SWMU 50 (585 mg/kg) exceeds the residential screening criterion of 400 mg/kg at one location and the arithmetic mean for lead in total soil was 72.8 mg/kg is well below the screening criterion, lead in soil was not evaluated using the IEUBK lead model. Lead passed the lead exposure assessment for the both the industrial and residential scenarios.

6.4.2 Iron Margin of Exposure Evaluation

Because iron concentrations in soil did not result in an HQ of 0.5 or higher for the child resident at either SWMU 50 or SWMU 59, it was not necessary to perform a "margin of exposure evaluation."

Table 6-4
Summary of Risks and Hazards
SWMU 50

Timeframe/Receptor	Risk	Risk Drivers	HI	Target Organ Segregation HI>1[a]
Current maintenance worker	**1E-06**	No individual chemical exceeded the 1E-06 risk.	1E-01	N/A
Future maintenance worker	**1E-06**	No individual chemical exceeded the 1E-06 risk.	1E-01	N/A
Future industrial worker	**6E-06**	**Surface Soil** TCDD TE Arsenic	3E-01	N/A
Future excavation worker	**1E-06**	N/A	8E-01	N/A
Future adult resident[b]	N/A	N/A	4E-01	N/A
Future child resident	**2E-05**	**Total Soil** TCDD TE Aroclor 1254 Arsenic	**3E+00**	No individual chemical HI exceeds 1.0 **CNS** (1.3) - Soil [TCDD TE - Ing (0.5); Aluminum - Ing (0.3); Manganese - Ing (0.6)]
Future lifetime resident[b]	**3E-05**	**Total Soil** TCDD TE Aroclor 1254 Benzo(a)pyrene Arsenic	N/A	N/A

NA = Not Applicable
HI = Hazard Index
HQ = Hazard Quotient
Bold = Exceeds USEPA Risk or Hazard Range.
TCDD TE = DioxinToxicity Equivalent
NOTE: Arsenic and manganese are within background concentrations for surface and total soil.

a) Cumulative HIs and individual HQs are rounded to the nearest tenth. HIs > 1 and HQs > 0.1 are listed.
b) The cancer risk for residents is averaged over a lifetime and is based on adult and child exposures. The noncancer HI for an adult resident is based on adult exposures only.

Table 6-5
Summary of Risks and Hazards
SWMU 59

Timeframe/Receptor	Risk	Risk Drivers	HI	Target Organ Segregation HI>1[a]
Current maintenance worker	**3E-06**	**Surface Soil** Arsenic	6E-02	N/A
Future maintenance worker	**3E-06**	**Surface Soil** Arsenic	6E-02	N/A
Future industrial worker	**1E-05**	**Surface Soil** Arsenic	3E-01	N/A
Future excavation worker	6E-07	N/A	6E-01	N/A
Future adult resident[b]	N/A	N/A	3E-01	N/A
Future child resident	**3E-05**	**Total Soil** Arsenic	**3E+00**	No individual chemical or target organ HI exceeds 1.0
Future lifetime resident[b]	**4E-05**	**Total Soil** Benzo(a)pyrene Arsenic	N/A	N/A

NA = Not applicable.
HI = Hazard Index.
HQ = Hazard Quotient.
Bold = Exceeds USEPA Risk or Hazard Range.
TCDD TE = DioxinToxicity Equivalent
NOTE: Arsenic is within background concentrations for surface and total soil.

a) Cumulative HIs and individual HQs are rounded to the nearest tenth. HIs > 1 and HQs > 0.1 are listed.
b) The cancer risk for residents is averaged over a lifetime and is based on adult and child exposures. The noncancer HI for an adult resident is based on adult exposures only.

6.4.3 Background

Statistical evaluations were conducted to compare metals concentrations in soil at SWMUs 50 and 59 with background concentrations presented in the RFAAP *Facility-Wide Background Study Report* (IT, 2001). These evaluations followed the procedures outlined in the USEPA *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites* (USEPA, 2002d) and were conducted using USEPA's ProUCL 4.0 statistical program. Statistical analyses included distribution testing of site data sets and background data sets, evaluation of data using descriptive summary statistics, and comparisons of site data to background. Distribution testing showed that either the site data sets or the background data sets in each case were not normal, and therefore, consistent with *Section 4.1* of the above-referenced USEPA guidance, comparisons of site to background were conducted using non-parametric testing rather than attempting to transform the data sets logarithmically. Unless otherwise noted, the Gehan test was conducted for each metal with background data sets to evaluate whether site concentrations were consistently higher or lower than the background data set. The Gehan test is preferred over the Wilcoxon Mann Whitney test when multiple detection limits are present (USEPA, 2007a).

For SWMU 50, notes on the methodology and the results of the background evaluation are summarized in **Tables 6-6 and 6-7**. The ProUCL 4.0 output is provided in **Appendix E-7**. Based on the background evaluation, the COPCs identified for SWMU 50 that exceed background concentrations include aluminum for surface soil and aluminum, chromium, copper, and lead for total soil.

For SWMU 59, notes on the methodology and the results of the background evaluation are summarized in **Tables 6-8 and 6-9**. The ProUCL 4.0 output is provided in **Appendix E-8**. None of the COPCs identified for either surface soil or total soil at SWMU 59 exceed background concentrations.

6.5 UNCERTAINTIES

Risk assessments involve the use of assumptions, judgments, and incomplete data to varying degrees that contribute to the uncertainty of the final estimates of risk. Uncertainties result both from the use of assumptions or models in lieu of actual data and from the error inherent in the estimation of risk related parameters and may cause risk to be overestimated or underestimated. Based on the uncertainties described below, this risk assessment should not be construed as presenting an absolute estimate of risk to persons potentially exposed to COPCs.

Consideration of the uncertainty attached to various aspects of the risk assessment allows better interpretation of the risk assessment results and understanding of the potential adverse effects on human health. In general, the primary sources of uncertainty are associated with environmental sampling and analysis, selection of chemicals for evaluation, toxicological data, and exposure assessment. The effects of these uncertainties on the risk estimates are discussed below.

6.5.1 Environmental Sampling and Analysis

If the samples do not adequately represent media at SWMU 50 and SWMU 59, hazard/risk estimates could be overestimated or underestimated. The sampling and analysis plan was designed to investigate anticipated areas of contamination and delineate area(s) of concern.

Table 6-6
Background Comparison for Surface Soil at SWMU 50

Soil COPEC	Gehan Test [a, b] Site > Background?	Considered to be Background?
Aluminum [c]	Yes	No
Antimony	Yes	No
Arsenic [c]	No	Yes
Barium	Yes	No
Beryllium	No	Yes
Cadmium	No	Yes
Chromium	Yes	No
Cobalt	No	Yes
Copper	Yes	No
Iron [c]	No	Yes
Lead [c]	No	Yes
Magnesium	Yes	No
Manganese [c]	No	Yes
Mercury	Yes	No
Nickel	Yes	No
Potassium	Yes	No
Selenium	Yes	No
Silver	Yes	No
Sodium	Yes	No
Thallium	No	Yes
Vanadium [c]	No	Yes
Zinc [c]	No	Yes

[a] Gehan test used unless otherwise noted. See Appendix for backup statistics.
[b] If both Site and Background data sets had normal distribution with 100% detects, the t-test was used (note: this did not occur for SWMU 50 surface soil vs. background comparisons).
[c] Wilcoxon-Mann-Whitney test used (for 100% detect data sets).

Table 6-7
Background Comparison for Total Soil at SWMU 50

Soil COPEC	Gehan Test [a, b] Site > Background?	Considered to be Background?
Aluminum [c]	Yes	No
Antimony	Yes	No
Arsenic	No	Yes
Barium	Yes	No
Beryllium	No	Yes
Cadmium	No	Yes
Chromium [c]	Yes	No
Cobalt	No	Yes
Copper	Yes	No
Iron	No	Yes
Lead [c]	Yes	No
Magnesium	No	Yes
Manganese [c]	No	Yes
Mercury	Yes	No
Nickel	No	Yes
Potassium	Yes	No
Selenium	Yes	No
Silver	Yes	No
Sodium	Yes	No
Thallium	No	Yes
Vanadium	No	Yes
Zinc [c]	No	Yes

[a] Gehan test used unless otherwise noted. See Appendix for backup statistics.
[b] If both Site and Background data sets had normal distribution with 100% detects, the t-test was used (note: this occurred for SWMU 50 total soil vs. background comparisons for iron and vanadium).
[c] Wilcoxon-Mann-Whitney test used (for 100% detect data sets).

Table 6-8
Background Comparison for Surface Soil at SWMU 59

Soil COPEC	Gehan Test [a, b] Site > Background?	Considered to be Background?
Aluminum [c]	No	Yes
Antimony	No	Yes
Arsenic [c]	No	Yes
Barium	Yes	No
Beryllium	No	Yes
Cadmium	No	Yes
Chromium [c]	No	Yes
Cobalt	No	Yes
Copper	Yes	No
Iron [c]	No	Yes
Lead [c]	No	Yes
Magnesium	No	Yes
Manganese [c]	No	Yes
Mercury	Yes	No
Nickel	No	Yes
Potassium	No	Yes
Selenium	Yes	No
Silver	No	Yes
Sodium	Yes	No
Thallium	No	Yes
Vanadium [c]	No	Yes
Zinc [c]	No	Yes

[a] Gehan test used unless otherwise noted. See Appendix for backup statistics.
[b] If both Site and Background data sets had normal distribution with 100% detects, the t-test was used (note: this did not occur for SWMU 59 surface soil vs. background comparisons).
[c] Wilcoxon-Mann-Whitney test used (for 100% detect data sets).

Table 6-9
Background Comparison for Total Soil at SWMU 59

Soil COPEC	Gehan Test [a, b] Site > Background?	Considered to be Background?
Aluminum [c]	No	Yes
Antimony	Yes	No
Arsenic	No	Yes
Barium	Yes	No
Beryllium	No	Yes
Cadmium	No	Yes
Chromium	No	Yes
Cobalt	No	Yes
Copper	No	Yes
Iron	No	Yes
Lead [c]	No	Yes
Magnesium	No	Yes
Manganese [c]	No	Yes
Mercury	Yes	No
Nickel	No	Yes
Potassium	No	Yes
Selenium	Yes	No
Silver	No	Yes
Sodium	Yes	No
Thallium	No	Yes
Vanadium	No	Yes
Zinc [c]	No	Yes

[a] Gehan test used unless otherwise noted. See Appendix for backup statistics.
[b] If both Site and Background data sets had normal distribution with 100% detects, the t-test was used (note: this occurred for SWMU 59 total soil vs. background comparisons for chromium, iron and vanadium).
[c] Wilcoxon-Mann-Whitney test used (for 100% detect data sets).

Therefore, there is less chance that the hazard/risk estimates are biased low. Also, if the analytical methods used do not apply to some chemicals that are present at each area, risk could be underestimated. Because the analytical methods at the site were selected to address all chemicals that are known or suspected to be present on the basis of the history of each area, the potential for not identifying a COPC is reduced.

Uncertainty in environmental chemical analysis can stem from several sources including errors inherent in the sampling or analytical procedures. Analytical accuracy errors or sampling errors can result in rejection of data, which decreases the available data for use in the HHRA, or in the qualification of data, which increases the uncertainty in the detected chemical concentrations. There is uncertainty associated with chemicals reported in samples at concentrations below the method reporting limit but still included in data analysis and with those chemicals qualified "J" indicating that the concentrations are estimated. Another issue involves the amount of blank related (i.e., B-qualified) data in the data set. Although B-qualified were eliminated, however, the amount of B-qualified data in the data set was low.

Another uncertainty associated with sampling and analysis concerns the inclusion of chemicals that are potentially present in the environment due to anthropogenic sources. For example, dioxins are considered ubiquitous in soil from anthropogenic sources, such as combustion and incineration of municipal waste, coal, wood, and fuel. If such chemicals are not site-related, the risks associated with the site may be overestimated. This uncertainty may have a low-to-moderate effect on overestimating risks.

6.5.2 Selection of Chemicals for Evaluation

A comparison of maximum detected chemical concentrations to USEPA Regional SLs was conducted for surface soil and total soil. Chemicals with maximum concentrations below their respective SLs were not carried through the assessment. It is unlikely that this risk-based screening excluded chemicals that should be included, based on the conservative exposure assumptions and conservatively derived toxicity criteria that are the basis of the SLs. Although following this methodology does not provide a quantitative risk estimate for every chemical, it focuses the assessment on the chemicals accounting for the greatest risks (i.e., chemicals whose maximum concentrations exceed their respective SLs) and the cumulative risk estimates would not be expected to be significantly greater. As presented on the non-detect MDL screening tables, the maximum MDL exceeded the adjusted SLs for several chemicals in soil; therefore, the site-related risks and hazards could be underestimated for the risk assessments due to inadequate detection limits. The results for the evaluations of non-detects at SWMU 50 and SWMU 59 are discussed in the following sections.

The reporting limits for chemicals that were not detected in surface soil and total soil at SWMU 50 were compared with SLs in **Appendix E-1, Tables E.1-3 and E.1-5,** respectively. As shown in **Table E.1-3,** reporting limits in surface soil exceeded SLs for 19 of 119 constituents (16 percent). These constituents include: nitroglycerin, thallium, MCPA, MCPP, toxaphene, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1260, 2,4-dinitrophenol, 3,3'-dichlorobenzidine, 3-nitroaniline, 4,6-dinitrocresol, bis(2-chloroethyl)ether, bis(2-chloroisopropyl)ether, hexachlorobenzene, n-nitroso-di-n-propylamine, and pentachlorophenol. Nitroglycerin has been detected elsewhere on the Installation. Past disposal of polychlorinated biphenyls (PCBs) at SWMU 50 cannot be ruled out because Aroclor 1254 was selected as a COPC in surface soil at SWMU 50. If these constituents are actually present,

risk and hazard could be underestimated. However, the reporting limits exceed SLs that are based on a cancer risk of 1E-06 or HQ of 0.1. If the reporting limits were compared with SLs based on 1E-05 and HQ of 1, many of them would not exceed. In addition, the maximum reporting limit was compared with the SL. The majority of the reporting limits did not individually exceed. For 10 of 119 constituents (8 percent) in surface soil, there were no SLs for comparison. These constituents include: pentaerythritol tetranitrate (PETN), dichloroprop, 2-nitroaniline, 2-nitrophenol, 4-nitrophenol, di-octylphthalate, p-chloro-m-cresol, 2-hexanone, 4-bromophenyl phenylether, and 4-chlorophenyl phenylether. These chemicals are not known to be associated with past disposal at SWMU 50.

As shown in **Table E.1-5**, reporting limits in total soil exceeded SLs for 37 of 124 constituents (30 percent). These constituents include: acrylonitrile, benzidine, nitroglycerin, n-nitrosodimethylamine, thallium, aldrin, alpha-BHC, dieldrin, heptachlor, heptachlor epoxide, MCPA, MCPP, toxaphene, Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1260, 2,4-dinitrophenol, 3,3'-dichlorobenzidine, 3-nitroaniline, 4,6-dinitrocresol, bis(2-chloroethyl)ether, bis(2-chloroisopropyl)ether, hexachlorobenzene, n-nitroso-di-n-propylamine, pentachlorophenol, 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, 1,2-dichloroethane, 1,2-dichloropropane, bromoethane, CT, chloromethane, cis-1,3-dichloro-1-propene, and vinyl chloride. Nitroglycerin has been detected elsewhere on the Installation. Past disposal of polychlorinated biphenyls (PCBs) at SWMU 50 cannot be ruled out because Aroclor 1254 was selected as a COPC in total soil at SWMU 50. If these constituents are actually present, risk and hazard could be underestimated. However, the reporting limits exceed SLs that are based on a cancer risk of 1E-06 or HQ of 0.1. If the reporting limits were compared with SLs based on 1E-05 and HQ of 1, most of these constituents would not exceed. In addition, the maximum reporting limit was compared with the SL. The majority of the reporting limits did not individually exceed. For 14 of 139 constituents (10 percent) in total soil, there were no SLs for comparison: 1,2-diphenylhydrazine, 2-chloroethyl vinyl ether, acraldehyde, pentaerythritol tetranitrate (PETN), dichloroprop, 2-nitroaniline, 2-nitrophenol, 4-nitrophenol, di-octylphthalate, p-chloro-m-cresol, 2-hexanone, 4-bromophenyl phenylether, and 4-chlorophenyl phenylether. These constituents were similar to those identified for surface soil. These chemicals are not known to be associated with past disposal at SWMU 50.

The reporting limits for chemicals that were not detected in surface soil and total soil at SWMU 59 were compared with SLs in **Appendix E-2, Tables E.2-3 and E.2-5**, respectively. As shown in **Table E.2-3,** reporting limits in surface soil exceeded SLs for 27 of 123 constituents (22 percent). These constituents include: benzidine, nitroglycerin, n-nitrosodimethylamine, 4,4'-DDE, aldrin, alpha-BHC, alpha-chlordane, beta.BHC, delta-BHC, endrin, gamma-BHC, heptachlor, MCPA, MCPP, toxaphene, Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1260, 3,3'dichlorbenzidine, 3-nitroaniline, 4,6-dinitro-o-cresol, bis(2-chloroethyl)ether, n-n-nitroso-di-n-propylamine, and pentachlorophenol. Nitroglycerin has been detected elsewhere on the Installation. Past disposal of polychlorinated biphenyls (PCBs) at SWMU 59 cannot be ruled out because Aroclor 1254 was selected as a COPC in soil at SWMU 50. If these constituents are actually present, risk and hazard could be underestimated. However, the reporting limits exceed SLs that are based on a cancer risk of 1E-06 or HQ of 0.1. If the reporting limits were compared with SLs based on 1E-05 and HQ of 1, they would not exceed. In addition, the maximum reporting limit was compared with the SL. The majority of the reporting limits did not individually exceed. For 12 of 123 constituents (10 percent) in surface soil, there were no SLs for comparison. These

constituents include: 1,2-diphenylhydrazine, pentaerythritol tetranitrate (PETN), dichloroprop, dimethylphthalate, 2-nitroaniline, 2-nitrophenol, 4-nitrophenol, di-octylphthalate, p-chloro-m-cresol, 2-hexanone, 4-bromophenyl phenylether, and 4-chlorophenyl phenylether. These chemicals are not known to be associated with past disposal at SWMU 59.

As shown in **Table E.2-5**, reporting limits in total soil exceeded SLs for 27 of 123 constituents (22 percent). These constituents include: benzidine, nitroglycerin, n-nitrosodimethylamine, 4,4'-DDE, aldrin, alpha-BHC, alpha-chlordane, beta.BHC, delta-BHC, endrin, gamma-BHC, heptachlor, MCPA, MCPP, toxaphene, Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1260, 3,3'dichlorbenzidine, 3-nitroaniline, 4,6-dinitro-o-cresol, bis(2-chloroethyl)ether, n-n-nitroso-di-n-propylamine, and pentachlorophenol. Nitroglycerin has been detected elsewhere on the Installation. Past disposal of polychlorinated biphenyls (PCBs) at SWMU 59 cannot be ruled out because Aroclor 1254 was selected as a COPC in soil at SWMU 50. If these constituents are actually present, risk and hazard could be underestimated. However, the reporting limits exceed SLs that are based on a cancer risk of 1E-06 or HQ of 0.1. If the reporting limits for 2,6-dinitrotoluene and dibenz(a,h)anthracene were compared with SLs based on 1E-05 and HQ of 1, these compounds would not exceed. For 12 of 123 constituents (10 percent) in total soil, there were no SLs for comparison. These constituents were similar to those identified for surface soil. These chemicals are not known to be associated with past disposal at SWMU 59. In addition, the maximum reporting limit was compared with the SL. The majority of the reporting limits did not individually exceed.

In general, these chemicals, if present in surface soil and total soil, could contribute additional risk and hazard at SWMU 50 and SWMU 59. Reporting limits for these analyses were reviewed at the start of the project. Although some of the reporting limits were known to exceed the SLs, the differences were small. Therefore, while risks and hazards associated with the site may be underestimated, this uncertainty is not anticipated to change the conclusions of this HHRA.

Background concentrations of metals in soil at RFAAP have been characterized and are used in statistical comparisons to site soil to evaluate whether concentrations of metals detected at SWMU 50 and SWMU 59 are consistently higher or lower than background. However, the background data obtained may not fully characterize naturally-occurring metals levels at SWMU 50. The excavated surface (e.g., trench or scar) that was identified in aerial photographs for SWMU 50 appears to have been filled (Shaw, 2007). Uncertainties associated with the use of these data may lead to a low-to-moderate overestimation or underestimation of surface and total soil risks due to metals.

Screening criteria are derived from RDAs for essential human dietary minerals, trace elements, and electrolytes that are potentially toxic at very high doses (i.e., calcium, magnesium, potassium, and sodium). None of these elements were selected as COPCs in soil. Omitting these essential human nutrients from further evaluation is expected to have a low effect on risk and hazard estimates.

6.5.3 Exposure Assessment

The primary areas of uncertainty affecting exposure parameter estimation involve the assumptions regarding exposure pathways, the estimation of exposure point concentrations, and the exposure parameters used to estimate chemical doses. An underlying assumption in the HHRA is that individuals at the site would engage in activities that result in exposures via each selected pathway. For example, it was assumed that maintenance workers engage in regular

activities (once a week) under current and future land use conditions resulting in exposure to COPCs. This assumption is conservative, in that it is more likely that the activity patterns occur occasionally.

For SWMU 50, the PEFs and VFs for the maintenance workers, industrial workers, and construction workers were based on the actual size of the site (2.06 acres). Per USEPA guidance, the PEF and VFs for the residents were based on a 0.5-acre residential lot. Because the sampling plan was based on less than 0.5 acre, the PEF and VF values underestimate the inhalation risk and hazard for the residents. Using the PEF and VFs based on the actual acreage of SWMU 50, however, would not have changed the conclusions of the HHRA. SWMU 59 is 0.57 acre in size, which is nearly equal to the 0.5-acre residential lot assumed in the HHRA.

The non-cancer hazard estimates for the inhalation of dust emissions by the construction worker receptor are based on the construction worker PEF calculation. Because future plans for construction or excavation at SWMU 50 and SWMU 59 are not known, assumptions regarding the duration of construction activities and type and number of construction vehicles were based on the acreage of each site. Although the inhalation cancer risk/non-cancer hazard estimates could be overestimated, the calculated risks and hazards were below the target risk range and hazard index. In addition, there is generally a higher level of uncertainty associated with the use of modeled concentrations (i.e., PEF) than in the use of measured concentrations if valid measurement data are available for the exposure medium and exposure location.

In establishing EPCs, the concentrations of chemicals in the media evaluated are assumed to remain constant over time. Depending on the properties of the chemical and the media in which it was detected, this assumption could overestimate or underestimate risks, based on the degree of chemical transport to other media or the rate and extent a chemical degrades over time. However, most of the COPCs identified at SWMUs 50 and 59, such as PAHs, dioxins, and metals, are relatively stable in the environment.

When calculating EPCs from sample data using ProUCL, non-detect samples are coded as "zeros." As indicated in the ProUCL output for SWMU 50, SWMU 59, and the TCDD toxicity equivalents (**Appendices E-4, E-5, and E-6**, respectively), summary statistics, such as the arithmetic mean, are based on the detected values only. For the calculation of the 95% UCL of the mean, the program substitutes surrogate values for the detection limits. Approaches which substitute values for non-detected chemical concentrations are associated with uncertainty, because chemicals that were not detected at the specified sample MDL may be absent from the medium or may be present at a concentration below the sample MDL. Furthermore, only the detected concentrations in each data set are used to determine the distribution of the data. For data sets with non-detects, the uncertainty associated with the distribution of the data could result in an over-estimation of the EPC.

The 95% UCL is used as the EPC for each medium if at least eight to ten samples are available. The 95% UCL was used as the EPC for each chemical in soil. Therefore, the cancer risk/non-cancer hazard estimates are not likely to be biased high. The exposure parameters used to describe the extent, frequency, and duration of exposure is associated with uncertainty. Actual risks for individuals within an exposed population may differ from those predicted, depending upon their actual intake rates (e.g., soil ingestion rates), nutritional status, or body weight. Exposure assumptions were selected to produce an upper bound estimate of exposure in accordance with USEPA guidelines regarding evaluation of potential exposures at Superfund

sites (e.g., exposures were assumed to occur for 25 years for workers). In addition, USEPA (1991b, 1997c, 2002b) exposure parameters are intended to be conservative and are based on risk management interpretations of limited data. For example, although current USEPA guidance recommends soil ingestion rates of 100 mg/day for individuals over 6 years of age, other studies, such as Calabrese et al. (1990), have shown that the USEPA default soil ingestion rate of 100 mg/day is likely to greatly overestimate adult exposures and risks. In addition, chemicals in soil are assumed 100% bioavailable; this assumes that ingested chemicals present in a soil matrix are absorbed through the gastrointestinal (GI) tract, which is unlikely due to the affinity of contaminants for soil particles. Therefore, based on the conservative exposure assumptions used in the HHRA, exposures and estimated potential risks are likely to be overestimated for the ingestion of soil pathways.

Evaluation of the dermal absorption exposure pathway is affected by uncertainties in dermal exposure parameters. For example, there is uncertainty associated with the exposed skin surface areas used, since the choice of exposed body parts could slightly overestimate or underestimate risks. Uncertainties that are more significant are associated with the selection and use of dermal absorption factors. For this HHRA, the dermal absorption factors and calculations were based on USEPA Region III guidance, USEPA's *Risk Assessment Guidance for Superfund (RAGS): Part E, Supplemental Guidance for Dermal Risk Assessment* (USEPA, 2004). Very limited information is available on dermal absorption of chemicals from contacted soil under environmental conditions. In fact, there are not actual human epidemiological data to support the hypothesis that absorption of soil bound compounds under exposure conditions is a complete route of exposure. For example, the Public Health Statements from the Agency for Toxic Substance Disease Registry (ATSDR, 1992; 2000a; 2004a,b; 2006a,b; 2007a,b) indicate that metals such as aluminum, arsenic, cobalt, copper, lead, manganese, nickel, and vanadium, are not known to result in human health effects by dermal absorption because very little can enter the body through the skin under normal circumstances (i.e., without exposure to very high concentrations for long periods or exposure to skin that is damaged). Although chromium has been associated with contact dermatitis (ATSDR, 2000b), this condition is most likely to occur due to contact with materials in industrial settings rather than contact with environmental media. Therefore, using the dermal absorption factors to evaluate dermal absorption exposures to soil may result in an overestimation of risks.

6.5.4 Toxicological Data

The HHRA relies on USEPA derived dose response criteria. These health effects criteria are conservative and are designed to be protective of sensitive subpopulations. The health criteria used to evaluate long-term exposures, such as RfDs or CSFs, are based on concepts and assumptions that bias an evaluation in the direction of overestimation of health risk. As USEPA notes in its *Guidelines for Carcinogenic Risk Assessment* (USEPA, 1986), there are major uncertainties in extrapolating both from animals to humans and from high to low doses. There are important species differences in uptake, metabolism, and organ distribution of carcinogens, as well as species and strain differences in target site susceptibility, human populations are variable with respect to genetic constitution, diet, occupational and home environment, activity patterns, and other cultural factors.

These uncertainties are compensated for by using upper bound 95% UCLs for CSFs (carcinogens), and safety factors for RfDs (non-carcinogens). The assumptions used here provide a rough but plausible estimate of the upper limit of risk; in other words, it is not likely

that the true risk would be much more than the estimated risk, but it could very well be considerably lower, even approaching zero. More refined modeling in the area of dose response calculation (e.g., using maximum likelihood dose response values rather than the 95% UCL) would be expected to substantially lower the final risk.

For dermal absorption exposure pathways, the absence of dermal toxicity criteria necessitates the use of oral toxicity data. To calculate risk estimates for the dermal absorption pathway, absorbed dermal absorption doses are combined with oral toxicity values (also discussed above in *Section 6.3*). Oral toxicity values, which are typically expressed in terms of potential (or administered) doses, should be adjusted when assessing dermal absorption doses, which are expressed as internal (or absorbed) doses. In this assessment, absolute oral absorption factors that reflect the toxicity study conditions were used to modify the oral toxicity criteria. For those chemicals lacking sufficient information, a default oral absorption factor of 1.0 was used. The risk estimates for the dermal absorption pathways may be overestimated or underestimated, depending on how the values used in the HHRA reflect the difference between the oral and dermal routes.

Inhalation toxicity criteria are unavailable for many of the COPCs. This HHRA does not use oral-based toxicity criteria to estimate risks from inhalation exposure because of the following uncertainties associated with such a substitution:

- Many contaminants show portal-of-entry toxicity - that is, adverse health effects occur primarily at the tissue site at which the chemical is introduced into the body (e.g., GI tract, lung, or skin).
- Physiological and anatomical differences between the GI tract and respiratory systems invalidate a cross-route quantitative risk extrapolation. The small intestine of humans contains a very large surface area that readily absorbs most compounds by passive diffusion (Klaasen et al., 1986). The oral absorption of a few compounds, such as iron, is an energy-dependent (active-transport) process, wherein the absorption rate is proportional to the body's current need for iron.
- The rate and extent of pulmonary absorption are much more complex and depend on such factors as particle size distribution of the airborne toxicant and blood-gas solubility of the toxicant (Klaasen et al. 1986). Particles with median aerodynamic diameters of approximately 1 micrometer (μm) or less are absorbed by the alveolar region of the human lung. Larger particles deposit in the tracheobronchial or nasopharyngeal regions where they are cleared by mucociliary mechanisms and subsequently swallowed or physically removed and exhaled. Therefore, pulmonary absorption is more highly dependent on the physiochemical properties of the material than oral absorption.
- Because highly soluble gases (e.g., chloroform) are more rapidly absorbed into the blood than poorly soluble gases (e.g., ethylene), they take much longer to reach equilibrium. Thus, the inhalation absorption rate of a gas is more dependent on blood solubility than the oral absorption rate of the same substance administered as a liquid.
- Human inhalation risk estimates based on oral toxicity data in subhuman species are distorted by both route-to-route extrapolation and interspecies extrapolation. For example, the rodent GI tract, which includes a structurally unique fore stomach, is

anatomically and functionally distinct from the human lung, which contains a very large alveolar surface area for extensive absorption. The rate and extent of absorption across these distinct physiological systems are not alike.

In addition, for inhalation exposure to substances present as dusts, vapors, gases, or airborne particulate matter, dose extrapolation is far more complex, and therefore associated with uncertainty. The major confounding factors that prohibit a direct dose extrapolation of an inhaled toxicant are the following:

- Over 40 functionally different cell types in the lung - the distribution, consequent metabolic reactions, and air exchange rates vary widely across species.
- Differential concentration and activity of the detoxifying protein glutathione.
- Interspecies and intraspecies differences in the ability to repair pulmonary cell damage, and to clear toxic contaminants and immune complexes from the respiratory tract. For example, species vary in the ability to activate macrophages - nonspecific immune cells that can both protect the inner lining of the respiratory system and, at high concentrations, damage healthy tissues.
- Anatomical variations in the respiratory pathway, which affect both absorption rates and time to reach steady-state blood levels.
- Sensitivity to solubility and concentration variables; because of metabolic saturation (i.e., the exhaustion of normal metabolic activity caused by exposure to high concentrations), highly soluble contaminants deviate from first-order kinetics - which makes it difficult to predict the rates and extent of biotransformation and detoxification reactions. Furthermore, intermittent inhalation exposure to highly blood-soluble chemicals results in bioaccumulation in fat tissue because of the insufficient time between exposure sessions for complete clearance of the contaminant. Such slow release from the fat compartment to other body tissues can result in toxicological and metabolic effects that are difficult to assess and vary across species.

The lack of toxicity values for the inhalation pathway could result in an underestimation of risk or hazard. With the exception of the excavation worker, however, risks and hazards associated with dusts and particulates are typically small relative to the ingestion and dermal pathways.

For chemicals without Integrated Risk Information System (IRIS) toxicity criteria, provisional toxicity criteria were used where available (**Appendix E-1, Tables E.1-23 through E.1-26** and **Appendix E-2, Tables E.2-18 through E.2-21**). Provisional toxicity criteria (i.e., PPRTVs) present a source of uncertainty, since USEPA has evaluated the compound, but consensus has not been established on the toxicity criteria. PPRTVs or other oral toxicity provisional values were used for Aroclor 1254, benzo(b)fluoranthene, chloroform, 2,3,7,8-TCDD toxicity equivalents, aluminum, cobalt, copper, iron, and vanadium for SWMU 50 and for 2,3,7,8-TCDD toxicity equivalents, aluminum, cobalt, iron, and vanadium at SWMU 59. Provisional inhalation toxicity values were used for Aroclor 1254, arsenic, benzo(a)pyrene, benzo(b)fluoranthene, 2,3,7,8-TCDD toxicity equivalents, 2,4-dinitrotoluene, aluminum, and cobalt for SWMU 50 and 2,3,7,8-TCDD toxicity equivalents, aluminum, arsenic, total chromium, chloroform, and cobalt for SWMU 59. In particular, the provisional oral RfD for 2,3,7,8-TCDD (1E-09 mg/kg-day) is based on an MRL established by the ATSDR (USEPA, 2008, ATSDR, 2009). An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without

appreciable risk of adverse noncancer health effects over a specified duration and route of exposure. The substance-specific estimates are intended to be used as SLs. Based on a review of more recent literature, ATSDR acknowledged that the MRL is approximately two orders of magnitude below the noncancer health effect levels observed in more recent studies (DeRosa et al, 1997). Although the HQs for 2,3,7,8-TCDD are likely to be overestimated, this uncertainty does not change the conclusion of the HHRA. For this assessment, use of provisional toxicity criteria was preferable to not evaluating the chemical in order to limit data gaps. However, because these toxicity criteria have not been formally accepted by USEPA, there is uncertainty with these values and, therefore, with the risks and hazards calculated using these toxicity criteria.

For some chemicals, toxicity criteria were unavailable (**Appendix E-1, Tables E.1-23 through E.1-26** and **Appendix E-2, Tables E.2-18 through E.1-21**). There are no toxicity values available or surrogates identified for carbazole, dibenzofuran, and dimethylphthalate in surface and total soil at SWMU 50; and carbazole and dibenzofuran in surface and total soil at SWMU 59. Although lack of published toxicity data could result in an underestimation of risk and hazard in this HHRA, this uncertainty is likely to be balanced by the conservative nature of the verified toxicity values that were available for use.

It is noted that the Supplemental SSL Guidance (USEPA, 2002b) recommends that toxicity values for subchronic exposures be used to calculate the hazard quotients (HQs) for exposures by the construction worker. Although subchronic values for some chemicals are included in USEPA's database of Provisional Peer-Reviewed Toxicity Values (PPRTVs), this website cannot be accessed without authorization. The overall lack of subchronic toxicity values for the COPCs at these sites contributes to the uncertainty of the HIs. Typically, subchronic toxicity values are 10-fold greater than chronic toxicity values. Because chronic toxicity values were used for all COPCs, the calculated hazards are likely to be overestimated. For both SWMU 50 and SWMU 59, however, hazards associated with individual COPCs for this pathway were below the target HI.

Lead was not included in the quantitative risk estimates since a dose-response toxicity value is not available for this chemical. Lead was selected as a COPC in total soil at SWMU 50 due to the exceedance of the residential screening criterion at one location. Because the non-carcinogenic effects from lead are evaluated separately in this RFI, these effects are not represented in the cumulative HI.

For SWMU 50, the inhalation toxicity value for total chromium was used to evaluate potential inhalation exposures to chromium in total soil. The toxicity value was derived on the basis of a 1:6 ratio of chromium VI to chromium III. It is unlikely that chromium in SWMU 50 soil exists as chromium VI. Therefore, the HQs for chromium may be slightly overestimated.

6.5.5 Risk Characterization

Minor uncertainty is associated with rounding of the risk and hazard estimates. Thus, the actual risk or hazard may be slightly greater or less than the presented values. A related issue is that rounding results in differences between summed risk and hazard values, depending on how the summing is performed. For example, the RAGS Table 7 and 8 spreadsheets in **Appendix E-1, Tables E.1-27 through E.1-38** and **Appendix E-2,Tables E.2-22 through E.2-33** present risks and hazards that are summed for exposure route, exposure point, exposure medium, and medium total. The individual chemical-specific risks and hazards are summed only for the initial

exposure route in deriving the total. For the subsequent summations (exposure point, exposure medium, and medium total), each is the summation of the preceding sums. For this reason, there can also be or rounding-related differences between the "same" values presented in RAGS Table 9 and 10 spreadsheets in **Appendix E-1, Tables E.1-39 through E.1-50** and **Appendix E-2, Tables E.2-34 through E.2-45**.

Because groundwater is being addressed under the RFI/CMS for SWMUs 48 and 49 (Shaw, 2008), cumulative risks and hazards for SWMUs 50 and 59 did not include risks and hazards associated with exposures to groundwater. Therefore, cumulative risk and hazards to receptors at SWMUs 50 and 59 is underestimated. However, this uncertainty does not affect the conclusions of the HHRA for soil at SWMUs 50 and 59.

6.6 HHRA SUMMARY AND CONCLUSIONS

This HHRA was performed to evaluate the potential human health effects associated with previous activities at SWMU 50 and SWMU 59. Receptors evaluated for both areas included current/future maintenance worker, future industrial worker, future excavation worker, future adult resident, future child resident, and lifetime resident.

6.6.1 SWMU 50 Summary

As presented in *Section 6.4*, the total cancer risk for current maintenance worker exposures to surface soil (1E-06) was equal to the lower limit of the target risk range of 1E-06 to 1E-04 due to arsenic. The total HI for surface soil was less than 1.

For the future maintenance worker, the total cancer risk for exposures to surface soil (1E-06) was equal to the lower limit of the target risk range of 1E-06 to 1E-04. The total HI for surface soil was less than 1. The total cancer risk for exposures to total soil (1E-06) was equal to the lower limit of the target risk range. The total HI for total soil was less than 1.

For future industrial worker exposures to surface soil, the total cancer risk for exposures to surface soil (6E-06) was within the target risk range of 1E-06 to 1E-04 due to dioxins/furans and arsenic. The total HI for surface soil was less than 1. The total cancer risk for exposures to total soil (6E-06) was within the target risk range due to dioxins/furans and arsenic. The total HI for total soil was less than 1.

For the future excavation worker, the total cancer risk for exposures to total soil (1E-06) was equal to the lower limit of the target risk range of 1E-06 to 1E-04. The total HI for total soil was less than 1.

For the future lifetime resident, the total cancer risk for exposures to total soil (3E-05) was within the target risk range of 1E-06 to 1E-04 due to dioxins/furans, Aroclor 1254, benzo(a)pyrene, and arsenic. The total HI for total soil was less than 1.

For the child resident, the total cancer risk for exposures to total soil (2E-05) was within the target risk range of 1E-06 to 1E-04 due to dioxins/furans, Aroclor 1254, and arsenic. The total HI for total soil (3E+00) was above 1. No individual COPC had an HI above 1. However, the target organ for the nervous system slightly exceeded an HI of 1 (**Table 6-4** and **Appendix E-1**, **Table E.1-44**). Of the constituents that contribute to the nervous system HI, concentrations of manganese were found to be within the background range. By excluding the HQ for manganese, the nervous system HI is less than 1.

6.6.2 SWMU 59 Summary

As presented in *Section 6.4*, the total cancer risk for current maintenance worker exposures to surface soil (3E-06) was within the target risk range of 1E-06 to 1E-04 due to arsenic. The total HI for surface soil was less than 1.

For the future maintenance worker, the total cancer risk for exposures to surface soil (2E-06) was within the target risk range of 1E-06 to 1E-04 due to arsenic. The total HI for surface soil was less than 1. The total cancer risk for exposures to total soil (3E-06) was within the target risk range due to arsenic. The total HI for total soil was less than 1.

For future industrial worker exposures to surface soil, the total cancer risk for exposures to surface soil (1E-05) was within the target risk range of 1E-06 to 1E-04 due to arsenic. The total HI for surface soil was less than 1. The total cancer risk for exposures to total soil (8E-06) was within the target risk range due to arsenic. The total HI for total soil was less than 1.

For the future excavation worker, the total cancer risk for exposures to total soil (6E-07) was below the target risk range of 1E-06 to 1E-04. The total HI for total soil was less than 1. The HIs for individual COPCs were less than 1.

For the future lifetime resident, the total cancer risk for exposures to total soil (4E-05) was within the target risk range of 1E-06 to 1E-04 due to benzo(a)pyrene and arsenic. The total HI for total soil was less than 1.

For the child resident, the total cancer risk for exposures to total soil (3E-05) was within the target risk range of 1E-06 to 1E-04 due to arsenic. The total HI for total soil (3E+00) was above 1. No individual chemical or target organ HI exceeded 1.

6.6.3 Groundwater Summary

As discussed throughout the HHRA, groundwater in the vicinity of SWMUs 48, 49, 50, and 59 was evaluated and addressed as part of the SWMUs 48 and 49 RFI/CMS (Shaw, 2008). For purposes of information, the results of the groundwater evaluation are summarized below.

The total cancer risk associated with groundwater was below the target risk range for the current/future maintenance worker and the future excavation worker. In addition, the total HI was less than 1 for these receptors, with the exception that the target organ HI for the liver exceeded an HI of 1 for the excavation worker.

For future industrial worker exposures to groundwater, the total cancer risk associated with groundwater was above the target risk range of 1E-06 to 1E-04, primarily due to CT, 1,2-dichloroethane, dioxins/furans, PCE, TCE, and arsenic. The total HI was above 1, primarily due to CT, iron, manganese, and vanadium. When recalculated by target organ, the following organs exceeded 1: liver, CNS, blood, GI irritation, and kidney. The MDC of lead in groundwater exceeded the MCL for lead.

For the future lifetime resident, the total cancer risk associated with groundwater was above the target risk range of 1E-06 to 1E-04, due to bis(2-ethylhexyl)phthalate, CT, 1,2-dichloroethane, pentachlorophenol, dioxins/furans, PCE, TCE, and arsenic. For future adult resident exposures, the total HI was above 1, primarily due to CT, TCE, aluminum, arsenic, iron, manganese, thallium, and vanadium. When recalculated by target organ, the following target organs exceeded 1: liver, CNS, blood, skin, vascular system, GI irritation, developing fetus, hair, and kidney. The MDC of lead exceeded the MCL for lead.

For the child resident, the total cancer risks associated with groundwater was above the target risk range of 1E-06 to 1E-04, due to CT, 1,2-dichloroethane, pentachlorophenol, dioxins/furans, PCE, TCE, and arsenic. For future child resident exposures, the total HI was above 1, primarily due to CT, TCE, aluminum, arsenic, barium, iron, manganese, nickel, thallium, and vanadium. When recalculated by target organ, the following target organs exceeded 1: spleen, liver, CNS, blood, skin, vascular system, GI irritation, hair, kidney, and developing fetus. For the residential scenario, site concentrations were above the health protective criterion for lead. The margin-of-exposure evaluation for iron indicated that the iron intake was above the allowable range.

Off-site residents were evaluated to address potential future migration of COPCs in groundwater. The risks and hazards for the off-site receptors were similar to those on-site because it was conservatively assumed that there was no change to groundwater concentrations as COPCs migrated off site. This is discussed more in detail in the SWMUs 48 and 49 RFI/CMS (Shaw, 2008).

7.0 SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

A screening level ecological risk assessment (SLERA) was performed at each site to provide an estimate of current and future ecological risk associated with potential hazardous substance releases at SWMUs 50 and/or 59. Common methods and procedures are presented in *Section 7.1*, and individual results for SWMU 50 and SWMU 59 are presented in *Section 7.2* and *Section 7.3*, respectively.

7.1 SLERA Methods and Procedures

This section provides the rationale for the methods and procedures used during the evaluation of the data collected at SWMUs 50 and 59 and performance of the SLERAs.

SLERAs were performed to provide an estimate of current and future ecological risk associated with potential hazardous substance releases at SWMU 50 and SWMU 59. The results of the SLERAs contribute to the overall characterization of the sites and the scientific/management decision points (SMDPs) reached from each SLERA includes one of the following:

- There is adequate information to conclude that ecological risks are negligible and therefore there is no need for further action at the site on the basis of ecological risk.
- The information is not adequate to make a decision at this point and further refinement of data is needed to augment the ecological risk screening.
- The information collected and presented indicates that a more thorough assessment is warranted.

The SLERAs were performed following the *RFAAP Final Master Work Plan* (URS, 2002), the *RFAAP Site Screening Process* (USEPA, 2001b), the *Tri-Service Procedural Guidelines for Ecological Risk Assessments* (Wentsel et al., 1996), and Steps 1, 2 and 3a of the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997d). Steps 1, 2 and 3a were completed as part of the SLERAs. The addition of Step 3a focuses the outcome of the SLERAs, streamlines the review process, and allows one assessment to function as the initial forum for ecological risk management decision making at the sites.

The primary objective of the SLERAs is to assess whether there is enough information to state that there is the potential for unacceptable risks to ecological receptors as a result of potential hazardous substance releases. Characterizing the ecological communities in the vicinity of SWMU 50 and SWMU 59, assessing the particular hazardous substances being released, identifying pathways for receptor exposure, and estimating the magnitude and likelihood of potential risk to identified receptors meets this objective. The SLERAs address the potential for adverse effects to vegetation, the soil invertebrate community, wildlife, endangered and threatened species, and wetlands or other sensitive habitats that may be associated with SWMU 50 and SWMU 59.

Concentrations of chemicals were measured in surface soil, which was the only relevant environmental media at SWMUs 50 and 59. Surface water was not present and groundwater does not discharge to the surface in the immediate vicinity of SWMUs 50 or 59, so there is no potential exposure for ecological receptors to surface water, sediment, or groundwater at the sites. Groundwater that may have been collected in association with SWMUs 50 or 59 is being

assessed under MWP Work Plan Addendum 009, "Horseshoe Area Groundwater Study" (IT, 2002b). Although area-wide groundwater does ultimately discharge to the New River as mentioned previously, groundwater is being assessed as a separate study.

Using available concentration data, the SLERAs were performed by following Steps 1 and 2 of USEPA (1997d). Step 1 includes a screening-level problem formulation and ecological effects evaluation, and Step 2 includes an SL preliminary exposure estimate and risk calculation. The SLERA is organized as follows: General SWMU 50 and SWMU 59 Site Characterization (*Section 7.1.1*); Methodologies for the Identification of Chemicals of Potential Ecological Concern (COPEC) and Concentration Statistics (*Section 7.1.2*); Identification of Exposure Pathways and Potential Receptors for Analysis (*Section 7.1.3*); Identification of Assessment and Measurement Endpoints (*Section 7.1.4*); Exposure Estimation (*Section 7.1.5*); Ecological Effects Assessment (*Section 7.1.6*); Risk Characterization (*Section 7.1.7*); Direct Contact Toxicity (*Section 7.1.8*); Background Metals Evaluation (*Section 7.1.9*); and General Uncertainty Analysis (*Section 7.1.10*).

7.1.1 General SWMU 50 and SWMU 59 Site Characterization

This section includes a general discussion of the Installation, vegetative communities, a species inventory, and a discussion on threatened and endangered species. SWMUs 50 and 59 are located in the south central section of the Horseshoe Area.

7.1.1.1 General Installation Background

The Virginia Department of Game and Inland Fisheries (1999) conducted the most recent Installation-wide biological survey at RFAAP. Major objectives of this survey were to sample flora and fauna, identify and delineate the major habitat community types, and provide management recommendations for both community types and threatened, endangered or species of concern. Eight community types were identified at RFAAP:

- Bottomland forest.
- Calcareous forest.
- Cliffs.
- Grasslands.
- Oak forest.
- Pine plantation.
- Successional forest.
- Water.

Endangered plants or animals were not observed at SWMUs 50 and 59 during the Installation-wide biological survey of 1999. Five state-listed rare plants were observed at RFAAP during this survey: *Clematis coattails, Cystoptris tennesseensis, Hasteola suaveolens, Sagittaria rigida,* and *Eleocharis intermedia*. State threatened animals located at RFAAP include the invertebrate *Speyeria idalia* and the birds *Ammodramus henslowii* (Henslow's sparrow) and *Lanius ludovicianus* (loggerhead shrike).

An earlier comprehensive inventory of the mammals, birds, reptiles, aquatic invertebrates, trees, and plants found on the Installation, and of fish inhabiting the New River where it flows through

the Installation, was conducted in 1976 during the RFAAP Installation Assessment (USATHAMA, 1976). Information from that assessment was summarized in previous documents (Dames and Moore, 1992). The summarized information was updated for the RFI through personal communication with RFAAP biologists and is presented in the following paragraphs (from URS, 2003).

Many of the reptiles, mammals, and birds listed in the assessment (USATHAMA, 1976) are believed to breed on the Installation. Migratory waterfowl are found throughout the spring and winter near the New River because the Installation is on the Atlantic Flyway. Public fishing occurs in the New River where it flows through RFAAP.

The Virginia Department of Game and Inland Fisheries identified the following terrestrial flora and fauna as endangered or threatened for Pulaski and Montgomery Counties:

- Plant species - six endangered, three threatened.
- Insect species - one endangered, four threatened.
- Bird species - three endangered.
- The locally endangered mountain lion.

In addition, a fish, salamander, four additional bird species, and the river otter are identified as species of concern in the two counties in which RFAAP is located.

Tree species at RFAAP include the shortleaf pine, loblolly pine, eastern white pine, yellow poplar, and black walnut. There are 2,537 acres of managed woodland on site (personal communication with T. Thompson, RFAAP Conservation Specialist 1995, as cited in URS, 2003).

RFAAP is located at the boundary of the central Appalachian Ridges and Valleys Ecoregion and the central Appalachian Ecoregion (Omernik, 1986). These two Ecoregions are characterized in **Table 7-1**.

Table 7-1
Ecoregions of RFAAP

Ecoregion	Land Surface Form	Potential Natural Vegetation	Land Use
Central Appalachian Ridges and Valleys	Open low hills to open low mountains	Appalachian oak in undisturbed areas	Mosaic of cropland and pasture with some woodland and forest
Central Appalachian	Open low to high hills, open mountains	Mixed mesophytic forest[1], Appalachian oak, northern hardwoods[2]	Forest and woodland mostly ungrazed

[1]maple, buckeye, beech, tuliptree, oak, linden
[2]maple, birch, beech, hemlock

Based on previous site visits and investigations, the available photographic record was compiled (**Appendix F-1, Figures F-1 through F-3**). A Shaw ecologist performed site reconnaissance activities in June 2002. Prior to the reconnaissance, relevant information was obtained, including topographic maps, township, county, or other appropriate maps. This information was used to identify the location of potential ecological units such as streams, creeks, ponds, grasslands, forest, and wetlands on or near many of the RFAAP SWMUs. Additionally, the Virginia

Department of Game and Inland Fisheries (1999) Installation-Wide Biological Survey, which identifies the locations of threatened and endangered species at RFAAP, was reviewed. The location of known or potential contaminant sources affecting the SWMUs and the probable gradient of the pathway by which contaminants may be released to the surrounding environment were identified. The reconnaissance was used to evaluate more subtle clues of potential effects from contaminant releases.

7.1.1.2 Surface Water

There is no surface water or aquatic habitat at the sites.

7.1.1.3 Groundwater

The proximity of SWMUs 50 and 59 to the New River (approximately 700 ft northwest of the river) make it unlikely that groundwater chemicals from SWMUs 50 or 59 are migrating to the New River. There are also no other groundwater to surface water discharges in close proximity to SWMUs 50 and 59, therefore groundwater will not have an adverse impact on aquatic life or wildlife.

7.1.1.4 Wetlands

According to the information presented in the Virginia Department of Game and Inland Fisheries (1999) Installation-Wide Biological Survey, and confirmed during a review of site photographs, there are no designated wetlands at SWMUs 50 and 59. There are also no wetlands close enough to the sites that could potentially be impacted or receive surface water drainage from the sites.

7.1.1.5 Vegetative Communities

Vegetative communities at the site, as presented in the Virginia Department of Game and Inland Fisheries (1999) Installation-Wide Biological Survey, were verified using the photographs in **Appendix F-1.** As shown in **Appendix F-1, Figures F-1 through F-3**, the area surrounding SWMUs 50 and 59 are primarily maintained grass, with some trees located along the edges.

These two habitat types (grass and successional forest edge) can be expected to support different wildlife species assemblages; however, given the close proximity of the habitats to each other, many species would be expected to spend some amount of time within each community type for foraging and resting activities, depending on the season.

Based on information from the Virginia Department of Game and Inland Fisheries (1999) Installation-Wide Biological Survey, and confirmed during a review of available site information, the following community description is presented for typical grassland communities at RFAAP.

The grassland communities at RFAAP are an aggregation of several community types that are so intermingled that delineation is impractical. Grassland may conveniently be subdivided into old field, meadow, and cultivated field. The term old field is used here to denote areas that were formerly open and subsequently abandoned, but are still open. In most cases, these areas were formerly pasture or hayfield. Trees or shrubs may be present individually or in small groups, but a canopy is lacking. At SWMUs 50 and 59, a few saplings and young trees are expected, but not large, mature trees. There is successional forest habitat just beyond the edges of the site. Old fields, in most cases, are dominated by native, warm-season species with a wide variety of other grasses, sedges, and herbs mixed in. The two dominants are little bluestem (*Schizachyrium scoparium*) and broomsedge (*Andropogon virginicus*) with others such as *Tridens flavus*,

Panicum oligosanthes, Panicum anceps, Eragrostis spectabilis, Setaria glauca, *Sorghastrum nutans,* and *Paspalum* being frequent. Much of the old-field community is mowed (on an infrequent basis) to help keep woody plant areas maintained.

Meadows are areas that are mowed regularly and, in most cases, have been planted in forage grasses for haying. These are typically non-native, cool-season species such as *Festuca elatior, Poa pratensis, Phleum pratense, Agrostis gigantea, Bromus inermis, Dactylis glomerata,* and *Arrhenatherum elatius*. These species may also be mixed with native species characteristic of old fields.

Cultivated fields are areas that have been plowed and seeded with various cover crops. These areas have a major ruderal component that persists after abandonment. Principal weed species are *Cirsium arvense, Carduus acanthoides, Carduus nutans, Erechtites hieracifolia, Hypochaeris radicata, Verbascum thapsus, Hieracium pilosella,* and *Datura stramonium.*

Grassland communities at RFAAP comprise 4,379 acres, or about 63 percent of the 6,901-acre total [Virginia Department of Game and Inland Fisheries (1999) Installation-Wide Biological Survey].

7.1.1.6 Species Inventory

As presented in the Virginia Department of Game and Inland Fisheries (1999) Installation-Wide Biological Survey, six different taxa and several species were recorded during the survey. **Table 7-2** presents the numbers of species recorded at RFAAP associated with the grassland community type.

Table 7-2
Species Inventory within RFAAP's Grassland Community Type

Taxa	Number of Species	Typical Examples
Plants	24	little bluestem, broomsedge, panic grass, orchard grass, foxtail, timothy, thistle, fireweed, hawkweed
Invertebrates	~250 in 17 taxonomic orders	millipedes, beetles, flies, springtails, seed bugs, bees, ants, moths, butterflies, dragonflies, mantis, caddisflies, isopods, pill bugs, amphipods
Reptiles and amphibians	24	salamanders, toads, frogs, turtles, snakes
Fish	12	sunfish, minnows, trout (not expected at the site)
Birds	83	robin, swift, dove, sparrow, warbler, wren, hawk
Mammals	13	red fox, white-tailed deer, shrew, meadow vole

7.1.1.7 Threatened, Rare and Endangered Species Information

Threatened, rare, or endangered species found within the grassland community type at RFAAP include those presented in **Table 7-3** [Virginia Department of Game and Inland Fisheries (1999) Installation-Wide Biological Survey]. Given the grassland community type at the sites, it is possible these species could also occur at the sites, however, as mentioned in *Section 7.1.1*, no threatened, rare, or endangered species have been documented at SWMUs 50 or 59.

Table 7-3
Threatened, Rare, and Endangered Species in RFAAP's Grassland Community

Common Name	Scientific Name	Federal Status	State Status
Midland sedge	*Carex mescochorea*	not available	Watchlist
Shaggy false gromwell	*Onosmodium hispidissimum*	not available	Watchlist
Regal fritillary butterfly	*Speyeria idalia*	not available	State threatened
Henslow's sparrow	*Ammodramus henslowii*	not available	State threatened
Loggerhead shrike	*Lanius ludovicianus*	not available	State threatened

Although a unique community type (calcareous fen) exists within the RFAAP grassland community type, it is not found at or near SWMUs 50 or 59.

7.1.2 Methodologies for the Identification of COPECs and Concentration Statistics

Using the chemical results from environmental media samples collected at SWMUs 50 and 59, a subset of the chemicals detected having data of good quality and that were not a result of non-site sources are identified. The COPEC selection process is described in more detail in the following subsections, however, screening results are presented with the write up for each site (*Sections 7.2.2 and 7.3.2*). A discussion of non-detected constituent concentrations compared with ecotoxicity screening values is presented in the Uncertainty Analysis sections for each site.

Lists of samples are presented in referenced tables in *Sections 7.2.1 and 7.3.1* for SWMUs 50 and 59, respectively. A general discussion of comparing non-detected constituent concentrations with ecotoxicity screening values is presented in the general Uncertainty Analysis section *(Section 7.1.10)*.

7.1.2.1 Data Organization

The data for each chemical have been sorted by medium. To assess potential ecological impacts, soil data from 0-2 ft bgs have been considered. The 0-2 ft depth interval was selected for three primary reasons: 1) to maintain consistency with other RFAAP ecological risk assessment documents that used 0-2 ft, or a similar depth interval (e.g., *Ecological Risk Assessment Approach*, IT, 1998; *Screening Ecological Risk Assessment*, IT, 1999); 2) to address the most important ecological soil depth exposure interval, as soil depths below 2 ft would be infrequently contacted; and 3) to focus on the soil depth interval expected to have the highest COPEC concentrations, as discharges at SWMUs 50 and 59 were primarily surficial. Although some burrowing wildlife (e.g., the red fox) may actually burrow to depths greater than 2 ft, their prey items would be primarily associated with surface soil, and incidental contact by the fox with deeper soil is expected to be insignificant compared to exposures associated with soil in the 0-2 ft depth range.

Chemicals that were not detected at least once in a medium are not included in the risk assessment, although non-detect constituents are discussed in the Uncertainty Analysis section for each site (*Sections 7 2.6 and 7.3.6*).

The analytical data may have qualifiers from the analytical laboratory quality control or from the data validation process that reflect the level of confidence in the data. Some of the more common qualifiers and their meanings from USEPA (1989a) are discussed, along with other data issues in **Appendix A**, **QA/QC Evaluation**. Besides taking into account the ecological depth of interest, the methodology for data summary was identical for the SLERA and the HHRA.

7.1.2.2 Descriptive Statistical Calculations

Because of the uncertainty associated with characterizing contamination in environmental media, the 95% UCL of the mean has been estimated for chemicals selected as COPECs. The calculation of EPCs follows the same procedure used for the HHRA (*Section 6.2.3*).

7.1.2.3 Frequency of Detection

Chemicals that are detected infrequently may be artifacts in the data that may not reflect site-related activity or disposal practices. These chemicals, however, have been included in the risk evaluation and a low frequency of detection was not used to deselect COPECs.

7.1.2.4 Natural Site Constituents (Essential Nutrients)

As a conservative step, the essential nutrients calcium, magnesium, potassium, and sodium were assessed in the SLERA.

7.1.2.5 Selection of COPECs

In general, COPECs were selected as a concern for the direct contact exposure pathway if the constituent was detected in an environmental medium. For food chain exposure pathways, detected COPECs were selected if they were important bioaccumulative constituents (USEPA, 2000c) or explosives. COPEC selection for SWMU 50 and SWMU 59 are detailed in *Sections 7.2.2 and 7.3.2*, respectively.

Dioxin-like compounds (PCDDs and PCDFs) were detected in soil at SWMUs 50 and 59. For the SLERAs, dioxin-like compounds were treated according to procedures provided by USEPA and the World Health Organization (WHO) (Van den Berg et al., 2006; USEPA, 1989b, 1994b; WHO, 1998). Dioxin-like compounds are present in the environmental media as complex mixtures. PCDDs and PCDFs consist of a family of approximately 75 and 135 congeners, respectively. To simplify the task of screening PCDDs/PCDFs for evaluation in this risk assessment, these compounds were evaluated with respect to a single member of this class of compounds. The concentration of each congener was evaluated on the basis of its concentration relative to that of 2,3,7,8-TCDD, which has been shown to be the most potent congener of the class of PCDDs/PCDFs. For the SLERA the higher of the toxicity equivalence factors (TEFs) for mammals and birds was used, as a conservative approach (Van den Berg et al., 2006; WHO, 1998). The toxicity equivalent procedure itself is described in the HHRA *(Section 6.1.1)*.

It should be noted that USEPA recommends that aluminum should only be identified as a COPEC for those sites with soil with a pH less than 5.5 (USEPA, 2000d). The technical basis for this rationale is that soluble and toxic forms of aluminum are present in soil with soil pH values of less than 5.5. An analysis of two SWMU 50 and 59 surface soil samples with available pH data revealed one sample with a pH less than a pH of 5.5; 50SS01 (pH = 5.33) and one with a pH greater than 59SS03 (pH = 7.24). Since the soil pH at SWMU 50 is less than 5.5, it is possible that aluminum is a concern for direct contact exposure at SWMU 50. The soil pH at SWMU 59 is greater than 5.5; therefore, it is not likely that aluminum is a concern for direct contact exposure at SWMU 59. However, aluminum is not considered by USEPA to be an important bioaccumulator (USEPA, 2000c); therefore, aluminum was selected as a COPEC for direct contact exposure at SWMU 50, but not for food chain exposure at either SWMU.

7.1.3 Identification of Exposure Pathways and Potential Receptors for Analysis

RFAAP terrestrial and aquatic wildlife may be exposed to COPECs by several pathways, including: 1) the ingestion of impacted soil, sediment, surface water, or food while foraging; 2) dermal absorption of chemicals from soil, sediment, or surface water; and, 3) inhalation of chemicals that have been wind-eroded from soil or have volatilized from soil or water. Among these potential exposure pathways, the greatest potential for exposure to chemicals is likely to result from the ingestion of chemicals in food and surface water. The incidental ingestion of impacted soil or sediment (while foraging) is a less important exposure route. The ingestion of food, soil, sediment, and surface water, however, are viable exposure pathways and were considered in the SLERAs, if relevant. As surface water or sediment samples were not collected at SWMUs 50 or 59, exposures to these media were not included.

Receptor-specific exposures via inhalation or dermal absorption were not selected for further evaluation because of a lack of appropriate exposure data and the expectation that these pathways would be insignificant in comparison to the other exposure pathways quantified. Inhalation exposure would be expected to be minimal due to dilution of airborne COPECs in ambient air. Dermal exposure would also be expected to be minimal due to the expectation that wildlife fur or feathers would act to impede the transport the COPECs to the dermal layer.

The appropriate assessment receptors have been selected for evaluation in the SLERAs. In order to narrow the exposure characterization portion of the SLERAs on species or components that are the most likely to be affected, the SLERAs have focused the selection process on species, groups of species, or functional groups, rather than higher organization levels such as communities or ecosystems. Site biota are organized into major functional groups. For terrestrial communities, the major groups are plants and wildlife, including terrestrial invertebrates, mammals, and birds. For aquatic and/or wetland communities, the major groups are flora and fauna, including vertebrates (waterfowl and fish), aquatic invertebrates, and semi-aquatic mammals and birds. Species presence was assessed during a literature review and during the site reconnaissance prior to identification of target receptor species.

Primary criteria for selecting appropriate assessment receptors included, but were not limited to, the following:

- The assessment receptor will have a relatively high likelihood of contacting chemicals via direct or indirect exposure.
- The assessment receptor will exhibit marked sensitivity to the COPECs given their mode of toxicity, propensity to bioaccumulate, etc.
- The assessment receptor will be a key component of ecosystem structure or function (e.g., importance in the food web, ecological relevance).

7.1.3.1 Terrestrial Receptors

Five representative receptor species that are expected or possible in the area of SWMUs 50 and 59 were selected as indicator species for the potential effects of COPECs. These indicator species represent two classes of vertebrate wildlife (mammals and birds) and a range of both body size and food habits, including herbivory, omnivory, and carnivory. Note: potential impacts to terrestrial plants were considered by documenting the presence or absence of vegetative stress at the site as well as by comparing soil concentrations with conservative screening values. The five animal species selected include the meadow vole (*Microtus*

pennsylvanicus) (small, herbivorous mammal), short-tailed shrew (*Blarina brevicauda*) (small, insectivorous mammal), American robin (*Turdus migratorius*) (small omnivorous bird), red-tailed hawk (*Buteo jamaicensis*) (large, carnivorous bird), and red fox (*Vulpes vulpes*) (medium, carnivorous mammal). Data used to model exposure for these species are summarized in **Appendix F-2, Table F-1**.

The meadow vole, shrew, and robin represent the prey base for the larger predators of the area (represented by the red-tailed hawk and the red fox). A terrestrial food web is presented on **Figure 7-1**. Many of these species have limited home ranges, particularly the meadow vole, shrew, and American robin, which make them particularly vulnerable to exposure from site constituents. Receptor profiles for these five selected species are presented in the following five sections.

Meadow Vole. The meadow vole inhabits grassy areas (upland and wetland) and obtains a significant portion of its herbivorous diet from the site. The vole resides in every area of the United States and Canada where there is good grass cover, ranges in size from about 9 to 13 centimeters in length, and weighs between 17 and 52 grams (USEPA, 1993). The meadow vole has a limited foraging range, increasing its potential to be exposed (directly or indirectly) to COPECs in on-site surface soil. The vole has an average home range of 0.09 acres, with summer ranges larger than winter ranges. The vole does not hibernate and is active year-round. Population densities can range up to several hundred per hectare (USEPA, 1993).

Short-Tailed Shrew. The short-tailed shrew is an insectivore that feeds largely on soil invertebrates. It would be potentially exposed to COPECs through prey items and have a relatively high rate of incidental ingestion of soil while foraging on earthworms. This short-tailed shrew weighs between 15 and 29 grams (Whitaker, 1995). Total length of this shrew is 76 to 102 millimeters (Burt and Grossenheider, 1980). The range of this shrew extends from southeastern Canada and the northeastern U.S. to Nebraska, Missouri, Kentucky, and in the mountains to Alabama (Whitaker, 1995). Preferable habitat for the shrew includes forests, grasslands, marshes, and brushy areas. It will make a nest of dry leaves, grass, and hair beneath logs, stumps, rocks, or debris (Burt and Grossenheider, 1980). This mammal has a voracious appetite, and will consume earthworms, other terrestrial invertebrates, and sometimes young mice (Whitaker, 1995). Mean population densities range from 5.7, in the winter, to 28 per acre in the summer (USEPA, 1993). Their home range varies from 0.5 to 1 acre (Burt and Grossenheider, 1980) and an average value of 0.96 acres has been used in the SLERAs (**Appendix F-2, Table F-1**).

American Robin. The American robin is an omnivore that feeds on both plants (primarily fruit) and terrestrial invertebrates including earthworms. The robin occurs throughout most of the continental United States and Canada during the breeding season and winters in the southern half of the United States and Mexico and Central America. They live in a variety of habitats, including woodlands, wetlands, suburbs and parks. Robins are likely to forage throughout RFAAP and are present year-round. Most robins build nests of mud and vegetation on the ground or in the crotches of trees or shrubs. Robins forage primarily on the ground and in low vegetation by probing and gleaning. They are approximately 25 centimeters in size, have a body weight range of 63 to 103 grams, and an average home range of 1.2 acres (USEPA, 1993).

Red-Tailed Hawk. The red-tailed hawk is a common predator in the mixed landscapes typifying RFAAP. The wooded habitats and riverside trees within RFAAP are considered ideal

foraging and nesting habitats for these raptors. This hawk is one of the most common and widespread members of the genus *Buteo* in the continental United States and Canada (Brown and Amadon, 1968). Red-tailed hawks live in a variety of habitats, such as farmlands, woodlands, mountains, and deserts, as long as there is open country interspersed with woods, bluffs, or streamside trees. They are primarily carnivorous, feeding on small rodents, as well as fish. Other prey items include amphibians, reptiles, crayfish, and other birds (Adamcik et al., 1979; Ehrlich et al., 1988). Home range has been reported as small as 66.8 acres, with a population density of 0.16 pairs per acre (Janes, 1984), although USEPA (1993) reports an average territory size of 2,081 acres. Breeding population density is one nest per 0.009 acre or one individual per 0.004 acre. Body weight for male red-tails is 1,028.6 to 1,142.9 grams, and for females 1,371.4 to 1,600 grams (Brown and Amadon, 1968), although USEPA (1993) reports an average body weight of 1,134 grams. More northerly populations are migratory, while the more southerly are year-round residents.

Red Fox. The red fox is a carnivorous predator that occurs in a wide range of habitats typical of RFAAP. Red fox use many types of habitat, including cropland, rolling farmland, brush, pastures, hardwood stands, and coniferous forests. They are present throughout the United States and Canada, and are the most widely distributed carnivore in the world. These foxes have a length of 56 to 63 centimeters, with a 35 to 41 centimeter tail and an average weight of 4,530 grams. They do not undergo hibernation, and most often occupy abandoned burrows or dens of other species.

One fox family per 100 to 1,000 hectares is typical, and the average home range is 892 hectares (2,204 acres) (USEPA, 1993). Fecundity is higher in areas of high mortality and low population density.

A pictorial representation of potential exposure has been prepared and is presented as **Figure 7-1**. This food web pictorial clarifies the conceptual site exposure model (CSEM). The CSEM traces the contaminant pathways through both abiotic components and biotic food web components of the environment. The CSEM presents potentially complete exposure pathways.

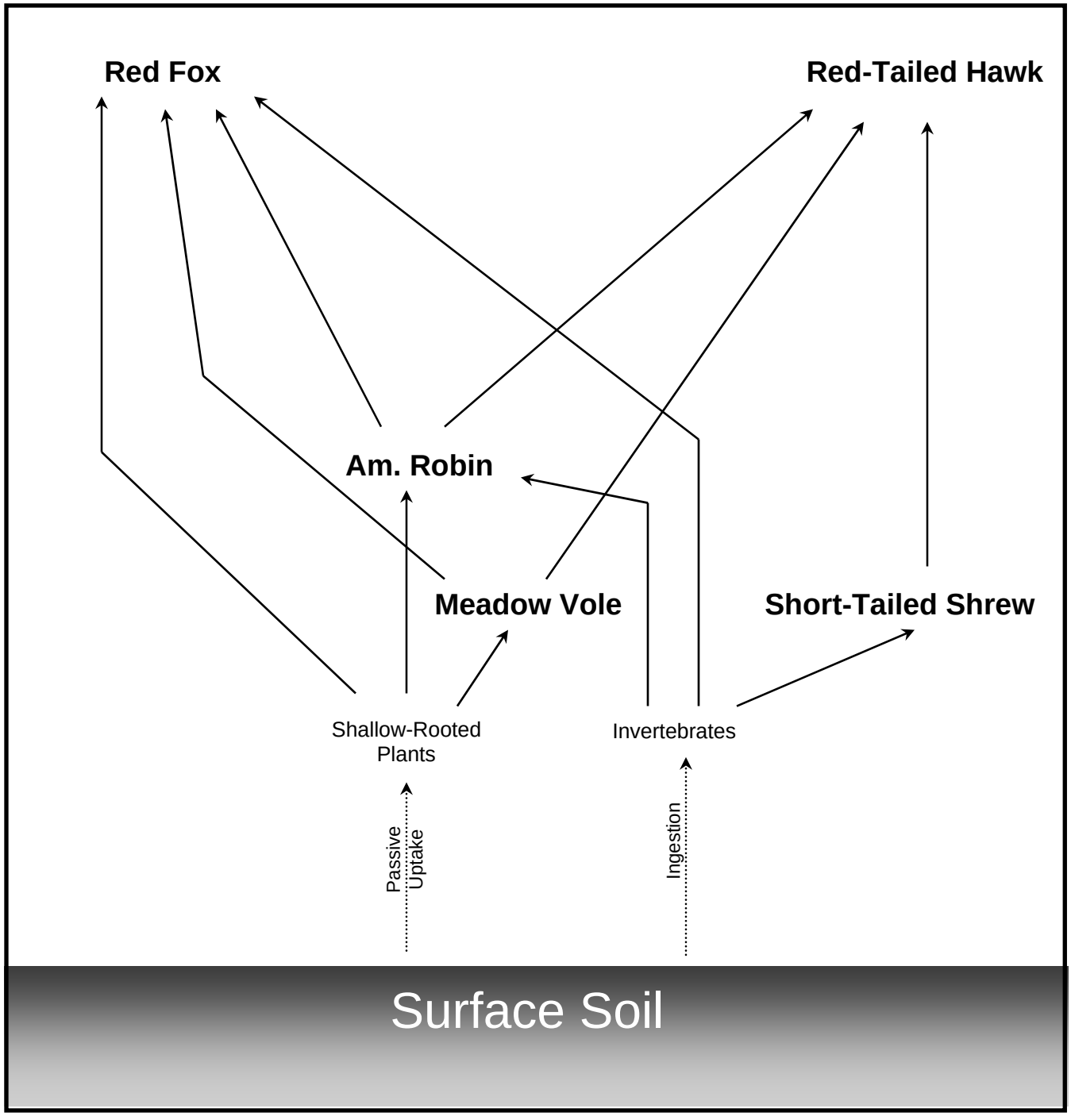
7.1.4 Identification of Assessment and Measurement Endpoints

The protection of ecological resources, such as habitats and species of plants and animals, is a principal motivation for conducting the SLERAs. To assess whether the protection of these resources are met at the site, assessment and measurement endpoints have been formulated to define the specific ecological values to be protected and to define the degree to which each may be protected.

Unlike the HHRA process, which focuses on individual receptors, a SLERA focuses on populations or groups of interbreeding nonhuman, non-domesticated receptors. In the SLERA process, the risks to individuals are generally assessed if they are protected under the Endangered Species Act.

Selected assessment endpoints reflect environmental values that are protected by law, are critical resources, and/or have relevance to ecological functions that may be impaired. Both the entity and attribute are identified for each assessment endpoint (Suter, 1993).

Figure 7-1
Simplified Terrestrial Food Web
Conceptual Site Exposure Model (CSEM)



Assessment endpoints are inferred from effects to one or more measurement endpoints. The measurement endpoint is a measurable response to a stressor that is related to the valued attribute of the chosen assessment endpoint. It serves as a surrogate attribute of the ecological entity of interest (or of a closely related ecological entity) that can be used to draw a predictive conclusion about the potential for effects to the assessment endpoint.

Measurement endpoints for the SLERAs are based on toxicity values from the available literature. When possible, receptors and endpoints have been concurrently selected by identifying those that are known to be adversely affected by chemicals at the site based on published literature.

7.1.4.1 Assessment Endpoints

ERAGS (USEPA, 1997d) states: "For the screening-level ecological risk assessment, assessment endpoints are any adverse effects on ecological receptors, where receptors are plant and animal populations and communities, habitats, and sensitive environments. Adverse effects on populations can be inferred from measures related to impaired reproduction, growth, and survival. Adverse effects on communities can be inferred from changes in community structure or function. Adverse effects on habitats can be inferred from changes in composition and characteristics that reduce the habitats' ability to support plant and animal populations and communities."

The selected assessment endpoints for SWMUs 50 and 59 are stated as the protection of long-term survival and reproductive capabilities for populations of herbivorous, insectivorous, and carnivorous mammals, and omnivorous, piscivorous, and carnivorous birds. The corresponding null hypothesis (H_o) for each of the assessment endpoints is stated as: the presence of site contaminants within soil, surface water, sediment, vegetation, and prey will have no effect on the survival or reproductive capabilities of populations of herbivorous, insectivorous, and carnivorous mammals, and omnivorous, piscivorous, and carnivorous birds. In addition, assessment endpoints for the base of the food chain are stated as the protection of long-term survival and reproduction of terrestrial plants and soil invertebrates.

The food web CSEM was developed to illustrate how the selected terrestrial species are ecologically linked. For terrestrial invertebrates, small prey items, and plants, partitioning coefficients and simple empirical uptake models were employed to estimate COPEC concentrations within tissues (*Section 7.1.5*). These tissue concentrations were then used as input values for exposure to higher trophic level receptors through the dietary route of exposure.

7.1.4.2 Measurement Endpoints

Measurement endpoints are frequently numerical expressions of observations (e.g., toxicity test results or community diversity indices) that can be compared statistically to detect adverse responses to a site contaminant (USEPA, 1997d).

As two of the selected receptor species (the American robin and the short-tailed shrew) feed on terrestrial invertebrates, a reduction in the abundance of these invertebrates could result in an adverse impact due to food shortages. Therefore, the direct contact toxicity of COPECs to soil invertebrates was selected as a measurement endpoint for protection of long-term survival and reproductive capabilities for populations of insectivorous mammals and omnivorous birds.

7.1.5 Exposure Estimation

This section includes a discussion of how COPEC exposures were quantified, including intake (*Section 7.1.5.1*) and bioaccumulation (*Section 7.1.5.2*).

An estimate of the nature, extent, and magnitude of potential exposure of assessment receptors to COPECs that are present at or migrating from the site was developed, considering both current and reasonably plausible future use scenarios.

Ecological routes of exposure for biota may be direct (bioconcentration) or through the food web via the consumption of contaminated organisms (bioaccumulation). Food web exposure can occur when terrestrial or aquatic fauna consume contaminated biota. Direct exposure routes include dermal contact, absorption, inhalation, and ingestion. Examples of direct exposure include animals incidentally ingesting contaminated soil or sediment; animals ingesting surface water; plants absorbing contaminants by uptake from contaminated soil or sediment; and the dermal contact of aquatic organisms with contaminated surface water or sediment. In addition, as discussed in *Section 7.1.3*, dermal contact and inhalation exposures are considered insignificant compared to other quantified routes of exposure.

Bioavailability of a chemical is an important contaminant characteristic that influences the degree of chemical-receptor interaction. The surface soil pH at SWMUs 50 and 59 were 5.33 and 7.24, respectively. For purposes of the SLERAs, bioavailability is conservatively assumed to be 100 percent.

For terrestrial and aquatic faunal receptors, calculation of exposure rates relies upon determination of an organism's exposure to COPECs found in surface soil, surface water, or sediment, and on transfer factors used for food-chain exposure. Exposure rates for terrestrial and aquatic wildlife receptors in these SLERAs are based solely upon ingestion of contaminants from these media and from consumption of other organisms.

7.1.5.1 Intake

The first step in estimating exposure rates for terrestrial and aquatic wildlife involves the calculation of food ingestion and drinking water intake rates for site receptors. USEPA (1993) includes a variety of exposure information for a number of avian and mammalian species. Information regarding feeding rates, watering rates and dietary composition are available for many species, or may be estimated using allometric equations (Nagy, 1987). Data have also been gathered on incidental ingestion of soil, and are incorporated for the receptor species. This information is summarized in **Appendix F-2**, **Table F-1**. For the SLERAs, conservative Tier 1 exposures are based on maximum dietary intake, maximum incidental soil intake, minimum body weight, 100 percent site exposure [i.e., area use factor (AUF) set equal to unity], and the use of COPEC MDCs as EPCs. Less conservative Tier 2 exposures are based on average dietary and incidental soil intake, average body weight, calculated AUF based on site area and home range of the receptor species, and COPEC EPCs set equal to 95% UCLs. These Tier 2 exposures may be considered as a portion of Step 3a of the ERAGS 8-step process.

Algorithms have been evaluated for calculating exposure for terrestrial vertebrates that account for exposure via ingestion of contaminated water, incidental ingestion of contaminated soil, ingestion of plants grown in contaminated soil, and prey items. Results for these algorithms are presented in **Appendix F, Tables F-2 through F-21**, and an example calculation is presented in **Appendix F, Table F-22**.

The basic equation for estimating dose through the dietary pathway is:

$$D_p = \sum_{k=1}^{m} (C_k \times F_k \times I_k) / W$$

where:

D_p = the potential average daily dose (mg/kg-day),
C_k = the average COPEC concentration in the k^{th} food type (mg/kg dry weight)
F_k = the fraction of the k^{th} food type that is contaminated
I_k = the ingestion rate of the k^{th} food type (kg dry weight/day)
W = the body weight of the receptor (kg wet weight).

Literature values for animal-specific sediment ingestion have been used if available. However, such values generally are not available in the literature. Where sediment ingestion rates could not be found, the animal-specific incidental soil ingestion rate is used for sediment ingestion as well, if the receptors life history profile suggests a significant aquatic component, and if sediment is a medium of concern at the site.

The estimated chemical intakes for the exposed receptors for the relevant pathway and scenario are presented in the risk characterization spreadsheets for each site referenced in *Sections 7.2.3 and 7.3.3*.

7.1.5.2 Bioaccumulation and Bioconcentration Factors

For the current SLERAs, bioaccumulation factors (BAFs) and bioconcentration factors (BCFs) for soil-to-plants, soil-to-earthworms, and soil-to-small mammals and birds are presented in **Appendix F-2**, **Tables F-23, F-24, and F-25**, respectively. BAFs and/or BCFs were not available for every COPEC, but were estimated as described in the footnotes to these tables. For each BAF/BCF pathway, both a Tier 1 and Tier 2 value is presented, as recommended in the *Site Screening Process* (USEPA, 2001b) and the *RFAAP Final MWP* (URS, 2003). The Tier 1 BAF/BCF is generally the upper bound value found in the literature, to represent a worst-case exposure scenario, while the Tier 2 BAF/BCF represents a conservative, yet more realistic exposure value.

Soil-to-plant BAF/BCF values (**Appendix F-2**, **Table F-23**) are based on information from Bechtel Jacobs (1998), USEPA (2007c), Efroymson (2001), Baes et al. (1984), International Atomic Energy Agency (IAEA) (1994), and Travis and Arms (1988). Values are based on regression equations, if available, that produce a BAF/BCF value that scales in a non-linear fashion with soil COPEC concentration. If a regression equation is not available or not recommended for a particular COPEC, a median value is used for the Tier 2 assessment. It should be noted that as the regression equation predicts COPEC concentrations in plants, the actual BAF/BCF value is estimated by dividing the estimated plant COPEC concentration by the soil COPEC concentration. For organic COPEC without available BAF/BCF values, the K_{ow} regression equation from Travis and Arms (1988) is used, as shown as follows:

$$Log\ BAF\ /\ BCF\ =\ -0.578 \times Log\ K_{ow} + 1.588$$

where:

Log Kow = log octanol-water partition coefficient (see **Appendix F-2, Table F-23**)

BAF/BCF values estimated for organics using the Travis and Arms (1988) equation ranged from 0.004 (TCDD) to 5.62 (1,3,5-trinitrobenzene) (**Appendix F-2**, **Table F-23**).

Soil-to-earthworm BAF/BCF values (**Appendix F-2**, **Table F-24**) are based on information from USEPA (2007c), Sample et al. (1998a), and Sample et al. (1999). Earthworms are used as a surrogate species to represent terrestrial invertebrates including insects. Values are based on Ecological SSL (EcoSSL) uptake values or regression equations, if available. If a regression equation or recommended uptake value is not available for a particular COPEC, an upper-bound value is used. It should be noted that as the regression equation predicts COPEC concentrations in earthworms, the actual BAF/BCF value is estimated by dividing the earthworm COPEC concentration by the soil COPEC concentration.

Soil-to-small mammal and small bird BAF/BCF values (**Appendix F-2**, **Table F-25**) are based on information from USEPA (2007c) and Sample et al. (1998b). Values are based on regression equations (USEPA, 2007c) or upperbound BAF/BCF values if no regression equation is available. If no organic surrogate soil uptake value was available, a conservative default BAF/BCF of 1 was used for the Tier 1 assessment, while a default BAF/BCF of 0.5 was used for the Tier 2 assessment.

7.1.6 Ecological Effects Characterization

This ecological effects characterization section presents the selection of literature benchmark values and the development of reference toxicity values.

7.1.6.1 Selection of Literature Benchmark Values

Appropriate sources for literature benchmark values have been consulted, such as Toxicological Benchmarks for Wildlife (Sample et al., 1996); Development of Toxicity Reference Values for Conducting Ecological Risk Assessments at Naval Facilities in California (Engineering Field Activity, West, 1998); Review of the Navy - USEPA Region IX BTAG Toxicity Reference Values for Wildlife (CH2M-Hill, 2000); and LD50 values from data bases such as the Registry of Toxic Effects Concentrations [extrapolated to chronic No-Observed-Adverse-Effect Level (NOAEL) or Lowest-Observed-Adverse-Effect Level (LOAEL) values using recommended Tri-Service (Wentsel et al., 1996) uncertainty factors].

7.1.6.2 Development of Toxicity Reference Values

Toxicity reference values (TRV) were selected from available data for use in the SWMU 50 and SWMU 59 SLERAs. These TRVs focus on the growth, survival, and reproduction of species and/or populations. Empirical data are available for the specific receptor-endpoint combinations in some instances. However, for some COPECs, data on surrogate species and/or on endpoints other than the NOAEL and LOAEL had to be used. The NOAEL is a dose of each COPEC that will produce no known adverse effects in the test species. The NOAEL was judged to be an appropriate toxicological endpoint for the Tier 1 approach since it would provide the greatest degree of protection to the receptor species; however, both NOAELs and LOAELs are used for

informational purposes in the Tier. Both the NOAEL and the LOAEL were also used in the Tier 2 approach; however, the LOAEL is recommended as a point of comparison for decision-making for risk management purposes. In general, LOAELs for growth, reproduction and/or developmental endpoints are thought to be protective at the population level of biological organization. In addition, in instances where data are unavailable for a site-associated COPEC, toxicological information for surrogate chemicals had to be used. Safety factors are used to adjust for these differences and extrapolate risks to the site's receptors at the NOAEL and/or LOAEL endpoint. This process is described below and the values are presented in **Appendix F-2, Tables F-26 and F-27** for NOAEL and LOAEL TRVs, respectively.

Toxicity information pertinent to identified receptors has been gathered for those analytes identified as COPECs. Because the measurement endpoint ranges from the NOAEL to the LOAEL, preference was given to chronic studies noting concentrations at which no adverse effects were observed and ones for which the lowest concentrations associated with adverse effects were observed.

Using the relevant toxicity information, TRVs have been calculated for each of the COPECs. TRVs represent NOAELs and LOAELs with safety factors incorporated for toxicity information derived from studies other than no-effects or lowest-effects studies.

TRVs have been calculated from LD_{50} values, when required, using safety factors specified in Ford et al. (1992) and reported in Wentsel et al. (1996) and summarized in the footnotes to **Appendix F-2, Tables F-26 and F-27**. As recommended by Hull et al. (2007), allometric dose scaling using body mass was not performed for chronic TRVs because this approach is not scientifically defensible and interclass toxicity extrapolations were not performed as physiological differences between classes are too great to be addressed with the use of simplistic safety factors. Separate uncertainty factors were used to account for extrapolation to the no effects or lowest-effects endpoints, for study duration, and for extrapolation across taxonomic groups (e.g., species, genus, family, order), as shown in **Appendix F-2, Table F-28** for the receptors used in the SLERAs. Although additional safety factors may be employed for endangered species, no endangered species were selected as representative receptors and these additional safety factors were not required.

These factors were used together to derive a final adjusted TRV, as shown in the risk characterization spreadsheets referenced in *Section 7.1.7.* TRVs provide a reference point for the comparison of toxicological effects upon exposure to a contaminant. To complete this comparison, receptor exposures to site contaminants are calculated.

7.1.7 Risk Characterization

The risk characterization phase integrates information on exposure, exposure-effects relationships, and defined or presumed target populations. The result is a determination of the likelihood, severity, and characteristics of adverse effects to environmental stressors present at a site. Qualitative and semi quantitative approaches have been taken to estimate the likelihood of adverse effects occurring as a result of exposure of the selected site receptors to COPECs.

For this assessment, TRVs and exposure rates have been calculated and are used to generate HQs (Wentsel et al., 1996), by dividing the receptor exposure rate for each contaminant by the calculated TRV. Environmental effects quotients (EEQs) or HQs are a means of estimating the

potential for adverse effects to organisms at a contaminated site, and for assessing the potential that toxicological effects will occur among site receptors.

7.1.7.1 Terrestrial Plant Impact Assessment

To assess the potential impact of COPEC concentrations in surface soil on terrestrial plant species, visual observations were recorded during the site reconnaissance. The overall health of the plant community at the site was comparable to the plant communities in the surrounding areas. Plants were not quantitatively evaluated in the SLERAs as the *RFAAP Final MWP* (URS, 2003) states: "Owing to the invasive and successive nature of plant communities, plants as receptors do not typically warrant a detailed examination of effects." In addition, because of an inadequate plant toxicity database, and because of the disturbed nature of the sites (i.e., mowing on an infrequent basis to eliminate woody plants), potential risks to plants are not deemed a reason to recommend further action. However, terrestrial plant impacts are discussed further in *Sections 7.2.4 and 7.3.4*.

7.1.7.2 Predictive Risk Estimation for Terrestrial Wildlife

The potential wildlife risks associated with SWMUs 50 and 59 are estimated in the SLERAs. The risk estimation has been performed through a series of quantitative HQ calculations that compare receptor-specific exposure values with TRVs. The EEQs (or HQs) are compared to HQ guidelines for assessing the risk posed from contaminants. It should be noted that HQs are not measures of risk, are not population-based statistics, and are not linearly-scaled statistics, and therefore an HQ above 1, even exceedingly so, does not guarantee that there is even one individual expressing the toxicological effect associated with a given chemical to which it was exposed (Allard et al., 2007; Tannenbaum, 2001; Bartell, 1996).

The simple HQ ratios are summed to provide conservative HI estimates for chemicals and exposure pathways for a given receptor. The criterion used to decide if HQ summation is appropriate and scientifically defensible includes those chemicals that have a similar mode of toxicological action. While individual contaminants may affect distinct target organs or systems within an organism, classes of chemicals may act in similar ways, thus being additive in effect.

Tier 1 and Tier 2 individual COPEC EEQs and HIs (summed EEQs) for terrestrial receptors at SWMU 50 and SWMU 59 are presented in risk characterization tables, referenced in each site SLERA section, for the five selected receptor species.

7.1.8 Approach for the Evaluation of Direct Contact Toxicity

To evaluate direct contact exposure, for those organisms that live within an environmental medium, COPEC media concentrations are compared with BTAG-approved direct-contact screening values, and secondarily, a variety of additional appropriate direct-contact benchmarks. Intake is not calculated because potential adverse effects are assessed by evaluating the COPEC concentrations in soil. The results are summarized in *Sections 7.2.4 and 7.3.4*.

7.1.8.1 Soil

A two-step process was used to assess direct contact soil toxicity. First, the maximum detected soil concentration was compared with the lowest available EcoSSL (USEPA, 2008), or if an EcoSSL was not available, with the lowest BTAG (USEPA, 1995b) soil screening value. A chemical was only retained as a COPEC if the MDC exceeded the EcoSSL, or in the absence of an EcoSSL, if the MDC exceeded the BTAG soil screening value. If no EcoSSL or BTAG value

was available (NVA), the value was also carried forward for comparison to other available screening values (listed below). The results are summarized in direct contact tables referenced in *Sections 7.2.4 and 7.3.4*.

In the second step, the MDCs of the chemicals carried-forward were compared with up to five individual soil screening values (in addition to the BTAG screening value, if one was available and relevant):

- Dutch intervention values (IVs), Spatial Planning and Environment Circular on Target Values and Intervention Values for Soil Remediation (Netherlands Ministry of Housing, 2000).
- Canadian Council of Ministers of the Environment (CCME), Canadian Environmental Quality Guidelines, December 2003.
- Lowest EcoSSL value for direct contact toxicity for either plants or terrestrial invertebrates (USEPA, 2007c).
- ORNL (1997a, ES/ER/TM-85/R3), screening benchmarks for plants.
- ORNL (1997b, ES/ER/TM-126/R2), screening benchmarks for earthworms.

The results of these SLERA evaluations are presented in *Sections 7.2.4 and 7.3.4*. It should be noted the updated NOAA SQuiRt soil values (Buchman, 2008) were not used in the screening process because they include values from sources already being used in the SLERA direct contact assessment (i.e., ORNL documents, USEPA EcoSSLs, etc), and they also use inappropriate food-chain screening values and/or generic soil background concentrations.

7.1.9 Background Metals Considerations

A background evaluation was conducted on the surface soil analytical results to determine if any inorganic COPECs were potentially related to naturally occurring soil concentrations. Inorganics with maximum detected concentrations (MDCs) that were shown not to be statistically different based on appropriate population statistical tests are considered background related (*Section 6.4.3*). Individual results are discussed in *Sections 7.2.5 and 7.3.5*.

7.1.10 General Uncertainty Analysis

The results of the SLERA are influenced to some degree by variability and uncertainty. In theory, investigators might reduce variability by increasing sample size of the media or species sampled. Alternatively, uncertainty within the risk analysis can be reduced by using species-specific and site-specific data (i.e., to better quantify contamination of media, vegetation, and prey through: direct field measurements, toxicity testing of site-specific media, and field studies using site-specific receptor species). Detailed media, prey, and receptor field studies are costly; thus, the preliminary analyses of risk have been conducted to limit the potential use of these resource-intensive techniques to those COPECs that continue to show a relatively high potential for ecological risk. Since assessment criteria were developed based on conservative assumptions, the result of the assessment errs on the side of conservatism. This has the effect of maximizing the likelihood of accepting a false positive (Type I error: the rejection of a true null hypothesis) and simultaneously minimizing the likelihood of accepting a true negative (Type II error: the acceptance of a false null hypothesis).

The nickel BAF/BCF for soil to earthworms has been withdrawn by USEPA (2007c) due to a lack of sufficient data to support an uptake factor. Rather than have a data gap, this SLERA used the nickel BAF/BCF values from Sample et al. (1998a, 1999). There is some uncertainty associated with this approach.

A number of factors contribute to the overall variability and uncertainty inherent in ecological risk assessments. Variability is due primarily to measurement error; laboratory media analyses and receptor study design are the major sources of this kind of error. Uncertainty, on the other hand, is associated primarily with deficiency or irrelevancy of effects, exposure, or habitat data to actual ecological conditions at the site. Calculating an estimated value based on a large number of assumptions is often the alternative to the accurate (but costly) method of direct field or laboratory observation, measurement, or testing.

There were numerous chemical constituents not detected in surface soil analytical samples. **Appendix F-2, Tables F-29 and F-30** evaluate the uncertainty associated with these constituents' detection limits for SWMUs 50 and 59, respectively, by presenting a comparison of the maximum detection limit for each non-detect constituent with conservative ecological toxicity screening values. Ecological screening values for the comparison were compiled and presented in **Appendix F-2, Table F-31**.

Some of the non-detect constituents had maximum detection limits that exceeded either one or both of the screening criteria (details are presented in *Sections 7.2.6 and 7.3.6*). This finding is not unexpected, given the conservative and numerically low screening values.

The general uncertainty analysis is presented in **Table 7-4** and lists some of the major assumptions made for the SLERAs; the direction of bias caused by each assumption (i.e., if the uncertainty results in an overestimate or underestimate of risk); the likely magnitude of impact [quantitative (percent difference), or qualitative (high, medium, low, or unknown)]; if possible, a description of recommendations for minimizing the identified uncertainties if the SLERA progresses to higher level assessment phases; and the ease of implementing the recommendation (USEPA, 1997c).

The uncertainty analysis identifies and, if possible, quantifies the uncertainty in the individual preliminary scoping assessment, problem formulation, exposure and effects assessment, and risk characterization phases of the SLERAs. Based on this uncertainty analysis, the most important biases that may result in an overestimation of risk include the following:

- Assuming that COPECs are 100 percent bioavailable.
- Using some laboratory-derived or empirically-estimated partitioning and transfer factors to predict COPEC concentrations in plants, invertebrates, and/or prey species.
- Use of the hazard quotient method to estimate risks to populations or communities.

Table 7-4
General Uncertainty Analysis

Component	Bias	Magnitude	Ways to Minimize Uncertainty	Additional Comments
Use of 95% UCL as source-term concentration	Overestimates Risk	Medium	Use central tendency	Easy to implement, but may not be acceptable to Agency.
Use of representative receptor species for site ecological community	Underestimates Risk	Low	Select additional receptor species	Easy to implement, but unlikely to change conclusions.
Use of conservative foraging factors (i.e., 100%) for some species	Overestimates Risk	Medium	Use more site-specific foraging factors, i.e., less than 100%	May be difficult to obtain site-specific foraging factors.
Assumption that COPECs are 100% bioavailable	Overestimates Risk	Medium to High	Obtain medium- and COPEC-specific bioavailability factors	Would be very difficult and costly to obtain these bioavailability factors.
Discounting of dermal and inhalation exposure routes	Underestimates Risk	Low	Include dermal and inhalation routes of exposure	Would be difficult to quantify these routes of exposure.
Use of partitioning and transfer factors to estimate COPEC concentrations in plants, invertebrates, and prey items.	Overestimates Risk	Medium to High	Measure COPEC concentrations in site plants, invertebrates, and/or other prey species.	Would be costly to implement, but could significantly reduce EEQs.
Use of safety factors to convert LOAEL and LD_{50} toxicity data to NOAELs	Overestimates Risk	Medium	Obtain COPEC-specific NOAEL data	Would be costly to implement, unless data available in the literature.
Use of uncertainty factor of 8 to extrapolate TRVs between most species within the same class	Overestimates Risk	Medium	1) Assume TRVs similar for species in the same genus, family, or order; or 2) obtain species-specific NOAEL data	1) May not be accepted by Agency. 2) Would be very difficult to obtain species-specific NOAEL data.
Use of surrogate constituents to estimate toxicity for those COPECs without available toxicity data	Overestimates Risk	Low to Medium	Obtain COPEC-specific toxicity data	Would be very costly to obtain COPEC-specific toxicity data, unless available in the literature.
Use of hazard quotient method to estimate risks to populations or communities may be biased	Overestimates Risk	High	Perform population or community studies	Would be very costly to perform.

7.2 SWMU 50 Screening Level Ecological Risk Assessment

This section presents the SLERA for SWMU 50, Calcium Sulfate Treatment/Disposal Area. The detailed methodology used for performance of the SLERA is presented in *Section 7.1*. This section includes a Site Characterization (*Section 7.2.1*); Summary of COPEC Selection (*Section 7.2.2*); Risk Characterization (*Section 7.2.3*); Direct Contact Assessment (*Section 7.2.4*); Background Evaluation (*Section 7.2.5*); Uncertainty Analysis (*Section 7.2.6*); and Results and Conclusions (*Section 7.2.7*).

7.2.1 Site Characterization

Based on a review of historical aerial photographs (USEPA, 1992) and an interview with plant personnel, it was concluded that the area was used for sludge disposal. Until 1982, this was the major disposal area at RFAAP for sludge removed from the calcium sulfate drying beds (SWMUs 35, 36, 37, 38, and Area Q).

According to USEPA (1992), activity (described as disturbed ground) was first noted at the SWMU in 1962 and revegetation of the disturbed ground was noted in 1971 (photos are presented in **Appendix F-1, Figures F-1 through F-3**). Analysis of aerial photographs indicated activity had occurred at the site (**Appendix F-1, Figure F-2**), where a ground scar, disturbed ground, light-toned, and mounded material was visible. A more recent investigation (**Appendix F-1, Figure F-3**) indicates the surface of the site appears to have been filled and there was no visible evidence of these features.

Surface soil samples collected from the site and utilized in the SLERA are listed in **Table 7-5**; note that subsurface soil samples were not used in the SLERA (see *Section 7.1.2.1* for discussion). Based on the aerial extent of soil sampling and the known site boundaries, the terrestrial habitat associated with the site is estimated to be 2.06 acres.

Table 7-5
SWMU 50 Sample Groupings

SURFACE SOIL		
50SS01	50SB06A	50SB11A
50SS02	50SB07A	50SB12A
50SS03	50SB08A	50SB13A
50SB04A	50SB09A	50SB14A
50SB05A	50SB10A	50SB15A

7.2.2 Summary of COPEC Selection

Tables 7-6 and 7-7 have been prepared for detected constituents in surface soil with the following information:

- CAS number.
- Chemical name.
- Range of detected concentrations, and associated qualifiers.
- Concentration units.
- Location of maximum detected concentration.
- Frequency of detection.

Table 7-6
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Direct Contact Exposure at SWMU 50

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Direct Contact COPEC (Y/N)	Rationale for Selection or Deletion
	N/A	2,3,7,8-TCDD-TE	2.37E-06	9.80E-05	mg/kg	50SB06A	10/10	N/A	Yes	DET
Surface Soil	67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	1.01E-06 B	5.19E-04	mg/kg	50SB06A	10/10	N/A	No	TEQ
	35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	5.27E-05	4.61E-03 J	mg/kg	50SB06A	10/10	N/A	No	TEQ
	55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	5.88E-07 J	2.97E-05	mg/kg	50SB06A	7/10	4.86E-07 - 5.54E-07	No	TEQ
	70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	3.24E-07 J	3.70E-05	mg/kg	50SB07A	9/10	5.54E-07 - 5.54E-07	No	TEQ
	39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	2.02E-07 J	1.46E-05	mg/kg	50SB07A	10/10	N/A	No	TEQ
	57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	1.20E-07 J	1.66E-05	mg/kg	50SB07A	9/10	5.54E-07 - 5.54E-07	No	TEQ
	57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	3.34E-07 J	1.22E-04	mg/kg	50SB06A	10/10	N/A	No	TEQ
	72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	7.77E-07 J	4.27E-06 J	mg/kg	50SB07A	4/10	4.86E-07 - 6.82E-07	No	TEQ
	19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	3.57E-07 J	4.12E-05	mg/kg	50SB06A	10/10	N/A	No	TEQ
	57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	9.99E-08 J	4.08E-06 J	mg/kg	50SB07A	8/10	5.54E-07 - 5.86E-07	No	TEQ
	40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	2.79E-07 J	6.68E-06	mg/kg	50SB07A	8/10	5.54E-07 - 5.75E-07	No	TEQ
	51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	2.16E-07 B	7.79E-06	mg/kg	50SB07A	9/10	3.93E-07 - 3.93E-07	No	TEQ
	N/A	Total Heptachlorodibenzofuran	1.55E-06 B	2.04E-03 J	mg/kg	50SB06A	10/10	N/A	No	TEQ
	N/A	Total Heptachlorodibenzo-p-dioxin	1.10E-04 J	7.35E-03	mg/kg	50SB06A	10/10	N/A	No	TEQ
	N/A	Total Hexachlorodibenzofuran	1.77E-06	5.18E-04	mg/kg	50SB06A	9/10	5.54E-07 - 5.54E-07	No	TEQ
	N/A	Total Hexachlorodibenzo-p-dioxin	3.11E-06 J	4.04E-04	mg/kg	50SB06A	10/10	N/A	No	TEQ
	N/A	Total Pentachlorodibenzofuran	8.82E-07 J	1.09E-04 J	mg/kg	50SB07A	9/10	5.54E-07 - 5.54E-07	No	TEQ
	N/A	Total Pentachlorodibenzo-p-dioxin	7.88E-07 J	1.78E-05 J	mg/kg	50SB07A	8/10	5.54E-07 - 5.75E-07	No	TEQ
	N/A	Total Tetrachlorodibenzofuran	5.16E-07	5.62E-05 J	mg/kg	50SB07A	9/10	3.93E-07 - 3.93E-07	No	TEQ
	N/A	Total Tetrachlorodibenzo-p-dioxin	3.71E-07 J	3.41E-06 J	mg/kg	50SB07A	6/10	1.59E-07 - 4.97E-07	No	TEQ
	60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	1.81E-07 J	1.53E-05	mg/kg	50SB07A	9/10	5.54E-07 - 5.54E-07	No	TEQ
	57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	1.46E-07 B	9.63E-06	mg/kg	50SB07A	9/10	5.54E-07 - 5.54E-07	No	TEQ
	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	1.30E-07 J	5.63E-07 J	mg/kg	50SB07A	3/10	1.39E-07 - 4.97E-07	No	TEQ
	3268-87-9	Octachlorodibenzodioxin	3.81E-03	5.02E-02 J	mg/kg	50SB06A	10/10	N/A	No	TEQ
	39001-02-0	Octachlorodibenzofuran	1.70E-06 B	2.09E-03	mg/kg	50SB06A	10/10	N/A	No	TEQ
	95-50-1	1,2-Dichlorobenzene	1.10E-02 J	1.10E-02 J	mg/kg	50SS02	1/15	1.70E-01 - 3.70E+00	Yes	DET
	541-73-1	1,3-Dichlorobenzene	8.60E-03 J	8.60E-03 J	mg/kg	50SS02	1/15	1.70E-01 - 3.70E+00	Yes	DET
	106-46-7	1,4-Dichlorobenzene	1.10E-02 J	1.10E-02 J	mg/kg	50SS02	1/15	1.70E-01 - 3.70E+00	Yes	DET
	93-76-5	2,4,5-T	8.18E-03 J	8.18E-03 J	mg/kg	50SS01	1/12	7.10E-03 - 1.14E-01	Yes	DET
	94-75-7	2,4-D	1.42E-01 J	1.42E-01 J	mg/kg	50SS03	1/12	2.23E-02 - 3.90E-02	Yes	DET
	121-14-2	2,4-Dinitrotoluene	1.01E-01 J	8.88E-01	mg/kg	50SB07A	5/14	2.00E-01 - 4.00E-01	Yes	DET

Table 7-6
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Direct Contact Exposure at SWMU 50

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Direct Contact COPEC (Y/N)	Rationale for Selection or Deletion
	91-57-6	2-Methylnaphthalene	9.10E-03	4.00E-01	mg/kg	50SB05A	4/14	2.80E-01 - 1.50E+00	Yes	DET
	72-54-8	4,4'-DDD	4.10E-04 J	4.47E-04 J	mg/kg	50SS03	2/12	3.60E-03 - 3.80E-02	Yes	DET
	72-55-9	4,4'-DDE	3.37E-03	3.37E-03	mg/kg	50SS03	1/11	3.60E-03 - 3.80E-02	Yes	DET
	50-29-3	4,4'-DDT	1.29E-02	1.29E-02	mg/kg	50SS03	1/12	7.43E-04 - 3.80E-02	Yes	DET
	83-32-9	Acenaphthene	1.60E-02	1.60E-02	mg/kg	50SB05A	1/11	2.80E-01 - 1.50E+00	Yes	DET
	208-96-8	Acenaphthylene	2.20E-03	2.00E-02	mg/kg	50SB05A	4/14	2.80E-01 - 1.50E+00	Yes	DET
	67-64-1	Acetone	7.45E-02 J	7.45E-02 J	mg/kg	50SB08A	1/13	5.70E-03 - 9.00E-02	Yes	DET
	120-12-7	Anthracene	3.00E-03	1.10E-02	mg/kg	50SB05A	3/14	2.10E-03 - 1.50E+00	Yes	DET
	11097-69-1	Aroclor 1254	1.04E-02 J	1.48E+00	mg/kg	50SB07A	7/14	1.80E-02 - 2.00E-02	Yes	DET
	56-55-3	Benzo(a)anthracene	3.60E-03	1.37E-01 L	mg/kg	50SB07A	5/14	5.60E-02 - 6.30E-02	Yes	DET
	50-32-8	Benzo(a)pyrene	3.30E-03	1.50E-01 L	mg/kg	50SB07A	6/14	5.60E-02 - 6.30E-02	Yes	DET
	205-99-2	Benzo(b)fluoranthene	6.50E-03	1.52E-01 L	mg/kg	50SB07A	6/14	5.60E-02 - 6.30E-02	Yes	DET
	191-24-2	Benzo(g,h,i)perylene	3.40E-03 J	5.90E-02	mg/kg	50SS02	5/14	5.60E-02 - 3.00E-01	Yes	DET
	207-08-9	Benzo(k)fluoranthene	2.00E-03 J	9.89E-02 L	mg/kg	50SB07A	6/14	5.60E-02 - 6.30E-02	Yes	DET
	86-74-8	Carbazole	1.10E-02 J	2.80E-02 J	mg/kg	50SB05A	3/15	1.70E-01 - 3.70E+00	Yes	DET
	218-01-9	Chrysene	6.10E-03	1.19E-01 L	mg/kg	50SB07A	6/14	5.60E-02 - 6.30E-02	Yes	DET
	53-70-3	Dibenz(a,h)anthracene	1.60E-03 J	1.40E-02	mg/kg	50SS02	4/14	5.60E-02 - 3.00E-01	Yes	DET
	132-64-9	Dibenzofuran	2.00E-02 J	2.00E-01 J	mg/kg	50SB05A	3/15	1.70E-01 - 3.70E+00	Yes	DET
	131-11-3	Dimethylphthalate	7.16E-01	1.50E+00	mg/kg	50SB12A	2/15	1.90E-01 - 1.50E+00	Yes	DET
	84-74-2	Di-n-butyl phthalate	1.29E-01 J	7.77E-01	mg/kg	50SB08A	3/11	1.90E-01 - 1.50E+00	Yes	DET
	33213-65-9	Endosulfan II	6.36E-04 J	2.24E-03	mg/kg	50SS03	2/12	3.60E-03 - 3.80E-02	Yes	DET
	72-20-8	Endrin	2.88E-04 J	2.88E-04 J	mg/kg	50SS01	1/12	7.59E-04 - 3.80E-02	Yes	DET
	206-44-0	Fluoranthene	9.00E-03	7.30E-02	mg/kg	50SS02	4/14	2.80E-01 - 1.50E+00	Yes	DET
	86-73-7	Fluorene	1.10E-03 J	1.80E-02 J	mg/kg	50SB05A	4/14	2.80E-01 - 1.50E+00	Yes	DET
	193-39-5	Indeno(1,2,3-cd)pyrene	2.30E-03	8.41E-02 L	mg/kg	50SB07A	6/14	5.60E-02 - 6.30E-02	Yes	DET
	72-43-5	Methoxychlor	1.29E-03	1.29E-03	mg/kg	50SS03	1/12	7.43E-04 - 3.80E-02	Yes	DET
	91-20-3	Naphthalene	2.70E-02	2.70E-01	mg/kg	50SB05A	3/13	2.80E-01 - 1.50E+00	Yes	DET
	86-30-6	n-Nitrosodiphenylamine	2.10E-02 J	2.10E+00 J	mg/kg	50SB04A	4/15	1.70E-01 - 7.70E-01	Yes	DET
	85-01-8	Phenanthrene	1.10E-02	2.60E-01	mg/kg	50SB05A	4/14	2.80E-01 - 1.50E+00	Yes	DET
	129-00-0	Pyrene	7.50E-03	8.50E-02	mg/kg	50SS02	4/14	2.80E-01 - 1.50E+00	Yes	DET
	7429-90-5	Aluminum	6.59E+03 J	2.43E+04	mg/kg	50SS03	14/14	N/A	Yes	DET
	7440-36-0	Antimony	3.30E-01 L	1.40E+00 L	mg/kg	50SB07A	11/12	5.47E-01 - 5.47E-01	Yes	DET

Table 7-6
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Direct Contact Exposure at SWMU 50

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Direct Contact COPEC (Y/N)	Rationale for Selection or Deletion
	7440-38-2	Arsenic	1.03E+00 J	7.40E+00 J	mg/kg	50SB09A	14/14	N/A	Yes	DET
	7440-39-3	Barium	3.39E+01 J	1.41E+02	mg/kg	50SS01	14/14	N/A	Yes	DET
	7440-41-7	Beryllium	3.50E-01	9.00E-01	mg/kg	50SB08A	10/10	N/A	Yes	DET
	7440-43-9	Cadmium	1.27E-01	1.43E-01	mg/kg	50SS02	2/12	5.70E-02 - 1.20E+00	Yes	DET
	7440-70-2	Calcium	4.84E+02 J	2.86E+04 J	mg/kg	50SS02	14/14	N/A	Yes	DET
	7440-47-3	Chromium	1.22E+01 J	1.16E+02 J	mg/kg	50SB07A	14/14	N/A	Yes	DET
	7440-48-4	Cobalt	3.40E+00 J	1.71E+01 J	mg/kg	50SB08A	14/14	N/A	Yes	DET
	7440-50-8	Copper	4.00E+00	5.64E+01	mg/kg	50SB07A	14/14	N/A	Yes	DET
	7439-89-6	Iron	7.51E+03 J	2.83E+04	mg/kg	50SS03	14/14	N/A	Yes	DET
	7439-92-1	Lead	6.60E+00 J	1.78E+02 J	mg/kg	50SB07A	14/14	N/A	Yes	DET
	7439-95-4	Magnesium	3.12E+02 J	2.02E+04	mg/kg	50SS02	14/14	N/A	Yes	DET
	7439-96-5	Manganese	6.28E+01 J	1.32E+03	mg/kg	50SS01	14/14	N/A	Yes	DET
	7439-97-6	Mercury	4.10E-02 J	8.16E-01	mg/kg	50SB05A	14/14	N/A	Yes	DET
	7440-02-0	Nickel	4.10E+00 J	5.01E+01 J	mg/kg	50SB07A	14/14	N/A	Yes	DET
	7440-09-7	Potassium	4.65E+02	2.05E+03	mg/kg	50SS02	8/8	N/A	Yes	DET
	7782-49-2	Selenium	4.80E+00 J	7.40E+00 J	mg/kg	50SB12A	9/13	1.09E+00 - 1.14E+00	Yes	DET
	7440-22-4	Silver	1.70E-01 J	8.90E-01 J	mg/kg	50SB05A	4/14	4.70E-02 - 1.11E+00	Yes	DET
	7440-23-5	Sodium	6.17E+01 J	7.25E+01 J	mg/kg	50SS03	3/14	4.20E+00 - 4.80E+01	Yes	DET
	7440-62-2	Vanadium	1.72E+01 J	4.91E+01 J	mg/kg	50SB12A	14/14	N/A	Yes	DET
	7440-66-6	Zinc	1.70E+01 J	9.33E+01 J	mg/kg	50SS02	14/14	N/A	Yes	DET

COPEC Selection Rationale Codes

Selection Reason: Detected constituent (DET)

Deletion Reason: Dioxins and furans will be analyzed by the toxicity equivalent provided by the TCDD-TE (TEQ)

Notes/Definitions:

N/A = Not Applicable or Not Available
COPEC = Chemical of Potential Ecological Concern
J = Estimated Value
L = Estimated Value
mg/kg = milligrams per kilogram

Table 7-7
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Food Chain Exposure at SWMU 50

Scenario Timeframe: Current/Future

Medium: Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Food Chain COPEC (Y/N)	Rationale for Selection or Deletion
	N/A	2,3,7,8-TCDD-TE	2.37E-06	9.80E-05	mg/kg	50SB06A	10/10	N/A	Yes	IBC
Surface Soil	67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	1.01E-06 B	5.19E-04	mg/kg	50SB06A	10/10	N/A	No	TEQ
	35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	5.27E-05	4.61E-03 J	mg/kg	50SB06A	10/10	N/A	No	TEQ
	55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	5.88E-07 J	2.97E-05	mg/kg	50SB06A	7/10	4.86E-07 - 5.54E-07	No	TEQ
	70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	3.24E-07 J	3.70E-05	mg/kg	50SB07A	9/10	5.54E-07 - 5.54E-07	No	TEQ
	39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	2.02E-07 J	1.46E-05	mg/kg	50SB07A	10/10	N/A	No	TEQ
	57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	1.20E-07 J	1.66E-05	mg/kg	50SB07A	9/10	5.54E-07 - 5.54E-07	No	TEQ
	57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	3.34E-07 J	1.22E-04	mg/kg	50SB06A	10/10	N/A	No	TEQ
	72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	7.77E-07 J	4.27E-06 J	mg/kg	50SB07A	4/10	4.86E-07 - 6.82E-07	No	TEQ
	19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	3.57E-07 J	4.12E-05	mg/kg	50SB06A	10/10	N/A	No	TEQ
	57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	9.99E-08 J	4.08E-06 J	mg/kg	50SB07A	8/10	5.54E-07 - 5.86E-07	No	TEQ
	40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	2.79E-07 J	6.68E-06	mg/kg	50SB07A	8/10	5.54E-07 - 5.75E-07	No	TEQ
	51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	2.16E-07 B	7.79E-06	mg/kg	50SB07A	9/10	3.93E-07 - 3.93E-07	No	TEQ
	N/A	Total Heptachlorodibenzofuran	1.55E-06 B	2.04E-03 J	mg/kg	50SB06A	10/10	N/A	No	TEQ
	N/A	Total Heptachlorodibenzo-p-dioxin	1.10E-04 J	7.35E-03	mg/kg	50SB06A	10/10	N/A	No	TEQ
	N/A	Total Hexachlorodibenzofuran	1.77E-06	5.18E-04	mg/kg	50SB06A	9/10	5.54E-07 - 5.54E-07	No	TEQ
	N/A	Total Hexachlorodibenzo-p-dioxin	3.11E-06 J	4.04E-04	mg/kg	50SB06A	10/10	N/A	No	TEQ
	N/A	Total Pentachlorodibenzofuran	8.82E-07 J	1.09E-04 J	mg/kg	50SB07A	9/10	5.54E-07 - 5.54E-07	No	TEQ
	N/A	Total Pentachlorodibenzo-p-dioxin	7.88E-07 J	1.78E-05 J	mg/kg	50SB07A	8/10	5.54E-07 - 5.75E-07	No	TEQ
	N/A	Total Tetrachlorodibenzofuran	5.16E-07	5.62E-05 J	mg/kg	50SB07A	9/10	3.93E-07 - 3.93E-07	No	TEQ
	N/A	Total Tetrachlorodibenzo-p-dioxin	3.71E-07 J	3.41E-06 J	mg/kg	50SB07A	6/10	1.59E-07 - 4.97E-07	No	TEQ
	60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	1.81E-07 J	1.53E-05	mg/kg	50SB07A	9/10	5.54E-07 - 5.54E-07	No	TEQ
	57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	1.46E-07 B	9.63E-06	mg/kg	50SB07A	9/10	5.54E-07 - 5.54E-07	No	TEQ
	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	1.30E-07 J	5.63E-07 J	mg/kg	50SB07A	3/10	1.39E-07 - 4.97E-07	No	TEQ
	3268-87-9	Octachlorodibenzodioxin	3.81E-03	5.02E-02 J	mg/kg	50SB06A	10/10	N/A	No	TEQ
	39001-02-0	Octachlorodibenzofuran	1.70E-06 B	2.09E-03	mg/kg	50SB06A	10/10	N/A	No	TEQ
	95-50-1	1,2-Dichlorobenzene	1.10E-02 J	1.10E-02 J	mg/kg	50SS02	1/15	1.70E-01 - 3.70E+00	Yes	IBC
	541-73-1	1,3-Dichlorobenzene	8.60E-03 J	8.60E-03 J	mg/kg	50SS02	1/15	1.70E-01 - 3.70E+00	Yes	IBC
	106-46-7	1,4-Dichlorobenzene	1.10E-02 J	1.10E-02 J	mg/kg	50SS02	1/15	1.70E-01 - 3.70E+00	Yes	IBC
	93-76-5	2,4,5-T	8.18E-03 J	8.18E-03 J	mg/kg	50SS01	1/12	7.10E-03 - 1.14E-01	No	NIBC
	94-75-7	2,4-D	1.42E-01 J	1.42E-01 J	mg/kg	50SS03	1/12	2.23E-02 - 3.90E-02	No	NIBC
	121-14-2	2,4-Dinitrotoluene	1.01E-01 J	8.88E-01	mg/kg	50SB07A	5/14	2.00E-01 - 4.00E-01	Yes	EXP
	91-57-6	2-Methylnaphthalene	9.10E-03	4.00E-01	mg/kg	50SB05A	4/14	2.80E-01 - 1.50E+00	No	NIBC
	72-54-8	4,4'-DDD	4.10E-04 J	4.47E-04 J	mg/kg	50SS03	2/12	3.60E-03 - 3.80E-02	Yes	IBC

Table 7-7
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Food Chain Exposure at SWMU 50

Scenario Timeframe: Current/Future

Medium: Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Food Chain COPEC (Y/N)	Rationale for Selection or Deletion
	72-55-9	4,4'-DDE	3.37E-03	3.37E-03	mg/kg	50SS03	1/11	3.60E-03 - 3.80E-02	Yes	IBC
	50-29-3	4,4'-DDT	1.29E-02	1.29E-02	mg/kg	50SS03	1/12	7.43E-04 - 3.80E-02	Yes	IBC
	83-32-9	Acenaphthene	1.60E-02	1.60E-02	mg/kg	50SB05A	1/11	2.80E-01 - 1.50E+00	Yes	IBC
	208-96-8	Acenaphthylene	2.20E-03	2.00E-02	mg/kg	50SB05A	4/14	2.80E-01 - 1.50E+00	Yes	IBC
	67-64-1	Acetone	7.45E-02 J	7.45E-02 J	mg/kg	50SB08A	1/13	5.70E-03 - 9.00E-02	No	NIBC
	120-12-7	Anthracene	3.00E-03	1.10E-02	mg/kg	50SB05A	3/14	2.10E-03 - 1.50E+00	Yes	IBC
	11097-69-1	Aroclor 1254	1.04E-02 J	1.48E+00	mg/kg	50SB07A	7/14	1.80E-02 - 2.00E-02	Yes	IBC
	56-55-3	Benzo(a)anthracene	3.60E-03	1.37E-01 L	mg/kg	50SB07A	5/14	5.60E-02 - 6.30E-02	Yes	IBC
	50-32-8	Benzo(a)pyrene	3.30E-03	1.50E-01 L	mg/kg	50SB07A	6/14	5.60E-02 - 6.30E-02	Yes	IBC
	205-99-2	Benzo(b)fluoranthene	6.50E-03	1.52E-01 L	mg/kg	50SB07A	6/14	5.60E-02 - 6.30E-02	Yes	IBC
	191-24-2	Benzo(g,h,i)perylene	3.40E-03 J	5.90E-02	mg/kg	50SS02	5/14	5.60E-02 - 3.00E-01	Yes	IBC
	207-08-9	Benzo(k)fluoranthene	2.00E-03 J	9.89E-02 L	mg/kg	50SB07A	6/14	5.60E-02 - 6.30E-02	Yes	IBC
	86-74-8	Carbazole	1.10E-02 J	2.80E-02 J	mg/kg	50SB05A	3/15	1.70E-01 - 3.70E+00	No	NIBC
	218-01-9	Chrysene	6.10E-03	1.19E-01 L	mg/kg	50SB07A	6/14	5.60E-02 - 6.30E-02	Yes	IBC
	53-70-3	Dibenz(a,h)anthracene	1.60E-03 J	1.40E-02	mg/kg	50SS02	4/14	5.60E-02 - 3.00E-01	Yes	IBC
	132-64-9	Dibenzofuran	2.00E-02 J	2.00E-01 J	mg/kg	50SB05A	3/15	1.70E-01 - 3.70E+00	No	NIBC
	131-11-3	Dimethylphthalate	7.16E-01	1.50E+00	mg/kg	50SB12A	2/15	1.90E-01 - 1.50E+00	No	NIBC
	84-74-2	Di-n-butyl phthalate	1.29E-01 J	7.77E-01	mg/kg	50SB08A	3/11	1.90E-01 - 1.50E+00	No	NIBC
	33213-65-9	Endosulfan II	6.36E-04 J	2.24E-03	mg/kg	50SS03	2/12	3.60E-03 - 3.80E-02	Yes	IBC
	72-20-8	Endrin	2.88E-04 J	2.88E-04 J	mg/kg	50SS01	1/12	7.59E-04 - 3.80E-02	Yes	IBC
	206-44-0	Fluoranthene	9.00E-03	7.30E-02	mg/kg	50SS02	4/14	2.80E-01 - 1.50E+00	Yes	IBC
	86-73-7	Fluorene	1.10E-03 J	1.80E-02 J	mg/kg	50SB05A	4/14	2.80E-01 - 1.50E+00	Yes	IBC
	193-39-5	Indeno(1,2,3-cd)pyrene	2.30E-03	8.41E-02 L	mg/kg	50SB07A	6/14	5.60E-02 - 6.30E-02	Yes	IBC
	72-43-5	Methoxychlor	1.29E-03	1.29E-03	mg/kg	50SS03	1/12	7.43E-04 - 3.80E-02	Yes	IBC
	91-20-3	Naphthalene	2.70E-02	2.70E-01	mg/kg	50SB05A	3/13	2.80E-01 - 1.50E+00	No	NIBC
	86-30-6	n-Nitrosodiphenylamine	2.10E-02 J	2.10E+00 J	mg/kg	50SB04A	4/15	1.70E-01 - 7.70E-01	No	NIBC
	85-01-8	Phenanthrene	1.10E-02	2.60E-01	mg/kg	50SB05A	4/14	2.80E-01 - 1.50E+00	Yes	IBC
	129-00-0	Pyrene	7.50E-03	8.50E-02	mg/kg	50SS02	4/14	2.80E-01 - 1.50E+00	Yes	IBC
	7429-90-5	Aluminum	6.59E+03 J	2.43E+04	mg/kg	50SS03	14/14	N/A	No	NIBC
	7440-36-0	Antimony	3.30E-01 L	1.40E+00 L	mg/kg	50SB07A	11/12	5.47E-01 - 5.47E-01	No	NIBC
	7440-38-2	Arsenic	1.03E+00 J	7.40E+00 J	mg/kg	50SB09A	14/14	N/A	Yes	IBC
	7440-39-3	Barium	3.39E+01 J	1.41E+02	mg/kg	50SS01	14/14	N/A	No	NIBC
	7440-41-7	Beryllium	3.50E-01	9.00E-01	mg/kg	50SB08A	10/10	N/A	No	NIBC
	7440-43-9	Cadmium	1.27E-01	1.43E-01	mg/kg	50SS02	2/12	5.70E-02 - 1.20E+00	Yes	IBC

Table 7-7
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Food Chain Exposure at SWMU 50

Scenario Timeframe: Current/Future

Medium: Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Food Chain COPEC (Y/N)	Rationale for Selection or Deletion
	7440-70-2	Calcium	4.84E+02 J	2.86E+04 J	mg/kg	50SS02	14/14	N/A	No	NIBC
	7440-47-3	Chromium	1.22E+01 J	1.16E+02 J	mg/kg	50SB07A	14/14	N/A	Yes	IBC
	7440-48-4	Cobalt	3.40E+00 J	1.71E+01 J	mg/kg	50SB08A	14/14	N/A	No	NIBC
	7440-50-8	Copper	4.00E+00	5.64E+01	mg/kg	50SB07A	14/14	N/A	Yes	IBC
	7439-89-6	Iron	7.51E+03 J	2.83E+04	mg/kg	50SS03	14/14	N/A	No	NIBC
	7439-92-1	Lead	6.60E+00 J	1.78E+02 J	mg/kg	50SB07A	14/14	N/A	Yes	IBC
	7439-95-4	Magnesium	3.12E+02 J	2.02E+04	mg/kg	50SS02	14/14	N/A	No	NIBC
	7439-96-5	Manganese	6.28E+01 J	1.32E+03	mg/kg	50SS01	14/14	N/A	No	NIBC
	7439-97-6	Mercury	4.10E-02 J	8.16E-01	mg/kg	50SB05A	14/14	N/A	Yes	IBC
	7440-02-0	Nickel	4.10E+00 J	5.01E+01 J	mg/kg	50SB07A	14/14	N/A	Yes	IBC
	7440-09-7	Potassium	4.65E+02	2.05E+03	mg/kg	50SS02	8/8	N/A	No	NIBC
	7782-49-2	Selenium	4.80E+00 J	7.40E+00 J	mg/kg	50SB12A	9/13	1.09E+00 - 1.14E+00	No	NIBC
	7440-22-4	Silver	1.70E-01 J	8.90E-01 J	mg/kg	50SB05A	4/14	4.70E-02 - 1.11E+00	Yes	IBC
	7440-23-5	Sodium	6.17E+01 J	7.25E+01 J	mg/kg	50SS03	3/14	4.20E+00 - 4.80E+01	No	NIBC
	7440-62-2	Vanadium	1.72E+01 J	4.91E+01 J	mg/kg	50SB12A	14/14	N/A	No	NIBC
	7440-66-6	Zinc	1.70E+01 J	9.33E+01 J	mg/kg	50SS02	14/14	N/A	Yes	IBC

COPEC Selection Rationale Codes

Selection Reason: Important Bioaccumulative Compounds (IBC) [as defined in Table 4-2, of USEPA 823-R-00-001, February 2000]
Explosives (EXP)

Deletion Reason: Not Important Bioaccumulative Compound (NIBC)
Dioxins and furans will be analyzed by the toxicity equivalent provided by the TCDD-TE (TEQ)

Notes/Definitions

N/A = Not Applicable or Not Available
COPEC = Chemical of Potential Ecological Concern
J = Estimated Value
L = Estimated Value
mg/kg = milligrams per kilogram

- Range of detection limits.
- COPEC selection conclusion: YES or NO.
- Rationale for selection or rejection of the COPEC.

COPECs were selected as shown in **Tables 7-6 and 7-7**. In general, COPECs were selected as a concern for the direct contact exposure pathway if the constituent was detected in an environmental medium (**Table 7-6**). For food chain exposure pathways, detected COPECs were selected if they were important bioaccumulative constituents (USEPA, 2000c) or explosive compounds (**Table 7-7**).

Fifty-nine COPECs (22 inorganic and 37 organic COPECs) have been selected for surface soil direct contact exposure (**Table 7-6**).

Thirty-six COPECs (9 inorganic and 27 organic COPECs) have been selected for surface soil for food chain exposure (**Table 7-7**). Detected chemicals that are important bioaccumulative compounds (USEPA, 2000c) or explosives are considered final food chain exposure COPECs and have been quantitatively evaluated in this SLERA.

Exposure point concentrations based on the statistical procedures discussed in *HHRA Section 6.2.3* are presented in **Table 7-8**. Arithmetic mean concentrations are presented for informational purposes.

7.2.3 Risk Characterization

This section presents the SLERA risk characterization results, following the detailed methods and procedures presented in *Section 7.1.7*.

7.2.3.1 Terrestrial Plant Impact Assessment

To assess the potential impact of COPEC concentrations in surface soil on terrestrial plant species, visual observations were recorded during the site reconnaissance, and no obvious signs of vegetative stress were noted. The overall health of the grassland/field communities at the site was comparable to those of the surrounding area. As allowed in the *RFAAP Final MWP* (URS, 2003), that states "owing to the invasive and successive nature of plant communities, plants as receptors do not typically warrant a detailed examination of effects," plants were not quantitatively evaluated in this SLERA. As there were no unique or site-specific terrestrial plant issues discovered at SWMU 50, a qualitative evaluation was deemed adequate. However, a terrestrial plant impact screening assessment is discussed in *Section 7.2.4*. It should also be noted that plants (and invertebrates) are included in the SLERAs as media through which the wildlife receptors may be exposed indirectly to COPECs in the soil by means of the food chain.

7.2.3.2 Predictive Risk Estimation for Terrestrial Wildlife

The potential wildlife risks associated with SWMU 50 are estimated in this section. The risk estimation has been performed through a series of quantitative HQ calculations that compare receptor-specific exposure values with TRVs. The EEQs (or HQs) are compared to HQ guidelines for assessing the risk posed from contaminants. It should be noted that HQs are not measures of risk, are not population-based statistics, and are not linearly-scaled statistics, and therefore an HQ above 1, even exceedingly so, does not guarantee that there is even one individual expressing the toxicological effect associated with a given chemical to which it was exposed (Allard et al., 2007; Tannenbaum, 2001; Bartell, 1996).

Table 7-8
Medium-Specific Exposure Point Concentration Summary for SWMU 50 Surface Soil

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean of Detects	Multiple Detection Limits? (Yes/No) [1]	95% UCL (Distribution) [2]	Maximum Concentration	Exposure Point Concentration			
							Value	Units	Statistic [3]	Rationale [4]
Surface Soil	2,3,7,8-TCDD-TE	mg/kg	2.86E-05	No	6.68E-05 (G)	9.80E-05	6.68E-05	mg/kg	95% Approx. Gamma	Test (6)
	1,2-Dichlorobenzene[5]	mg/kg	1.10E-02	N/A	4.01E-01 (NP)	1.10E-02	1.10E-02	mg/kg	Max	Test (2)
	1,3-Dichlorobenzene[5]	mg/kg	8.60E-03	N/A	4.02E-01 (NP)	8.60E-03	8.60E-03	mg/kg	Max	Test (2)
	1,4-Dichlorobenzene[5]	mg/kg	1.10E-02	N/A	3.97E-01 (NP)	1.10E-02	1.10E-02	mg/kg	Max	Test (2)
	2,4,5-T[5]	mg/kg	8.18E-03	N/A	1.38E-02 (NP)	8.18E-03	8.18E-03	mg/kg	Max	Test (2)
	2,4-D[5]	mg/kg	1.42E-01	N/A	3.92E-02 (NP)	1.42E-01	3.92E-02	mg/kg	95% UCL-Bst	Test (8)
	2,4-Dinitrotoluene	mg/kg	3.93E-01	Yes	4.44E-01 (N)	8.88E-01	4.44E-01	mg/kg	95% KM-% Btstrp	Test (1)
	2-Methylnaphthalene	mg/kg	1.26E-01	Yes	1.21E-01 (G)	4.00E-01	1.21E-01	mg/kg	95% KM-t	Test (1)
	4,4'-DDD[5]	mg/kg	4.29E-04	N/A	4.82E-03 (NP)	4.47E-04	4.47E-04	mg/kg	Max	Test (2)
	4,4'-DDE[5]	mg/kg	3.37E-03	N/A	5.48E-03 (NP)	3.37E-03	3.37E-03	mg/kg	Max	Test (2)
	4,4'-DDT[5]	mg/kg	1.29E-02	N/A	6.36E-03 (NP)	1.29E-02	6.36E-03	mg/kg	95% UCL-Bst	Test (8)
	Acenaphthene[5]	mg/kg	1.60E-02	N/A	2.84E-01 (NP)	1.60E-02	1.60E-02	mg/kg	Max	Test (2)
	Acenaphthylene	mg/kg	8.83E-03	Yes	1.61E-02 (N)	2.00E-02	1.61E-02	mg/kg	95% KM-t	Test (1)
	Acetone[5]	mg/kg	7.45E-02	N/A	3.94E-02 (NP)	7.45E-02	3.94E-02	mg/kg	95% UCL-Bst	Test (8)
	Anthracene	mg/kg	6.73E-03	Yes	1.10E-02 (N)	1.10E-02	1.10E-02	mg/kg	95% KM-% Btstrp	Test (1)
	Aroclor 1254	mg/kg	3.44E-01	Yes	3.76E-01 (G)	1.48E+00	3.76E-01	mg/kg	95% KM-t	Test (1)
	Benzo(a)anthracene	mg/kg	4.65E-02	Yes	5.31E-02 (N)	1.37E-01	5.31E-02	mg/kg	95% KM-t	Test (1)
	Benzo(a)pyrene	mg/kg	4.28E-02	Yes	5.27E-02 (G)	1.50E-01	5.27E-02	mg/kg	95% KM-t	Test (1)
	Benzo(b)fluoranthene	mg/kg	5.25E-02	Yes	5.46E-02 (N)	1.52E-01	5.46E-02	mg/kg	95% KM-t	Test (1)
	Benzo(g,h,i)perylene	mg/kg	2.23E-02	Yes	2.89E-02 (N)	5.90E-02	2.89E-02	mg/kg	95% KM-t	Test (1)
	Benzo(k)fluoranthene	mg/kg	2.66E-02	Yes	3.23E-02 (G)	9.89E-02	3.23E-02	mg/kg	95% KM-t	Test (1)
	Carbazole	mg/kg	1.87E-02	Yes	2.80E-02 (N)	2.80E-02	2.80E-02	mg/kg	95% KM-% Btstrp	Test (1)
	Chrysene	mg/kg	4.50E-02	Yes	5.30E-02 (N)	1.19E-01	5.30E-02	mg/kg	95% KM-% Btstrp	Test (1)
	Dibenz(a,h)anthracene	mg/kg	5.60E-03	Yes	1.06E-02 (N)	1.40E-02	1.06E-02	mg/kg	95% KM-t	Test (1)
	Dibenzofuran	mg/kg	8.33E-02	Yes	2.00E-01 (N)	2.00E-01	2.00E-01	mg/kg	95% KM-% Btstrp	Test (1)
	Dimethylphthalate[5]	mg/kg	1.11E+00	N/A	5.47E-01 (NP)	1.50E+00	5.47E-01	mg/kg	95% UCL-Bst	Test (8)

Table 7-8
Medium-Specific Exposure Point Concentration Summary for SWMU 50 Surface Soil
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Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean of Detects	Multiple Detection Limits? (Yes/No) [1]	95% UCL (Distribution) [2]	Maximum Concentration	Exposure Point Concentration			
							Value	Units	Statistic [3]	Rationale [4]
	Di-n-butyl phthalate	mg/kg	3.78E-01	Yes	7.77E-01 (N)	7.77E-01	7.77E-01	mg/kg	95% KM-% Btstrp	Test (1)
	Endosulfan II[5]	mg/kg	1.44E-03	N/A	5.02E-03 (NP)	2.24E-03	2.24E-03	mg/kg	Max	Test (2)
	Endrin[5]	mg/kg	2.88E-04	N/A	4.85E-03 (NP)	2.88E-04	2.88E-04	mg/kg	Max	Test (2)
	Fluoranthene	mg/kg	3.73E-02	Yes	6.23E-02 (N)	7.30E-02	6.23E-02	mg/kg	95% KM-% Btstrp	Test (1)
	Fluorene	mg/kg	6.88E-03	Yes	1.38E-02 (N)	1.80E-02	1.38E-02	mg/kg	95% KM-% Btstrp	Test (1)
	Indeno(1,2,3-cd)pyrene	mg/kg	2.70E-02	Yes	3.46E-02 (N)	8.41E-02	3.46E-02	mg/kg	95% KM-t	Test (1)
	Methoxychlor[5]	mg/kg	1.29E-03	N/A	5.01E-03 (NP)	1.29E-03	1.29E-03	mg/kg	Max	Test (2)
	Naphthalene	mg/kg	1.08E-01	Yes	2.70E-01 (NP)	2.70E-01	2.70E-01	mg/kg	95% KM-BCA	Test (1)
	n-Nitrosodiphenylamine	mg/kg	6.20E-01	Yes	4.90E-01 (G)	2.10E+00	4.90E-01	mg/kg	95% KM-t	Test (1)
	Phenanthrene	mg/kg	9.35E-02	Yes	1.95E-01 (N)	2.60E-01	1.95E-01	mg/kg	95% KM-% Btstrp	Test (1)
	Pyrene	mg/kg	4.16E-02	Yes	7.21E-02 (N)	8.50E-02	7.21E-02	mg/kg	95% KM-% Btstrp	Test (1)
	Aluminum	mg/kg	1.54E+04	No	1.75E+04 (N)	2.43E+04	1.75E+04	mg/kg	95% Student's-t	Test (4)
	Antimony	mg/kg	1.08E+00	No	1.21E+00 (N)	1.40E+00	1.21E+00	mg/kg	95% KM-t	Test (4)
	Arsenic	mg/kg	3.96E+00	No	4.90E+00 (N)	7.40E+00	4.90E+00	mg/kg	95% Student's-t	Test (4)
	Barium	mg/kg	8.92E+01	No	1.01E+02 (N)	1.41E+02	1.01E+02	mg/kg	95% Student's-t	Test (4)
	Beryllium	mg/kg	6.49E-01	No	7.47E-01 (N)	9.00E-01	7.47E-01	mg/kg	95% Student's-t	Test (4)
	Cadmium[5]	mg/kg	1.35E-01	N/A	5.21E-01 (NP)	1.43E-01	1.43E-01	mg/kg	Max	Test (2)
	Calcium	mg/kg	5.82E+03	No	2.80E+04 (NP)	2.86E+04	2.80E+04	mg/kg	99% Cheby, Mean, Sd	Test (3)
	Chromium	mg/kg	3.26E+01	No	4.44E+01 (G)	1.16E+02	4.44E+01	mg/kg	95% Approx. Gamma	Test (6)
	Cobalt	mg/kg	9.06E+00	No	1.09E+01 (N)	1.71E+01	1.09E+01	mg/kg	95% Student's-t	Test (4)
	Copper	mg/kg	1.69E+01	No	2.44E+01 (G)	5.64E+01	2.44E+01	mg/kg	95% Approx. Gamma	Test (6)
	Iron	mg/kg	1.95E+04	No	2.21E+04 (N)	2.83E+04	2.21E+04	mg/kg	95% Student's-t	Test (4)
	Lead	mg/kg	4.38E+01	No	1.09E+02 (NP)	1.78E+02	1.09E+02	mg/kg	95% Cheby, Mean, Sd	Test (3)
	Magnesium	mg/kg	3.82E+03	No	7.15E+03 (G)	2.02E+04	7.15E+03	mg/kg	95% Approx. Gamma	Test (6)
	Manganese	mg/kg	6.96E+02	No	8.73E+02 (N)	1.32E+03	8.73E+02	mg/kg	95% Student's-t	Test (4)
	Mercury	mg/kg	1.45E-01	No	3.78E-01 (NP)	8.16E-01	3.78E-01	mg/kg	95% Cheby, Mean, Sd	Test (3)
	Nickel	mg/kg	1.29E+01	No	1.81E+01 (G)	5.01E+01	1.81E+01	mg/kg	95% Approx. Gamma	Test (6)
	Potassium	mg/kg	1.28E+03	No	1.60E+03 (N)	2.05E+03	1.60E+03	mg/kg	95% Student's-t	Test (4)
	Selenium	mg/kg	6.09E+00	Yes	6.25E+00 (N)	7.40E+00	6.25E+00	mg/kg	95% KM-% Btstrp	Test (1)
	Silver	mg/kg	5.63E-01	Yes	6.57E-01 (N)	8.90E-01	6.57E-01	mg/kg	95% KM-% Btstrp	Test (1)

Table 7-8
Medium-Specific Exposure Point Concentration Summary for SWMU 50 Surface Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean of Detects	Multiple Detection Limits? (Yes/No) [1]	95% UCL (Distribution) [2]	Maximum Concentration	Exposure Point Concentration			
							Value	Units	Statistic [3]	Rationale [4]
	Sodium	mg/kg	6.64E+01	Yes	7.25E+01 (N)	7.25E+01	7.25E+01	mg/kg	95% KM-% Btstrp	Test (1)
	Vanadium	mg/kg	3.81E+01	No	4.25E+01 (N)	4.91E+01	4.25E+01	mg/kg	95% Student's-t	Test (4)
	Zinc	mg/kg	4.77E+01	No	6.03E+01 (N)	9.33E+01	6.03E+01	mg/kg	95% Student's-t	Test (4)

Notes: N/A = Not applicable

[1] ProUCL software (version 4.0, USEPA, 2007) recommends use of Kaplan-Meier method if there are multiple detection limits.

[2] Statistical Distribution and 95% UCL as determined by ProUCL (unless otherwise noted): (G) the data were determined to follow gamma distribution; (L) the data were determined to follow lognormal distribution; (NP) the data were determined to be non-parametric; (N) the data were determined to be normally distributed.

[3] Statistic: Maximum Detected Value (Max); 95% KM Chebyshev (95% KM-Cheby); 97.5% KM Chebyshev (97.5% KM-Cheby); 99% KM Chebyshev (99% KM-Cheby); 95% KM Percentile Bootstrap (95% KM-% Btstrp); 95% KM-t (95% KM-t); 95% KM-BCA (95% KM-BCA); 95% H-UCL (95% H-UCL); 95% Chebyshev -Mean, SD- UCL (95% Cheby, Mean, SD); 97.5% Chebyshev -Mean, SD- UCL (97.5% Cheby, Mean, SD); 99% Chebyshev -Mean, SD- UCL (99% Cheby, Mean, SD); 95% UCL of Log-transformed Data (95% UCL-T) 95% Student's-t (95% Student's-t); 95% Modified-t (95% Modified-t); 95% UCL based on bootstrap statistic (95% UCL-Bst); 95% Approximate Gamma UCL (95% Approx. Gamma); 95% KM Chebyshev-MVUE (95% KM-Cheby-MVUE).

[4] Unless otherwise noted (see footnote 5), ProUCL EPC selection rationale based on, detection limit values, distribution, standard deviation, and sample size (see ProUCL output in appendix for further details):

Test (1): Kaplan-Meier method recommended by ProUCL due to multiple detection limits.
Test (2): The 95% UCL exceeds the maximum detected concentration, therefore, maximum concentration used for EPC.
Test (3): Shapiro-Wilk W test, Kolmogorov-Smirnov (K-S), and Anderson-Darling (A-D) tests, indicate data follow nonparametric distribution.
Test (4): Shapiro-Wilk W test indicates data are normally distributed.
Test (5): Shapiro-Wilk W test indicates data are log-normally distributed.
Test (6): Kolmogorov-Smirnov (K-S) and/or Anderson-Darling (A-D) tests indicate data follow gamma distribution.
Test (7): Sample size is less than or equal to 5, therefore, maximum concentration used for EPC.
Test (8): 95% UCL estimated by a non-Pro-UCL bootstrap method.

[5] Infrequent detection resulted in ProUCL modeling error for this constituent, therefore the distribution was assumed to be non-parametric and the UCL was determined using a non-ProUCL bootstrap method with random numbers for NDs (see text for details).

The simple HQ ratios are summed to provide conservative HI estimates for chemicals and exposure pathways for a given receptor. The criterion used to decide if HQ summation is appropriate and scientifically defensible includes those chemicals that have a similar mode of toxicological action. While individual contaminants may affect distinct target organs or systems within an organism, classes of chemicals may act in similar ways, thus being additive in effect.

The summation of HQs into an HI was performed in this SLERA as a conservative approach. To assess whether or not individual COPEC HQs should be segregated based on dissimilar modes of toxicological action, individual COPEC effects were evaluated. However, as risk drivers resulted in HQs ranging from less than 1 to 9,446 (see following paragraphs), segregation of COPECs by mode of toxicological action was not necessary.

Tier 1 and Tier 2 individual COPEC EEQs and HIs (summed EEQs) for terrestrial receptors at SWMU 50 are presented in risk characterization tables (**Appendix F-2, Tables F-2 through F-11**) for the five selected receptor species. These summed EEQs are presented in **Table 7-9** (generally rounded to two significant figures), along with the hazard driver [COPEC(s) contributing the majority of the total estimated EEQ] and the exposure pathway of concern (the pathway contributing the most to the total estimated EEQ).

As shown in **Table 7-9**, Tier 1 total EEQs ranged from approximately 6 to 9,446 for the five receptor species, using TRVs based on either NOAEL or LOAEL values. The short-tailed shrew was predicted to be the most impacted, followed by the American robin, the red fox, the meadow vole, and the red-tailed hawk. The inorganic constituents selenium and chromium; and the organic constituents TCDD, Aroclor 1254, and 4,4-DDE were the COPECs contributing the most to the total EEQs for each of the receptors. Exposure pathways of most concern, based on the results of the Tier 1 food-chain modeling, were plant, terrestrial invertebrate, and small mammal ingestion.

More realistic Tier 2 total EEQs were also elevated, especially values based on NOAEL TRVs, which ranged from 0.02 to 551. However, Tier 2 total EEQs were much lower than Tier 1 total EEQs, and both the NOAEL and LOAEL Tier 2 total EEQs for the red-tailed hawk and red fox were below one. Tier 2 total EEQs based on LOAEL values were 72 for the short-tailed shrew, 23 for the American robin, and 12 for the meadow vole (**Table 7-9**). TCDD was identified as the main hazard drivers for the short-tailed shrew based on invertebrate ingestion, selenium was the hazard driver for the meadow vole based on plant ingestion, and chromium and selenium were the drivers for the American robin based on earthworm and plant ingestion.

The specific results of the Tier 2 risk estimation for the meadow vole, short-tailed shrew, and American robin are discussed below. The specific results for the red-tailed hawk and red fox are not discussed because the summed EEQs are below one.

Meadow Vole. The total EEQs for both NOAEL and LOAEL TRVs exceeded one (25 and 12, respectively). Five COPECs had individual NOAEL-based EEQs that exceeded 1 (EEQ in parenthesis): selenium (17), arsenic (2.1), TCDD (1.6), 2,4-dinitrotoluene (1.5), and copper (1.1). Only selenium (10) had a LOAEL-based EEQ that exceeded 1. The primary exposure pathway was the ingestion of plants. The results of the Tier 2 risk evaluation for meadow voles are presented in **Appendix F-2, Table F-3**.

Table 7-9
Wildlife EEQ Hazard Summary for Food Chain Exposure at SWMU 50

Receptor	Tier 1[a]		Tier 2[b]	
	NOAEL-Based EEQ	LOAEL-Based EEQ	NOAEL-Based EEQ	LOAEL-Based EEQ
Meadow vole	93	43	25	12
Hazard Driver(s)[c]:	Selenium - plant ingestion		Selenium - plant ingestion	
Short-tailed shrew	9,446	1,128	551	72
Hazard Driver(s)[c]:	TCDD - terrestrial invertebrate ingestion		TCDD - terrestrial invertebrate ingestion	
American robin	1,057	162	117	23
Hazard Driver(s)[c]:	Aroclor 1254 - terrestrial invertebrate ingestion		Chromium and Selenium - terrestrial invertebrate and plant ingestion	
Red-tailed hawk	34	6.0	0.02	0.003
Hazard Driver(s)[c]:	Chromium, TCDD, and 4,4-DDE - small mammal ingestion		--	
Red fox	366	47	0.06	0.009
Hazard Driver(s)[c]:	TCDD - terrestrial invertebrate and small mammal ingestion		--	

[a] Tier 1 = Max EEQ using max EPC, max BAF/BCF (EcoSSL BAF/ regression equation was used when available), max Intake Rates, min BW, and FHR =1.
[b] Tier 2 = EEQ using 95% EPC, non-max BAF/BCF (EcoSSL BAF/ regression equation was used when available), avg Intake Rates, avg BW and calculated FHR less than or equal to 1.
[c] Hazard drivers are those chemicals contributing the most to the total estimated EEQ, and the primary route of exposure associated with this driver.

Notes:
EEQ = Ecological Effects Quotient.
LOAEL = Lowest-Observed-Adverse-Effect Level
NOAEL = No-Observed-Adverse-Effect Level

Short-tailed Shrew. The total EEQs for both NOAEL and LOAEL TRVs exceeded one (551 and 72, respectively). Eight COPECs had individual NOAEL-based EEQs that exceeded 1 (EEQ in parenthesis): TCDD (482), selenium (25), Aroclor-1254 (15), arsenic (12), lead (6.8), zinc (2.5), cadmium (2.1), and copper (1.5). Six COPECs had individual LOAEL-based EEQs that exceeded 1 (EEQ in parenthesis): TCDD (48), selenium (15), Aroclor-1254 (3), arsenic (1.2), zinc (1.2), and copper (1.2). The primary exposure pathway was the ingestion of terrestrial invertebrates. The results of the short-tailed shrew Tier 2 risk evaluation is presented in **Appendix F-2, Table F-5**.

American Robin. The total EEQs for both NOAEL and LOAEL TRVs exceeded one (117 and 23, respectively). Ten COPECs had individual NOAEL-based EEQs that exceeded 1 (EEQ in parenthesis): 4,4-DDT (23), TCDD (19), 4,4-DDE (18), zinc (18), selenium (13), lead (8.6), Aroclor-1254 (6.1), chromium (5.0), 4,4-DDD (3.3), and mercury (1.6). Seven COPECs had individual LOAEL-based EEQs that exceeded 1 (EEQ in parenthesis): selenium (6.6),

chromium (4.8), 4,4-DDT (2.3), zinc (2.0), TCDD (1.9), 4,4-DDE (1.8), and lead (1.7). The primary exposure pathway was the ingestion of terrestrial invertebrates and plants. The results of the American robin Tier 2 risk evaluation is presented in **Appendix F-2, Table F-7**.

7.2.4 Approach for the Evaluation of Direct Contact Toxicity

To evaluate direct contact exposure, for those organisms that live within an environmental medium, COPEC media concentrations are compared with BTAG-approved direct-contact screening values, and secondarily, a variety of additional appropriate direct-contact benchmarks. Surface soil was the only exposure medium at SWMU 50. Intake is not calculated because potential adverse effects are assessed by evaluating the COPEC concentrations in soil. Detailed procedures are presented in *Section 7.1.8* and the results are summarized in **Table 7-10**.

7.2.4.1 Soil

Based on the results of the first step, 14 COPECs were selected based on an EcoSSL or BTAG exceedance while 15 additional chemicals were evaluated further because of the lack of available EcoSSL or BTAG screening values (**Table 7-10**). In the second step, the MDC of these 29 chemicals was compared with up to five individual soil screening values. The results of the second screening step are as follows:

- There were no available benchmarks available for: 2-methylnaphthalene, 2,4,5-T, 2,4-D, 2,4-DNT, acetone, carbazole, dibenzofuran, calcium, magnesium, potassium, and sodium.
- The Aroclor 1254 MDC exceeded two of the three available benchmarks; however, there is no reference to determine the basis or appropriateness of the BTAG value. One of benchmarks exceeded is in the CCME guidance but there is no soil benchmark listed for Aroclor 1254 and the exceedance is of the generic PCB benchmark. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 50.
- The aluminum MDC exceeded the one available benchmark for plant toxicity, and the soil pH at SWMU 50 is 5.33 based on one soil sample. USEPA (2007c) recommends that aluminum should only be identified as a COPEC in soils with a pH of less than 5.5. Therefore, the potential for direct plant contact toxicity is a potential concern at SWMU 50. However, the pH value of 5.33 is close to pH 5.5 and if additional samples would have been collected it is possible that the average soil pH would be slightly higher. Also, as discussed in *Section 7.2.3.1*, plant toxicity is not an overriding concern for the Site. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 50.
- The chromium MDC exceeded four out of five available benchmarks for direct contact for trivalent chromium; however, the EcoSSL guidance (USEPA, 2007c) says that data are insufficient to derive a direct contact benchmark for this inorganic constituent. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 50.

Table 7-10
Direct Toxicity Evaluation for Surface Soil at SWMU 50

Chemical (1)	Detection Frequency	Maximum Concentration	Exposure Point Concentration	Minimum Concentration	BTAG or USEPA EcoSSL Screening Toxicity Value (2)	Retain COPEC as Max Conc > BTAG or EcoSSL Value?	If Retained as COPEC, Comment on BTAG or EcoSSL Value	Dutch Intervention Value (3)	CCME Value (4)	USEPA EcoSSL Direct Contact Value (5)	ORNL Screening Benchmark for Plants (6)	ORNL Screening Benchmark for Invertebrates (7)	COPEC Weight of Evidence Summary - Number of Direct Contact Benchmarks Exceeded Using MDC	Comment
2,3,7,8-TCDD-TE	10/10	9.80E-05	6.68E-05	2.37E-06	1.00E-02	No								
1,2-Dichlorobenzene	1/15	1.10E-02	1.10E-02	1.10E-02	1.00E-01	No								
1,3-Dichlorobenzene	1/15	8.60E-03	8.60E-03	8.60E-03	NVA	Yes		NVA	0.1	NVA	NVA	20	0/2	No exceedences
1,4-Dichlorobenzene	1/15	1.10E-02	1.10E-02	1.10E-02	1.00E-01	No								
2-Methylnaphthalene	4/14	4.00E-01	1.21E-01	9.10E-03	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
2,4,5-T	1/12	8.18E-03	8.18E-03	8.18E-03	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
2,4-D	1/12	1.42E-01	3.92E-02	1.42E-01	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
2,4-Dinitrotoluene	5/14	8.88E-01	4.44E-01	1.01E-01	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
4,4'-DDD	2/12	4.47E-04	4.47E-04	4.10E-04	1.00E-01	No								
4,4'-DDE	1/11	3.37E-03	3.37E-03	3.37E-03	1.00E-01	No								
4,4'-DDT	1/12	1.29E-02	6.36E-03	1.29E-02	1.00E-01	No								
Acenaphthene	1/11	1.60E-02	1.60E-02	1.60E-02	2.9E+01 (LMW)	No								
Acenaphthylene	4/14	2.00E-02	1.61E-02	2.20E-03	2.9E+01 (LMW)	No								
Acetone	1/13	7.45E-02	3.94E-02	7.45E-02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Anthracene	3/14	1.10E-02	1.10E-02	3.00E-03	2.9E+01 (LMW)	No								
Aroclor 1254	7/14	1.48E+00	3.76E-01	1.04E-02	1.00E-01	Yes	Plant tox (no ref)	1	0.5	NVA	40	NVA	2/3	
Benzo(a)anthracene	5/14	1.37E-01	5.31E-02	3.60E-03	1.1E+00 (HMW)	No								
Benzo(a)pyrene	6/14	1.50E-01	5.27E-02	3.30E-03	1.1E+00 (HMW)	No								
Benzo(b)fluoranthene	6/14	1.52E-01	5.46E-02	6.50E-03	1.1E+00 (HMW)	No								
Benzo(g,h,i)perylene	5/14	5.90E-02	2.89E-02	3.40E-03	1.1E+00 (HMW)	No								
Benzo(k)fluoranthene	6/14	9.89E-02	3.23E-02	2.00E-03	1.1E+00 (HMW)	No								
Carbazole	3/15	2.80E-02	2.80E-02	1.10E-02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Chrysene	6/14	1.19E-01	5.30E-02	6.10E-03	1.1E+00 (HMW)	No								
Dibenz(a,h)anthracene	4/14	1.40E-02	1.06E-02	1.60E-03	1.1E+00 (HMW)	No								
Dibenzofuran	3/15	2.00E-01	2.00E-01	2.00E-02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Dimethylphthalate	2/15	1.50E+00	5.47E-01	7.16E-01	NVA	Yes		60	NVA	NVA	NVA	200	0/2	No exceedences
Di-n-butyl phthalate	3/11	7.77E-01	7.77E-01	1.29E-01	NVA	Yes		60	NVA	NVA	200	NVA	0/2	No exceedences
Endosulfan II	2/12	2.24E-03	2.24E-03	6.36E-04	NVA	Yes		4	NVA	NVA	NVA	NVA	0/1	No exceedences
Endrin	1/12	2.88E-04	2.88E-04	2.88E-04	1.00E-01	No								
Fluoranthene	4/14	7.30E-02	6.23E-02	9.00E-03	1.1E+00 (HMW)	No								
Fluorene	4/14	1.80E-02	1.38E-02	1.10E-03	2.9E+01 (LMW)	No								
Indeno(1,2,3-cd)pyrene	6/14	8.41E-02	3.46E-02	2.30E-03	1.1E+00 (HMW)	No								
Methoxychlor	1/12	1.29E-03	1.29E-03	1.29E-03	1.00E-01	No								
Naphthalene	3/13	2.70E-01	2.70E-01	2.70E-02	2.9E+01 (LMW)	No								
n-Nitrosodiphenylamine	4/15	2.10E+00	4.90E-01	2.10E-02	NVA	Yes		NVA	NVA	NVA	NVA	20	0/1	No exceedences
Phenanthrene	4/14	2.60E-01	1.95E-01	1.10E-02	2.9E+01 (LMW)	No								
Pyrene	4/14	8.50E-02	7.21E-02	7.50E-03	1.1E+00 (HMW)	No								

Table 7-10
Direct Toxicity Evaluation for Surface Soil at SWMU 50

Chemical (1)	Detection Frequency	Maximum Concentration	Exposure Point Concentration	Minimum Concentration	BTAG or USEPA EcoSSL Screening Toxicity Value (2)	Retain COPEC as Max Conc > BTAG or EcoSSL Value?	If Retained as COPEC, Comment on BTAG or EcoSSL Value	Dutch Intervention Value (3)	CCME Value (4)	USEPA EcoSSL Direct Contact Value (5)	ORNL Screening Benchmark for Plants (6)	ORNL Screening Benchmark for Invertebrates (7)	COPEC Weight of Evidence Summary - Number of Direct Contact Benchmarks Exceeded Using MDC	Comment
Aluminum	14/14	2.43E+04	1.75E+04	6.59E+03	1.00E+00	Yes	pH < 5.5; Plant tox (OHMTADS)	NVA	NVA	NVA	50	NVA	1/1	pH = 5.33
Antimony	11/12	1.40E+00	1.21E+00	3.30E-01	2.70E-01	Yes	Mammal tox	15	20	78	5	NVA	0/4	No exceedences
Arsenic	14/14	7.40E+00	4.90E+00	1.03E+00	1.80E+01	No								
Barium	14/14	1.41E+02	1.01E+02	3.39E+01	3.30E+02	No								
Beryllium	10/10	9.00E-01	7.47E-01	3.50E-01	2.10E+01	No								
Cadmium	2/12	1.43E-01	1.43E-01	1.27E-01	3.60E-01	No								
Calcium	14/14	2.86E+04	2.80E+04	4.84E+02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Chromium (Cr III tox)	14/14	1.16E+02	4.44E+01	1.22E+01	2.60E+01	Yes		380	64	NVA	1	0.4	3/4	
Chromium (Cr VI tox)	14/14	1.16E+02	4.44E+01	1.22E+01	1.30E+02	No								
Cobalt	14/14	1.71E+01	1.09E+01	3.40E+00	1.30E+01	Yes	Plant tox	240	40	13	20	NVA	1/4	
Copper	14/14	5.64E+01	2.44E+01	4.00E+00	2.80E+01	Yes	Bird tox	190	63	70	100	50	1/5	
Iron	14/14	2.83E+04	2.21E+04	7.51E+03	5 ≤ pH ≤ 8	No								
Lead	14/14	1.78E+02	1.09E+02	6.60E+00	1.10E+01	Yes	Bird tox	530	70	120	50	500	3/5	
Magnesium	14/14	2.02E+04	7.15E+03	3.12E+02	4.40E+03	Yes	No reference	NVA	NVA	NVA	NVA	NVA	NVA	
Manganese	14/14	1.32E+03	8.73E+02	6.28E+01	2.20E+02	Yes	Plant tox	NVA	NVA	220	500	NVA	2/2	Plant tox
Mercury	14/14	8.16E-01	3.78E-01	4.10E-02	5.80E-02	Yes	No reference	10	6.6	NVA	0.3	0.1	2/4	
Nickel	14/14	5.01E+01	1.81E+01	4.10E+00	3.80E+01	Yes	Plant tox	210	50	38	30	200	3/5	Plant tox
Potassium	8/8	2.05E+03	1.60E+03	4.65E+02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Selenium	9/13	7.40E+00	6.25E+00	4.80E+00	5.20E-01	Yes	Plant tox	NVA	1	0.52	1	70	3/4	Plant tox
Silver	4/14	8.90E-01	6.57E-01	1.70E-01	4.20E+00	No								
Sodium	3/14	7.25E+01	7.25E+01	6.17E+01	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Vanadium	14/14	4.91E+01	4.25E+01	1.72E+01	7.80E+00	Yes	Bird tox	NVA	130	NVA	2	NVA	1/2	EcoSSL says data insufficient to derive direct contact SSL
Zinc	14/14	9.33E+01	6.03E+00	1.70E+01	4.60E+01	Yes	Plant tox (OHMTADS)	720	200	120	50	200	1/5	Plant tox

All values presented in mg/kg.
NVA = No Value Available
LMW = Low Molecular Weight PAH
HMW = High Molecular Weight PAH
Surface soil pH of 5.33 based on one sample (50SS01) collected at SWMU 50.

(1) COPECs from Table 7-6.
(2) Screening toxicity values from BTAG (1995) or EcoSSL (USEPA, 2007). EcoSSLs given highest priority as they are more definitive.
(3) Dutch Intervention Values are from the Netherlands Ministry of Housing, Spacial Planning and Environment (February 2000).
(4) Canadian Council of Ministers of the Environment (CCME), Canadian Environmental Quality Guidelines, December 2003.
(5) Lowest EcoSSL value for direct contact toxicity for either plants or terrestrial invertebrates (USEPA, 2007).
(6) Screening benchmarks for plants from ORNL (1997, ES/ER/TM-85/R3).
(7) Screening benchmarks for earthworms from ORNL (1997, ES/ER/TM-126/R2).
(8) EcoSSL (USEPA, 2007) for LMW PAHs and HMW PAHs.
LMW and HMW PAHs based on the number of ring structures (less than 4 rings = LMW; 4 or more rings = HWM).

- The cobalt MDC exceeded only one of four available benchmarks and the one exceedance was for plant toxicity. As discussed in Section 7.2.3.1, plant toxicity is not an overriding concern for the Site. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 50.
- The copper MDC exceeded only one of five available benchmarks (i.e., less than 50 percent of available benchmarks). Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 50.
- The lead MDC exceeded three of the five available benchmarks for direct contact. Therefore, there is potential for direct contact toxicity for lead at SWMU 50. This may or may not result in the reduction of terrestrial invertebrates as a food source at SWMU 50.
- The manganese MDC exceeded the two available benchmarks. The EcoSSL and ORNL exceedances were for plant toxicity, and as discussed in *Section 7.2.3.1*, plant toxicity is not an overriding concern for the Site. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 50.
- The mercury MDC exceeded two of the three available benchmarks. Therefore, there is potential for direct contact toxicity for mercury at SWMU 50. This may or may not result in the reduction of terrestrial invertebrates as a food source at SWMU 50.
- The nickel MDC exceeded three of five available benchmarks. In addition, the ORNL exceedance was for plant toxicity, and as discussed in *Section 7.2.3.1*, plant toxicity is not an overriding concern for the Site. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 50.
- The selenium MDC exceeded three of four available benchmarks. In addition, the ORNL exceedance was for plant toxicity, and as discussed in *Section 7.2.3.1*, plant toxicity is not an overriding concern for the Site. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 50.
- The vanadium MDC only exceeded one of the two available benchmarks. In addition, the EcoSSL guidance (USEPA, 2007c) says that data are insufficient to derive a direct contact benchmark for this inorganic constituent; and the ORNL exceedance was for plant toxicity, and as discussed in *Section 7.2.3.1*, plant toxicity is not an overriding concern for the Site. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 50.
- The zinc MDC only exceeded one of the five available benchmarks. In addition, the ORNL exceedance was for plant toxicity, and as discussed in *Section 7.2.3.1*, plant toxicity is not an overriding concern for the Site. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 50.
- None of the other COPECs selected in the first screening step had any benchmark exceedances.

These results suggest that direct contact toxicity for COPECs in soil may be a concern for lead and mercury. It should also be noted that toxicity to terrestrial invertebrates is assessed indirectly, as terrestrial invertebrates such as earthworms are included in the food-chain models used in the assessments.

7.2.5 Background Metals Considerations

A background evaluation was conducted on the soil analytical results to determine if any inorganic COPEC drivers discussed in the previous sections were potentially related to naturally occurring soil concentrations. From the Tier 2 LOAEL assessment, the inorganic COPEC drivers with EEQs greater than 1 for the food chain assessment were: arsenic, chromium, copper, lead, selenium, and zinc. COPEC hazard drivers for the direct contact assessment were lead and mercury. Inorganic COPECs that were not statistically different based on appropriate statistical tests are considered background related (see *HHRA Section 6.4.3* for details). Based on information presented in **Table 7-11**, copper and selenium (food chain); and mercury, nickel, and selenium (direct contact) COPECs in SWMU 50 surface soil considered to be potentially site related and not attributed to background.

Table 7-11
Background Comparison for Surface Soil at SWMU 50

Soil COPEC	Gehan Test [a, b] Site > Background?	Considered to be Background?
Aluminum [c]	Yes	No
Antimony	Yes	No
Arsenic [c]	No	Yes
Barium	Yes	No
Beryllium	No	Yes
Cadmium	No	Yes
Chromium [c]	No	Yes
Cobalt	No	Yes
Copper	Yes	No
Iron [c]	No	Yes
Lead [c]	No	Yes
Magnesium	Yes	No
Manganese [c]	No	Yes
Mercury	Yes	No
Nickel	Yes	No
Potassium	Yes	No
Selenium	Yes	No
Silver	Yes	No
Sodium	Yes	No
Thallium	No	Yes
Vanadium [c]	No	Yes
Zinc [c]	No	Yes

[a] Gehan test used unless otherwise noted. See Appendix for backup statistics.
[b] If both Site and Background data sets had normal distribution with 100% detects, the t-test was used (note: this did not occur for SWMU 50 surface soil vs. background comparisons).
[c] Wilcoxon-Mann-Whitney test used (for 100% detect data sets).

7.2.6 Uncertainty Analysis

There were 119 chemical constituents not detected in surface soil analytical samples. **Appendix F-2, Table F-29** evaluates the uncertainty associated with these constituents' detection limits by presenting a comparison of the maximum detection limit for each non-detect constituent with conservative ecological toxicity screening values. Ecological screening values were compiled and presented in **Appendix F-2, Table F-31**.

Forty-five of the non-detect constituents had maximum detection limits that exceeded either one or both of the screening criteria. This finding is not unexpected, given the conservative and numerically low screening values.

One inorganic (selenium) had Tier 2 LOAEL-based EEQs that were not attributed to background and exceeded 1 when rounded to one significant figure. The selenium based EEQs were 10, 15, and 6.6 for the meadow vole, shrew, and robin, respectively. Four organics (TCDD, Aroclor-1254, 4,4,-DDT, 4,4-DDE) had Tier 2 LOAEL-based EEQs that exceeded 1 when rounded to one significant figure. The TCDD-based EEQs were 48 and 2 for the shrew and robin, respectively. The Aroclor-1254 based EEQ was 3 for the shrew. The 4,4-DDT and 4,4-DDE based EEQs were both 2 for the robin. Given the uncertainties associated with the SLERA process, the key parameters associated with these elevated EEQs were examined in more detail in the following sections.

Selenium. For selenium, the elevated meadow vole EEQ of 10 was primarily from the plant ingestion pathway (96 percent). The LOAEL of 0.33 mg/kg-day that was used was based on a laboratory rat study from Sample et al. (1996) and the use of a toxicity extrapolation UF of 4 (**Appendix F-2, Table F-28**). The use of this UF is conservative; however, the use of an alternative UF of 2 would still result in the selenium EEQ slightly exceeding one (5) when rounded to one significant figure. The elevated shrew EEQ of 15 was primarily from the earthworm ingestion pathway (85 percent). The LOAEL of 0.33 mg/kg-day that was used was based on a laboratory rat study from Sample et al. (1996) and the use of a toxicity extrapolation UF of 8 (**Appendix F-2, Table F-28**). The use of this UF is quite conservative; however, the use of an alternative UF of 2 would still result in the selenium EEQ slightly exceeding one (4) when rounded to one significant figure. For the elevated robin EEQ of 6.6, the primary exposure was from the plant (60 percent) and invertebrate (34 percent) ingestion pathways. The LOAEL of 1.0 mg/kg-day that was used was based on a mallard duck laboratory study from Sample et al. (1996) and the use of a toxicity extrapolation UF of 8 (**Appendix F-2, Table F-28**). The use of this UF is quite conservative; however, the use of an alternative UF of 2 would still result in the selenium EEQ slightly exceeding one (2) when rounded to one significant figure. Based on this evaluation for selenium, the use of alternative factors (e.g., an alternative UF for TRV species extrapolation), would reduce the estimated LOAEL-based EEQs, but the meadow vole, short-tailed shrew, and American robin EEQs would still exceed 1.

TCDD. For the elevated shrew EEQ of 48, the primary exposure was from the invertebrate ingestion pathway (98 percent). The LOAEL of 1E-5 mg/kg-day that was used was based on a laboratory rat study from Sample et al. (1996) and the use of a toxicity extrapolation UF of 8 (**Appendix F-2, Table F-28**). The use of this UF is quite conservative; however, the use of an alternative UF of 2 would still result in the TCDD EEQ exceeding one (12). For the slightly elevated robin EEQ of 2, the primary exposure was from the invertebrate ingestion pathway (98 percent). The LOAEL of 1.4E-04 mg/kg-day that was used was based on a ring-necked

pheasant laboratory study from Sample et al. (1996) and the use of a toxicity extrapolation UF of 8 (**Appendix F-2, Table F-28**). The use of this UF is quite conservative, and the use of an alternative UF of approximately 4 to 5 would result in the TCDD EEQ of 2 dropping to less than 1. Based on this evaluation, the use of alternative factors (e.g., an alternative UF for TRV species extrapolation), would reduce the estimated LOAEL-based EEQ to less than 1 when rounded to one significant figure for the American robin, but the meadow vole EEQ would still exceed 1.

Aroclor-1254. For the slightly elevated shrew EEQ of 3, the primary exposure was from the invertebrate ingestion pathway (98 percent). The LOAEL of 0.68 mg/kg-day that was used was based on a laboratory mouse study from Sample et al. (1996) and the use of a toxicity extrapolation UF of 8 (**Appendix F-2, Table F-28**). The use of this UF is quite conservative, and the use of an alternative UF of approximately 2 to 3 would result in the Aroclor-1254 EEQ of 3 dropping to 1 when rounded to one significant figure.

4,4-DDT. For the slightly elevated robin EEQ of 2, the primary exposure was from the invertebrate ingestion pathway (99 percent). The LOAEL of 0.028 mg/kg-day that was used was based on a brown pelican laboratory study from Sample et al. (1996) and the use of a toxicity extrapolation UF of 8 (**Appendix F-2, Table F-28**). The use of this UF is quite conservative, and the use of an alternative UF of approximately 2 would result in the 4,4-DDT EEQ of 2 dropping to 1 when rounded to one significant figure.

4,4-DDE. For the slightly elevated robin EEQ of 2, the primary exposure was from the invertebrate ingestion pathway (99.5 percent). The LOAEL of 0.028 mg/kg-day that was used was based on a brown pelican laboratory study (based on 4,4-DDT) from Sample et al. (1996) and the use of a toxicity extrapolation UF of 8 (**Appendix F-2, Table F-28**). The use of this UF is quite conservative, and the use of an alternative UF of approximately 2 would result in the 4,4-DDE EEQ of 2 dropping to less than 1.

7.2.7 SLERA Results and Conclusions

The data, results, and conclusions of the SLERA evaluated risks to ecological populations inhabiting SWMU 50. Conclusions are derived from the risk assessment and are based on the responses to the assessment hypotheses and assessment endpoints. The assessment results for food chain exposure are summarized in **Table 7-9**, and direct contact exposure results for terrestrial invertebrates, which may serve as a food source for wildlife are summarized in **Table 7-10** and discussed in *Section 7.2.4.1*.

The food chain assessment suggests potential adverse impacts to terrestrial wildlife, especially shrews, robins, and voles for modeled contact with the hazard drivers (primarily selenium and TCDD; and to a lesser extent Aroclor-1254, 4,4-DDT, and 4,4-DDE) in surface soil that are not statistically related to naturally-occurring surface soil concentrations (*Section 7.2.5*). Based on the Tier 2 LOAEL-based approach, only selenium (vole, shrew, and robin), TCDD (shrew and robin), Aroclor-1254 (shrew), 4,4-DDT (robin), and 4,4-DDE (robin) had estimated EEQs greater than 1 when rounded to one significant figure. In addition, when alternative exposure and/or toxicity factors were used in the SLERA EEQ calculations, estimated EEQs would be expected to drop to 1 or less for all constituents except TCDD (shrew) and selenium (vole, shrew, and robin), which were slightly elevated above 1. The direct contact assessment results suggest a potential reduction in wildlife food supply due to mercury and lead in surface soil;

however, due to the small size of the Site (2.06 acres), this potential reduction in food is not considered biologically significant.

Based on uncertainties of toxicity, the fact that no wildlife rare, threatened, or endangered (RTE) species have been confirmed at the SWMU study area, alternative exposure and/or toxicity factors that could be used, and the relatively small size of the SWMU (2.06 acres), remedial measures solely to address ecological concerns are not warranted for soil. The SMDP reached for this SLERA is that the information collected and presented indicates that a more thorough assessment is not warranted. As the HHRA has identified some COPCs potentially associated with adverse health effects (*Section 6.1.2*), the corrective measures study should consider if attainment of human health PRGs would result in TCDD and selenium EEQs dropping to 1 or lower, or would result in a significant reduction of estimated ecological hazard for SWMU 50.

Migration of COPECs in groundwater to surface waters and sediment of the New River was determined unlikely due to the distance of this receptor area from the Site and therefore was not deemed to be an ecological concern.

The assessment results may serve as the focus of discussions with risk managers and regulatory agencies. It is very important to note that many conservative assumptions and modeling approaches were used in the assessment, and actual hazards to wildlife may be orders of magnitude lower than predicted herein.

7.3 SWMU 59 Screening Level Ecological Risk Assessment

This section presents the SLERA for SWMU 59, Bottom Ash Pile. The detailed methodology used for performance of the SLERA is presented in *Section 7.1*. This section includes a Site Characterization (*Section 7.3.1*); Summary of COPEC Selection (*Section 7.3.2*); Risk Characterization (*Section 7.3.3*); Direct Contact Assessment (*Section 7.3.4*); Background Evaluation (*Section 7.3.5*); Uncertainty Analysis (*Section 7.3.6*); and Results and Conclusions (*Section 7.3.7*).

7.3.1 Site Characterization

Bottom ash is permitted to be buried in landfills on the Installation (in particular, Former Ash Landfill No. 2). Some bottom ash is apparently stored in piles around RFAAP for use on roadbeds and as landfill cover material (USEPA, 1987). It can be assumed that this pile or similar piles have existed at RFAAP since operation of the coal-fueled power plant began. According to USEPA (1992), activity was first noted at the site in aerial photography, where a large area of dark-toned material was visible (**Appendix F-1, Figure F-2**). The bottom ash pile is no longer visible at the site.

Surface soil samples collected from the site and utilized in the SLERA are listed in **Table 7-12**; note that subsurface soil samples were not used in the SLERA (see *Section 7.1.2.1* for discussion). Based on the aerial extent of soil sampling and the known site boundaries, the terrestrial habitat associated with the site is estimated to be 0.57 acres.

Table 7-12
SWMU 59 Sample Groupings

SURFACE SOIL		
59SS1 (RVFS*110)	59SS06	59SB02A
59SS2 (RVFS*108)	59SS07	59SB03A
59SS2 (RVFS*109) [duplicate]	59SS08	59SB04A
59SS03	59SS09	59SB05A
59SS04	59SS10	59SB06A
59SS05	59SB01A	

7.3.2 Summary of COPEC Selection

Table 7-13 and 7-14 have been prepared for detected constituents in surface soil with the following information:

- CAS number.
- Chemical name.
- Range of detected concentrations, and associated qualifiers.
- Concentration units.
- Location of maximum detected concentration.
- Frequency of detection.
- Range of detection limits.
- COPEC selection conclusion: YES or NO.
- Rationale for selection or rejection of the COPEC.

Table 7-13
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Direct Contact Exposure at SWMU 59

Scenario Timeframe: Current/Future

Medium: Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Direct Contact COPEC (Y/N)	Rationale for Selection or Deletion
	N/A	2,3,7,8-TCDD-TE	2.61E-07	1.18E-05	mg/kg	59SS06	10/10	N/A	Yes	DET
Surface Soil	67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	8.38E-07 B	4.92E-05	mg/kg	59SS08	10/10	N/A	No	TEQ
	35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	9.48E-06 J	2.74E-04	mg/kg	59SS06	10/10	N/A	No	TEQ
	55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	2.87E-07 J	2.09E-06 J	mg/kg	59SS08	7/10	4.75E-07 - 5.48E-07	No	TEQ
	70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	4.23E-07 B	2.11E-06 J	mg/kg	59SS07	8/10	4.75E-07 - 5.28E-07	No	TEQ
	39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	1.48E-07 J	3.47E-06 J	mg/kg	59SS08	8/10	4.75E-07 - 5.28E-07	No	TEQ
	57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	1.25E-07 B	1.38E-06 J	mg/kg	59SS08	8/10	4.75E-07 - 5.28E-07	No	TEQ
	57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	3.10E-07 J	8.25E-06	mg/kg	59SS08	9/10	4.75E-07 - 4.75E-07	No	TEQ
	72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	1.21E-07 J	5.81E-07 J	mg/kg	59SS06	3/10	4.75E-07 - 5.94E-07	No	TEQ
	19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	3.08E-07 J	9.49E-06	mg/kg	59SS08	9/10	4.75E-07 - 4.75E-07	No	TEQ
	57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	1.52E-07 J	3.02E-07 J	mg/kg	59SS06	7/10	4.75E-07 - 5.48E-07	No	TEQ
	40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	9.34E-08 J	2.03E-06 J	mg/kg	59SS08	7/10	4.75E-07 - 5.48E-07	No	TEQ
	60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	2.46E-07 J	1.95E-06 J	mg/kg	59SS08	7/10	4.75E-07 - 5.48E-07	No	TEQ
	57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	1.84E-07 B	5.37E-07 J	mg/kg	59SS08	7/10	4.75E-07 - 5.48E-07	No	TEQ
	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	2.31E-07 J	2.48E-07 J	mg/kg	59SS09	3/10	1.37E-07 - 3.69E-07	No	TEQ
	51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	1.57E-07 J	5.66E-07 B	mg/kg	59SS08	9/10	2.43E-07 - 2.43E-07	No	TEQ
	N/A	Total Heptachlorodibenzofuran	2.00E-06	1.54E-04	mg/kg	59SS06	10/10	N/A	No	TEQ
	N/A	Total Heptachlorodibenzo-p-dioxin	2.95E-05	4.90E-04	mg/kg	59SS06	10/10	N/A	No	TEQ
	N/A	Total Hexachlorodibenzofuran	3.16E-07	4.94E-05	mg/kg	59SS06	9/10	4.75E-07 - 4.75E-07	No	TEQ
	N/A	Total Hexachlorodibenzo-p-dioxin	9.27E-07	5.53E-05	mg/kg	59SS08	10/10	N/A	No	TEQ
	N/A	Total Pentachlorodibenzofuran	8.77E-07	8.48E-06 J	mg/kg	59SS08	7/10	4.75E-07 - 5.48E-07	No	TEQ
	N/A	Total Pentachlorodibenzo-p-dioxin	5.04E-07	7.45E-06	mg/kg	59SS08	8/10	4.75E-07 - 5.48E-07	No	TEQ
	N/A	Total Tetrachlorodibenzofuran	2.25E-07	5.30E-06	mg/kg	59SS09	9/10	2.43E-07 - 2.43E-07	No	TEQ
	N/A	Total Tetrachlorodibenzo-p-dioxin	4.18E-07	1.33E-05	mg/kg	59SS10	6/10	1.37E-07 - 3.69E-07	No	TEQ
	3268-87-9	Octachlorodibenzodioxin	4.41E-04 J	1.74E-02 J	mg/kg	59SS06	10/10	N/A	No	TEQ
	39001-02-0	Octachlorodibenzofuran	2.11E-06 B	1.50E-04	mg/kg	59SS06	10/10	N/A	No	TEQ
	99-35-4	1,3,5-Trinitrobenzene	1.34E-01	1.38E-01	mg/kg	59SS05	2/13	1.00E-01 - 2.50E-01	Yes	DET
	90-12-0	1-Methylnaphthalene	5.14E-02 J	9.20E-02 J	mg/kg	59SS09	2/10	2.80E-01 - 3.00E-01	Yes	DET
	93-76-5	2,4,5-T	3.66E-02 J	3.66E-02 J	mg/kg	59SS05	1/13	7.00E-03 - 1.20E-01	Yes	DET
	91-57-6	2-Methylnaphthalene	5.64E-02 J	2.10E-01	mg/kg	59SB01A	4/14	4.90E-02 - 3.00E-01	Yes	DET
	72-54-8	4,4'-DDD	6.76E-04 J	1.00E-03 J	mg/kg	59SS08	2/15	7.60E-04 - 2.00E+00	Yes	DET
	50-29-3	4,4'-DDT	1.97E-03	4.41E-03	mg/kg	59SS03	2/14	3.50E-03 - 2.00E+00	Yes	DET
	208-96-8	Acenaphthylene	2.00E-03	2.90E-03	mg/kg	59SB01A	2/15	2.00E-03 - 3.00E-01	Yes	DET

Table 7-13
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Direct Contact Exposure at SWMU 59

Scenario Timeframe: Current/Future

Medium: Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Direct Contact COPEC (Y/N)	Rationale for Selection or Deletion
	120-12-7	Anthracene	3.50E-03	2.00E-02	mg/kg	59SS03	3/15	3.30E-02 - 3.00E-01	Yes	DET
	11097-69-1	Aroclor 1254	1.11E-02 J	6.10E-02	mg/kg	59SS03	5/15	1.70E-02 - 1.00E+01	Yes	DET
	56-55-3	Benzo(a)anthracene	1.20E-02	6.00E-02	mg/kg	59SS03	7/15	5.60E-02 - 8.00E-01	Yes	DET
	50-32-8	Benzo(a)pyrene	6.60E-03	4.60E-02	mg/kg	59SS03	7/15	5.60E-02 - 1.00E+00	Yes	DET
	205-99-2	Benzo(b)fluoranthene	1.20E-02	6.30E-02	mg/kg	59SS03	8/15	5.60E-02 - 1.00E+00	Yes	DET
	191-24-2	Benzo(g,h,i)perylene	8.20E-03 J	2.50E-02 J	mg/kg	59SS03	6/15	5.60E-02 - 1.00E+00	Yes	DET
	207-08-9	Benzo(k)fluoranthene	2.30E-03	3.30E-02	mg/kg	59SS03	7/15	5.60E-02 - 3.00E-01	Yes	DET
	86-74-8	Carbazole	7.30E-02 J	7.30E-02 J	mg/kg	59SS03	1/13	1.70E-01 - 2.00E-01	Yes	DET
	218-01-9	Chrysene	1.60E-02	5.70E-02	mg/kg	59SS03	8/15	5.60E-02 - 6.00E-01	Yes	DET
	53-70-3	Dibenz(a,h)anthracene	1.80E-03 J	6.40E-03	mg/kg	59SS03	3/15	5.60E-02 - 1.00E+00	Yes	DET
	132-64-9	Dibenzofuran	1.60E-02 J	3.20E-02 J	mg/kg	59SS05	3/15	3.50E-02 - 2.00E-01	Yes	DET
	60-57-1	Dieldrin	4.40E-04 J	4.52E-03	mg/kg	59SS05	3/15	7.60E-04 - 2.00E+00	Yes	DET
	959-98-8	Endosulfan I	9.61E-04	9.61E-04	mg/kg	59SB01A	1/15	7.77E-04 - 3.00E+00	Yes	DET
	33213-65-9	Endosulfan II	3.33E-03	3.94E-03	mg/kg	59SB01A	2/15	7.98E-04 - 3.00E+00	Yes	DET
	1031-07-8	Endosulfan sulfate	2.10E-03 J	7.10E-03	mg/kg	59SS09	2/15	7.60E-04 - 3.00E+00	Yes	DET
	7421-93-4	Endrin aldehyde	4.28E-04 J	4.28E-04 J	mg/kg	59SS03	1/15	7.60E-04 - 2.00E+00	Yes	DET
	53494-70-5	Endrin ketone	1.66E-03	2.90E-03	mg/kg	59SS05	3/15	3.40E-03 - 2.00E+00	Yes	DET
	206-44-0	Fluoranthene	1.30E-02	1.10E-01	mg/kg	59SS03	6/15	6.80E-02 - 3.00E-01	Yes	DET
	86-73-7	Fluorene	4.30E-03 J	9.10E-03 J	mg/kg	59SS03	3/15	3.30E-02 - 3.00E-01	Yes	DET
	5103-74-2	gamma-Chlordane	1.10E-03	1.10E-03	mg/kg	59SS03	1/15	7.60E-04 - 2.00E+00	Yes	DET
	1024-57-3	Heptachlor epoxide	4.60E-04 J	1.06E-03	mg/kg	59SB01A	3/15	7.77E-04 - 2.00E+00	Yes	DET
	193-39-5	Indeno(1,2,3-cd)pyrene	3.60E-03	2.63E-02 J	mg/kg	59SS08	6/15	5.60E-02 - 1.00E+00	Yes	DET
	72-43-5	Methoxychlor	2.82E-03	1.02E-02	mg/kg	59SS05	3/15	3.50E-03 - 2.00E+00	Yes	DET
	91-20-3	Naphthalene	6.00E-02	1.30E-01	mg/kg	59SB01A	3/14	3.70E-02 - 3.00E-01	Yes	DET
	85-01-8	Phenanthrene	4.53E-02 J	3.00E-01	mg/kg	59SS2 (RVFS*108	9/15	3.30E-02 - 3.00E-01	Yes	DET
	129-00-0	Pyrene	1.60E-02	9.20E-02	mg/kg	59SS03	5/15	3.30E-02 - 3.00E-01	Yes	DET
	67-64-1	Acetone	4.63E-02 J	6.58E-02 J	mg/kg	59SS10	2/12	5.40E-03 - 1.20E-01	Yes	DET
	108-88-3	Toluene	2.80E-03 J	2.80E-03 J	mg/kg	59SB01A	1/13	5.40E-03 - 1.30E-02	Yes	DET
	7429-90-5	Aluminum	3.12E+03 J	1.78E+04 J	mg/kg	59SB04A	16/16	N/A	Yes	DET
	7440-36-0	Antimony	7.40E-01 L	7.40E-01 L	mg/kg	59SB03A	1/16	2.00E-01 - 7.14E+00	Yes	DET
	7440-38-2	Arsenic	1.60E+00 J	3.70E+01	mg/kg	59SS2 (RVFS*108	16/16	N/A	Yes	DET
	7440-39-3	Barium	5.71E+01	1.90E+02	mg/kg	59SS1 (RVFS*110	16/16	N/A	Yes	DET
	7440-41-7	Beryllium	4.93E-01	1.30E+00	mg/kg	59SB06A	15/15	N/A	Yes	DET

Table 7-13
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Direct Contact Exposure at SWMU 59

Scenario Timeframe: Current/Future

Medium: Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Direct Contact COPEC (Y/N)	Rationale for Selection or Deletion
	7440-43-9	Cadmium	1.10E-01 J	1.10E-01 J	mg/kg	59SS03	2/16	5.10E-02 - 7.00E-01	Yes	DET
	7440-70-2	Calcium	1.92E+02 J	2.68E+03	mg/kg	59SS03	16/16	N/A	Yes	DET
	7440-47-3	Chromium	7.50E+00	2.88E+01 J	mg/kg	59SB04A	16/16	N/A	Yes	DET
	7440-48-4	Cobalt	2.90E+00 J	1.01E+01	mg/kg	59SS1 (RVFS*110	16/16	N/A	Yes	DET
	7440-50-8	Copper	3.30E+00 J	1.53E+01	mg/kg	59SS09	16/16	N/A	Yes	DET
	7439-89-6	Iron	4.20E+03	2.44E+04 J	mg/kg	59SB04A	16/16	N/A	Yes	DET
	7439-92-1	Lead	5.37E+00	3.09E+01	mg/kg	59SS03	16/16	N/A	Yes	DET
	7439-95-4	Magnesium	2.27E+02	2.27E+03	mg/kg	59SS03	16/16	N/A	Yes	DET
	7439-96-5	Manganese	6.80E+01	3.63E+03 J	mg/kg	59SB06A	16/16	N/A	Yes	DET
	7439-97-6	Mercury	4.10E-02 J	5.61E-01	mg/kg	59SS2 (RVFS*108	13/14	5.00E-02 - 5.00E-02	Yes	DET
	7440-02-0	Nickel	5.20E+00 J	1.28E+01	mg/kg	59SS03	16/16	N/A	Yes	DET
	7440-09-7	Potassium	3.00E+02 J	1.07E+03	mg/kg	59SS08	12/12	N/A	Yes	DET
	7782-49-2	Selenium	2.60E-01 L	7.00E+00 K	mg/kg	59SS08	11/15	1.10E-01 - 1.20E+00	Yes	DET
	7440-22-4	Silver	4.98E-01	4.98E-01	mg/kg	59SS2 (RVFS*108	1/16	4.60E-02 - 1.20E+00	Yes	DET
	7440-23-5	Sodium	3.54E+01	3.70E+02 L	mg/kg	59SB04A	6/8	4.20E+01 - 4.30E+01	Yes	DET
	7440-28-0	Thallium	7.30E-02 J	2.10E-01 J	mg/kg	59SS04	4/16	2.60E-01 - 1.20E+01	Yes	DET
	7440-62-2	Vanadium	1.21E+01	5.06E+01 J	mg/kg	59SB04A	16/16	N/A	Yes	DET
	7440-66-6	Zinc	7.23E+00 J	7.63E+01 J	mg/kg	59SS03	16/16	N/A	Yes	DET

COPEC Selection Rationale Codes

Selection Reason: Detected constituent (DET)

Deletion Reason: Dioxins and furans will be analyzed by the toxicity equivalent provided by the TCDD-TE (TEQ)

Notes/Definitions:

N/A = Not Applicable or Not Available
COPEC = Chemical of Potential Ecological Concern
J = Estimated Value
L = Estimated Value
mg/kg = milligrams per kilogram

Table 7-14
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Food Chain Exposure at SWMU 59

Scenario Timeframe: Current/Future

Medium: Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Food Chain COPEC (Y/N)	Rationale for Selection or Deletion
Surface Soil	N/A	2,3,7,8-TCDD-TE	2.61E-07	1.18E-05	mg/kg	59SS06	10/10	N/A	Yes	IBC
	67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	8.38E-07 B	4.92E-05	mg/kg	59SS08	10/10	N/A	No	TEQ
	35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	9.48E-06 J	2.74E-04	mg/kg	59SS06	10/10	N/A	No	TEQ
	55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	2.87E-07 J	2.09E-06 J	mg/kg	59SS08	7/10	4.75E-07 - 5.48E-07	No	TEQ
	70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	4.23E-07 B	2.11E-06 J	mg/kg	59SS07	8/10	4.75E-07 - 5.28E-07	No	TEQ
	39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	1.48E-07 J	3.47E-06 J	mg/kg	59SS08	8/10	4.75E-07 - 5.28E-07	No	TEQ
	57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	1.25E-07 B	1.38E-06 J	mg/kg	59SS08	8/10	4.75E-07 - 5.28E-07	No	TEQ
	57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	3.10E-07 J	8.25E-06	mg/kg	59SS08	9/10	4.75E-07 - 4.75E-07	No	TEQ
	72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	1.21E-07 J	5.81E-07 J	mg/kg	59SS06	3/10	4.75E-07 - 5.94E-07	No	TEQ
	19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	3.08E-07 J	9.49E-06	mg/kg	59SS08	9/10	4.75E-07 - 4.75E-07	No	TEQ
	57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	1.52E-07 J	3.02E-07 J	mg/kg	59SS06	7/10	4.75E-07 - 5.48E-07	No	TEQ
	40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	9.34E-08 J	2.03E-06 J	mg/kg	59SS08	7/10	4.75E-07 - 5.48E-07	No	TEQ
	60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	2.46E-07 J	1.95E-06 J	mg/kg	59SS08	7/10	4.75E-07 - 5.48E-07	No	TEQ
	57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	1.84E-07 B	5.37E-07 J	mg/kg	59SS08	7/10	4.75E-07 - 5.48E-07	No	TEQ
	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	2.31E-07 J	2.48E-07 J	mg/kg	59SS09	3/10	1.37E-07 - 3.69E-07	No	TEQ
	51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	1.57E-07 J	5.66E-07 B	mg/kg	59SS08	9/10	2.43E-07 - 2.43E-07	No	TEQ
	N/A	Total Heptachlorodibenzofuran	2.00E-06	1.54E-04	mg/kg	59SS06	10/10	N/A	No	TEQ
	N/A	Total Heptachlorodibenzo-p-dioxin	2.95E-05	4.90E-04	mg/kg	59SS06	10/10	N/A	No	TEQ
	N/A	Total Hexachlorodibenzofuran	3.16E-07	4.94E-05	mg/kg	59SS06	9/10	4.75E-07 - 4.75E-07	No	TEQ
	N/A	Total Hexachlorodibenzo-p-dioxin	9.27E-07	5.53E-05	mg/kg	59SS08	10/10	N/A	No	TEQ
	N/A	Total Pentachlorodibenzofuran	8.77E-07	8.48E-06 J	mg/kg	59SS08	7/10	4.75E-07 - 5.48E-07	No	TEQ
	N/A	Total Pentachlorodibenzo-p-dioxin	5.04E-07	7.45E-06	mg/kg	59SS08	8/10	4.75E-07 - 5.48E-07	No	TEQ
	N/A	Total Tetrachlorodibenzofuran	2.25E-07	5.30E-06	mg/kg	59SS09	9/10	2.43E-07 - 2.43E-07	No	TEQ
	N/A	Total Tetrachlorodibenzo-p-dioxin	4.18E-07	1.33E-05	mg/kg	59SS10	6/10	1.37E-07 - 3.69E-07	No	TEQ
	3268-87-9	Octachlorodibenzodioxin	4.41E-04 J	1.74E-02 J	mg/kg	59SS06	10/10	N/A	No	TEQ
	39001-02-0	Octachlorodibenzofuran	2.11E-06 B	1.50E-04	mg/kg	59SS06	10/10	N/A	No	TEQ
	99-35-4	1,3,5-Trinitrobenzene	1.34E-01	1.38E-01	mg/kg	59SS05	2/13	1.00E-01 - 2.50E-01	Yes	EXP
	90-12-0	1-Methylnaphthalene	5.14E-02 J	9.20E-02 J	mg/kg	59SS09	2/10	2.80E-01 - 3.00E-01	No	NIBC
	93-76-5	2,4,5-T	3.66E-02 J	3.66E-02 J	mg/kg	59SS05	1/13	7.00E-03 - 1.20E-01	No	NIBC
	91-57-6	2-Methylnaphthalene	5.64E-02 J	2.10E-01	mg/kg	59SB01A	4/14	4.90E-02 - 3.00E-01	No	NIBC
	72-54-8	4,4'-DDD	6.76E-04 J	1.00E-03 J	mg/kg	59SS08	2/15	7.60E-04 - 2.00E+00	Yes	IBC
	50-29-3	4,4'-DDT	1.97E-03	4.41E-03	mg/kg	59SS03	2/14	3.50E-03 - 2.00E+00	Yes	IBC
	208-96-8	Acenaphthylene	2.00E-03	2.90E-03	mg/kg	59SB01A	2/15	2.00E-03 - 3.00E-01	Yes	IBC

Table 7-14
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Food Chain Exposure at SWMU 59

Scenario Timeframe: Current/Future

Medium: Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Food Chain COPEC (Y/N)	Rationale for Selection or Deletion
	120-12-7	Anthracene	3.50E-03	2.00E-02	mg/kg	59SS03	3/15	3.30E-02 - 3.00E-01	Yes	IBC
	11097-69-1	Aroclor 1254	1.11E-02 J	6.10E-02	mg/kg	59SS03	5/15	1.70E-02 - 1.00E+01	Yes	IBC
	56-55-3	Benzo(a)anthracene	1.20E-02	6.00E-02	mg/kg	59SS03	7/15	5.60E-02 - 8.00E-01	Yes	IBC
	50-32-8	Benzo(a)pyrene	6.60E-03	4.60E-02	mg/kg	59SS03	7/15	5.60E-02 - 1.00E+00	Yes	IBC
	205-99-2	Benzo(b)fluoranthene	1.20E-02	6.30E-02	mg/kg	59SS03	8/15	5.60E-02 - 1.00E+00	Yes	IBC
	191-24-2	Benzo(g,h,i)perylene	8.20E-03 J	2.50E-02 J	mg/kg	59SS03	6/15	5.60E-02 - 1.00E+00	Yes	IBC
	207-08-9	Benzo(k)fluoranthene	2.30E-03	3.30E-02	mg/kg	59SS03	7/15	5.60E-02 - 3.00E-01	Yes	IBC
	86-74-8	Carbazole	7.30E-02 J	7.30E-02 J	mg/kg	59SS03	1/13	1.70E-01 - 2.00E-01	No	NIBC
	218-01-9	Chrysene	1.60E-02	5.70E-02	mg/kg	59SS03	8/15	5.60E-02 - 6.00E-01	Yes	IBC
	53-70-3	Dibenz(a,h)anthracene	1.80E-03 J	6.40E-03	mg/kg	59SS03	3/15	5.60E-02 - 1.00E+00	Yes	IBC
	132-64-9	Dibenzofuran	1.60E-02 J	3.20E-02 J	mg/kg	59SS05	3/15	3.50E-02 - 2.00E-01	No	NIBC
	60-57-1	Dieldrin	4.40E-04 J	4.52E-03	mg/kg	59SS05	3/15	7.60E-04 - 2.00E+00	Yes	IBC
	959-98-8	Endosulfan I	9.61E-04	9.61E-04	mg/kg	59SB01A	1/15	7.77E-04 - 3.00E+00	Yes	IBC
	33213-65-9	Endosulfan II	3.33E-03	3.94E-03	mg/kg	59SB01A	2/15	7.98E-04 - 3.00E+00	Yes	IBC
	1031-07-8	Endosulfan sulfate	2.10E-03 J	7.10E-03	mg/kg	59SS09	2/15	7.60E-04 - 3.00E+00	Yes	IBC
	7421-93-4	Endrin aldehyde	4.28E-04 J	4.28E-04 J	mg/kg	59SS03	1/15	7.60E-04 - 2.00E+00	Yes	IBC
	53494-70-5	Endrin ketone	1.66E-03	2.90E-03	mg/kg	59SS05	3/15	3.40E-03 - 2.00E+00	Yes	IBC
	206-44-0	Fluoranthene	1.30E-02	1.10E-01	mg/kg	59SS03	6/15	6.80E-02 - 3.00E-01	Yes	IBC
	86-73-7	Fluorene	4.30E-03 J	9.10E-03 J	mg/kg	59SS03	3/15	3.30E-02 - 3.00E-01	Yes	IBC
	5103-74-2	gamma-Chlordane	1.10E-03	1.10E-03	mg/kg	59SS03	1/15	7.60E-04 - 2.00E+00	Yes	IBC
	1024-57-3	Heptachlor epoxide	4.60E-04 J	1.06E-03	mg/kg	59SB01A	3/15	7.77E-04 - 2.00E+00	Yes	IBC
	193-39-5	Indeno(1,2,3-cd)pyrene	3.60E-03	2.63E-02 J	mg/kg	59SS08	6/15	5.60E-02 - 1.00E+00	Yes	IBC
	72-43-5	Methoxychlor	2.82E-03	1.02E-02	mg/kg	59SS05	3/15	3.50E-03 - 2.00E+00	Yes	IBC
	91-20-3	Naphthalene	6.00E-02	1.30E-01	mg/kg	59SB01A	3/14	3.70E-02 - 3.00E-01	Yes	IBC
	85-01-8	Phenanthrene	4.53E-02 J	3.00E-01	mg/kg	59SS2 (RVFS*108	9/15	3.30E-02 - 3.00E-01	Yes	IBC
	129-00-0	Pyrene	1.60E-02	9.20E-02	mg/kg	59SS03	5/15	3.30E-02 - 3.00E-01	Yes	IBC
	67-64-1	Acetone	4.63E-02 J	6.58E-02 J	mg/kg	59SS10	2/12	5.40E-03 - 1.20E-01	No	NIBC
	108-88-3	Toluene	2.80E-03 J	2.80E-03 J	mg/kg	59SB01A	1/13	5.40E-03 - 1.30E-02	No	NIBC
	7429-90-5	Aluminum	3.12E+03 J	1.78E+04 J	mg/kg	59SB04A	16/16	N/A	No	NIBC
	7440-36-0	Antimony	7.40E-01 L	7.40E-01 L	mg/kg	59SB03A	1/16	2.00E-01 - 7.14E+00	No	NIBC
	7440-38-2	Arsenic	1.60E+00 J	3.70E+01	mg/kg	59SS2 (RVFS*108	16/16	N/A	Yes	IBC
	7440-39-3	Barium	5.71E+01	1.90E+02	mg/kg	59SS1 (RVFS*110	16/16	N/A	No	NIBC
	7440-41-7	Beryllium	4.93E-01	1.30E+00	mg/kg	59SB06A	15/15	N/A	No	NIBC

Table 7-14
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Food Chain Exposure at SWMU 59

Scenario Timeframe: Current/Future

Medium: Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Food Chain COPEC (Y/N)	Rationale for Selection or Deletion
	7440-43-9	Cadmium	1.10E-01 J	1.10E-01 J	mg/kg	59SS03	2/16	5.10E-02 - 7.00E-01	Yes	IBC
	7440-70-2	Calcium	1.92E+02 J	2.68E+03	mg/kg	59SS03	16/16	N/A	No	NIBC
	7440-47-3	Chromium	7.50E+00	2.88E+01 J	mg/kg	59SB04A	16/16	N/A	Yes	IBC
	7440-48-4	Cobalt	2.90E+00 J	1.01E+01	mg/kg	59SS1 (RVFS*110	16/16	N/A	No	NIBC
	7440-50-8	Copper	3.30E+00 J	1.53E+01	mg/kg	59SS09	16/16	N/A	Yes	IBC
	7439-89-6	Iron	4.20E+03	2.44E+04 J	mg/kg	59SB04A	16/16	N/A	No	NIBC
	7439-92-1	Lead	5.37E+00	3.09E+01	mg/kg	59SS03	16/16	N/A	Yes	IBC
	7439-95-4	Magnesium	2.27E+02	2.27E+03	mg/kg	59SS03	16/16	N/A	No	NIBC
	7439-96-5	Manganese	6.80E+01	3.63E+03 J	mg/kg	59SB06A	16/16	N/A	No	NIBC
	7439-97-6	Mercury	4.10E-02 J	5.61E-01	mg/kg	59SS2 (RVFS*108	13/14	5.00E-02 - 5.00E-02	Yes	IBC
	7440-02-0	Nickel	5.20E+00 J	1.28E+01	mg/kg	59SS03	16/16	N/A	Yes	IBC
	7440-09-7	Potassium	3.00E+02 J	1.07E+03	mg/kg	59SS08	12/12	N/A	No	NIBC
	7782-49-2	Selenium	2.60E-01 L	7.00E+00 K	mg/kg	59SS08	11/15	1.10E-01 - 1.20E+00	Yes	IBC
	7440-22-4	Silver	4.98E-01	4.98E-01	mg/kg	59SS2 (RVFS*108	1/16	4.60E-02 - 1.20E+00	Yes	IBC
	7440-23-5	Sodium	3.54E+01	3.70E+02 L	mg/kg	59SB04A	6/8	4.20E+01 - 4.30E+01	No	NIBC
	7440-28-0	Thallium	7.30E-02 J	2.10E-01 J	mg/kg	59SS04	4/16	2.60E-01 - 1.20E+01	No	NIBC
	7440-62-2	Vanadium	1.21E+01	5.06E+01 J	mg/kg	59SB04A	16/16	N/A	No	NIBC
	7440-66-6	Zinc	7.23E+00 J	7.63E+01 J	mg/kg	59SS03	16/16	N/A	Yes	IBC

COPEC Selection Rationale Codes

Selection Reason: Important Bioaccumulative Compounds (IBC) [as defined in Table 4-2, of USEPA 823-R-00-001, February 2000]
Explosives (EXP)

Deletion Reason: Not Important Bioaccumulative Compound (NIBC)
Dioxins and furans will be analyzed by the toxicity equivalent provided by the TCDD-TE (TEQ)

Notes/Definitions

N/A = Not Applicable or Not Available
COPEC = Chemical of Potential Ecological Concern
J = Estimated Value
L = Estimated Value
mg/kg = milligrams per kilogram

COPECs were selected as shown in **Tables 7-13 and 7-14**. In general, COPECs were selected as a concern for the direct contact exposure pathway if the constituent was detected in an environmental medium (**Table 7-13**). For food chain exposure pathways, detected COPECs were selected if they were important bioaccumulative constituents (USEPA, 2000c) or explosive compounds (**Table 7-14**).

Fifty-nine COPECs (23 inorganic and 36 organic COPECs) have been selected for surface soil direct contact exposure (**Table 7-13**).

Thirty-nine COPECs (10 inorganic and 29 organic COPECs) have been selected for surface soil for food chain exposure (**Table 7-14**). Detected chemicals that are important bioaccumulative compounds (USEPA, 2000c) or explosives are considered final food chain exposure COPECs and have been quantitatively evaluated in this SLERA.

Exposure point concentrations based on the statistical procedures discussed in *HHRA Section 6.2.3* are presented in **Table 7-15**. Arithmetic mean concentrations are presented for informational purposes.

7.3.3 Risk Characterization

This section presents the SLERA risk characterization results, following the detailed methods and procedures presented in *Section 7.1.7*.

7.3.3.1 Terrestrial Plant Impact Assessment

To assess the potential impact of COPEC concentrations in surface soil on terrestrial plant species, visual observations were recorded during the site reconnaissance and no obvious signs of vegetative stress were noted. The overall health of the grassland/field communities at the site was comparable to those of the surrounding area. As allowed in the *RFAAP Final MWP* (URS, 2003), that states "owing to the invasive and successive nature of plant communities, plants as receptors do not typically warrant a detailed examination of effects," plants were not quantitatively evaluated in this SLERA. As there were no unique or site-specific terrestrial plant issues discovered at SWMU 59, a qualitative evaluation was deemed adequate. However, a terrestrial plant impact screening assessment is discussed in *Section 7.3.4*. It should also be noted that plants (and invertebrates) are included in the SLERAs as media through which the wildlife receptors may be exposed indirectly to COPECs in the soil by means of the food chain.

7.3.3.2 Predictive Risk Estimation for Terrestrial Wildlife

The potential wildlife risks associated with SWMU 59 are estimated in this section. The risk estimation has been performed through a series of quantitative HQ calculations that compare receptor-specific exposure values with TRVs. The EEQs (or HQs) are compared to HQ guidelines for assessing the risk posed from contaminants. It should be noted that HQs are not measures of risk, are not population-based statistics, and are not linearly-scaled statistics, and therefore an HQ above 1, even exceedingly so, does not guarantee that there is even one individual expressing the toxicological effect associated with a given chemical to which it was exposed (Allard et al., 2007; Tannenbaum, 2001; Bartell, 1996).

The simple HQ ratios are summed to provide conservative HI estimates for chemicals and exposure pathways for a given receptor. The criterion used to decide if HQ summation is appropriate and scientifically defensible includes those chemicals that have a similar mode of

Table 7-15
Medium-Specific Exposure Point Concentration Summary for SWMU 59 Surface Soil

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean of Detects	Multiple Detection Limits? (Yes/No) [1]	95% UCL (Distribution) [2]	Maximum Concentration	Exposure Point Concentration			
							Value	Units	Statistic [3]	Rationale [4]
Surface Soil	2,3,7,8-TCDD-TE	mg/kg	4.80E-06	No	8.67E-06 (G)	1.21E-05	8.67E-06	mg/kg	95% Approx. Gamma	Test (6)
	1,3,5-Trinitrobenzene[5]	mg/kg	1.36E-01	N/A	1.41E-01 (NP)	1.38E-01	1.38E-01	mg/kg	Max	Test (2)
	1-Methylnaphthalene[5]	mg/kg	7.17E-02	N/A	1.78E-01 (NP)	9.20E-02	9.20E-02	mg/kg	Max	Test (2)
	2,4,5-T[5]	mg/kg	3.66E-02	N/A	2.50E-02 (NP)	3.66E-02	2.50E-02	mg/kg	95% UCL-Bst	Test (8)
	2-Methylnaphthalene	mg/kg	1.23E-01	Yes	1.65E-01 (N)	2.10E-01	1.65E-01	mg/kg	95% KM-% Btstrp	Test (1)
	4,4'-DDD[5]	mg/kg	8.38E-04	N/A	1.64E-01 (NP)	1.00E-03	1.00E-03	mg/kg	Max	Test (2)
	4,4'-DDT[5]	mg/kg	3.19E-03	N/A	1.66E-01 (NP)	4.41E-03	4.41E-03	mg/kg	Max	Test (2)
	Acenaphthylene[5]	mg/kg	2.45E-03	N/A	1.45E-01 (NP)	2.90E-03	2.90E-03	mg/kg	Max	Test (2)
	Anthracene	mg/kg	9.30E-03	Yes	2.00E-02 (N)	2.00E-02	2.00E-02	mg/kg	95% KM-% Btstrp	Test (1)
	Aroclor 1254	mg/kg	2.68E-02	Yes	2.80E-02 (N)	6.10E-02	2.80E-02	mg/kg	95% KM-% Btstrp	Test (1)
	Benzo(a)anthracene	mg/kg	2.98E-02	Yes	3.67E-02 (N)	6.00E-02	3.67E-02	mg/kg	95% KM-t	Test (1)
	Benzo(a)pyrene	mg/kg	2.56E-02	Yes	3.59E-02 (N)	4.60E-02	3.59E-02	mg/kg	95% KM-t	Test (1)
	Benzo(b)fluoranthene	mg/kg	3.07E-02	Yes	3.87E-02 (N)	6.30E-02	3.87E-02	mg/kg	95% KM-t	Test (1)
	Benzo(g,h,i)perylene	mg/kg	1.76E-02	Yes	2.21E-02 (N)	2.50E-02	2.21E-02	mg/kg	95% KM-t	Test (1)
	Benzo(k)fluoranthene	mg/kg	2.02E-02	Yes	2.90E-02 (N)	3.30E-02	2.90E-02	mg/kg	95% KM-t	Test (1)
	Carbazole[5]	mg/kg	7.30E-02	N/A	1.14E-01 (NP)	7.30E-02	7.30E-02	mg/kg	Max	Test (2)
	Chrysene	mg/kg	3.15E-02	Yes	3.87E-02 (N)	5.70E-02	3.87E-02	mg/kg	95% KM-t	Test (1)
	Dibenz(a,h)anthracene	mg/kg	3.37E-03	Yes	6.40E-03 (L)	6.40E-03	6.40E-03	mg/kg	95% KM-% Btstrp	Test (1)
	Dibenzofuran	mg/kg	2.37E-02	Yes	3.20E-02 (N)	3.20E-02	3.20E-02	mg/kg	95% KM-% Btstrp	Test (1)
	Dieldrin	mg/kg	1.90E-03	Yes	4.52E-03 (N)	4.52E-03	4.52E-03	mg/kg	95% KM-% Btstrp	Test (1)
	Endosulfan I[5]	mg/kg	9.61E-04	N/A	2.58E-01 (NP)	9.61E-04	9.61E-04	mg/kg	Max	Test (2)
	Endosulfan II[5]	mg/kg	3.64E-03	N/A	2.32E-01 (NP)	3.94E-03	3.94E-03	mg/kg	Max	Test (2)
	Endosulfan sulfate[5]	mg/kg	4.60E-03	N/A	2.44E-01 (NP)	7.10E-03	7.10E-03	mg/kg	Max	Test (2)
	Endrin aldehyde[5]	mg/kg	4.28E-04	N/A	1.68E-01 (NP)	4.28E-04	4.28E-04	mg/kg	Max	Test (2)
	Endrin ketone	mg/kg	2.33E-03	Yes	2.97E-03 (N)	2.90E-03	2.90E-03	mg/kg	Max	Test (2)
	Fluoranthene	mg/kg	6.02E-02	Yes	8.28E-02 (N)	1.10E-01	8.28E-02	mg/kg	95% KM-t	Test (1)

Table 7-15
Medium-Specific Exposure Point Concentration Summary for SWMU 59 Surface Soil
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Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean of Detects	Multiple Detection Limits? (Yes/No) [1]	95% UCL (Distribution) [2]	Maximum Concentration	Exposure Point Concentration			
							Value	Units	Statistic [3]	Rationale [4]
	Fluorene	mg/kg	6.40E-03	Yes	9.10E-03 (N)	9.10E-03	9.10E-03	mg/kg	95% KM-% Btstrp	Test (1)
	gamma-Chlordane[5]	mg/kg	1.10E-03	N/A	1.55E-01 (NP)	1.10E-03	1.10E-03	mg/kg	Max	Test (2)
	Heptachlor epoxide	mg/kg	6.67E-04	Yes	1.06E-03 (N)	1.06E-03	1.06E-03	mg/kg	95% KM-% Btstrp	Test (1)
	Indeno(1,2,3-cd)pyrene	mg/kg	1.56E-02	Yes	2.27E-02 (N)	2.63E-02	2.27E-02	mg/kg	95% KM-t	Test (1)
	Methoxychlor	mg/kg	7.67E-03	Yes	1.02E-02 (N)	1.02E-02	1.02E-02	mg/kg	95% KM-% Btstrp	Test (1)
	Naphthalene	mg/kg	9.07E-02	Yes	1.30E-01 (N)	1.30E-01	1.30E-01	mg/kg	95% KM-% Btstrp	Test (1)
	Phenanthrene	mg/kg	9.23E-02	Yes	1.10E-01 (G)	3.00E-01	1.10E-01	mg/kg	95% KM-t	Test (1)
	Pyrene	mg/kg	5.73E-02	Yes	8.34E-02 (N)	9.20E-02	8.34E-02	mg/kg	95% KM-% Btstrp	Test (1)
	Acetone[5]	mg/kg	5.61E-02	N/A	4.67E-02 (NP)	6.58E-02	4.67E-02	mg/kg	95% UCL-Bst	Test (8)
	Toluene[5]	mg/kg	2.80E-03	N/A	4.75E-03 (NP)	2.80E-03	2.80E-03	mg/kg	Max	Test (2)
	Aluminum	mg/kg	1.01E+04	No	1.22E+04 (N)	1.78E+04	1.22E+04	mg/kg	95% Student's-t	Test (4)
	Antimony[5]	mg/kg	7.40E-01	N/A	1.10E+00 (NP)	7.40E-01	7.40E-01	mg/kg	Max	Test (2)
	Arsenic	mg/kg	8.51E+00	No	2.07E+01 (NP)	3.70E+01	2.07E+01	mg/kg	95% Cheby, Mean, Sd	Test (3)
	Barium	mg/kg	1.16E+02	No	1.41E+02 (G)	1.90E+02	1.41E+02	mg/kg	95% Approx. Gamma	Test (6)
	Beryllium	mg/kg	7.78E-01	No	9.09E-01 (G)	1.30E+00	9.09E-01	mg/kg	95% Approx. Gamma	Test (6)
	Cadmium[5]	mg/kg	1.10E-01	N/A	2.32E-01 (NP)	1.10E-01	1.10E-01	mg/kg	Max	Test (2)
	Calcium	mg/kg	1.11E+03	No	1.55E+03 (G)	2.68E+03	1.55E+03	mg/kg	95% Approx. Gamma	Test (6)
	Chromium	mg/kg	1.63E+01	No	1.91E+01 (N)	2.88E+01	1.91E+01	mg/kg	95% Student's-t	Test (4)
	Cobalt	mg/kg	6.11E+00	No	7.07E+00 (N)	1.01E+01	7.07E+00	mg/kg	95% Student's-t	Test (4)
	Copper	mg/kg	1.05E+01	No	1.20E+01 (N)	1.53E+01	1.20E+01	mg/kg	95% Student's-t	Test (4)
	Iron	mg/kg	1.42E+04	No	1.70E+04 (N)	2.44E+04	1.70E+04	mg/kg	95% Student's-t	Test (4)
	Lead	mg/kg	1.48E+01	No	1.82E+01 (N)	3.09E+01	1.82E+01	mg/kg	95% Student's-t	Test (4)
	Magnesium	mg/kg	9.54E+02	No	1.37E+03 (G)	2.27E+03	1.37E+03	mg/kg	95% Approx. Gamma	Test (6)
	Manganese	mg/kg	6.15E+02	No	1.17E+03 (L)	3.63E+03	1.17E+03	mg/kg	95% Cheby-MVUE	Test (5)
	Mercury	mg/kg	2.36E-01	No	3.00E-01 (N)	5.61E-01	3.00E-01	mg/kg	95% KM-t	Test (4)
	Nickel	mg/kg	7.81E+00	No	8.80E+00 (N)	1.28E+01	8.80E+00	mg/kg	95% Student's-t	Test (4)
	Potassium	mg/kg	5.99E+02	No	7.44E+02 (N)	1.07E+03	7.44E+02	mg/kg	95% Student's-t	Test (4)
	Selenium	mg/kg	2.99E+00	Yes	6.70E+00 (NP)	7.00E+00	6.70E+00	mg/kg	97.5% KM-Cheby	Test (1)
	Silver[5]	mg/kg	4.98E-01	N/A	3.44E-01 (NP)	4.98E-01	3.44E-01	mg/kg	95% UCL-Bst	Test (8)
	Sodium	mg/kg	1.54E+02	Yes	2.07E+02 (N)	3.70E+02	2.07E+02	mg/kg	95% KM-t	Test (1)

Table 7-15
Medium-Specific Exposure Point Concentration Summary for SWMU 59 Surface Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean of Detects	Multiple Detection Limits? (Yes/No) [1]	95% UCL (Distribution) [2]	Maximum Concentration	Exposure Point Concentration			
							Value	Units	Statistic [3]	Rationale [4]
	Thallium	mg/kg	1.34E-01	Yes	1.90E-01 (N)	2.10E-01	1.90E-01	mg/kg	95% KM-% Btstrp	Test (1)
	Vanadium	mg/kg	2.85E+01	No	3.36E+01 (N)	5.06E+01	3.36E+01	mg/kg	95% Student's-t	Test (4)
	Zinc	mg/kg	3.01E+01	No	3.80E+01 (N)	7.63E+01	3.80E+01	mg/kg	95% Student's-t	Test (4)

Notes: N/A = Not applicable

[1] ProUCL software (version 4.0, USEPA, 2007) recommends use of Kaplan-Meier method if there are multiple detection limits.

[2] Statistical Distribution and 95% UCL as determined by ProUCL (unless otherwise noted): (G) the data were determined to follow gamma distribution; (L) the data were determined to follow lognormal distribution; (NP) the data were determined to be non-parametric; (N) the data were determined to be normally distributed.

[3] Statistic: Maximum Detected Value (Max); 95% KM Chebyshev (95% KM-Cheby); 97.5% KM Chebyshev (97.5% KM-Cheby); 99% KM Chebyshev (99% KM-Cheby); 95% KM Percentile Bootstrap (95% KM-% Btstrp); 95% KM-t (95% KM-t); 95% KM-BCA (95% KM-BCA); 95% H-UCL (95% H-UCL); 95% Chebyshev -Mean, SD- UCL (95% Cheby, Mean, SD); 97.5% Chebyshev -Mean, SD- UCL (97.5% Cheby, Mean, SD); 99% Chebyshev -Mean, SD- UCL (99% Cheby, Mean, SD); 95% UCL of Log-transformed Data (95% UCL-T) 95% Student's-t (95% Student's-t); 95% Modified-t (95% Modified-t); 95% UCL based on bootstrap statistic (95% UCL-Bst); 95% Approximate Gamma UCL (95% Approx. Gamma); 95% Chebyshev-MVUE (95% Cheby-MVUE).

[4] Unless otherwise noted (see footnote 5), ProUCL EPC selection rationale based on, detection limit values, distribution, standard deviation, and sample size (see ProUCL output in appendix for further details):

Test (1): Kaplan-Meier method recommended by ProUCL due to multiple detection limits.
Test (2): The 95% UCL exceeds the maximum detected concentration, therefore, maximum concentration used for EPC.
Test (3): Shapiro-Wilk W test, Kolmogorov-Smirnov (K-S), and Anderson-Darling (A-D) tests, indicate data follow nonparametric distribution.
Test (4): Shapiro-Wilk W test indicates data are normally distributed.
Test (5): Shapiro-Wilk W test indicates data are log-normally distributed.
Test (6): Kolmogorov-Smirnov (K-S) and/or Anderson-Darling (A-D) tests indicate data follow gamma distribution.
Test (7): Sample size is less than or equal to 5, therefore, maximum concentration used for EPC.
Test (8): 95% UCL estimated by a non-Pro-UCL bootstrap method.

[5] Infrequent detection resulted in ProUCL modeling error for this constituent, therefore the distribution was assumed to be non-parametric and the UCL was determined using a non-ProUCL bootstrap method with random numbers for NDs (see text for details).

toxicological action. While individual contaminants may affect distinct target organs or systems within an organism, classes of chemicals may act in similar ways, thus being additive in effect.

The summation of HQs into an HI was performed in this SLERA as a conservative approach. To assess whether or not individual COPEC HQs should be segregated based on dissimilar modes of toxicological action, individual COPEC effects were evaluated. However, as risk drivers resulted in HQs ranging from less than 1 to 1,254 (see following paragraphs), segregation of COPECs by mode of toxicological action was not necessary.

Tier 1 and Tier 2 individual COPEC EEQs and HIs (summed EEQs) for terrestrial receptors at SWMU 59 are presented in risk characterization tables (**Appendix F-2, Tables F-12 through F-21**) for the five selected receptor species. These summed EEQs are presented in **Table 7-16** (generally rounded to two significant figures), along with the hazard driver [COPEC(s) contributing the majority of the total estimated EEQ] and the exposure pathway of concern (the pathway contributing the most to the total estimated EEQ). An example EEQ calculation is presented **Appendix F-2, Table F-22**.

As shown in **Table 7-16**, Tier 1 total EEQs ranged from 2.9 to 1,254 for the five receptor species, using TRVs based on either NOAEL or LOAEL values. The short-tailed shrew was predicted to be the most impacted, followed by the American robin, the meadow vole, the red fox, and the red-tailed hawk. The inorganic constituents chromium, mercury, and selenium; and the organic constituent TCDD were the COPECs contributing the most to the total EEQs for each of the receptors. Exposure pathways of most concern, based on the results of the Tier 1 food-chain modeling, were plant, terrestrial invertebrate, and small mammal ingestion.

More realistic Tier 2 total EEQs were also elevated, especially values based on NOAEL TRVs, which ranged from 0.002 to 74. However, Tier 2 total EEQs were much lower than Tier 1 total EEQs, and both the NOAEL and LOAEL Tier 2 total EEQs for the red-tailed hawk and red fox were below one. Tier 2 total EEQs based on LOAEL values were 18 for the short-tailed shrew, 7.4 for the American robin, and 13 for the meadow vole (**Table 7-16**). Selenium and TCDD were identified as the main hazard drivers for the short-tailed shrew based on invertebrate ingestion. Selenium was the hazard driver for both the meadow vole, based on plant ingestion, and the American robin based on invertebrate and plant ingestion.

The specific results of the Tier 2 risk estimation for the meadow vole, short-tailed shrew, and American robin are discussed below. The specific results for the red-tailed hawk and red fox are not discussed because the summed EEQs are below 1.

Meadow Vole. The total EEQs for both NOAEL and LOAEL TRVs exceeded one (30 and 13, respectively). Two COPECs had individual NOAEL-based EEQs that exceeded 1 (EEQ in parenthesis): selenium (19) and arsenic (8.7). Only selenium (11) had a LOAEL-based EEQ that exceeded 1. The primary exposure pathway was the ingestion of plants. The results of the Tier 2 risk evaluation for meadow voles are presented in **Appendix F-2, Table F-13**.

Short-tailed Shrew. The total EEQs for both NOAEL and LOAEL TRVs exceeded one (74 and 18, respectively). Five COPECs had individual NOAEL-based EEQs that exceeded 1 (EEQ in parenthesis): TCDD (26), arsenic (23), selenium (15), dieldrin (3.1), and zinc (1.2). Four COPECs had individual LOAEL-based EEQs that exceeded 1 (EEQ in parenthesis): selenium (9.4), TCDD (2.6), arsenic (2.3), and dieldrin (1.6). The primary exposure pathway was the

ingestion of terrestrial invertebrates. The results of the short-tailed shrew Tier 2 risk evaluation is presented in **Appendix F-2, Table F-15**.

American Robin. The total EEQs for both NOAEL and LOAEL TRVs exceeded one (30 and 7.4, respectively). Four COPECs had individual NOAEL-based EEQs that exceeded 1 (EEQ in parenthesis): 4,4-DDT (8.1), zinc (7.1), selenium (6.7), and 4,4-DDT (2.8). Only selenium (3.4) had and individual LOAEL-based EEQ that exceeded. The primary exposure pathway was the ingestion of terrestrial invertebrates and plants. The results of the Tier 2 risk evaluation for American robins are presented in **Appendix F-2, Table F-17**.

Table 7-16
Wildlife EEQ Hazard Summary for Food Chain Exposure at SWMU 59

Receptor	Tier 1[a]		Tier 2[b]	
	NOAEL-Based EEQ	LOAEL-Based EEQ	NOAEL-Based EEQ	LOAEL-Based EEQ
Meadow vole	104	40	30	13
Hazard Driver(s)[c]:	Selenium - plant ingestion		Selenium - plant ingestion	
Short-tailed shrew	1,254	166	74	18
Hazard Driver(s)[c]:	TCDD - terrestrial invertebrate ingestion		Selenium and TCDD - terrestrial invertebrate ingestion	
American robin	199	52	30	7.4
Hazard Driver(s)[c]:	Mercury and Selenium - plant and terrestrial invertebrate ingestion		Selenium - plant and terrestrial invertebrate ingestion	
Red-tailed hawk	11	2.9	0.002	0.0005
Hazard Driver(s)[c]:	Selenium and Chromium - small mammal ingestion		--	
Red fox	69	15	0.005	0.001
Hazard Driver(s)[c]:	Selenium and TCDD - small mammal and terrestrial invertebrate ingestion		--	

[a] Tier 1 = Max EEQ using max EPC, max BAF/BCF (EcoSSL BAF/ regression equation was used when available), max Intake Rates, min BW, and FHR =1.
[b] Tier 2 = EEQ using 95% EPC, non-max BAF/BCF (EcoSSL BAF/ regression equation was used when available), avg Intake Rates, avg BW and calculated FHR less than or equal to 1.

[c] Hazard drivers are those chemicals contributing the most to the total estimated EEQ, and the primary route of exposure associated with this driver.

Notes:

EEQ = Ecological Effects Quotient.

LOAEL = Lowest-Observed-Adverse-Effect Level

NOAEL = No-Observed-Adverse-Effect Level

7.3.4 Approach for the Evaluation of Direct Contact Toxicity

To evaluate direct contact exposure, for those organisms that live within an environmental medium, COPEC media concentrations are compared with BTAG-approved direct contact screening values, and secondarily, a variety of additional appropriate direct-contact benchmarks. Surface soil was the only exposure medium at SWMU 59. Intake is not calculated because potential adverse effects are assessed by evaluating the COPEC concentrations in soil. Detailed procedures are presented in *Section 7.1.8* and the results are summarized in **Table 7-17**.

7.3.4.1 Soil

Based on the results of the first step, 10 COPECs were selected based on an EcoSSL or BTAG exceedance while 13 additional chemicals were evaluated further because of the lack of available EcoSSL or BTAG screening values (**Table 7-17**). In the second step, the MDC of these 23 chemicals was compared with up to five individual soil screening values. The results of the second screening step are as follows:

- There were no available benchmarks available for: 1,3,5-trinitrobenzene, 1-methylnaphthalene, 2-methylnaphthalene, 2,4,5-T, acetone, carbazole, dibenzofuran, calcium, potassium, and sodium.
- The arsenic MDC exceeded three of the five available benchmarks; however, two of the exceeded benchmarks are for plant toxicity and as discussed in *Section 7.3.3.1*, plant toxicity is not an overriding concern for the Site. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 59.
- Aluminum should only be identified as a COPEC in soils with a pH of less than 5.5 (USEPA, 2007c). The soil pH at SWMU 59 was 7.24. Therefore, no further action for direct contact toxicity is recommended at SWMU 59.
- The chromium MDC exceeded two of four available benchmarks for direct contact for trivalent chromium; however, one of the exceeded benchmarks is for plant toxicity and as discussed in *Section 7.3.3.1*, plant toxicity is not an overriding concern for the Site. In addition, the EcoSSL guidance (USEPA, 2007c) says that data are insufficient to derive a direct contact benchmark for this inorganic constituent. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 59.
- The manganese MDC exceeded the two available benchmarks. The EcoSSL and ORNL exceedances were for plant toxicity, and as discussed in *Section 7.3.3.1*, plant toxicity is not an overriding concern for the Site. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 59.
- The mercury MDC exceeded three of the four available benchmarks. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 59.
- The selenium MDC exceeded three of the four available benchmarks. However, the ORNL exceedance was for plant toxicity, and as discussed in *Section 7.3.3.1*, plant toxicity is not an overriding concern for the Site. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 59.

Table 7-17
Direct Toxicity Evaluation for Surface Soil at SWMU 59

Chemical (1)	Detection Frequency	Maximum Concentration	Exposure Point Concentration	Minimum Concentration	BTAG or USEPA EcoSSL Screening Toxicity Value (2)	Retain COPEC as Max Conc > BTAG or EcoSSL Value?	If Retained as COPEC, Comment on BTAG or EcoSSL Value	Dutch Intervention Value (3)	CCME Value (4)	USEPA EcoSSL Direct Contact Value (5)	ORNL Screening Benchmark for Plants (6)	ORNL Screening Benchmark for Invertebrates (7)	COPEC Weight of Evidence Summary - Number of Direct Contact Benchmarks Exceeded Using MDC	Comment
2,3,7,8-TCDD-TE	10/10	1.18E-05	8.67E-06	2.61E-07	1.00E-02	No								
1,3,5-Trinitrobenzene	2/13	1.38E-01	1.38E-01	1.34E-01	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
1-Methylnaphthalene	2/10	9.20E-02	9.20E-02	5.14E-02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
2-Methylnaphthalene	4/14	2.10E-01	1.65E-01	5.64E-02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
2,4,5-T	1/13	3.66E-02	2.50E-02	3.66E-02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
4,4'-DDD	2/15	1.00E-03	1.00E-03	6.76E-04	1.00E-01	No								
4,4'-DDT	2/14	4.41E-03	4.41E-03	1.97E-03	1.00E-01	No								
Acenaphthylene	2/15	2.90E-03	2.90E-03	2.00E-03	2.9E+01 (LMW)	No								
Acetone	2/12	6.58E-02	4.67E-02	4.63E-02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Anthracene	3/15	2.00E-02	2.00E-02	3.50E-03	2.9E+01 (LMW)	No								
Aroclor 1254	5/15	6.10E-02	2.80E-02	1.11E-02	1.00E-01	No								
Benzo(a)anthracene	7/15	6.00E-02	3.67E-02	1.20E-02	1.1E+00 (HMW)	No								
Benzo(a)pyrene	7/15	4.60E-02	3.59E-02	6.60E-03	1.1E+00 (HMW)	No								
Benzo(b)fluoranthene	8/15	6.30E-02	3.87E-02	1.20E-02	1.1E+00 (HMW)	No								
Benzo(g,h,i)perylene	6/15	2.50E-02	2.21E-02	8.20E-03	1.1E+00 (HMW)	No								
Benzo(k)fluoranthene	7/15	3.30E-02	2.90E-02	2.30E-03	1.1E+00 (HMW)	No								
Carbazole	1/13	7.30E-02	7.30E-02	7.30E-02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Chrysene	8/15	5.70E-02	3.87E-02	1.60E-02	1.1E+00 (HMW)	No								
Dibenz(a,h)anthracene	3/15	6.40E-03	6.40E-03	1.80E-03	1.1E+00 (HMW)	No								
Dibenzofuran	3/15	3.20E-02	3.20E-02	1.60E-02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Dieldrin	3/15	4.52E-03	4.52E-03	4.40E-04	4.90E-03	No								
Endosulfan I	1/15	9.61E-04	9.61E-04	9.61E-04	NVA	Yes		4	NVA	NVA	NVA	NVA	0/1	No exceedences
Endosulfan II	2/15	3.94E-03	3.94E-03	3.33E-03	NVA	Yes		4	NVA	NVA	NVA	NVA	0/1	No exceedences
Endosulfan sulfate	2/15	7.10E-03	7.10E-03	2.10E-03	NVA	Yes		4	NVA	NVA	NVA	NVA	0/1	No exceedences
Endrin aldehyde	1/15	4.28E-04	4.28E-04	4.28E-04	1.00E-01	No								
Endrin ketone	3/15	2.90E-03	2.90E-03	1.66E-03	1.00E-01	No								
Fluoranthene	6/15	1.10E-01	8.28E-02	1.30E-02	1.1E+00 (HMW)	No								
Fluorene	3/15	9.10E-03	9.10E-03	4.30E-03	2.9E+01 (LMW)	No								
gamma-Chlordane	1/15	1.10E-03	1.10E-03	1.10E-03	1.00E+02	No								
Heptachlor epoxide	3/15	1.06E-03	1.06E-03	4.60E-04	1.00E-01	No								
Indeno(1,2,3-cd)pyrene	6/15	2.63E-02	2.27E-02	3.60E-03	1.1E+00 (HMW)	No								
Methoxychlor	3/15	1.02E-02	1.02E-02	2.82E-03	1.00E-01	No								
Naphthalene	3/14	1.30E-01	1.30E-01	6.00E-02	2.9E+01 (LMW)	No								
Phenanthrene	9/15	3.00E-01	1.10E-01	4.53E-02	2.9E+01 (LMW)	No								
Pyrene	5/15	9.20E-02	8.34E-02	1.60E-02	1.1E+00 (HMW)	No								

Table 7-17
Direct Toxicity Evaluation for Surface Soil at SWMU 59
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Chemical (1)	Detection Frequency	Maximum Concentration	Exposure Point Concentration	Minimum Concentration	BTAG or USEPA EcoSSL Screening Toxicity Value (2)	Retain COPEC as Max Conc > BTAG or EcoSSL Value?	If Retained as COPEC, Comment on BTAG or EcoSSL Value	Dutch Intervention Value (3)	CCME Value (4)	USEPA EcoSSL Direct Contact Value (5)	ORNL Screening Benchmark for Plants (6)	ORNL Screening Benchmark for Invertebrates (7)	COPEC Weight of Evidence Summary - Number of Direct Contact Benchmarks Exceeded Using MDC	Comment
Toluene	1/13	2.80E-03	2.80E-03	2.80E-03	1.00E-01	No								
Aluminum	16/16	1.78E+04	1.22E+04	3.12E+03	1.00E+00	Yes	pH < 5.5; Plant tox (OHMTADS)							pH = 7.24
Antimony	1/16	7.40E-01	7.40E-01	7.40E-01	2.70E-01	Yes	Mammal tox	15	20	78	5	NVA	0/4	No exceedences
Arsenic	16/16	3.70E+01	2.07E+01	1.60E+00	1.80E+01	Yes	Plant tox	55	12	18	10	60	3/5	
Barium	16/16	1.90E+02	1.41E+02	5.71E+01	3.30E+02	No								
Beryllium	15/15	1.30E+00	9.09E-01	4.93E-01	2.10E+01	No								
Cadmium	2/16	1.10E-01	1.10E-01	1.10E-01	3.60E-01	No								
Calcium	16/16	2.68E+03	1.55E+03	1.92E+02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Chromium (Cr III tox)	16/16	2.88E+01	1.91E+01	7.50E+00	2.60E+01	Yes		380	64	NVA	1	0.4	2/4	
Chromium (Cr VI tox)	16/16	2.88E+01	1.91E+01	7.50E+00	1.30E+02	No								
Cobalt	16/16	1.01E+01	7.07E+00	2.90E+00	1.30E+01	No								
Copper	16/16	1.53E+01	1.20E+01	3.30E+00	2.80E+01	No								
Iron	16/16	2.44E+04	1.70E+04	4.20E+03	5 ≤ pH ≤ 8	No								
Lead	16/16	3.09E+01	1.82E+01	5.37E+00	1.10E+01	Yes	Bird tox	530	70	120	50	500	0/5	No exceedences
Magnesium	16/16	2.27E+03	1.37E+03	2.27E+02	4.40E+03	No								
Manganese	16/16	3.63E+03	1.17E+03	6.80E+01	2.20E+02	Yes	Plant tox	NVA	NVA	220	500	NVA	2/2	Plant tox
Mercury	13/14	5.61E-01	3.00E-01	4.10E-02	5.80E-02	Yes	No reference	10	6.6	NVA	0.3	0.1	2/4	
Nickel	16/16	1.28E+01	8.80E+00	5.20E+00	3.80E+01	No								
Potassium	12/12	1.07E+03	7.44E+02	3.00E+02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Selenium	11/15	7.00E+00	6.70E+00	2.60E-01	5.20E-01	Yes	Plant tox	NVA	1	0.52	1	70	3/4	Plant tox
Silver	1/16	4.98E-01	3.44E-01	4.98E-01	4.20E+00	No								
Sodium	6/8	3.70E+02	2.07E+02	3.54E+01	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Thallium	4/16	2.10E-01	1.90E-01	7.30E-02	1.00E-03	No								
Vanadium	16/16	5.06E+01	3.36E+01	1.21E+01	7.80E+00	Yes	Bird tox	NVA	130	NVA	2	NVA	1/2	EcoSSL says data insufficient to derive direct contact SSL
Zinc	16/16	7.63E+01	3.80E+01	7.23E+00	4.60E+01	Yes	Plant tox (OHMTADS)	720	200	120	50	200	1/5	

All values presented in mg/kg.
NVA = No Value Available
LMW = Low Molecular Weight PAH
HMW = High Molecular Weight PAH
Surface soil pH of 7.24 based on one sample (59SS03) collected at SWMU 59.

(1) COPECs from Table 7-13.
(2) Screening toxicity values from BTAG (1995) or EcoSSL (USEPA, 2007). EcoSSLs given highest priority as they are more definitive.
(3) Dutch Intervention Values are from the Netherlands Ministry of Housing, Spacial Planning and Environment (February 2000).
(4) Canadian Council of Ministers of the Environment (CCME), Canadian Environmental Quality Guidelines, December 2003.
(5) Lowest EcoSSL value for direct contact toxicity for either plants or terrestrial invertebrates (USEPA, 2007).
(6) Screening benchmarks for plants from ORNL (1997, ES/ER/TM-85/R3).
(7) Screening benchmarks for earthworms from ORNL (1997, ES/ER/TM-126/R2).
(8) EcoSSL (USEPA, 2007) for LMW PAHs and HMW PAHs.
LMW and HMW PAHs based on the number of ring structures (less than 4 rings = LMW; 4 or more rings = HWM).

- The vanadium MDC only exceeded one of the two available benchmarks. In addition, the EcoSSL guidance (USEPA, 2007c) says that data are insufficient to derive a direct contact benchmark for this inorganic constituent; and the ORNL exceedance was for plant toxicity, and as discussed in *Section 7.3.3.1*, plant toxicity is not an overriding concern for the Site. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 59.
- The zinc MDC only exceeded one of the five available benchmarks. In addition, the ORNL exceedance was for plant toxicity, and as discussed in *Section 7.3.3.1*, plant toxicity is not an overriding concern for the Site. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 59.
- None of the other COPECs selected in the first screening step had any benchmark exceedances.

These results suggest that direct contact toxicity for COPECs in soil is not a concern. It should also be noted that toxicity to terrestrial invertebrates is assessed indirectly, as terrestrial invertebrates such as earthworms are included in the food-chain models used in the assessments.

7.3.5 Background Metals Considerations

A background evaluation was conducted on the soil analytical results to determine if any inorganic COPEC drivers discussed in the previous sections were potentially related to naturally-occurring soil concentrations. From the Tier 2 LOAEL assessment, the inorganic COPEC drivers with EEQs greater than 1 for the food chain assessment were arsenic and selenium. No COPEC hazard drivers were identified for the direct contact assessment. Inorganic COPECs that were not statistically different based on appropriate statistical tests are considered background related (see *HHRA Section 6.4.3* for details). Based on information presented in **Table 7-18**, selenium for the food chain assessment is the COPEC in SWMU 59 surface soil considered to be potentially site related and not attributed to background.

Table 7-18
Background Comparison for Surface Soil at SWMU 59

Soil COPEC	Gehan Test [a, b] Site > Background?	Considered to be Background?
Aluminum [c]	No	**Yes**
Antimony	No	**Yes**
Arsenic [c]	No	**Yes**
Barium	Yes	No
Beryllium	No	**Yes**
Cadmium	No	**Yes**
Chromium [c]	No	**Yes**
Cobalt	No	**Yes**
Copper	Yes	No
Iron [c]	No	**Yes**
Lead [c]	No	**Yes**

Table 7-18, Continued
Background Comparison for Surface Soil at SWMU 59

Soil COPEC	Gehan Test [a, b] Site > Background?	Considered to be Background?
Magnesium	No	**Yes**
Manganese [c]	No	**Yes**
Mercury	Yes	No
Nickel	No	**Yes**
Potassium	No	**Yes**
Selenium	Yes	No
Silver	No	**Yes**
Sodium	Yes	No
Thallium	No	**Yes**
Vanadium [c]	No	**Yes**
Zinc [c]	No	**Yes**

[a] Gehan test used unless otherwise noted. See Appendix for backup statistics.
[b] If both Site and Background data sets had normal distribution with 100% detects, the t-test was used (note: this did not occur for SWMU 59 surface soil vs. background comparisons).
[c] Wilcoxon-Mann-Whitney test used (for 100% detect data sets).

7.3.6 Uncertainty Analysis

There were 123 chemical constituents not detected in surface soil analytical samples. **Appendix F-2, Table F-30** evaluates the uncertainty associated with these constituents' detection limits by presenting a comparison of the maximum detection limit for each non-detect constituent with conservative ecological toxicity screening values. Ecological screening values were compiled and presented in **Appendix F-2, Table F-31**.

Fifty of the non-detect constituents had maximum detection limits that exceeded either one or both of the screening criteria. This finding is not unexpected, given the conservative and numerically low screening values.

One inorganic (selenium) had Tier 2 LOAEL-based EEQs that were not attributed to background and exceeded 1 when rounded to one significant figure. The selenium based EEQs were 11, 9, and 3 for the meadow vole, shrew, and robin, respectively. Two organics (TCDD and dieldrin) had Tier 2 LOAEL-based EEQs that exceeded 1 when rounded to one significant figure. The TCDD-based EEQ was 3 for the shrew and the dieldrin-based EEQ was 2 for the shrew. Given the uncertainties associated with the SLERA process, the key parameters associated with these elevated EEQs were examined in more detail in the following sections.

Selenium. For the elevated meadow vole EEQ of 11, the primary exposure was from the plant ingestion pathway (96 percent). The LOAEL of 0.33 mg/kg-day that was used was based on a laboratory rat study from Sample et al. (1996) and the use of a toxicity extrapolation UF of 4 (**Appendix F-2, Table F-28**). The use of this UF is conservative; however, the use of an alternative UF of 2 would still result in the selenium EEQ slightly exceeding one (6) when rounded to one significant figure. The elevated shrew EEQ of 9 was primarily from the earthworm ingestion pathway (84 percent). The LOAEL of 0.33 mg/kg-day that was used was based on a laboratory rat study from Sample et al. (1996) and the use of a toxicity extrapolation

UF of 8 (**Appendix F-2, Table F-28**). The use of this UF is quite conservative; however, the use of an alternative UF of 2 would still result in the selenium EEQ slightly exceeding one (2) when rounded to one significant figure. For the elevated robin EEQ of 3, the primary exposure was from the plant (60 percent) and invertebrate (34 percent) ingestion pathways. The LOAEL of 1.0 mg/kg-day that was used was based on a mallard duck laboratory study from Sample et al. (1996) and the use of a toxicity extrapolation UF of 8 (**Appendix F-2, Table F-28**). The use of this UF is quite conservative, and the use of an alternative UF of approximately 2 would result in the selenium EEQ of 3 dropping to less than 1. Based on this evaluation, the use of alternative factors (e.g., an alternative UF for TRV species extrapolation), would reduce the estimated LOAEL-based EEQ to less than 1 when rounded to one significant figure for the American robin, but the meadow vole and short-tailed shrew EEQs would still exceed 1.

TCDD. For the slightly elevated shrew EEQ of 3, the primary exposure was from the invertebrate ingestion pathway (98 percent). The LOAEL of 1E-5 mg/kg-day that was used was based on a laboratory rat study from Sample et al. (1996) and the use of a toxicity extrapolation UF of 8 (**Appendix F-2, Table F-28**). The use of this UF is quite conservative; however, the use of an alternative UF of 4 would result in the TCDD EEQ of 3 dropping to 1 when rounded to one significant figure.

Dieldrin. For the slightly elevated shrew EEQ of 2, the primary exposure was from the invertebrate ingestion pathway (99 percent). The LOAEL of 0.02 mg/kg-day that was used was based on a laboratory rat study from the EcoSSL (USEPA, 2007c) and the use of a toxicity extrapolation UF of 8 (**Appendix F-2, Table F-28**). The use of this UF is quite conservative, and the use of an alternative UF of approximately 4-5 would result in the dieldrin EEQ of 2 dropping to less than 1.

7.3.7 SLERA Results and Conclusions

The data, results, and conclusions of the SLERA evaluated risks to ecological populations inhabiting SWMU 59. Conclusions are derived from the risk assessment and are based on the responses to the assessment hypotheses and assessment endpoints. The assessment results for food chain exposure are summarized in **Table 7-16**, and direct contact exposure results for terrestrial invertebrates, which may serve as a food source for wildlife are summarized in **Table 7-17** and discussed in *Section 7.3.4.1*.

The food chain assessment suggests potential adverse impacts to terrestrial wildlife, especially shrews, robins, and voles for modeled contact with the hazard drivers (primarily selenium; and to a lesser extent TCDD and dieldrin) in surface soil that are not statistically related to naturally occurring surface soil concentrations (*Section 7.3.5*). Based on the Tier 2 LOAEL-based approach, only selenium (vole, shrew, and robin), TCDD (shrew), and dieldrin (shrew) had estimated EEQs greater than 1 when rounded to one significant figure. In addition, when alternative exposure and/or toxicity factors were used in the SLERA EEQ calculations, estimated EEQs would be expected to drop to 1 or less for all constituents except selenium (vole and shrew), which were slightly elevated above 1. The direct contact assessment results suggest that no additional action is required at the site, as direct contact benchmark exceedances 1) are either only for potential plant toxicity (not an overriding concern at the site), or 2) do not exceed more than 50 percent of the available direct contact benchmarks.

Based on uncertainties of toxicity, the fact that no wildlife RTE species have been confirmed at the SWMU study area, alternative exposure and/or toxicity factors that could be used, and the

relatively small size of the SWMU (0.57 acres), remedial measures solely to address ecological concerns are not warranted for soil. The SMDP reached for this SLERA is that the information collected and presented indicates that a more thorough assessment is not warranted. As the HHRA has identified some COPCs potentially associated with adverse health effects (*Section 6.1.2*), the corrective measures study should consider if attainment of human health PRGs would result in selenium EEQs dropping to 1 or lower, or would result in a significant reduction of estimated ecological hazard for SWMU 59.

Migration of COPECs in groundwater to surface waters and sediment of the New River was determined unlikely due to the distance of this receptor area from the Site and therefore was not deemed to be an ecological concern.

The assessment results may serve as the focus of discussions with risk managers and regulatory agencies. It is very important to note that many conservative assumptions and modeling approaches were used in the assessment, and actual hazards to wildlife may be orders of magnitude lower than predicted herein.

8.0 SUMMARY AND CONCLUSIONS

SWMUs 50 and 59 are two non-contiguous areas used for calcium sulfate treatment/disposal and bottom ash storage. SWMU 50 was identified as the major disposal area at RFAAP, until 1982, for sludge removed from the calcium sulfate drying beds. It was assumed that the area was covered with fill by 1986. SWMU 59 was used to store bottom ash from the coal-fired power plant used to supply steam to the buildings in the HSA. However, the bottom ash pile is no longer visible at the site.

Data from two previous investigations was combined with data from the current (2007) investigation to evaluate the nature and extent of contamination (*Section 4.0*) and to assess potential impacts to human health (*Section 6.0*) and/or ecological receptors (*Section 7.0*).

Contamination Assessment

The contamination assessment for SWMU 50 indicated that explosives, pesticides, and herbicides are not a concern at the site since they were not greater than SLs in any soil samples. For SWMU 59, the contamination assessment indicated that explosives, pesticides, and herbicides are not a concern at the site since they were not greater than SLs in any soil samples.

VOCs

VOCs were detected in the SWMU 50 and SWMU 59 samples. At SWMU 50, one VOC (chloroform) was detected above its i-SL and r-SL only in one 1992 sample. No VOCs were detected above SLs in SWMU 59 soil samples. Chloroform was not detected in site groundwater samples. However, three other VOCs (CT, PCE, and TCE) were detected at concentrations above tw-SLs in 2007 groundwater sample 50WM02. Therefore, it does not seem that the VOCs in groundwater originated from the site.

SVOCs/PAHs

Two PAHs [benzo(a)pyrene and benzo(b)fluoranthene] were detected above r-SLs in SWMU 50 soil samples and three PAHs [benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene] were detected above their r-SLs in a single SWMU 59 surface soil sample. One non-PAH SVOC [bis(2-ethylhexyl)phthalate] was detected above its SL in a single groundwater sample (50MW02). These results indicate that there has been no migration of SVOCs from soil to groundwater and are not a concern at these sites.

PCBs

PCB-1254 was detected above SLs in both SWMU 50 and SWMU 59. At SWMU 50, PCB-1254 was above its i-SL in 5 samples and above its r-SL in 12 samples out of 31 tested. At SWMU 59, PCB-1254 was detected above its r-SL in 2 out of 27 samples. However, PCBs were not detected in any site groundwater samples. Therefore, these results indicate that there has been no migration of PCBs from soil to groundwater. The detections of PCBs in soil were scattered and did not exhibit a pattern indicating a source or hotspot of PCBs at either site. Additionally, there is no evidence that there were ever activities that would be known to cause a release of PCBs at the site.

Metals

Metals were detected at both SWMU 50 and SWMU 59. At SWMU 50, five metals (chromium, copper, lead, mercury, and nickel) were detected above their r-SLs in one or two samples out of 29 samples. At SWMU 59, two metals (arsenic and manganese) were detected above their i-SLs and r-SLs in one and two samples, respectively, out of 28 samples. In site groundwater samples, ten metals (aluminum, arsenic, cadmium, chromium, cobalt, iron, lead, manganese, mercury, and vanadium) were detected above their SLs.

Dioxins/Furans

Dioxins/furans were detected in SWMU 50 and SWMU 59 soil samples. In SWMU 50 soil samples, seven dioxins/furans (1,2,3,6,7,8-HXCDD, OCDD, total PECDD, total HXCDD, total HPCDD, total HXCDF, and total HPCDF) were detected above SLs. In SWMU 59 soil samples, only two dioxins/furans (OCDD and total HPCDD) were detected above their r-SLs. Dioxins/furans were also detected in 2007 site groundwater samples. Five dioxins/furans (2,3,4,7,8-PECDF, total PECDD, total HXCDD, total) were detected above their r-SLs. Dioxins are considered ubiquitous in soil at RFAAP, from anthropogenic sources such as combustion and incineration of municipal waste, coal, wood, and fuel. If such chemicals are not site-related, the risks associated with the site may be overestimated. This uncertainty may have a low-to-moderate effect on overestimating risks. Therefore, dioxins/furans are not thought to be a major concern in the soil at this site.

Human Health Risk Assessment

An HHRA (*Section 6.0*) was conducted at SWMUs 50 and 59 to evaluate the potential human health effects associated with previous activities at the sites. Risks associated with surface soil, total soil and groundwater (for sites 48, 49, 50, and 59) were evaluated for several different current and hypothetical future exposure scenarios. Risks and hazards from these scenarios are summarized below.

For soil at SWMU 50 and SWMU 59, the total cancer risk for all evaluated constituents exposures to all media types were either within or below their target risk range or equal to the lower limit of their target risk range. The analytes that contributed to these results at SWMU 50 were dioxins/furans, Aroclor-1254, benzo(a)pyrene, and arsenic. Only benzo(a)pyrene and arsenic contributed to these results at SWMU 59. In addition, each total HI for all media types evaluated at both SWMUs were less than 1. The only constituent at SWMU 50 not fitting these results was the HI for the child resident's exposure to total soil, which was above 1. No individual COPC had an HI above 1. However, the target organ for the nervous system slightly exceeded an HI of 1. Of the constituents that contribute to the nervous system HI, manganese was found to be within the background range. By excluding the HQ for manganese, the nervous system HI is less than 1. The only constituent at SWMU 59 not fitting these results was the HI for the child resident's exposure to total soil, which was above 1. No individual chemical or target organ HI was above 1.

Groundwater in the vicinity of SWMUs 48, 49, 50, and 59 was evaluated and addressed as part of the SWMUs 48 and 49 RFI/CMS (Shaw, 2008), as discussed throughout the HHRA. For purposes of information, the results of the groundwater evaluation are summarized below.

The total cancer risk associated with groundwater was below the target risk range for the current/future maintenance worker and the future excavation worker. In addition, the total HI

was less than 1 for these receptors, with the exception that the target organ HI for the liver exceeded an HI of 1 for the excavation worker.

For future industrial worker, future lifetime resident, and child resident exposures to groundwater, the total cancer risks associated with groundwater were all above their target risk ranges, due to some of the following: bis(2-ethylhexyl)phthalate, CT, 1,2-dichloroethane, pentachlorophenol, dioxins/furans, PCE, TCE, and arsenic. Their total HIs were all above 1, primarily due to some of the following: CT, TCE, aluminum, arsenic, barium, iron, manganese, nickel, thallium, and vanadium.

Off-site residents were evaluated to address potential future migration of COPCs in groundwater. The risks and hazards for the off-site receptors were similar to those on-site because it was conservatively assumed that there was no change to groundwater concentrations as COPCs migrated off site.

Screening Level Ecological Risk Assessment

A SLERA (*Section 7.0*) was performed to provide an estimate of current and future ecological risk associated with potential hazardous substance releases at SWMU 50 and/or 59. The data, results, and conclusions of the SLERA evaluated risks to ecological populations inhabiting SWMU 50 and SWMU 59. Conclusions are derived from the risk assessment and are based on the responses to the assessment hypotheses and assessment endpoints.

SWMU 50. The food chain assessment suggests potential adverse impacts to terrestrial wildlife, especially shrews, robins, and voles for modeled contact with the hazard drivers (primarily selenium and TCDD; and to a lesser extent Aroclor-1254, 4,4-DDT, and 4,4-DDE) in surface soil that are not statistically related to naturally-occurring surface soil concentrations (*Section 7.2.5*). Based on the Tier 2 LOAEL-based approach, only selenium (vole, shrew, and robin), TCDD (shrew and robin), Aroclor-1254 (shrew), 4,4-DDT (robin), and 4,4-DDE (robin) had estimated EEQs greater than 1 when rounded to one significant figure. In addition, when alternative exposure and/or toxicity factors were used in the SLERA EEQ calculations, estimated EEQs would be expected to drop to 1 or less for all constituents except TCDD (shrew) and selenium (vole, shrew, and robin), which were slightly elevated above 1. The direct contact assessment results suggest a potential reduction in wildlife food supply due to mercury and lead in surface soil; however, due to the small size of the Site (2.06 acres), this potential reduction in food is not considered biologically significant.

Based on uncertainties of toxicity, the fact that no wildlife RTE species have been confirmed at the SWMU study area, alternative exposure and/or toxicity factors that could be used, and the relatively small size of the SWMU (2.06 acres), remedial measures solely to address ecological concerns are not warranted for soil. The SMDP reached for this SLERA is that the information collected and presented indicates that a more thorough assessment is not warranted. As the HHRA has identified some COPCs potentially associated with adverse health effects (*Section 6.1.2*), the corrective measures study should consider if attainment of human health PRGs would result in TCDD and selenium EEQs dropping to 1 or lower, or would result in a significant reduction of estimated ecological hazard for SWMU 50.

Migration of COPECs in groundwater to surface waters and sediment of the New River was determined unlikely due to the distance of this receptor area from the Site and therefore was not deemed to be an ecological concern.

The assessment results may serve as the focus of discussions with risk managers and regulatory agencies. It is very important to note that many conservative assumptions and modeling approaches were used in the assessment, and actual hazards to wildlife may be orders of magnitude lower than predicted herein.

SWMU 59. The food chain assessment suggests potential adverse impacts to terrestrial wildlife, especially shrews, robins, and voles for modeled contact with the hazard drivers (primarily selenium; and to a lesser extent TCDD and dieldrin) in surface soil that are not statistically related to naturally-occurring surface soil concentrations (*Section 7.3.5*). Based on the Tier 2 LOAEL-based approach, only selenium (vole, shrew, and robin), TCDD (shrew), and dieldrin (shrew) had estimated EEQs greater than 1 when rounded to one significant figure. In addition, when alternative exposure and/or toxicity factors were used in the SLERA EEQ calculations, estimated EEQs would be expected to drop to 1 or less for all constituents except selenium (vole and shrew), which were slightly elevated above 1. The direct contact assessment results suggest that no additional action is required at the site, as direct contact benchmark exceedances 1) are either only for potential plant toxicity (not an overriding concern at the site), or 2) do not exceed more than 50 percent of the available direct contact benchmarks.

Based on uncertainties of toxicity, the fact that no wildlife RTE species have been confirmed at the SWMU study area and the site will remain in its current state of being groomed by RFAAP, alternative exposure and/or toxicity factors that could be used, and the relatively small size of the SWMU (0.57 acres), remedial measures solely to address ecological concerns are not warranted for soil. The SMDP reached for this SLERA is that the information collected and presented indicates that a more thorough assessment is not warranted. As the HHRA has identified some COPCs potentially associated with adverse health effects (*Section 6.1.2*), the corrective measures study should consider if attainment of human health PRGs would result in selenium EEQs dropping to 1 or lower, or would result in a significant reduction of estimated ecological hazard for SWMU 59.

Migration of COPECs in groundwater to surface waters and sediment of the New River was determined unlikely due to the distance of this receptor area from the Site and therefore was not deemed to be an ecological concern.

The assessment results may serve as the focus of discussions with risk managers and regulatory agencies. It is very important to note that many conservative assumptions and modeling approaches were used in the assessment, and actual hazards to wildlife may be orders of magnitude lower than predicted herein.

Groundwater Remediation Plan

Groundwater data from SWMUs 48, 49, 50, and 59 were assessed together for the HHRA. The results of that assessment indicated that additional steps are needed to remediate the contaminants of interest (COIs) (CT, TCE) in site groundwater. The nature and extent of these constituents suggests that SWMU 49 is the source area and remediation of the affected groundwater under SWMUs 50 and 59 will be associated with SWMU 49. As with the initial assessment, wells from all four SWMUs (48, 49, 50, and 59) will be monitored to ensure that COIs are decreasing to acceptable levels within a timely rate.

Conclusion

Risks and hazards to current workers associated with exposure to soil at the site are within or below acceptable limits. In addition, risks and hazards were within acceptable limits for hypothetical future residential soil receptors. The SLERA concluded that based on uncertainties of toxicity, the fact that no wildlife RTE species have been confirmed at the SWMU study area, alternative exposure and/or toxicity factors that could be used, and the relatively small size of the SWMU (0.57 acres), remedial measures solely to address ecological concerns are not warranted for soil.

The results of the contamination assessment indicate that COIs in groundwater in the area of SMWUs 49, 48, 50 and 59 are associated with SWMU 49; therefore, groundwater remediation for these four SWMUs is to be addressed as part of any SWMU 49 effort. As the current and future risks and hazards for human and ecological receptors associated with soil at SWMUs 50 and 59 are within acceptable ranges and any groundwater effort is deferred to SWMU 49, the soil at SWMUs 50 and 59 will require no further action.

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