

RADFORD ARMY AMMUNITION PLANT, VIRGINIA

SWMU 41 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

February 2011



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

11-27

March 23, 2011

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

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

VIA Electronic Mail

Re: Radford Army Ammunition Plant, VA
Solid Waste Management Unit 41
RCRA Facility Investigation Report

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) February 2011 Final RCRA Facility Investigation Report for Solid Waste Management Unit 41, 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; the report is considered final. If you have any questions, please call me at 215-814-3284.

Sincerely,

A handwritten signature in cursive script that reads "Erich Weissbart".

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

c: James Cutler, VDEQ



*Printed on 100% recycled/recyclable paper with 100% post-consumer fiber and process chlorine free.
Customer Service Hotline: 1-800-438-2474*



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

www.atk.com

February 24, 2011

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

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

Subject: With Certification, SWMU 41RCRA Facility Investigation Report, Final Document, February 2011
EPA ID: VA1210020730

Dear Mr. Geiger and Mr. Cutler:

Enclosed is the certification for the subject document that was sent to you on February 23, 2011. Also enclosed is the 23 February 2011 transmittal email.

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

Sincerely,

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

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

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

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

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

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

Coordination: J. McKenna
J. McKenna

M. A. Miano
M. A. Miano

Concerning the following:

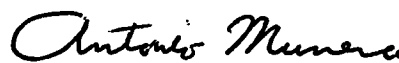
Radford Army Ammunition Plant
SWMU 41
RCRA Facility Investigation Report
Final Document, February 2011

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

SIGNATURE:

PRINTED NAME:

TITLE:



Antonio Munera

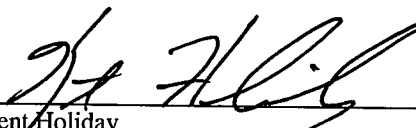
LTC, CM

Commanding

SIGNATURE:

PRINTED NAME:

TITLE:



Kent Holiday

Vice President and General Manager

ATK Energetic Systems

Greene, Anne

From: McKenna, Jim
Sent: Wednesday, February 23, 2011 3:17 PM
To: Greene, Anne; dennis.druck@us.army.mil; durwood willis2; Geiger.William@epamail.epa.gov; Redder, Jerome; jim spencer; Cutler,Jim; Sismour,Karen; Llewellyn, Tim; Lohman,Elizabeth; Mendoza, Rich; Meyer, Tom NAB02; Parks, Jeffrey N; Timothy.Leahy@shawgrp.com; Tina_MacGillivray@URSCorp.com
Subject: Final SWMU 41 RFI Report November 2009 (UNCLASSIFIED)
Attachments: SWMU 41 EPAVDEQ RTCs_Rev-well 22 Jul 2010.pdf
Importance: High

Classification: UNCLASSIFIED
Caveats: FOUO

All:

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

A certification letter will follow.

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

Jim McKenna

Jim McKenna 1Z63V8840190373208

Mr. Richard Mendoza 1Z63V8840190896037

Mr. Tom Meyer 1Z63V8840190909817

Mr. Dennis Druck 1Z63V8840191717424

Mr. James Cutler 1Z63V8840194657869

Ms. Elizabeth Lohman 1Z63V8840193320474

Mr. William Geiger 1Z63V8840191766256

Classification: UNCLASSIFIED
Caveats: FOUO

Presented below are EPA/VDEQ comments on the Draft *SWMU 41 RCRA Facility Investigation Report* for the Radford Army Ammunition Plant (RFAAP) located in Radford, Virginia, dated November 2009 (hereinafter referred to as the RFI).

GENERAL COMMENTS

1. *Master Work Plan Addendum 19: SWMU 48, SWMU 49, SWMU 50, SWMU 59, SWMU 41, Area O, FLFA, SWMU 43, Area P (Work Plan Addendum 19)*, dated July 2007, Page 3-16, indicates that “At the northeast corner of Area B, a small area of buried material (less than 1 foot thick and 3 feet wide) is exposed underneath an overhang of fill material where a small area of fill material has slumped away.” The RFI does not include this description, or otherwise describe the current condition of this area. However, the RFI does indicate that the clayey fill placed at Area B “acts as a soil cap...preventing downward migration of the constituents present in soil as a result of former disposal activities” (Page 8-3). If the integrity of the “clayey fill cap” is deteriorating in certain portions of the Solid Waste Management Unit (SWMU), its effectiveness at preventing future downward migration of constituents in soil may also be affected. It is also unclear as to whether a sample of the exposed material was collected, and included in the risk assessments. If buried material is exposed, there may be potential risks to current receptors that have not been quantified adequately (i.e., since surface soil only was evaluated for current receptors). Please revise the RFI to describe the current condition of SWMU 41B including any areas where buried material may be exposed, and to address the concerns noted above.

Response: The area described in the work plan could not be located during the 2007 field investigation. An additional attempt was made to find the area in June 2010 in response to this comment and the area could not be found. The following photographs were taken of the top (southeastern) corner of the Area B to show the current conditions of the clayey fill cap.

2. Continued groundwater monitoring has not been proposed as part of the long-term monitoring of the site, but justification for this approach has not been provided. Several constituents were detected above screening criteria (tapwater Regional Screening Levels [RSLs] and/or maximum contaminant levels [MCLs]) in groundwater at both SWMU 41A and 41B, and tetrachloroethylene (PCE), arsenic, TCDD TE, and 2,6-dinitrotoluene were found to be risk drivers in the HHRA. It appears that future groundwater monitoring may be warranted, and installation of permanent wells or other appropriate monitoring points at SWMU 41A should be considered. Please revise the RFI to provide justification for not proposing long-term groundwater monitoring at SWMU 41A and 41B, or alternatively, propose a long-term groundwater monitoring program at the site.

Response: The land use in the future is expected to stay the same as the current land use (grass is mown 3-4 times/year). For the HHRA it was conservatively assumed that the current and future maintenance worker would mow the grass at the site once per week for a total of 50 days/year (based on two weeks of vacation). Hypothetical future receptors (industrial workers, construction workers, and hypothetical residents) were evaluated using site specific data and standard risk assessment exposure parameters for each scenario. These receptors are evaluated in a consistent manner so that risks at various

sites can be compared. However, the use of these standard assumptions (ie. number of days onsite; hours per day; etc.) is not consistent with the actual exposures that can be expected onsite. For example, it was conservatively assumed that a future hypothetical industrial worker would work outdoors at the site for 225 days/year over a 25-year period. It is highly unlikely that one individual would continuously work at SWMU 41 for this frequency and duration. With the evaluation of actual likely exposure times, the Army believes that Institutional Controls to prevent residential development and groundwater extraction and use are protective of human health and the environment.

3. Section 6.1.2, Identification of [Chemicals of Potential Concern] COPCs, indicates that maximum detected concentrations (MDCs) of constituents in surface water were compared to the tapwater Regional Screening Levels (RSLs), presented in the April 2009 RSL Tables, to select or eliminate COPCs in surface water, and MDCs of constituents in sediment were compared to the residential soil RSLs to select or eliminate COPCs in sediment. However, Appendix E Tables E.1-8 and E.2-8 indicate that the tapwater RSLs were increased by a factor of 10 to account for surface water exposures. Additionally, Appendix E Tables E.1-6 and E.2-6 indicate that the residential soil RSLs were also increased by a factor of 10. Please revise this section of the RFI to include the rationale and supporting references for the adjustments made to the sediment and surface water RSLs.

Response: Text will be added to indicate that the RSLs for residential soil and tap water were adjusted by a factor of 10 for the evaluation of COPCs in sediment and surface water, respectively. This approach was originally described in the *Final Master Work Plan* (URS, 2002) for RFAAP and has been consistently applied in previous HHRA. This justification will be added to the text.

4. Several of the Appendix E tables apparently have been revised (as noted by the electronic file names on the CD that accompanies the hard copy RFI report), and two sets of the same table are presented for some of the tables. For example, the file “App E 1_RAGS Spreadsheets_1-66_SWMU41A” includes Tables E.1-3 through Tables E.1-10, but these same table numbers are also presented in the file “App E 1_RAGS Spreadsheets_SWMU41A_revised tables only.” To avoid confusion, please ensure that the final RFI report includes only one version of each table, and the tables are presented in numerical order, preferably in one Excel file.

Response: The Appendix E tables will be re-organized for the Final RFI Report. Tables will be checked for duplication and organized in numerical order. If the file size allows, all tables will be included in one Excel file.

5. While most of the exposure factors used in the human health risk assessment (HHRA) have been appropriately obtained from applicable guidance documents, several exposure factors were used without sufficient justification. Please revise the HHRA to address the following:

- The exposure frequency (EF) selected for an excavation worker is 125 days/year, which according to the Appendix E tables, is a value from EPA’s 2002 *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*,

OSWER 9355.4-24 (SSL Guidance). However, the default EF for a construction worker listed in the SSL Guidance is 250 days/year (Exhibit 5-1). Please revise the HHRA to use the default EF of 250 days/year or provide additional justification for using an EF of 125 days/year.

- The EF selected for the industrial worker is 225 days/yr for both an indoor industrial worker and outdoor industrial worker. However, EPA's 2004 *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* (RAGS Part E), Exhibit 3-5, specifies an EF of 250 days/year should be used for evaluating reasonable maximum exposure (RME) to industrial workers. Revise the HHRA to use the default EF of 250 days/year for an indoor industrial worker, or provide additional justification for using an EF of 225 days.
- A soil to skin adherence factor (SSAF) of 0.6 mg/cm²-day was selected for the maintenance worker, outdoor industrial worker, and excavation worker (Table E.1-27 cites EPA RAGS Part E). EPA RAGS Part E does not have an established SSAF for sediment exposures. Please revise the HHRA to justify the use of the aforementioned SSAF in evaluating sediment exposures to on-site workers. Additionally, an SSAF of 0.2 mg/cm²-day was selected for residents, however, given the increased moisture content of sediment and the increased ability to adhere to skin, a higher SSAF should be selected to evaluate sediment dermal exposure to residents, especially for the wading scenario. Please revise the HHRA accordingly and note that the weighted soil adherence factor for children playing in wet soil is 3.3 mg/cm²-day (Exhibit 3-3, RAGS Part F).
- The ingestion rate of produce was extracted from the 1997 *Exposure Factors Handbook*, Volume I (EPA/600/P-95/002Fa), with the same value (18.6 g/d) being used for both the adult and child receptor. Please note that EPA's *Child-Specific Exposure Factors Handbook*, Final Report, dated 2008, (EPA/600/R-06/096F) includes produce ingestion rates specific to the child receptor. Revise the HHRA to use a child-specific produce ingestion rate.

Response: The specific responses to each item are, as follows:

- Area A and Area B at SWMU 41 were evaluated separately. There is no current construction at either SWMU 41A or SWMU 41B. Given the sizes of SWMUs 41A and 41B (0.19 acres and 1.08 acres, respectively) and the sloping topography at these locations, extensive construction would not be expected. Assuming five-day work weeks, the EF of 125 days/year represents a six-month construction period, which would seem reasonable for a site of this size and location. In addition, this EF value is consistent with the EF values used for previous HHRAs at RFAAP. Text will be added to Section 6.2.1 to clarify this assumption.
- As stated above, the EF selected for the industrial worker is 225 days/yr for both an indoor industrial worker and outdoor industrial worker. As cited in the comment, the RME value for the indoor worker is an EF of 250 days/yr. To be consistent with previous HHRAs at RFAAP, the potential future industrial worker scenario represents a composite of the outdoor and indoor worker scenarios.

For soil, the difference in the EF is balanced by the difference in soil ingestion rates. For example, the ingestion rate for the outdoor worker is 100 mg/day while the ingestion rate for the indoor worker is 50 mg/day. For soil exposures, the risks and hazards for the outdoor worker would be higher than those for the indoor worker.

For groundwater exposures, the primary differences are the EF (225 days/yr for the outdoor worker versus 250 days/yr for the indoor worker) and exposures to groundwater COPCs via ambient air for the outdoor worker versus indoor air for the indoor worker. For the ingestion pathway, the risks and hazards would be slightly higher for the indoor worker. For the inhalation pathway, risks and hazards for both ambient air and indoor air are calculated and the pathway with higher risks and hazards is added into the overall cumulative risk and hazard index for the industrial worker. There were no volatile COPCs identified for groundwater at SWMU 41A, but PCE was identified as a COPC at SWMU 41B. Therefore, inhalation risks and hazards associated with indoor air were included in the calculations for the industrial worker at SWMU 41B. For both the ingestion and inhalation pathways, the results would have been slightly higher if the EF of 250 days/yr would have been used. However, the risk associated with groundwater would have still been within the acceptable risk range and the hazard would have been below 1.

Overall, there would have been no change to the conclusions for SWMU 41. Text will be added to the uncertainty section to explain that the industrial worker scenario represents a composite of outdoor and indoor worker exposures and to address the effects of these parameters.

- The soil-to-skin adherence factors that were applied at SWMUs 41A and 41B are consistent with factors that were recommended by USEPA in comments on the HHRA for the Rail Yard at RFAAP. The comments were dated October 2004. The comment referenced Exhibit 3-3 of U.S. EPA's *Risk Assessment Guidance for Superfund Part E, Supplemental Guidance for Dermal Risk Assessment* (RAGS Part E) (Activity Specific-Surface Area Weighted Soil Adherence Factors), which provides different adherence factors for dry and wet soil conditions. USEPA suggested that exposure scenarios involving wading activities that would result in direct exposure to sediment use wet soil adherence factor values, as outlined below.
 - Maintenance and Excavation Workers – suggested adherence factor of 0.6 mg/cm², based on “Staged Activity: Pipe Layers (wet soil)” from RAGS Part E, Exhibit 3-3.
 - Adult Residents – suggested that the adherence factor be adjusted upwards from 0.07 mg/cm². Child resident adherence factor already referenced the suggested adherence factor for wet soil conditions.

In the response, RFAAP agreed to treat all sediment exposures as “wet soil” to be conservative. The adherence factors were adjusted to reflect wet soil conditions.

An adherence factor of 0.6 mg/cm^2 was applied for the maintenance and excavation workers, as suggested. Although there are no specific adherence factors listed in Exhibit 3-3 (RAGS, Part E) for adult resident exposures to wet soil, an adherence factor of 0.2 mg/cm^2 was used. This value reflected the 95th percentile value for landscaping/rockery. It is also in the same range as the average value of adherence factors for farmers, rugby players, archaeologists, and reed gatherers (based on geometric mean) that are likely to have similar exposures to wet soil. The same value (0.2 mg/cm^2) was also used as the adherence factor (based on the geometric mean) for children playing in wet soil. The response to the comment on the Rail Yard HHRA was accepted by letter from the USEPA dated April 25, 2005.

These factors are also consistent with those applied to sediment exposures in a recent HHRA at Area P. Text from RAGS, Part E will be added to the HHRA for SWMU 41 to justify these values.

- The *Child-Specific Exposure Factors Handbook* will be reviewed to determine whether the child-specific ingestion rate for fruits and vegetables would be more conservative than the values used in the HHRA for SWMU 41. In the event that the ingestion rate is more conservative, the HHRA will be revised accordingly. Conversely, if the ingestion rate for the adult is sufficiently protective of the child, the calculations will not be revised because there would be no change in the conclusions. The potential impacts on the HHRA due to differences between the ingestion rates would then be discussed in the uncertainty section.

6. A review of the surface soil, sediment, and surface water samples collected from areas A and B showed that the largest datasets (area A sediments and surface water and area B surface soils) had a minimum of six valid sample results. The reviewer acknowledges the prior agreements among the parties which states that at least six valid sampling results are needed to calculate 95% UCLs. However, the ProUCL software gives a warning when datasets are too small ($n < 10$), thereby suggesting that the 95% UCL values used in the HHRA and SLERA may be unreliable. For example, ProUCL gave the following warning when a “dummy” dataset of six samples (all detected results) was imported into Version 4.00.02 (the version used for this risk assessment) to calculate a 95% UCL: “It should be noted that even though bootstrap may be performed on this data set, the resulting calculation may not be reliable enough to draw conclusions. It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.”

Based on this warning, it is recommended to discuss this issue in the uncertainty analysis and to evaluate how replacing the 95% UCL-based Exposure Point Concentrations (EPCs) with maximum concentrations may affect risk.

Response: Text will be added to the uncertainty section of the risk assessments discussing the implications of using maximum detected concentrations, instead of bootstrapped 95% UCLs, and how risk results would be affected.

7. The fish Bioaccumulation Factor (BAF)/Bioconcentration Factors (BCF) values used in the SLERA assume that fish are only exposed to chemicals in the surface water (water-to-fish

BAF/BCF). No consideration was given to the sediment-to-fish exposure pathway where fish are exposed to and potentially bioaccumulate Contaminants of Potential Ecological Concern (COPECs) in sediment by ingesting sediment-dwelling invertebrates or other smaller invertivorous fish which have accumulated these COPECs. Currently, 25 sediment COPECs are excluded as potential fish tissue contaminants. Omitting the sediment-to-fish BAF/BCFs could underestimate risk to the mink and great blue heron, especially since fish makes up 65% (mink) and 96% (great blue heron) of their diet. It is understood that this omission would not greatly alter the final risk conclusions given the small sizes of the two exposure areas versus the large home ranges of the mink and heron applied in the Tier 2 evaluation. This issue should, at a minimum, be recognized and discussed in terms of an uncertainty. Alternatively, the mink and the great blue heron total dietary exposure could be recalculated for a handful of the sediment COPECs using published sediment-to-fish BAF/BCFs to confirm that the risk is not underestimated. A default value of 1.0 (Tier 1) and 0.5 (Tier 2) should be considered if a sediment-to-fish BAF/BCF value is not available for specific sediment COPECs.

Response: A discussion of sediment-to-fish BAFs/BCFs and the sediment to fish pathway will be added to the uncertainty section of the SLERA. It should be noted that sediment-to-fish BAFs/BCFs are very uncertain, and are not presented in the Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (USEPA, 1999). While such factors are presented in Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities (USEPA, 2005; online HHRAP data base), they are only presented for the lipophilic compounds dioxin/furans (values range from 0.0001 to 0.09) and PCBs (value of 2.0 presented for Aroclor 1016 and 1254). In addition, these factors are for the consumption of game fish fillets by humans, not the ingestion of total fish by wildlife. Additional factors are available in The Incidence and Severity of Sediment Contamination in Surface Waters of the United States (USEPA, 1997).

Use of default Tier 1 and Tier 2 sediment-to-fish BAF/BCF values of 0.5 and 1.0 in the SLERA for chemicals without published values is not supported, as SWMU 41 COPECs (besides perhaps dioxin) are generally not lipophilic and would not be expected to bioaccumulate in fish at concentrations approximately PCBs. Therefore, the assessment of this pathway in the uncertainty section will be qualitative, unless published sediment-to-fish BAF/BCF values are readily available for important bioaccumulative compounds (USEPA, 2000) from the guidance documents listed previously.

8. The potential risk to soil- and sediment-dwelling invertebrates is evaluated using a direct contact approach. Section 7.1.8 (Approach for the Evaluation of Direct Contact Toxicity) states that, “Measured COPEC concentrations were simply compared with direct contact benchmarks appropriate for these communities. COPEC media concentrations are compared with BTAG-approved direct contact screening values, and secondarily, a variety of additional appropriate direct contact benchmarks.” This two-step process differs from the approach used in other ERAs performed for Radford Army Ammunition Plant. For example, the direct contact approach used at SWMU 13 included two steps. The first step is to calculate a Hazard Quotient (HQ) based on the ratio of the Maximum Detected Concentration (MDC) and the Toxicity Reference Value (TRV), whereas the second step is to calculate a HQ based on the ratio of the EPC and the TRV. Please explain why the direct contact approach for SWMU 41 differs from the approach used in past assessments and also confirm that this modified approach was approved by all parties involved.

Response: Different contractors (e.g., for SWMU 13) use slightly different SLERA approaches. The direct contact approach used by Shaw follows review comments received by USEPA Region 3 BTAG over the past five or so years. The direct contact information presented in the SLERA allows conclusions to be based on the assessment findings.

9. The dietary composition for the mink included terrestrial plants (18% of diet) (Table F-1 – Data used to Model Exposure in the Indicator Wildlife Species). However, the dietary composition of the mink as described in Section 7.1.3.2 (Aquatic Receptors) states that “mammals can be the mink’s most important prey year-round, but mink also hunt aquatic prey such as fish, amphibians, and crustaceans and other terrestrial prey such as birds, reptiles, and insects, depending on the season.” Based on this information, please explain why terrestrial plants were included as a dietary item for the mink.

Response: The vegetation intake of 18% is based on diet information presented in the Wildlife Exposure Factors Handbook (USEPA, 1993). Text in Section 7.1.3.2 will be revised to include this information.

SPECIFIC COMMENTS

1. **Section 2.3, Site Soil, Page 2-4:** This section discusses both natural clayey material and clay fill. It is not clear where the waste is located with respect to the natural material and added clay for both A and B. Was the rinsate added directly on the bedrock at Area A? Please indicate the approximate boundary of natural material for Area B in Figure 2-6.

Response: The text and Figure 2-6 will be revised to show that the waste at Area B was placed on natural clay and that clayey fill was placed on top of the waste material. Similarly, at Area A, the original geology consisted of natural clay and saprolite on top of the bedrock. Additional fill material was placed over the existing clay to build the area up into a relatively flat area.

2. **Section 2.4, Site Geology, Page 2-4:** The section describes dozens of borings that were completed during the 2005 RFI; however, the majority of these direct-push soil boring locations are not shown on a site figure. EPA Comment 15 on Work Plan Addendum 19 documented this same concern. In the response to EPA Comment 15, RFAAP indicated that 40 borings were installed to characterize lithology and overburden thickness; however, samples were only collected from 15 of these borings. The response further noted that “all borings (including the stratigraphic) will be shown in the RFI report.” The RFI report does not show the locations of these stratigraphic borings and no boring logs for these borings have been provided in Appendix B. Please revise the RFI to include a figure showing all borings, including those completed to characterize lithology and overburden thickness only, and provide the boring logs and all data associated with these borings.

Response: The stratigraphic boring locations and boring logs from the 2005 RFI will be added to the report.

3. **Section 2.5, Site Hydrogeology, Page 2-6:** The third paragraph notes that three attempts were made to install a permanent monitoring well at Area A; however, groundwater was not encountered in any of the boreholes. The RFI has not described the location of the boreholes, the depths that were reached, or the drilling techniques that were attempted. Please revise the RFI to include additional information on the attempts to install a permanent well at Area A. This information should also be presented in Section 3.1.6, Modifications to the Sampling Plan, where the attempts to install a groundwater monitoring well are also discussed.

Response: The three attempts were made using a hollow stem auger drill rig. All three attempts hit solid, unweathered bedrock at approximately 30 ft below ground surface. HSA was used instead of a bedrock drilling technique (ie. air rotary) because the conceptual site model for Area A suggests that groundwater at the site would be more likely to infiltrate and discharge into the unnamed tributary than infiltrate through the thick clay layer into a bedrock aquifer. The locations of the attempts will be added to Figures 2-4 and 3-1.

4. **Section 2.6.2, VI, Dames and Moore, 1992, Page 2-15:** Under the Surface Water subsection, the RFI states, “TNT was detected at a concentration [1.38 micrograms per liter (ug/l)] below its current (April 2009) adjusted tap water screening level (tw-SL).” Table 2-3, Analytes Detected in SWMU 41 Area A Surface Water Samples – 1992 VI, shows that 2,4,6-trinitrotoluene (TNT) was detected above the tw-SL of 0.22 ug/l. Please revise the text of the RFI to address this discrepancy.

Response: The text will be revised as requested.

5. **Table 2-2, Analytes Detected in SWMU 41 Area A Soil Samples – 1992 VI:** This table does not include a legend which defines the meaning of the bold/underline and red font highlighting of some values or the acronyms and abbreviations used. Please revise Table 2-3 to include a legend which defines the meaning of the highlighted values and any acronyms and abbreviations used.

Response: A legend will be added to the table.

6. **Table 2-3, Analytes Detected in SWMU 41 Area A Surface Water Samples – 1992 VI:** This table does not include a legend to define the meaning of the bold outline around the 2,4,6-TNT result or the acronyms and abbreviations used. This information is likely found in the legend presented in Table 2-4; however, for consistency, a legend should also be presented for Table 2-3. Please revise Table 2-3 to include a legend which defines the meaning of the bold outline and any acronyms and abbreviations used.

Response: A legend will be added to the table.

7. **Section 3.1.3, Groundwater, Page 3-2:** This section indicates that samples 41GW01, 41GW02, and 41GW03 were direct-push samples collected from Area A. The boring logs provided in Appendix B1 state that these wells were installed with a hollow-stem auger rather than using a direct-push drilling technique. The boring logs also show that the wells had 10-foot well screens. The response to EPA Comment 21 on Work Plan

Addendum 19 indicated the Hydropunch sampling may be performed at this SWMU 41, if necessary. Please revise the RFI to clarify the type of drilling and sampling technique that was used to collect the groundwater samples from 41GW01, 41GW02, and 41GW03. Additionally, clarify why 10-foot well screens are shown on the boring logs when the samples were supposedly collected at discrete sampling points.

Response: Borings were originally attempted with a direct push (geoprobe) rig. Water was not encountered during this attempt at any of the three locations. A hollow stem auger and hydropunch were used during a second attempt to obtain water from the base of the overburden. The hydropunches were dry when installed; however, in order to allow more time to obtain water, a 10 ft screen was placed in the hole and left for approximately three days. After that time, there was enough turbid water to collect a sample from 41GW02. This information will be added to the text.

8. **Section 3.1.6, Modifications to the Sampling Plan, Page 3-3:** Under the Groundwater subsection, it is stated that no water was present in the borings at Area A during boring advancement. The boring log for 41GW01 shows that groundwater was encountered at approximately 32 feet below grade in this boring. Please revise the RFI and/or boring logs to clarify this discrepancy.

Response: See Response to Comment 7 above. The statement as written is correct, since water was not encountered during boring advancement. Water, however, was present in the boring after leaving the borehole open for several days. Additional text will be added to clarify the original statement.

9. **Section 4.2, Soil Screening Level Comparison, Page 4-14:** This section states “Two metals (arsenic and iron) were each detected once at concentrations their SSLs and background levels in one sample (41SB4C).” Please revise the referenced sentence to state “Two metals (arsenic and iron) were each detected once at concentrations *greater than* their SSLs...”

Response: This typographical error in the text will be corrected as requested.

10. **Section 4.3, Nature and Extent Summary and Conclusions, Page 4-22:** At the end of each subsection, the RFI puts forth a statement regarding whether the specific medium (soil, sediment, etc.) is or is not considered a concern at Areas A or B. Since the human health and ecological risk assessments have not yet been presented in the document, conclusions regarding potential concern should be removed until the results of the HHRA and ERA are presented. Please revise Section 4.3 to remove conclusions regarding potential concern of site media.

Response: The text will be revised to state that based on the nature and extent of contamination and comparison with chemical specific screening levels, a chemical either does or doesn't appear to represent a concern. Additional text will also be added to the Section 4.3 that explicitly states that Human Health and Ecological Risk Assessments have been conducted and that the results of these assessments are included in Sections 6 and 7 of the report, respectively.

11. **Section 4.3.4, Groundwater, Page 4-39:** If the surface water sample is accurate (represents dissolved phase) then what are implications regarding a soil source concentration in light of the remarks regarding groundwater concentrations? Would colloidal suspensions or organic complexing be a mechanism for transport of dioxins?

Response: It is more likely that a small amount of entrained sediment was captured with the surface water. This conclusion is supported by the differences in metals detected in the total and filtered fractions of the sample. The likely transport mechanism for these hydrophobic compounds is mass transport of soil particles down the steep slope at the eastern edge of Area A.

12. **Section 5.2.7, Organic Compounds, Page 5-7:** Detailed information on the fate and transport characteristics of dioxins/furans are described in this section, but similar information for other organic risk drivers (such as PCE and 2,6-dinitrotoluene) are not presented. Since these constituents are also risk drivers, summary information for PCE and 2,6-dinitrotoluene should also be presented. Revise Section 5.2.7 to include information for PCE and 2,6-dinitrotoluene.

Response: The text will be revised as requested.

13. **Section 6.1.1, Data Summary, Page 6-3:** This section states that TCDD equivalents are calculated for surface soil, total soil, and groundwater in Appendix E-3. Based on the information presented in Appendix E-3, it appears that TCDD equivalents were also calculated for surface water and sediment. Please revise Section 6.1.1 to note that TCDD equivalents are also calculated for surface water and sediment.

Response: The text will be revised to note that TCDD equivalents were also calculated for surface water and sediment at SWMU 41A and for sediment at SWMU 41B.

14. **Section 6.1.1.1, Surface Soil and Total Soil, Page 6-3:** The third sentence states, “As presented in Table 6-1, the soil samples for SWMUs 41A and 41B have been divided into surface soil (0 to 1.0 ft bgs) and subsurface soil (typically 8 to 15 ft bgs).” Table 6-1 only divides the data into surface soil and total soil, not subsurface soil. To avoid confusion, please revise Section 6.1.1.1 to accurately document the soil sample groupings on Table 6-1.

Response: Section 6.1.1.1 will be revised to describe the surface soil and total soil sample groups shown in Table 6-1.

15. **Section 6.1.2, Identification of COPCs, Page 6-4:** The third paragraph states, “Analytes for which no screening criteria exist were also selected as COPCs.” This approach was followed for some of the chemicals but not others. It appears that screening criteria for surrogate chemicals may have been used for some chemicals for which screening criteria are not available (i.e., the screening value for 1,2,4-trichlorobenzene was used for 1,2,3-trichlorobenzene). This approach is generally acceptable; however the HHRA should discuss the use of surrogate chemicals in the COPC selection process, and clarify why the selected surrogates are considered

appropriate. Revise Section 6.1.2 to acknowledge the use of surrogates in the COPC selection process and to discuss the structure activity relationship between chemicals lacking toxicity criteria and any identified surrogates.

Response: The surrogates used in this HHRA were consistent with those selected as surrogates in the Virginia Department of Environmental Quality's (VDEQ's) risk assessment guidance (VDEQ, 2009). A brief discussion regarding the use of surrogates for chemicals lacking toxicity values will be briefly discussed in Section 6.1.2.

16. **Section 6.2.1, Conceptual Site Model/Receptor Characterization, Page 6-12:** The Appendix E tables include evaluations for several off-site receptors, including residents and industrial workers (Table E.1-59, E.1-60, E.1-63, etc.) but the off-site receptors are not mentioned in Section 6.2.1, or included on the Conceptual Site Model figures (Figures 6-1 through 6-4). Please revise the text of the RFI to describe any off-site receptors that are evaluated as part of the HHRA.

Response: Section 6.2.1 will be revised to include a discussion regarding off-site receptors.

17. **Section 6.3, Toxicity Assessment, Page 6-15:** This section indicates that the Integrated Exposure Uptake Biokinetic (IEUBK) Lead Model was used to address potential exposures to lead at SWMU 41A since lead was identified as a COPC in groundwater at this SWMU. Table 6-3, Summary of Chemicals of Potential Concern at SWMU 41B, notes that lead was also selected as a COPC in surface water at SWMU 41B, but the HHRA does not address potential lead exposures at this SWMU. Please revise the HHRA to address lead exposures at SWMU 41B since lead was selected as a COPC in surface water.

Response: As noted in the comment, lead was identified as a COPC in surface water at SWMU 41B. The maximum value of lead (29 µg/L) exceeded the drinking water action level for lead (15 µg/L). When applying the IEUBK model, the input value for the lead concentration is typically based on the arithmetic mean concentration of lead in the medium of interest. Because the arithmetic mean for lead in surface water at SWMU 41B (7.58 µg/L as shown in Table E.2-15) was below the action level, lead was not evaluated using the IEUBK model. The appropriate sections of the text will be revised to acknowledge that the maximum concentration of lead exceeded the drinking water action level and will explain the reasoning for not running the IEUBK model for SWMU 41B. A caveat will also be added to Table 6-5.

18. **Section 6.4.4, Background, Page 6-24:** This section references Appendices E-9 and E-10 for the ProUCL outputs for the background evaluations for SWMU 41A and 41B, respectively. These two appendices do not exist. The correct references are Appendices E-7 and E-8. Please revise the RFI to provide the correct references for the background evaluation ProUCL outputs.

Response: The references to the appendices will be corrected.

19. **Section 7.1.2.2, Descriptive Statistical Calculations, Page 7-7:** This section references Section 6.2.3 for more details on the use of Pro UCL. A review of Section 6.2.3 (Calculations of EPCs) found that the version of ProUCL used was 4.00.02. Please note that a more recent version (4.00.04) was released in February 2009. The latest version of ProUCL should be used in future risk assessments.

Response: Comment noted.

20. **Section 7.1.8.3, Surface Water, Page 7-22:** The USEPA National Recommended Water Quality Criteria (NRWQC) from 2006 is referenced as a source of surface water screening values. Please note that the NRWQC were updated in 2009 (<http://www.epa.gov/waterscience/criteria/wqctable/>). Comparing Tables 7-18 (Surface Water Direct contact Assessment for Aquatic Life at SWMU 41 Area A) and 7-33 (Surface Water Direct Contact Assessment for Aquatic Life at SWMU 41 Area B) with the 2009 NRWQC values indicates that the acute and chronic toxicity for copper were the only values affected by the update. Please update these values to reflect the 2009 version of NRWQC.

Response: Values will be updated, as recommended.

21. **Section 7.3.6, Uncertainty Analysis, Page 7-87:** The second paragraph on this page states, “Twenty-nine of the non-detect surface soil and 47 of the non-detect sediment constituents, and 23 of the non-detect surface water constituents had maximum detection limits that exceeded the screening criteria, respectively. These findings are not unexpected, given the conservative and numerically low screening values.” The current evaluation of the non-detects does not quantify the actual exceedances, which provide an important piece of information for risk management decision making. Please add a table showing the HQs based on dividing the maximum non-detect detection limit with the corresponding screening value. This additional information will help the reader understand the magnitude of the exceedances and their potential to cause ecological harm.

Response: Calculation of HQs based on maximum detection limits for 100 percent non-detect constituents, is not recommended, due to the fact that there is a high degree of uncertainty associated with what the potential exposure actually might be, as the concentration could range from essentially zero to the detection limit. In addition, as no further action is recommended based on the outcome of this uncertainty analysis (e.g., resampling with lower detection limits is not advised), additional evaluation, as suggested in the comment, would not provide usable information.

22. **Table 7-10, Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern for Surface Water Direct Contact Exposure at SWMU 41 Area A:** Table 7-10 shows manganese with a frequency of detection of 5/6 (# of detects/total # of samples). However, when compared to the raw surface water data presented in Table 2-7 (Analytes Detected in SMWU 41 Area A Surface Water Samples – 2005 RFI and Table 4-1 (Analytes Detected in SWMU 41 Area A Surface Water Samples – 2007 RFI manganese was only detected 3/6. Manganese was not detected in 41SW5, 41SW6, or

41SW7. Please review Table 2-7 to ensure that all of the frequencies of detections are accurate and update accordingly.

Response: Several of the samples, including 41SW5, 41SW6 and 41SW7 were analyzed for both total and dissolved metals. The FOD of 5/6 is correct for the total manganese, while the 3/6 is correct for the dissolved manganese. The ecological risk assessment uses the more conservative total metals values. Table 2-7, 4-1 and 7-10 will be double checked to ensure they are consistent.

23. Table F-42, Selection of Ecological Soil Screening Toxicity Values for SWMU 41:

This table includes all of the potential soil screening values except the 1995 BTAG values. Please include the 1995 BTAG soil screening values in this table.

Response: The 1995 BTAG soil screening values are no longer available on the BTAG website, and according to Bruce Pluta (USEPA Region 3 BTAG), they are in the process of being updated. It is therefore inappropriate to include these values in Table F-42. While the 1995 BTAG screening values are used in the direct contact assessment of detected COPECs (in addition to other screening values from other sources), this is done as a specific USEPA Region 3 BTAG requirement on previous RFAAP SLERAs prepared by Shaw.

24. Section 8.0, Summary and Conclusions, Page 8-2: This section notes that 2,3,7,8-TCDD TE was detected in two direct-push groundwater samples and in one surface water sample from SWMU 41A above the tapwater RSL (and also above the MCL in one of the groundwater samples). The RFI indicates that dioxins/furans are attributable to past practices at the site. Based on the exceedances in groundwater and surface water, it is recommended that a permanent well be installed at SWMU 41A to collect a more representative sample of the groundwater in this area (since previous sampling was conducted without a sandpack), and also to monitor site concentrations over time. It is acknowledged that the concentrations of dioxins detected in groundwater may be associated with sediment in the samples; however, the detection of dioxins in surface water, which is the likely discharge point of groundwater at the site, deems it a possibility that dioxins have impacted groundwater at elevated concentrations. Please revise the RFI to address the need for a permanent well or other appropriate monitoring point(s) at SWMU 41A.

Response: A monitoring well will be installed in the center of SWMU 41A to obtain a representative groundwater sample. The well will be installed in the bedrock aquifer underlying the site. A groundwater sample will be collected from the well and analyzed for TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans and perchlorate. The data collected from the newly installed well will be used in the human health risk assessment and will replace the data from the turbid, direct push samples collected at the site in 2007.

25. Section 8.0, Summary and Conclusions, Page 8-3: In the summary of the Human Health Risk Assessment, elevated risks are described for several receptors, and it is noted that the results of the IEUBK model indicated that lead concentrations in groundwater failed the lead exposure assessment for the future lifetime resident and child resident.

The margin-of-exposure evaluation for iron indicated that the iron intake was above the allowable range for the child resident. Page 8-7 of this same section goes on to state that the HHRA showed “limited risk to theoretical receptors...” This statement appears to contradict what is presented earlier in the same section. Please revise the RFI to address this discrepancy.

Response: The text will be reviewed and revised for clarity.

26. **Section 8.0, Summary and Conclusions, Page 8-7:** Page 8-7 states, “Overall, there appears to be minimal risk associated with current and expected future land use at this site. Unacceptable risks were calculated for hypothetical future child and lifetime residents.” While land use controls (LUCs) will be put in place to prevent residential development of SWMUs 41A and 41B, concerns exist for current and expected land use at this site. For example, cumulative cancer risks at SWMU 41A exceed 1E-06 for multiple current and future anticipated land use receptors (e.g., current maintenance worker [2E-05], future maintenance worker [2E-05], future industrial worker [1E-3], future excavation worker [2E-06], and future off-site industrial worker [9E-04]) as well as SWMU 41B (e.g., current maintenance worker [6E-06], future maintenance worker [6E-06], future industrial worker [7E-05], future excavation worker [2E-06], future off-site industrial worker [4E-05]). Many of the associated cumulative cancer risks fall within EPA’s risk range of 1E-06 to 1E-04, however, please note that while cancer risks falling within this range may be deemed acceptable by EPA, this decision is made on a site-specific basis. The ultimate decision regarding an “acceptable” level of residual risk lies with the EPA Risk Manager. Please omit the statement referenced at the beginning of this comment from the RFI Report.

Additionally, cumulative cancer risk for future on-site industrial workers (1E-3) and future off-site industrial workers (9E-04) at SWMU 41A exceed the upper bound (1E-04) of EPA’s risk range and the total hazard indices (HI) exceed 1.0 for several anticipated receptors based on current and future expected land use at SWMU 41A (e.g., future industrial worker [HI=30], future excavation worker [HI=2], future off-site industrial worker [HI=30],) and SWMU 41B (e.g., future industrial worker [HI=2] and future excavation worker [HI=2]). Please revise the “Conclusions and Recommendations” to omit the statement, “The results of the investigations to date and the results of the risk assessment indicate that there is little risk associated with the expected future land use at this site.” Alternatively, please justify disregarding the aforementioned cumulative risk and hazards that exceed EPA limits from further consideration in a subsequent Feasibility Study and reference appropriate sections of the HHRA where further detail is included.

Response: The land use in the future is expected to stay the same as the current land use (grass is mown 3-4 times/year). For the HHRA it was conservatively assumed that the current and future maintenance worker would mow the grass at the site once per week for a total of 50 days/year (based on two weeks of vacation). Hypothetical future receptors (industrial workers, construction workers, and hypothetical residents) were evaluated using site specific data and standard risk assessment exposure parameters for each scenario. These receptors are evaluated in a consistent manner so that risks at various sites can be compared. However, the use of these standard assumptions (ie. number of days onsite; hours per day; etc.) is not consistent with the actual exposures that can be

expected onsite. For example, it was conservatively assumed that a future hypothetical industrial worker would work outdoors at the site for 225 days/year over a 25-year period. It is highly unlikely that one individual would continuously work at SWMU 41 for this frequency and duration.

As stated within the comment, these decisions are made on a case-by-case basis and should take into account the actual, expected land use rather than the standard risk assessment assumptions. Given the fact that the risks and hazard were within, or only slightly above, the EPA's risk range even when very conservative risk assessment parameters are used, Institutional Controls to prevent residential development and groundwater extraction and use are protective of human health and the environment.

Leahy, Timothy

From: Geiger.William@epamail.epa.gov
Sent: Friday, May 21, 2010 3:24 PM
To: McKenna, Jim J Mr CIV USA AMC
Cc: Parks, Jeffrey; jeremy.flint@atk.com; jerome.redder@atk.com; jlcutler@deq.virginia.gov; Mendoza, Richard R Mr CIV USA IMCOM; Leahy, Timothy; Meyer, Tom NAB02
Subject: SWMU 41 RFI Comments (UNCLASSIFIED)
Attachments: SWMU 41 comments.doc

Here are EPA/VDEQ comments on the SWMU 41 RFI. Please call or email me with any questions.

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

Presented below are EPA/VDEQ comments on the Draft *SWMU 41 RCRA Facility Investigation Report* for the Radford Army Ammunition Plant (RFAAP) located in Radford, Virginia, dated November 2009 (hereinafter referred to as the RFI).

GENERAL COMMENTS

1. *Master Work Plan Addendum 19: SWMU 48, SWMU 49, SWMU 50, SWMU 59, SWMU 41, Area O, FLFA, SWMU 43, Area P (Work Plan Addendum 19)*, dated July 2007, Page 3-16, indicates that “At the northeast corner of Area B, a small area of buried material (less than 1 foot thick and 3 feet wide) is exposed underneath an overhang of fill material where a small area of fill material has slumped away.” The RFI does not include this description, or otherwise describe the current condition of this area. However, the RFI does indicate that the clayey fill placed at Area B “acts as a soil cap....preventing downward migration of the constituents present in soil as a result of former disposal activities” (Page 8-3). If the integrity of the “clayey fill cap” is deteriorating in certain portions of the Solid Waste Management Unit (SWMU), its effectiveness at preventing future downward migration of constituents in soil may also be affected. It is also unclear as to whether a sample of the exposed material was collected, and included in the risk assessments. If buried material is exposed, there may be potential risks to current receptors that have not been quantified adequately (i.e., since surface soil only was evaluated for current receptors). Please revise the RFI to describe the current condition of SWMU 41B including any areas where buried material may be exposed, and to address the concerns noted above.
2. Continued groundwater monitoring has not been proposed as part of the long-term monitoring of the site, but justification for this approach has not been provided. Several constituents were detected above screening criteria (tapwater Regional Screening Levels [RSLs] and/or maximum contaminant levels [MCLs]) in groundwater at both SWMU 41A and 41B, and tetrachloroethylene (PCE), arsenic, TCDD TE, and 2,6-dinitrotoluene were found to be risk drivers in the HHRA. It appears that future groundwater monitoring may be warranted, and installation of permanent wells or other appropriate monitoring points at SWMU 41A should be considered. Please revise the RFI to provide justification for not proposing long-term groundwater monitoring at SWMU 41A and 41B, or alternatively, propose a long-term groundwater monitoring program at the site.
3. Section 6.1.2, Identification of [Chemicals of Potential Concern] COPCs, indicates that maximum detected concentrations (MDCs) of constituents in surface water were compared to the tapwater Regional Screening Levels (RSLs), presented in the April 2009 RSL Tables, to select or eliminate COPCs in surface water, and MDCs of constituents in sediment were compared to the residential soil RSLs to select or eliminate COPCs in sediment. However, Appendix E Tables E.1-8 and E.2-8 indicate that the tapwater RSLs were increased by a factor of 10 to account for surface water exposures. Additionally, Appendix E Tables E.1-6 and E.2-6 indicate that the residential soil RSLs were also increased by a factor of 10. Please revise this section of the RFI to include the rationale and supporting references for the adjustments made to the sediment and surface water RSLs.

4. Several of the Appendix E tables apparently have been revised (as noted by the electronic file names on the CD that accompanies the hard copy RFI report), and two sets of the same table are presented for some of the tables. For example, the file “App E 1_RAGS Spreadsheets_1-66_SWMU41A” includes Tables E.1-3 through Tables E.1-10, but these same table numbers are also presented in the file “App E 1_RAGS Spreadsheets_SWMU41A_revised tables only.” To avoid confusion, please ensure that the final RFI report includes only one version of each table, and the tables are presented in numerical order, preferably in one Excel file.
5. While most of the exposure factors used in the human health risk assessment (HHRA) have been appropriately obtained from applicable guidance documents, several exposure factors were used without sufficient justification. Please revise the HHRA to address the following:
 - The exposure frequency (EF) selected for an excavation worker is 125 days/year, which according to the Appendix E tables, is a value from EPA’s 2002 *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*, OSWER 9355.4-24 (SSL Guidance). However, the default EF for a construction worker listed in the SSL Guidance is 250 days/year (Exhibit 5-1). Please revise the HHRA to use the default EF of 250 days/year or provide additional justification for using an EF of 125 days/year.
 - The EF selected for the industrial worker is 225 days/yr for both an indoor industrial worker and outdoor industrial worker. However, EPA’s 2004 *Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* (RAGS Part E), *Exhibit 3-5, specifies an EF of 250 days/year should be used for evaluating reasonable maximum exposure (RME) to industrial workers*. Revise the HHRA to use the default EF of 250 days/year for an indoor industrial worker, or provide additional justification for using an EF of 225 days.
 - A soil to skin adherence factor (SSAF) of 0.6 mg/cm²-day was selected for the maintenance worker, outdoor industrial worker, and excavation worker (Table E.1-27 cites EPA RAGS Part E). EPA RAGS Part E does not have an established SSAF for sediment exposures. Please revise the HHRA to justify the use of the aforementioned SSAF in evaluating sediment exposures to on-site workers. Additionally, an SSAF of 0.2 mg/cm²-day was selected for residents, however, given the increased moisture content of sediment and the increased ability to adhere to skin, a higher SSAF should be selected to evaluate sediment dermal exposure to residents, especially for the wading scenario. Please revise the HHRA accordingly and note that the weighted soil adherence factor for children playing in wet soil is 3.3 mg/cm²-day (Exhibit 3-3, RAGS Part F).
 - The ingestion rate of produce was extracted from the 1997 *Exposure Factors Handbook*, Volume I (EPA/600/P-95/002Fa), with the same value (18.6 g/d) being used for both the adult and child receptor. Please note that EPA’s *Child-Specific Exposure Factors Handbook*, Final Report, dated 2008, (EPA/600/R-06/096F) includes produce ingestion rates specific to the child receptor. Revise the HHRA to use a child-specific produce ingestion rate.

6. A review of the surface soil, sediment, and surface water samples collected from areas A and B showed that the largest datasets (area A sediments and surface water and area B surface soils) had a minimum of six valid sample results. The reviewer acknowledges the prior agreements among the parties which states that at least six valid sampling results are needed to calculate 95% UCLs. However, the ProUCL software gives a warning when datasets are too small ($n < 10$), thereby suggesting that the 95% UCL values used in the HHRA and SLERA may be unreliable. For example, ProUCL gave the following warning when a “dummy” dataset of six samples (all detected results) was imported into Version 4.00.02 (the version used for this risk assessment) to calculate a 95% UCL: “It should be noted that even though bootstrap may be performed on this data set, the resulting calculation may not be reliable enough to draw conclusions. It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.”

Based on this warning, it is recommended to discuss this issue in the uncertainty analysis and to evaluate how replacing the 95% UCL-based Exposure Point Concentrations (EPCs) with maximum concentrations may affect risk.

7. The fish Bioaccumulation Factor (BAF)/Bioconcentration Factors (BCF) values used in the SLERA assume that fish are only exposed to chemicals in the surface water (water-to-fish BAF/BCF). No consideration was given to the sediment-to-fish exposure pathway where fish are exposed to and potentially bioaccumulate Contaminants of Potential Ecological Concern (COPECs) in sediment by ingesting sediment-dwelling invertebrates or other smaller invertivorous fish which have accumulated these COPECs. Currently, 25 sediment COPECs are excluded as potential fish tissue contaminants. Omitting the sediment-to-fish BAF/BCFs could underestimate risk to the mink and great blue heron, especially since fish makes up 65% (mink) and 96% (great blue heron) of their diet. It is understood that this omission would not greatly alter the final risk conclusions given the small sizes of the two exposure areas versus the large home ranges of the mink and heron applied in the Tier 2 evaluation. This issue should, at a minimum, be recognized and discussed in terms of an uncertainty. Alternatively, the mink and the great blue heron total dietary exposure could be recalculated for a handful of the sediment COPECs using published sediment-to-fish BAF/BCFs to confirm that the risk is not underestimated. A default value of 1.0 (Tier 1) and 0.5 (Tier 2) should be considered if a sediment-to-fish BAF/BCF value is not available for specific sediment COPECs.
8. The potential risk to soil- and sediment-dwelling invertebrates is evaluated using a direct contact approach. Section 7.1.8 (Approach for the Evaluation of Direct Contact Toxicity) states that, “Measured COPEC concentrations were simply compared with direct contact benchmarks appropriate for these communities. COPEC media concentrations are compared with BTAG-approved direct contact screening values, and secondarily, a variety of additional appropriate direct contact benchmarks.” This two-step process differs from the approach used in other ERAs performed for Radford Army Ammunition Plant. For example, the direct contact approach used at SWMU 13 included two steps. The first step is to calculate a Hazard Quotient (HQ) based on the ratio of the Maximum Detected Concentration (MDC) and the Toxicity Reference Value (TRV), whereas the second step is to calculate a HQ based on the ratio of the EPC and the TRV. Please explain why the direct contact approach for SWMU 41 differs from the approach used in past assessments and also confirm that this modified approach was approved by all parties involved.
9. The dietary composition for the mink included terrestrial plants (18% of diet) (Table F-1 – Data

used to Model Exposure in the Indicator Wildlife Species). However, the dietary composition of the mink as described in Section 7.1.3.2 (Aquatic Receptors) states that “mammals can be the mink’s most important prey year-round, but mink also hunt aquatic prey such as fish, amphibians, and crustaceans and other terrestrial prey such as birds, reptiles, and insects, depending on the season.” Based on this information, please explain why terrestrial plants were included as a dietary item for the mink.

SPECIFIC COMMENTS

1. **Section 2.3, Site Soil, Page 2-4:** This section discusses both natural clayey material and clay fill. It is not clear where the waste is located with respect to the natural material and added clay for both A and B. Was the rinsate added directly on the bedrock at Area A? Please indicate the approximate boundary of natural material for Area B in Figure 2-6.
2. **Section 2.4, Site Geology, Page 2-4:** The section describes dozens of borings that were completed during the 2005 RFI; however, the majority of these direct-push soil boring locations are not shown on a site figure. EPA Comment 15 on Work Plan Addendum 19 documented this same concern. In the response to EPA Comment 15, RFAAP indicated that 40 borings were installed to characterize lithology and overburden thickness; however, samples were only collected from 15 of these borings. The response further noted that “all borings (including the stratigraphic) will be shown in the RFI report.” The RFI report does not show the locations of these stratigraphic borings and no boring logs for these borings have been provided in Appendix B. Please revise the RFI to include a figure showing all borings, including those completed to characterize lithology and overburden thickness only, and provide the boring logs and all data associated with these borings.
3. **Section 2.5, Site Hydrogeology, Page 2-6:** The third paragraph notes that three attempts were made to install a permanent monitoring well at Area A; however, groundwater was not encountered in any of the boreholes. The RFI has not described the location of the boreholes, the depths that were reached, or the drilling techniques that were attempted. Please revise the RFI to include additional information on the attempts to install a permanent well at Area A. This information should also be presented in Section 3.1.6, Modifications to the Sampling Plan, where the attempts to install a groundwater monitoring well are also discussed.
4. **Section 2.6.2, VI, Dames and Moore, 1992, Page 2-15:** Under the Surface Water subsection, the RFI states, “TNT was detected at a concentration [1.38 micrograms per liter (ug/l)] below its current (April 2009) adjusted tap water screening level (tw-SL).” Table 2-3, Analytes Detected in SWMU 41 Area A Surface Water Samples – 1992 VI, shows that 2,4,6-trinitrotoluene (TNT) was detected above the tw-SL of 0.22 ug/l. Please revise the text of the RFI to address this discrepancy.
5. **Table 2-2, Analytes Detected in SWMU 41 Area A Soil Samples – 1992 VI:** This table does not include a legend which defines the meaning of the bold/underline and red font highlighting of some values or the acronyms and abbreviations used. Please revise Table 2-3 to include a legend which defines the meaning of the highlighted values and any acronyms and abbreviations used.

6. **Table 2-3, Analytes Detected in SWMU 41 Area A Surface Water Samples – 1992 VI:** This table does not include a legend to define the meaning of the bold outline around the 2,4,6-TNT result or the acronyms and abbreviations used. This information is likely found in the legend presented in Table 2-4; however, for consistency, a legend should also be presented for Table 2-3. Please revise Table 2-3 to include a legend which defines the meaning of the bold outline and any acronyms and abbreviations used.
7. **Section 3.1.3, Groundwater, Page 3-2:** This section indicates that samples 41GW01, 41GW02, and 41GW03 were direct-push samples collected from Area A. The boring logs provided in Appendix B1 state that these wells were installed with a hollow-stem auger rather than using a direct-push drilling technique. The boring logs also show that the wells had 10-foot well screens. The response to EPA Comment 21 on Work Plan Addendum 19 indicated the Hydropunch sampling may be performed at this SWMU 41, if necessary. Please revise the RFI to clarify the type of drilling and sampling technique that was used to collect the groundwater samples from 41GW01, 41GW02, and 41GW03. Additionally, clarify why 10-foot well screens are shown on the boring logs when the samples were supposedly collected at discrete sampling points.
8. **Section 3.1.6, Modifications to the Sampling Plan, Page 3-3:** Under the Groundwater subsection, it is stated that no water was present in the borings at Area A during boring advancement. The boring log for 41GW01 shows that groundwater was encountered at approximately 32 feet below grade in this boring. Please revise the RFI and/or boring logs to clarify this discrepancy.
9. **Section 4.2, Soil Screening Level Comparison, Page 4-14:** This section states “Two metals (arsenic and iron) were each detected once at concentrations their SSLs and background levels in one sample (41SB4C).” Please revise the referenced sentence to state “Two metals (arsenic and iron) were each detected once at concentrations *greater than* their SSLs...”
10. **Section 4.3, Nature and Extent Summary and Conclusions, Page 4-22:** At the end of each subsection, the RFI puts forth a statement regarding whether the specific medium (soil, sediment, etc.) is or is not considered a concern at Areas A or B. Since the human health and ecological risk assessments have not yet been presented in the document, conclusions regarding potential concern should be removed until the results of the HHRA and ERA are presented. Please revise Section 4.3 to remove conclusions regarding potential concern of site media.
11. **Section 4.3.4, Groundwater, Page 4-39:** If the surface water sample is accurate (represents dissolved phase) then what are implications regarding a soil source concentration in light of the remarks regarding groundwater concentrations? Would colloidal suspensions or organic complexing be a mechanism for transport of dioxins?
12. **Section 5.2.7, Organic Compounds, Page 5-7:** Detailed information on the fate and transport characteristics of dioxins/furans are described in this section, but similar information for other organic risk drivers (such as PCE and 2,6-dinitrotoluene) are not presented. Since these constituents are also risk drivers, summary information for PCE

and 2,6-dinitrotoluene should also be presented. Revise Section 5.2.7 to include information for PCE and 2,6-dinitrotoluene.

13. **Section 6.1.1, Data Summary, Page 6-3:** This section states that TCDD equivalents are calculated for surface soil, total soil, and groundwater in Appendix E-3. Based on the information presented in Appendix E-3, it appears that TCDD equivalents were also calculated for surface water and sediment. Please revise Section 6.1.1 to note that TCDD equivalents are also calculated for surface water and sediment.
14. **Section 6.1.1.1, Surface Soil and Total Soil, Page 6-3:** The third sentence states, “As presented in Table 6-1, the soil samples for SWMUs 41A and 41B have been divided into surface soil (0 to 1.0 ft bgs) and subsurface soil (typically 8 to 15 ft bgs).” Table 6-1 only divides the data into surface soil and total soil, not subsurface soil. To avoid confusion, please revise Section 6.1.1.1 to accurately document the soil sample groupings on Table 6-1.
15. **Section 6.1.2, Identification of COPCs, Page 6-4:** The third paragraph states, “Analytes for which no screening criteria exist were also selected as COPCs.” This approach was followed for some of the chemicals but not others. It appears that screening criteria for surrogate chemicals may have been used for some chemicals for which screening criteria are not available (i.e., the screening value for 1,2,4-trichlorobenzene was used for 1,2,3-trichlorobenzene). This approach is generally acceptable; however the HHRA should discuss the use of surrogate chemicals in the COPC selection process, and clarify why the selected surrogates are considered appropriate. Revise Section 6.1.2 to acknowledge the use of surrogates in the COPC selection process and to discuss the structure activity relationship between chemicals lacking toxicity criteria and any identified surrogates.
16. **Section 6.2.1, Conceptual Site Model/Receptor Characterization, Page 6-12:** The Appendix E tables include evaluations for several off-site receptors, including residents and industrial workers (Table E.1-59, E.1-60, E.1-63, etc.) but the off-site receptors are not mentioned in Section 6.2.1, or included on the Conceptual Site Model figures (Figures 6-1 through 6-4). Please revise the text of the RFI to describe any off-site receptors that are evaluated as part of the HHRA.
17. **Section 6.3, Toxicity Assessment, Page 6-15:** This section indicates that the Integrated Exposure Uptake Biokinetic (IEUBK) Lead Model was used to address potential exposures to lead at SWMU 41A since lead was identified as a COPC in groundwater at this SWMU. Table 6-3, Summary of Chemicals of Potential Concern at SWMU 41B, notes that lead was also selected as a COPC in surface water at SWMU 41B, but the HHRA does not address potential lead exposures at this SWMU. Please revise the HHRA to address lead exposures at SWMU 41B since lead was selected as a COPC in surface water.
18. **Section 6.4.4, Background, Page 6-24:** This section references Appendices E-9 and E-10 for the ProUCL outputs for the background evaluations for SWMU 41A and 41B, respectively. These two appendices do not exist. The correct references are Appendices

E-7 and E-8. Please revise the RFI to provide the correct references for the background evaluation ProUCL outputs.

19. **Section 7.1.2.2, Descriptive Statistical Calculations, Page 7-7:** This section references Section 6.2.3 for more details on the use of Pro UCL. A review of Section 6.2.3 (Calculations of EPCs) found that the version of ProUCL used was 4.00.02. Please note that a more recent version (4.00.04) was released in February 2009. The latest version of ProUCL should be used in future risk assessments.
20. **Section 7.1.8.3, Surface Water, Page 7-22:** The USEPA National Recommended Water Quality Criteria (NRWQC) from 2006 is referenced as a source of surface water screening values. Please note that the NRWQC were updated in 2009 (<http://www.epa.gov/waterscience/criteria/wqctable/>). Comparing Tables 7-18 (Surface Water Direct contact Assessment for Aquatic Life at SWMU 41 Area A) and 7-33 (Surface Water Direct Contact Assessment for Aquatic Life at SWMU 41 Area B) with the 2009 NRWQC values indicates that the acute and chronic toxicity for copper were the only values affected by the update. Please update these values to reflect the 2009 version of NRWQC.
21. **Section 7.3.6, Uncertainty Analysis, Page 7-87:** The second paragraph on this page states, “Twenty-nine of the non-detect surface soil and 47 of the non-detect sediment constituents, and 23 of the non-detect surface water constituents had maximum detection limits that exceeded the screening criteria, respectively. These finding are not unexpected, given the conservative and numerically low screening values.” The current evaluation of the non-detects does not quantify the actual exceedances, which provide an important piece of information for risk management decision making. Please add a table showing the HQs based on dividing the maximum non-detect detection limit with the corresponding screening value. This additional information will help the reader understand the magnitude of the exceedances and their potential to cause ecological harm.
22. **Table 7-10, Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern for Surface Water Direct Contact Exposure at SWMU 41 Area A:** Table 7-10 shows manganese with a frequency of detection of 5/6 (# of detects/total # of samples). However, when compared to the raw surface water data presented in Table 2-7 (Analytes Detected in SMWU 41 Area A Surface Water Samples – 2005 RFI and Table 4-1 (Analytes Detected in SWMU 41 Area A Surface Water Samples – 2007 RFI manganese was only detected 3/6. Manganese was not detected in 41SW5, 41SW6, or 41SW7. Please review Table 2-7 to ensure that all of the frequencies of detections are accurate and update accordingly.
23. **Table F-42, Selection of Ecological Soil Screening Toxicity Values for SWMU 41:** This table includes all of the potential soil screening values except the 1995 BTAG values. Please include the 1995 BTAG soil screening values in this table.
24. **Section 8.0, Summary and Conclusions, Page 8-2:** This section notes that 2,3,7,8-TCDD TE was detected in two direct-push groundwater samples and in one surface water sample from SWMU 41A above the tapwater RSL (and also above the MCL in one of the

groundwater samples). The RFI indicates that dioxins/furans are attributable to past practices at the site. Based on the exceedances in groundwater and surface water, it is recommended that a permanent well be installed at SWMU 41A to collect a more representative sample of the groundwater in this area (since previous sampling was conducted without a sandpack), and also to monitor site concentrations over time. It is acknowledged that the concentrations of dioxins detected in groundwater may be associated with sediment in the samples; however, the detection of dioxins in surface water, which is the likely discharge point of groundwater at the site, deems it a possibility that dioxins have impacted groundwater at elevated concentrations. Please revise the RFI to address the need for a permanent well or other appropriate monitoring point(s) at SWMU 41A.

25. **Section 8.0, Summary and Conclusions, Page 8-3:** In the summary of the Human Health Risk Assessment, elevated risks are described for several receptors, and it is noted that the results of the IEUBK model indicated that lead concentrations in groundwater failed the lead exposure assessment for the future lifetime resident and child resident. The margin-of-exposure evaluation for iron indicated that the iron intake was above the allowable range for the child resident. Page 8-7 of this same section goes on to state that the HHRA showed “limited risk to theoretical receptors...” This statement appears to contradict what is presented earlier in the same section. Please revise the RFI to address this discrepancy.
26. **Section 8.0, Summary and Conclusions, Page 8-7:** Page 8-7 states, “Overall, there appears to be minimal risk associated with current and expected future land use at this site. Unacceptable risks were calculated for hypothetical future child and lifetime residents.” While land use controls (LUCs) will be put in place to prevent residential development of SWMUs 41A and 41B, concerns exist for current and expected land use at this site. For example, cumulative cancer risks at SWMU 41A exceed 1E-06 for multiple current and future anticipated land use receptors (e.g., current maintenance worker [2E-05], future maintenance worker [2E-05], future industrial worker [1E-3], future excavation worker [2E-06], and future off-site industrial worker [9E-04]) as well as SWMU 41B (e.g., current maintenance worker [6E-06], future maintenance worker [6E-06], future industrial worker [7E-05], future excavation worker [2E-06], future off-site industrial worker [4E-05]). Many of the associated cumulative cancer risks fall within EPA’s risk range of 1E-06 to 1E-04, however, please note that while cancer risks falling within this range may be deemed acceptable by EPA, this decision is made on a site-specific basis. The ultimate decision regarding an “acceptable” level of residual risk lies with the EPA Risk Manager. Please omit the statement referenced at the beginning of this comment from the RFI Report.

Additionally, cumulative cancer risk for future on-site industrial workers (1E-3) and future off-site industrial workers (9E-04) at SWMU 41A exceed the upper bound (1E-04) of EPA’s risk range and the total hazard indices (HI) exceed 1.0 for several anticipated receptors based on current and future expected land use at SWMU 41A (e.g., future industrial worker [HI=30], future excavation worker [HI=2], future off-site industrial worker [HI=30],) and SWMU 41B (e.g., future industrial worker [HI=2] and future excavation worker [HI=2]). Please revise the “Conclusions and Recommendations” to omit the statement, “The results of the investigations to date and the results of the risk

assessment indicate that there is little risk associated with the expected future land use at this site.” Alternatively, please justify disregarding the aforementioned cumulative risk and hazards that exceed EPA limits from further consideration in a subsequent Feasibility Study and reference appropriate sections of the HHRA where further detail is included.



DEPARTMENT OF THE ARMY
US ARMY PUBLIC HEALTH COMMAND (PROVISIONAL)
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MD 21010-5403

MCHB-TS-REH

17 JAN 2010

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

SUBJECT: Draft RCRA Facility Investigation Report for SWMU-41, Radford Army
Ammunition Plant, Virginia, November 2009

1. The US Army Public Health Command (Provisional), formerly the US Army Center for Health Promotion and Preventive Medicine, reviewed the subject document on behalf of the Office of The Surgeon General pursuant to Army Regulation 200-1 (Environmental Protection and Enhancement). We appreciate the opportunity to review the report.
2. Our previous comment has been addressed and we have no further comments.
3. The document was reviewed by Mr. Dennis Druck, Environmental Health Risk Assessment Program. He can be reached at DSN 584-2953, commercial (410) 436-2953 or electronic mail, dennis.druck@us.army.mil.

FOR THE COMMANDER:

A handwritten signature in cursive script, reading "Jeffrey S. Kirkpatrick", is positioned above the printed name.

JEFFREY S. KIRKPATRICK
Director, Health Risk Management

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



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

www.atk.com

December 10, 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, SWMU 41 RCRA Facility Investigation Report, Draft Document November 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 December 9, 2009. Also enclosed is the 9 December 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.

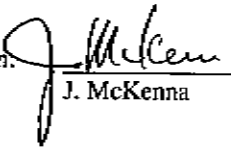
c: Karen Sismour
Virginia Department of Environmental Quality
P. O. Box 10009
Richmond, VA 23240-0009

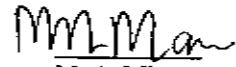
E. A. Lohman
Virginia Department of Environmental Quality
Blue Ridge Regional Office
3019 Peters Creek Road
Roanoke, VA 24019

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

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

Concerning the following:

Radford Army Ammunition Plant
SWMU41
RCRA Facility Investigation Report
Draft November 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:

TITLE:



Antonio Munera

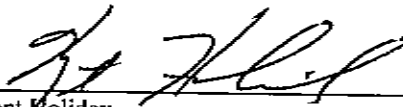
LTC, CM

Commanding

SIGNATURE:

PRINTED NAME:

TITLE:



Kent Holiday

Vice President and General Manager

ATK Energetics Systems

Greene, Anne

From: McKenna, Jim J Mr CIV USA AMC [jim.mckenna@us.army.mil]
Sent: Wednesday, December 09, 2009 4:19 PM
To: Anne Greene; dennis.druck@us.army.mil; diane.wisbeck@arcadis-us.com; durwood willis2; Geiger.William@epamail.epa.gov; jerome.redder@atk.com; jlm spencer; jlcutler@deq.virginia.gov; Karen Sismour; 'Llewellyn, Tim'; Lohman,Elizabeth; Mendoza, Rich; Meyer, Tom NAB02; Parks, Jeffrey N; Timothy.Leahy@shawgrp.com; Tina_MacGillivray@URSCorp.com
Subject: Draft SWMU 41 RFI Report November 2009 (UNCLASSIFIED)
Importance: High

Classification: UNCLASSIFIED
Caveats: FOUO

All:

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

A certification letter will follow.

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

Jim McKenna

Jim McKenna	1Z63V8841395974448
Mr. Richard Mendoza	1Z63V8841393772179
Mr. Tom Meyer	1Z63V8841390239564
Mr. Dennis Druck	1Z63V8841393387345
Mr. James Cutler	1Z63V8841391689540
Ms. Elizabeth Lohman	1Z63V8841390200158
Mr. William Geiger	1Z63V8841391749930

Classification: UNCLASSIFIED
Caveats: FOUO

Classification: UNCLASSIFIED
Caveats: FOUO



DEPARTMENT OF THE ARMY
US ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND MD 21010-5403

MCHB-TS-REH

31 AUG 2009

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

SUBJECT: Draft RCRA Facility Investigation Report for SWMU 41, Radford Army
Ammunition Plant, Virginia, July 2009

1. The US Army Center for Health Promotion and Preventive Medicine reviewed the subject document on behalf of the Office of The Surgeon General pursuant to Army Regulation 200-1 (Environmental Protection and Enhancement). We appreciate the opportunity to review this report.
2. We concur with the recommendations for this site as being protective of human health and the environment.
3. The document was reviewed by Mr. Dennis Druck, Environmental Health Risk Assessment Program. He can be reached at DSN 584-2953, commercial (410) 436-2953 or electronic mail, dennis.druck@us.army.mil.

FOR THE COMMANDER:

JEFFREY S. KIRKPATRICK
Director, Health Risk Management

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

TABLE OF CONTENTS

<i>Section</i>	<i>Page</i>
EXECUTIVE SUMMARY	ES-1
1.0 INTRODUCTION	1-1
2.0 SITE BACKGROUND.....	2-1
2.1 Site Description.....	2-1
2.2 Site History and Operations	2-1
2.3 Site Soil	2-4
2.4 Site Geology.....	2-4
2.5 Site Hydrogeology	2-6
2.6 Previous Investigations	2-12
2.6.1 Installation Assessment (Aerial Photo Interpretation), 1992.....	2-12
2.6.2 VI, Dames and Moore, 1992.....	2-16
2.6.3 Geophysical Survey, ANL, 2002	2-16
2.6.4 RFI, URS Corporation, 2005	2-21
3.0 FIELD INVESTIGATION PROGRAM	3-1
3.1 RFI, Shaw, 2007 and 2010.....	3-2
3.1.1 Surface Water.....	3-2
3.1.2 Sediment	3-2
3.1.3 Groundwater	3-2
3.1.4 Global Positioning System Activities	3-3
3.1.5 Quality Assurance.....	3-3
3.1.6 Modifications to the Sampling Plan.....	3-3
4.0 NATURE AND EXTENT OF CONTAMINATION.....	4-1
4.1 RFI, Shaw, 2007 and 2010.....	4-1
4.1.1 Surface Water Analytical Results	4-1
4.1.2 Sediment Analytical Results	4-5
4.1.3 Groundwater Analytical Results.....	4-5
4.2 Soil Screening Level Comparison	4-19
4.3 Nature and Extent Summary and Conclusions	4-27
4.3.1 Soil	4-27
4.3.2 Surface Water.....	4-33
4.3.3 Sediment	4-38
4.3.4 Groundwater	4-44
5.0 CONTAMINANT FATE AND TRANSPORT	5-1
5.1 Soil Properties Affecting Fate and Transport	5-1
5.2 Fate and Transport of Analytes Detected Above Screening Levels	5-3
5.2.1 Inorganic Compounds.....	5-3
5.2.2 Aluminum	5-4
5.2.3 Arsenic	5-4
5.2.4 Cobalt.....	5-5

5.2.5	Iron	5-6
5.2.6	Manganese	5-6
5.2.7	Organic Compounds	5-7
6.0	HUMAN HEALTH RISK ASSESSMENT	6-1
6.1	Data Summary and Selection of COPCs	6-1
6.1.1	Data Summary	6-1
6.1.2	Identification of COPCs.....	6-4
6.2	Exposure Assessment.....	6-5
6.2.1	Conceptual Site Model/Receptor Characterization.....	6-5
6.2.2	Identification of Exposure Pathways	6-13
6.2.3	Calculation of EPCs	6-13
6.2.4	Quantification of Exposure: Calculation of Daily Intakes.....	6-13
6.3	Toxicity Assessment	6-15
6.3.1	Calculations for COPCs with Mutagenic Mode of Action	6-15
6.3.2	Evaluation of Lead.....	6-16
6.4	Risk Characterization.....	6-17
6.4.1	Iron Margin of Exposure Evaluation	6-23
6.4.2	Background.....	6-23
6.5	Uncertainties	6-28
6.5.1	Environmental Sampling and Analysis.....	6-28
6.5.2	Selection of Chemicals for Evaluation	6-29
6.5.3	Exposure Assessment.....	6-33
6.5.4	Toxicological Data.....	6-41
6.5.5	Risk Characterization.....	6-44
6.6	HHRA Summary and Conclusions	6-44
6.6.1	SWMU 41A Summary.....	6-44
6.6.2	SWMU 41B Summary.....	6-46
7.0	SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT.....	7-1
7.1	SLERA Methods and Procedures	7-1
7.1.1	General SWMU 41 Area A and Area B Site Characterization.....	7-2
7.1.2	Methodologies for the Identification of COPECs and Concentration Statistics	7-6
7.1.3	Identification of Exposure Pathways and Potential Receptors for Analysis.....	7-8
7.1.4	Identification of Assessment and Measurement Endpoints	7-13
7.1.5	Exposure Estimation	7-15
7.1.6	Ecological Effects Characterization.....	7-18
7.1.7	Risk Characterization.....	7-19
7.1.8	Approach for the Evaluation of Direct Contact Toxicity.....	7-20
7.1.9	Background Metals Considerations	7-22
7.1.10	General Uncertainty Analysis	7-22
7.2	SWMU 41, Area A, Screening Level Ecological Risk Assessment.....	7-25
7.2.1	Site Characterization.....	7-25
7.2.2	Summary of COPEC Selection.....	7-25
7.2.3	Risk Characterization.....	7-40

7.2.4	Approach for the Evaluation of Direct Contact Toxicity.....	7-48
7.2.5	Background Metals Considerations	7-55
7.2.6	Uncertainty Analysis.....	7-56
7.2.7	SLERA Results and Conclusions.....	7-58
7.3	SWMU 41, Area B, Screening Level Ecological Risk Assessment	7-59
7.3.1	Site Characterization.....	7-59
7.3.2	Summary of COPEC Selection.....	7-59
7.3.3	Risk Characterization.....	7-70
7.3.4	Approach for the Evaluation of Direct Contact Toxicity.....	7-79
7.3.5	Background Metals Considerations	7-87
7.3.6	Uncertainty Analysis.....	7-88
7.3.7	SLERA Results and Conclusions.....	7-90
8.0	SUMMARY AND CONCLUSIONS.....	8-1
9.0	REFERENCES	9-1

LIST OF TABLES

	<i>Page</i>
Table 2-1	Previous Investigations Samples and Analyses 2-13
Table 2-2	Analytes Detected in SWMU 41 Area A Soil Samples – 1992 VI..... 2-17
Table 2-3	Analytes Detected in SWMU 41 Area A Surface Water Samples – 1992 VI 2-18
Table 2-4	Analytes Detected in SWMU 41 Groundwater Samples – 1992 VI..... 2-19
Table 2-5	Analytes Detected in SWMU 41 Area A Soil Samples – 2005 RFI..... 2-25
Table 2-6	Analytes Detected in SWMU 41 Area B Soil Samples – 2005 RFI..... 2-30
Table 2-7	Analytes Detected in SWMU 41 Area A Surface Water Samples – 2005 RFI 2-37
Table 2-8	Analytes Detected in SWMU 41 Area B Surface Water Samples – 2005 RFI 2-39
Table 2-9	Analytes Detected in SWMU 41 Area A Sediment Samples – 2005 RFI 2-41
Table 2-10	Analytes Detected in SWMU 41 Area B Sediment Samples – 2005 RFI 2-44
Table 2-11	Analytes Detected in SWMU 41 Groundwater Samples – 2005 RFI..... 2-47
Table 3-1	2007 RFI and 2010 Samples and Analyses..... 3-1
Table 4-1	Analytes Detected in SWMU 41 Area A Surface Water Samples – 2007 RFI 4-2
Table 4-2	Analytes Detected in SWMU 41 Area A Sediment Samples – 2007 RFI 4-6
Table 4-3	Analytes Detected in SWMU 41 Area B Sediment Samples – 2007 RFI 4-9
Table 4-4	Analytes Detected in SWMU 41 Groundwater Samples - – 2007 RFI 4-11
Table 4-5	Analytes Detected in SWMU 41 Direct-Push Groundwater Samples – 2007..... 4-14
Table 4-6	Analytes Detected in SWMU 41 Groundwater Samples - 2010..... 4-17
Table 4-7	Overall SSL Transfer Exceedance Summary for SWMU 41 Area A..... 4-20
Table 4-8	Overall SSL Transfer Exceedance Summary for SWMU 41 Area B..... 4-23
Table 4-9	Overall Soil Summary for SWMU 41 Area A..... 4-28
Table 4-10	Overall Soil Summary for SWMU 41 Area B..... 4-30
Table 4-11	Overall Surface Water Summary for SWMU 41 Area A 4-34
Table 4-12	Overall Surface Water Summary for SWMU 41 Area B 4-36
Table 4-13	Overall Sediment Summary for SWMU 41 Area A 4-39
Table 4-14	Overall Sediment Summary for SWMU 41 Area B 4-42
Table 5-1	SWMU 41 Geotechnical Laboratory Data Summary 5-2
Table 6-1	SWMU 41A and SWMU 41B Sample Groupings 6-2
Table 6-2	Summary of Chemicals of Potential Concern at SWMU 41A 6-6
Table 6-3	Summary of Chemicals of Potential Concern at SWMU 41B..... 6-7
Table 6-4	Summary of Risks and Hazards - SWMU 41A 6-18
Table 6-5	Summary of Risks and Hazards - SWMU 41B 6-21
Table 6-6	Background Comparison for Surface Soil at SWMU 41 Area A 6-24
Table 6-7	Background Comparison for Total Soil at SWMU 41 Area A..... 6-25
Table 6-8	Background Comparison for Surface Soil at SWMU 41 Area B 6-26
Table 6-9	Background Comparison for Total Soil at SWMU 41 Area B 6-27
Table 7-1	Ecoregions of RFAAP 7-3
Table 7-2	Species Inventory within RFAAP's Grassland Community Type 7-5
Table 7-3	Threatened, Rare, and Endangered Species in RFAAP's Grassland Community... 7-6
Table 7-4	General Uncertainty Analysis..... 7-24
Table 7-5	SWMU 41 Area A Sample Groupings..... 7-25
Table 7-6	Occurrence, Distribution, and Selection of COPECs for Surface Soil Direct Contact Exposure at SWMU 41 Area A 7-26

Table 7-7	Occurrence, Distribution, and Selection of COPECs for Surface Soil Food Chain Exposure at SWMU 41 Area A.....	7-28
Table 7-8	Occurrence, Distribution, and Selection of COPECs for Sediment Direct Contact Exposure at SWMU 41 Area A.....	7-30
Table 7-9	Occurrence, Distribution, and Selection of COPECs for Sediment Food Chain Exposure at SWMU 41 Area A.....	7-33
Table 7-10	Occurrence, Distribution, and Selection of COPECs for Surface Water Direct Contact Exposure at SWMU 41 Area A.....	7-36
Table 7-11	Occurrence, Distribution, and Selection of COPECs for Surface Water Food Chain Exposure at SWMU 41 Area A.....	7-38
Table 7-12	Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area A Surface Soil.....	7-41
Table 7-13	Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area A Sediment.....	7-43
Table 7-14	Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area A Surface Water.....	7-45
Table 7-15	Wildlife EEQ Hazard Summary for Food Chain Exposure at SWMU 41 Area A.....	7-47
Table 7-16	Direct Contact Toxicity Evaluation for Surface Soil at SWMU 41 Area A.....	7-49
Table 7-17	Direct Contact Toxicity Evaluation for Sediment at SWMU 41 Area A.....	7-50
Table 7-18	Surface Water Direct Contact Assessment for Aquatic Life at SWMU 41 Area A.....	7-52
Table 7-19	Background Comparison for Surface Soil at SWMU 41 Area A.....	7-56
Table 7-20	SWMU 41 Area B Sample Groupings.....	7-59
Table 7-21	Occurrence, Distribution, and Selection of COPECs for Surface Soil Direct Contact Exposure at SWMU 41 Area B.....	7-60
Table 7-22	Occurrence, Distribution, and Selection of COPECs for Surface Soil Food Chain Exposure at SWMU 41 Area B.....	7-62
Table 7-23	Occurrence, Distribution, and Selection of COPECs for Sediment Direct Contact Exposure at SWMU 41 Area B.....	7-64
Table 7-24	Occurrence, Distribution, and Selection of COPECs for Sediment Food Chain Exposure at SWMU 41 Area B.....	7-66
Table 7-25	Occurrence, Distribution, and Selection of COPECs for Surface Water Direct Contact Exposure at SWMU 41 Area B.....	7-68
Table 7-26	Occurrence, Distribution, and Selection of COPECs for Surface Water Food Chain Exposure at SWMU 41 Area B.....	7-69
Table 7-27	Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area B Surface Soil.....	7-71
Table 7-28	Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area B Sediment.....	7-74
Table 7-29	Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area B Surface Water.....	7-76
Table 7-30	Wildlife EEQ Hazard Summary for Food Chain Exposure at SWMU 41 Area B.....	7-78
Table 7-31	Direct Contact Toxicity Evaluation for Surface Soil at SWMU 41 Area B.....	7-80
Table 7-32	Direct Contact Toxicity Evaluation for Sediment at SWMU 41 Area B.....	7-82

Table 7-33	Surface Water Direct Contact Assessment for Aquatic Life at SWMU 41 Area B	7-83
Table 7-34	Background Comparison for Surface Soil at SWMU 41 Area B	7-87

LIST OF FIGURES

	<i>Page</i>
Figure 1-1	SWMU 41 Site Location Map 1-2
Figure 2-1	Site Location Map, Main Manufacturing Area, SWMU 41 2-2
Figure 2-2	SWMU 41 Previous Investigation Sample Locations 2-3
Figure 2-3	SCS Soil Types at the Main Manufacturing Area 2-5
Figure 2-4	SWMU 41 Sample Locations 2-7
Figure 2-5	SWMU 41 Geologic Cross Section 2-8
Figure 2-6	SWMU 41 Geologic Cross Section A-A' 2-9
Figure 2-7	SWMU 41 Geologic Cross Section B-B' 2-10
Figure 2-8	SWMU 41 Potentiometric Surface Map..... 2-11
Figure 3-1	SWMU 41 2007 Investigation Sample Locations 3-4
Figure 3-2	Surface Water Results at SWMU 41 3-5
Figure 3-3	Sediment Results at SWMU 41 3-6
Figure 3-4	Soil and Groundwater Results at SWMU 41 3-7
Figure 6-1	Current Land Use Conceptual Site Model for SWMU 41A..... 6-8
Figure 6-2	Future Land Use Conceptual Site Model for SWMU 41A..... 6-9
Figure 6-3	Current Land Use Conceptual Site Model for SWMU 41B 6-10
Figure 6-4	Future Land Use Conceptual Site Model for SWMU 41B..... 6-11
Figure 7-1	Simplified Terrestrial Food Web Conceptual Site Exposure Model (CSEM)..... 7-10
Figure 7-2	Simplified Aquatic Food Web Conceptual Site Exposure Model (CSEM)..... 7-12
Figure 8-1	Institutional Controls at SWMU 41 8-8

LIST OF APPENDICES

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

Appendix A Quality Assurance/Quality Control

- Appendix A-1 Analytical Services and Procedures
- Appendix A-2 Quality Assurance/Quality Control Evaluation
- Appendix A-3 Validation Reports and Form 1s

Appendix B Lithologic Boring Logs and Soil Gas Survey

- Appendix B-1 Lithologic Boring Logs
- Appendix B-2 2007 RFI Well Purge Forms
- Appendix B-3 ANL Geophysical Report

Appendix C Sample Location Coordinates and Elevations

Appendix D Contaminant Fate and Transport

Appendix E HHRA Tables and Statistical Comparison Results

- Appendix E-1 RAGS Part D Tables - SWMU 41A
- Appendix E-2 RAGS Part D Tables - SWMU 41B
- Appendix E-3 Calculations for 2,3,7,8-TCDD Equivalents - SWMU 41A & 41B
- Appendix E-4 Exposure Point Concentrations - ProUCL 4.0 Output - SWMU 41A
- Appendix E-5 Exposure Point Concentrations - ProUCL 4.0 Output - SWMU 41B
- Appendix E-6 Johnson & Ettinger Model - Input and Output - SWMU 41B
Groundwater
- Appendix E-7 Background Comparisons - ProUCL 4.0 Output - SWMU 41A
- Appendix E-8 Background Comparisons - ProUCL 4.0 Output - SWMU 41B

Appendix F SLERA Site Reconnaissance Photographs and Supporting Information

- Appendix F-1 SWMU 41 Aerial Photograph
- Appendix F-2 SLERA Supporting Information

Appendix G National Environmental Policy Act Compliance Evaluation

LIST OF ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius	CSM	Conceptual Site Model
µg/L.....	micrograms per liter	DA.....	dose absorbed per unit area per event
1,1,2,2-TCA	1,1,2,2-Tetrachloroethane	DNT	Dinitrotoluene
2,3,7,8-TCDD ...	2,3,7,8-tetrachlorodibenzo- p-dioxin	DQO.....	Data Quality Objective
2,4,6-TNT	2,4,6-Trinitrotoluene	EcoSSL	Ecological Soil Screening Level
ADAF.....	Age-Dependent Adjustment Factor	EEQ.....	Environmental Effects Quotient
ANL	Argonne National Laboratory	EPC	Exposure Point Concentration
ARCS	Assessment and Remediation of Contaminated Sediments	EPD.....	Effective Prediction Domain
ASTM	American Society for Testing and Materials	EPI.....	Estimation Programs Interface
ATSDR	Agency for Toxic Substances Disease Registry	EPIC.....	Environmental Photographic Interpretation Center
AUF.....	Area Use Factor	ERAGS	Ecological Risk Assessment Guidance for Superfund
BAF.....	Bioaccumulation Factor	FA	fraction absorbed dose
BCF	Bioconcentration Factor	FDEP.....	Florida Department of Environmental Protection
bgs	below ground surface	FHR.....	Fraction of Home Ranges
BLM.....	Biotic Ligand Model	ft msl	feet above mean sea level
BSAF.....	Biota-Sediment Accumulation Factor	ft	feet
BTAG.....	Biological Technical Assistance Group	g/dL	grams per deciliter
CCA	Copper Chromated Arsenate	GI	Gastrointestinal
CCME	Canadian Council of Ministers of the Environment	HEAST.....	Health Effects Assessment Summary Tables
CDI.....	Chronic Daily Intake	HHRA	Human Health Risk Assessment
CERCLA.....	Comprehensive Environmental Response, Compensation, and Liability Act	HI	Hazard Index
CFR.....	Code of Federal Regulations	HQ.....	Hazard Quotient
cm.....	centimeters	IC.....	Institutional Control
CMS	Corrective Measures Study	IEUBK	Integrated Exposure Uptake Biokinetic
CNS.....	Central Nervous System	IRIS	Integrated Risk Information System
COPC	Chemical of Potential Concern	i-SL	Industrial Screening Level
COPEC.....	Chemical of Potential Ecological Concern	LOAEL	Lowest-Observed-Adverse- Effect Level
CSEM.....	Conceptual Site Exposure Model	MCL	Maximum Contaminant Level
CSF	Cancer Slope Factor		

MDC	Maximum Detected Concentration	SLERA	Screening Level Ecological Risk Assessment
MDL	Method Detection Limit	SMDP	Scientific/Management Decision Point
mg/kg	milligrams per kilogram	SSL	Soil Screening Level
mg/L	milligrams per liter	SVOC	Semivolatile Organic Compound
MMA	Main Manufacturing Area	SWMU	Solid Waste Management Unit
MRL	Minimum Risk Level	TAL	Target Analyte List
MWP	Master Work Plan	TCE	Trichloroethene
ng/kg	nanograms per kilogram	TCL	Target Compound List
NOAA	National Oceanic and Atmospheric Administration	TCLP	Toxicity Characteristic Leaching Procedure
NOAEL	No-Observed-Adverse-Effect Level	TE	Toxicity Equivalent
NRWQC	National Recommended Water Quality Criteria	TEF	Toxicity Equivalent Factor
ORNL	Oak Ridge National Laboratory	TNT	Trinitrotoluene
PAH	Polynuclear Aromatic Hydrocarbon	TOC	Total Organic Carbon
PCB	Polychlorinated Biphenyl	TOX	Total Organic Halides
PCE	Tetrachloroethene	TRV	Toxicity Reference Value
PEF	Particulate Emission Factor	tw-SL	Tap Water Screening Level
PEL	Probable Effects Level	UCL	Upper Confidence Limit
PETN	Pentaerythritol tetranitrate	UF	Uncertainty Factor
PPRTV	Provisional Peer Reviewed Toxicity Value	URS	URS Corporation
QA	Quality Assurance	USACE	U.S. Army Corps of Engineers
QC	Quality Control	USEPA	U.S. Environmental Protection Agency
RAGS	Risk Assessment Guidance for Superfund	UTL	Upper Tolerance Limit
RBCA	Risk-Based Corrective Action	VDEQ	Virginia Department of Environmental Quality
RCRA	Resource Conservation and Recovery Act	VF	Volatilization Factor
RDA	Recommended Daily Allowance	VI	Verification Investigation
RFAAP	Radford Army Ammunition Plant	VOC	Volatile Organic Compound
RfD	Risk Reference Dose	VRP	Voluntary Remediation Program
RFI	RCRA Facility Investigation	WHO	World Health Organization
r-SL	Residential Screening Level	WQS	Water Quality Standards
RTE	Rare, Threatened, or Endangered		
Shaw	Shaw Environmental, Inc.		
SL	Screening Level		

EXECUTIVE SUMMARY

Shaw Environmental, Inc. (Shaw) conducted a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) at Solid Waste Management Unit (SWMU) 41 (RAAP-011) - the Red Water Ash Burial Area 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 (VDEQ).

In addition to the MWP Addendum 019 field investigation, four other previous investigations were conducted at SWMU 41 Areas A and B. These investigations included an Installation Assessment (Aerial Photo Interpretation) in 1992 to evaluate multiple SWMUs at RFAAP (including SWMU 41) using selected aerial photos from 1937 to 1986 (USEPA, 1992), a Verification Investigation (VI) in 1992 to characterize the nature and extent of contamination, a Geophysical Survey in 2002 to assist in the delineation of potential red water ash burial locations within Area B, and an RFI in 2005 to further refine the nature and extent of contamination.

During the development of MWP Addendum 019, existing data was reviewed to assess whether there were any data gaps in the characterization of the site. This review indicated that groundwater at SWMU 41 Area A represented a data gap. It was determined that surface water was adequately characterized; however, additional Area A surface water samples that are contemporaneous with the planned groundwater samples would allow for an analysis of the relationship between groundwater and the adjacent creek. No data gaps were identified at Area B; however, additional samples from the wells and seep at Area B could be used to compare to existing data in order to establish trends in the groundwater concentrations over time. Once the data needs were identified, sampling strategies were developed to complete characterization of Areas A and B. 2007 RFI activities included the collection and chemical analysis of three surface water samples, four sediment samples, and six groundwater samples from SWMU 41 Areas A and B. It was determined that the three direct-push samples (41GW-01, -02, and -03) collected in 2007 were very turbid and the results were unreliable because of this. A new well (41MW4) was installed and sampled in 2010 in Area A to collect groundwater results that would replace, in the HHRA, the unreliable direct-push results from 2007. Chemical results from these samples were evaluated to assess the nature and extent of contamination (Section 4.0), fate and transport analysis (Section 5.0), and potential impacts to human health (Section 6.0) and/or ecological receptors (Section 7.0).

Contamination Assessment

Area A. As shown in the Area A summary table below, the contamination assessment indicated that with the exception of 2,4,6-trinitrotoluene (2,4,6-TNT), benzo(a)pyrene, and 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) toxicity equivalent (TE), there were only single detections of eight organics and five metals above screening levels (SLs) in all site media. In soil samples, the calculated concentration of 2,3,7,8-TCDD TE, PCB-1254, aluminum, arsenic, and iron were above residential screening levels (r-SLs); however, only arsenic and iron were present at concentrations above industrial screening levels (i-SLs) in one subsurface soil sample.

In surface water samples, 2,4,6-TNT, 2,3,7,8-TCDD, and the calculated 2,3,7,8-TCDD TE were present at concentrations above tap water screening levels (tw-SLs). None of these analytes or dissolved metals in filtered samples was present above maximum contaminant levels (MCLs). In sediment samples, benzo(a)pyrene, nitroglycerin, and arsenic were detected at concentrations greater than r-SLs. However, none of these constituents (with the exception of arsenic in one sample) were present at concentrations above i-SLs in any samples. In Area A 2007 direct-push groundwater samples, the calculated concentration of 2,3,7,8-TCDD TE, 2,4,6-TNT, chloroform, cobalt, and manganese were detected at concentrations above tw-SLs. However, only manganese and 2,3,7,8-TCDD TE were present at concentrations above the MCL (both in one direct-push sample). The presence of these constituents was attributed to the entrained sediment in the turbid geoprobe samples. A groundwater monitoring well was installed in 2010 to collect a more representative sample. In the 2010 Area A groundwater well sample, the chemicals detected above tw-SLs were chloroform, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and heptachlor. The metals detected above the MCL in that sample were aluminum and iron. However, the duplicate sample for that well (41TM4) did not detect any of the polynuclear aromatic hydrocarbons (PAHs) [benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene], making it seem as though the PAHs may have come from a soil particulate in the one sample.

Area A Screening Level Exceedances

Analyte	Soil	Surface Water	Sediment	Groundwater
Organics				
2,3,7,8-TCDD		1		
2,3,7,8-TCDD TE	1	1		2
2,4,6-Trinitrotoluene		2		1
Benzo(a)pyrene			6	1
Benzo(b)fluoranthene				1
Chloroform				1
Dibenz(a,h)anthracene				1
Heptachlor				1
Indeno(1,2,3-cd)pyrene				1
Nitroglycerin			1	
PCB-1254	1			
Metals				
Aluminum	1			1
Arsenic	1		1	
Cobalt				1*
Iron	1			1
Manganese				1*

* Filtered metals

Since Area A was a former lagoon that received rinsate from ash-transport vehicle rinsing, dioxins/furans and explosives are the only constituents detected above SLs that are attributable to past practices at the site. 2,3,7,8-TCDD and the calculated 2,3,7,8-TCDD TE was only reported above the tw-SL (but below the MCL) in one surface water sample collected directly downgradient of Area A and in two direct-push groundwater samples. These groundwater samples were collected without a sandpack, which increases the amount of sediment in the sample. It is very likely that the high concentrations of dioxins/furans in these samples were due to the sediment entrained in the samples. Dioxins/furans were not detected in any of the existing well samples from the site. Dioxin/furans are highly hydrophobic and based upon the high percentage of clay contained in the fill material, the thickness of the clay fill [up to 15 feet (ft)], and the low permeability, it is unlikely that these concentrations migrated downward and impacted groundwater. Because of this, the highly turbid samples (41GW1, 41GW2, and 41GW3) were removed from the human health risk assessment (HHRA) and replaced with a sample from the newly-installed Area A well (41MW4) that better represents groundwater in that area.

Based on the Nature and Extent Assessment of Area A, it does not appear as though site media has been significantly impacted as a result of former site activities.

Area B. As shown in the Area B summary table below, the contamination assessment indicated that four organics and seven metals were detected at concentrations above SLs in site media. In soil samples, the calculated concentration of 2,3,7,8-TCDD TE, PCB-1254, aluminum, arsenic, copper, iron, manganese, and mercury were present at concentrations above r-SLs; however, only arsenic and manganese concentrations were above i-SLs. In surface water samples, the only analyte present at concentrations above tw-SLs (but below MCLs) was chloroform. Total metals were detected at concentrations greater than MCLs in surface water samples; however, none of the dissolved metals concentrations were present above tw-SLs or MCLs in the filtered samples. In sediment samples, PCB-1254, arsenic, and manganese were present at concentrations above r-SLs. Arsenic and manganese were both detected in the same sample above i-SLs. In groundwater samples from the existing wells, tetrachloroethene (PCE), arsenic, and cobalt were detected at concentrations greater than tw-SLs. However, none of the concentrations detected in the existing wells were present above MCLs.

Area B Screening Level Exceedances

Analyte	Soil	Surface Water	Sediment	Groundwater
Organics				
2,3,7,8-TCDD TE	1			
Chloroform		3		
PCB-1254	1		2	
Tetrachloroethene				3
Metals				
Aluminum	1			
Arsenic	15		1	1
Cobalt				1

Analyte	Soil	Surface Water	Sediment	Groundwater
Copper	2			
Iron	2			
Manganese	2		1	
Mercury	1			

* Filtered metals

Area B was used as a red water ash disposal area. Clayey fill has been placed in an approximately 1.08-acre area at Area B. The clay fill emplaced at the site acts as a soil cap at Area B, preventing downward migration of the constituents present in soil as a result of former disposal activities. Sampling results from the soil investigations at Area B indicate that the subsurface soil has been minimally impacted at one location by dioxins/furans. Based upon the high percentage of clay contained in the clay cap, the thickness of the clay fill (4-9 ft), the low permeability cap, and groundwater results from the existing wells at Area B, dioxins/furans are not migrating from soil and negatively impacting groundwater. Sample results from ash collected at Area B indicated that all detected Toxicity Characteristic Leaching Procedure (TCLP) concentrations were below regulatory limits and that explosives were not detected in any of the ash samples.

Based on the Nature and Extent Assessment of Area B, it does not appear as though site media has been significantly impacted as a result of former site activities.

Human Health Risk Assessment

An HHRA (Section 6.0) was conducted at SWMU 41 to evaluate the potential human health risks associated with previous activities at SWMU 41A and SWMU 41B. The risks associated with five exposure scenarios were calculated at the site: current/hypothetical future maintenance workers, hypothetical future industrial workers, hypothetical future excavation workers, hypothetical future adult residents, hypothetical future child residents, and lifetime residents. The lifetime resident scenario represents the combined cancer risks for child residents (birth to six years old) and adult residents (16 to 30 years old), whereas the adult resident scenario represents the non-cancer hazards for 30-year exposures. Exposure scenarios for off-site lifetime/adult and child residents were also evaluated for potential exposures to groundwater in the event that groundwater migrates off site in the future.

At SWMU 41A, the total cancer risks for current maintenance worker exposures to surface soil, sediment, and surface water were within the acceptable risk range of 1E-06 to 1E-04 due to arsenic (for surface soil and sediment) and dioxins/furans (for surface water). Exposures to groundwater were below the acceptable risk range of 1E-06 to 1E-04. The total hazard indices (HIs) for surface soil, sediment, surface water, and groundwater were all less than 1.

For the hypothetical future maintenance worker, the total cancer risks for exposures to surface soil, total soil, sediment, and surface water were within the acceptable risk range due to arsenic (surface soil and sediment) and dioxins/furans (for surface water). Exposures to groundwater were below the acceptable risk range of 1E-06 to 1E-04. The total HIs for surface soil, total soil, sediment, surface water, and groundwater were less than 1.

For the hypothetical future industrial worker, the total cancer risks for exposures to surface soil, total soil, sediment, surface water, and groundwater were within the acceptable risk range due to

arsenic and dioxins/furans (for surface water) and heptachlor (groundwater). The total HIs for surface soil, total soil, sediment, and groundwater were less than 1. The total HI for surface water was equal to 1. When recalculated by target organ, the HI for the central nervous system (CNS) slightly exceeded 1.

For the hypothetical future excavation worker, the total cancer risks for exposures to total soil, sediment, and groundwater were below the acceptable risk range. The total HIs for total soil, sediment, surface water, and groundwater were less than 1. The total cancer risk for exposures to surface water was equal to the lower limit of the acceptable risk range due to dioxins/furans. The total cancer risk was below the acceptable risk range and the total HI was less than 1. When recalculated by target organ, the HI for CNS slightly exceeded 1.

For the hypothetical future lifetime resident, the total cancer risks for exposures to total soil, sediment, and surface water were within the acceptable risk range due to dioxins/furans (for total soil and surface water) and arsenic (for total soil and sediment). The total HIs for total soil, sediment, and surface water were less than 1. The total cancer risk associated with groundwater was above the acceptable risk range, primarily due to benzo(a)pyrene, benzo(b)fluoranthene, chloroform, dibenzo(a,h)anthracene, heptachlor, and indeno(1,2,3-cd)pyrene. The total HI for groundwater was less than 1.

For the hypothetical child resident, the total cancer risks for exposures to total soil, sediment, and surface water were within the acceptable risk range due to dioxins/furans (total soil and surface water) and arsenic (total soil and sediment). The total HI for total soil was above 1, primarily due to manganese. The total HIs for sediment and surface water were less than 1. The total cancer risk associated with groundwater was within the acceptable risk range, primarily due to benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, heptachlor, and indeno(1,2,3-cd)pyrene. The total HI for groundwater was less than 1.

Off-site receptors were evaluated to address potential future migration of chemicals of potential concern (COPCs) in groundwater. For the hypothetical future maintenance worker, exposures to groundwater were below the acceptable risk range of 1E-06 to 1E-04. The total HI for groundwater was less than 1.

For hypothetical future industrial workers, the total cancer risk for exposures to off-site groundwater was within the acceptable risk range, primarily due to heptachlor. The total HI for groundwater was less than 1.

For the hypothetical future excavation worker, the total cancer risk was below the acceptable risk range. The total HI was less than 1.

For the hypothetical future lifetime resident, the total cancer risk for exposures to off-site groundwater was above the acceptable risk range, primarily due to benzo(a)pyrene, benzo(b)fluoranthene, chloroform, dibenzo(a,h)anthracene, heptachlor, and indeno(1,2,3-cd)pyrene. The total HI for groundwater was less than 1.

For the hypothetical child resident, the total cancer risk for exposures to off-site groundwater was within the acceptable risk range, primarily due to benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, heptachlor, and indeno(1,2,3-cd)pyrene. The total HI for groundwater was less than 1.

At SWMU 41B, the total cancer risk for current maintenance worker exposures to surface soil and sediment was within the acceptable risk range due to arsenic. The total HIs for surface soil,

sediment, surface water, and groundwater were less than 1. The total cancer risk for exposures to surface water and groundwater were both below the acceptable risk range.

For the hypothetical future maintenance worker, the total cancer risk for exposures to surface soil, total soil, and sediment was within the acceptable risk range due to arsenic. The total HIs for surface soil, total soil, sediment, surface water, and groundwater were less than 1. The total cancer risks for exposures to surface water and groundwater were both below the acceptable risk range.

For the hypothetical future industrial worker, the total cancer risk for exposures to surface soil, total soil, and sediment, and groundwater was within the acceptable risk range due to arsenic and PCE (groundwater only). The total cancer risk for exposures to surface water was below the acceptable risk range. The total HIs for surface soil, total soil, sediment, surface water, and groundwater were less than 1.

For the hypothetical future excavation worker, the total cancer risk for exposures to total soil was equal to the lower limit of the acceptable risk range. The risks for individual total soil COPCs were below the acceptable risk range. The total HI for total soil was equal to 1. The HIs for individual total soil COPCs were below 1. The total cancer risks for exposures to sediment, surface water, and groundwater were below the acceptable risk range. The total HIs for sediment, surface water, and groundwater were less than 1.

For the hypothetical future lifetime resident, the total cancer risks for exposures to total soil and sediment were within the acceptable risk range due to dioxins/furans (total soil only) and arsenic. The total HIs for total soil, sediment, and surface water were less than 1. The total cancer risk for exposures to surface water was below the acceptable risk range. The total cancer risk associated with groundwater was above the acceptable risk range, primarily due to PCE and arsenic. The total HI was equal to 1. The HIs for individual COPCs and target organs were below 1.

For the hypothetical child resident, the total cancer risks for exposures to total soil, sediment, and groundwater were within the acceptable risk range due to arsenic and PCE (groundwater only). The total HIs for total soil and groundwater were both above 1, primarily due to arsenic, manganese (total soil only), and cobalt (groundwater only). The total HIs for sediment and surface water were both less than 1. The total cancer risk for exposures to surface water was below the acceptable risk range. When recalculating groundwater exposure risk by target organ, several organs also exceeded 1. The margin-of-exposure evaluation for iron indicated that the iron intake was within the allowable range.

Off-site receptors were evaluated to address potential future migration of COPCs in groundwater. For the hypothetical future maintenance worker and hypothetical future excavation worker, total cancer risk associated with off-site groundwater was below the acceptable risk range. The total HIs for both were below 1.

For hypothetical future industrial workers and child residents, the total cancer risk for exposures to off-site groundwater was within the acceptable risk range due to PCE and arsenic. The total HI for hypothetical future industrial workers was below 1. For the child resident, the total HI was above 1, primarily due to arsenic and cobalt. When recalculated by target organ, the skin and the vascular system exceeded 1.

For the hypothetical future lifetime resident, the total cancer risk for exposures to off-site groundwater was above the acceptable risk range, primarily due to PCE and arsenic. The total HI was equal to 1. The HIs for individual COPCs and target organs were below 1.

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 41 Area A and Area B.

At Area A, the food chain assessment results suggest potential adverse impacts to terrestrial wildlife, especially shrews, robins, and voles for modeled contact with the hazard drivers (arsenic, copper, selenium, and zinc) in surface soil. However, based on the Tier 2 lowest-observed-adverse-effect level (LOAEL)-based approach no individual environmental effects quotients (EEQs) (when rounded to one significant figure) were greater than 1. The direct contact assessment results suggest a potential reduction in wildlife food supply due to lead and zinc in surface soil; TCDD, acetone, benzo(b)fluoranthene, carbon disulfide, cyanide, iron, and manganese in sediment; and TCDD, aluminum, and barium in surface water. However, due to the small size of the site (0.19 acres), this potential reduction in food is not considered biologically significant. Based on the fact that no Tier 2 LOAEL EEQs exceeded 1, the fact that no wildlife rare, threatened, or endangered (RTE) species have been confirmed in the study area, and the relatively small size of the site, remedial measures solely to address ecological concerns are not warranted for soil.

At Area B, the food chain assessment suggests potential adverse impacts to terrestrial wildlife, especially shrews, voles and American robins for modeled contact with arsenic, cadmium, chromium, copper, selenium, and zinc in surface soil. Use of alternative SLERA parameters would reduce the estimated Tier 2 LOAEL-based EEQs to essentially 1. The direct contact assessment results suggest a potential reduction in wildlife food supply due to arsenic, lead, and zinc in surface soil; TCDD, 4,4'-DDT, carbon disulfide, iron, manganese, and total cyanide in sediment; and aluminum, barium, and iron in surface water. However, given the relatively small size of the site (1.08 acres), it is unlikely that the potential loss of prey would be biologically significant. In addition, although six chemicals of potential ecological concern (COPECs) in sediment and three COPECs in surface water had concentrations that exceeded more than 50 percent of the available screening benchmarks (or for surface water, exceeded a promulgated criterion), the small size of the site and the associated small size of the sampled aquatic habitat suggests further ecological assessment is not warranted.

Based on uncertainties of toxicity, the finding that chromium concentrations in soil are background related, the fact that no wildlife RTE species have been confirmed at the SWMU study area, and the relatively small size of the site, 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.

Conclusions and Recommendations

Overall, there appears to be minimal risk associated with current and expected future land use at this site. Unacceptable risks were calculated for hypothetical future child and lifetime residents. The SLERA concluded that there may be potential adverse impacts to terrestrial wildlife from site media. However, because no RTE wildlife species have been confirmed at the site and because of the relatively small size of the site, remedial measures to address ecological concerns are not warranted. The results of the investigations to date and the results of the risk assessment indicate that there is little risk associated with the expected future land use at this site.

Based on the results of the Nature and Extent of Contamination Assessment, as well as the results of Human Health and Ecological Risk Assessments, both of which show limited risk to theoretical receptors, Institutional Controls (ICs) are recommended for Area B. No further action is recommended for Area A due to the extremely limited risk to hypothetical receptors and the small size of the site (0.19 acres). This recommendation of Response Complete, with Institutional Controls for Area B, is in support of the current Industrial/Commercial use of the property, and would prevent any residential development from occurring at the site. The implementation of ICs is described below.

Institutional Controls. ICs are being implemented at the site within the boundary of Area B (**Figure 8-1**). The objective of the ICs is to maintain Area B in its current industrial/commercial state as a closed SWMU and to prevent any future residential use. Specifically, this site has been incorporated into plant management manual to ensure long-term protection of human health and the environment. The management manual provides for advance notice, assessment and approval of intrusive work that may occur within the plant with a general digging prohibition at sites such as this. In the event the property is transferred or leased, equivalent ICs will be put into terms and conditions of the deed or lease, which are no less restrictive than the IC objectives described above. Furthermore, the transferee or lessee will be responsible for ensuring IC compliance by any future users. However, the Army acknowledges the responsibility for all original liability under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and its right and responsibility to enforce ICs unless otherwise transferred to the new property recipient.

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) 41 (RAAP-011) - the Red Water Ash Burial Area. The SWMU is comprised of two Areas (A and B) located adjacent to one another in the southeastern portion of the Main Manufacturing Area (MMA) of Radford Army Ammunition Plant (RFAAP), southeast of the main bridge over the New River (**Figure 1-1**). The two areas are non-contiguous disposal areas for red water ash, a byproduct of combustion of trinitrotoluene (TNT) production wastewater (i.e., “red water”). 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.

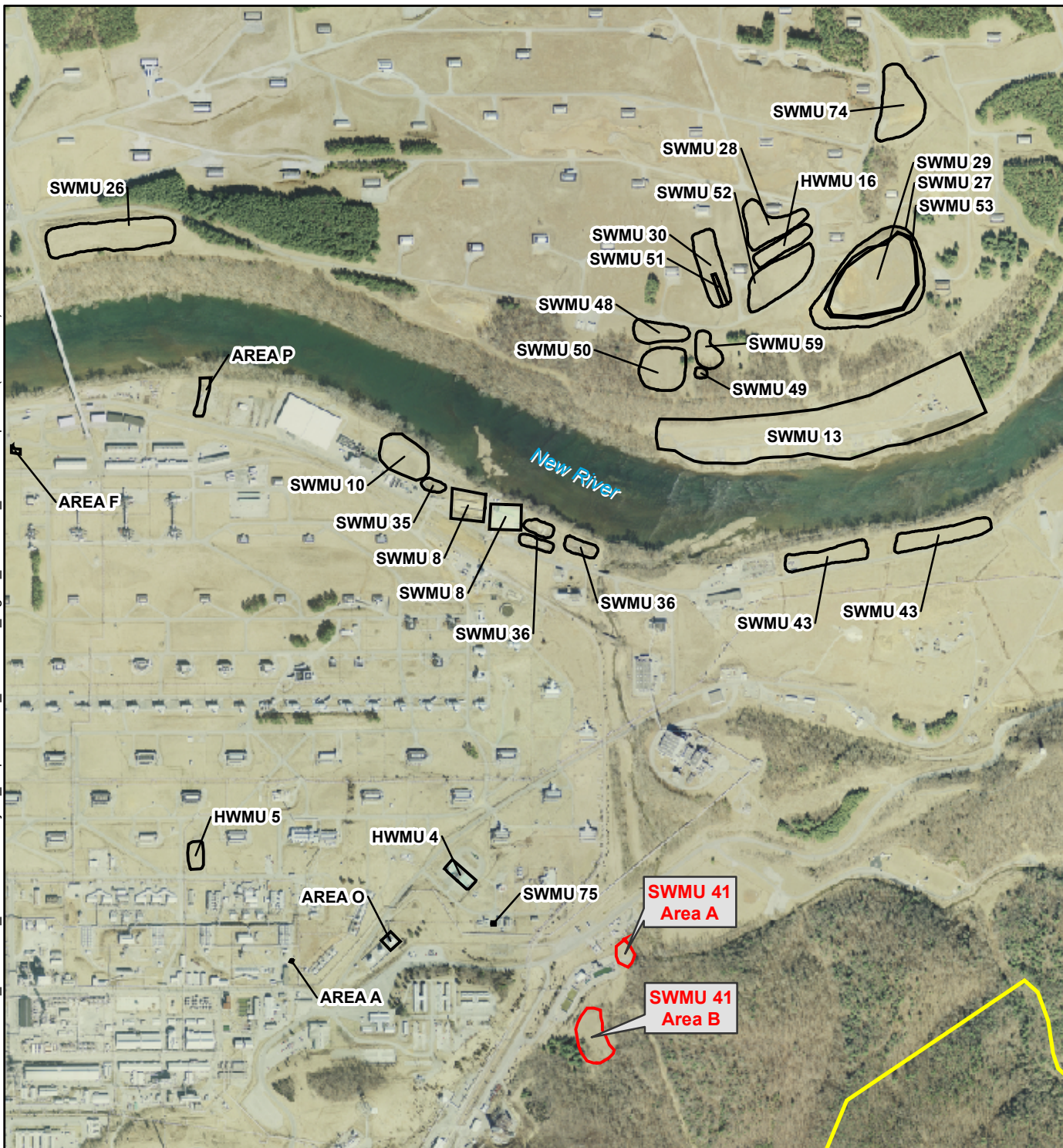
Previous investigations have been conducted as a collective effort at or adjacent to SWMU 41 and are discussed in the following section of this report. A data review, including the development of a conceptual site model (CSM) and a data gap analysis, was performed in *MWP Addendum 019* (Shaw, 2007). 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 SWMU 41.

The objectives of the field investigation at SWMU 41 were designed to:

- Collect sufficient samples in order to complete risk assessments.
- Further characterize groundwater to demonstrate that site soil is not impacting groundwater.
- Further characterize surface water to assess any impacts from groundwater to surface water and the unnamed tributary.

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 3.1.6*.

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*), Human Health Risk Assessment (HHRA) (*Section 6.0*), and Screening Level Ecological Risk Assessment (SLERA) (*Section 7.0*).

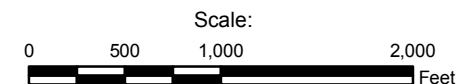


LEGEND

-  SWMU 41 Boundary
-  Other SWMU Boundary
-  Installation Boundary

Notes:

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



U.S. Army Corps of Engineers



Shaw® Shaw Environmental, Inc.

FIGURE 1-1
SWMU 41
Site Location Map
Radford Army Ammunition Plant,
Radford, VA

2.0 SITE BACKGROUND

2.1 Site Description

SWMU 41 is located in the southeastern portion of the RFAAP MMA (**Figure 1-1**). As illustrated on **Figure 2-1**, the site consists of two non-contiguous disposal areas (Areas A and B) for red water ash, a byproduct of combustion of TNT production wastewater (i.e., “red water”).

Area A is an approximate 0.19-acre [approximately 93 feet (ft) by 109 ft] former unlined lagoon area, which has been backfilled with up to 15 ft of fill. This lagoon received rinsate from ash-transport vehicle rinsing (USEPA, 1987).

Area B is a natural clay-lined landfill, approximately 225 ft by 70 ft, containing red water ash. Clayey fill has been placed in an approximately 1.08-acre area at Area B. Prior to the construction of the red water treatment plant, red water was concentrated by evaporation and burned in four rotary kilns located in the TNT manufacturing area. The ash produced from these kilns was disposed of in SWMU 41 Area B from 1967 to 1971.

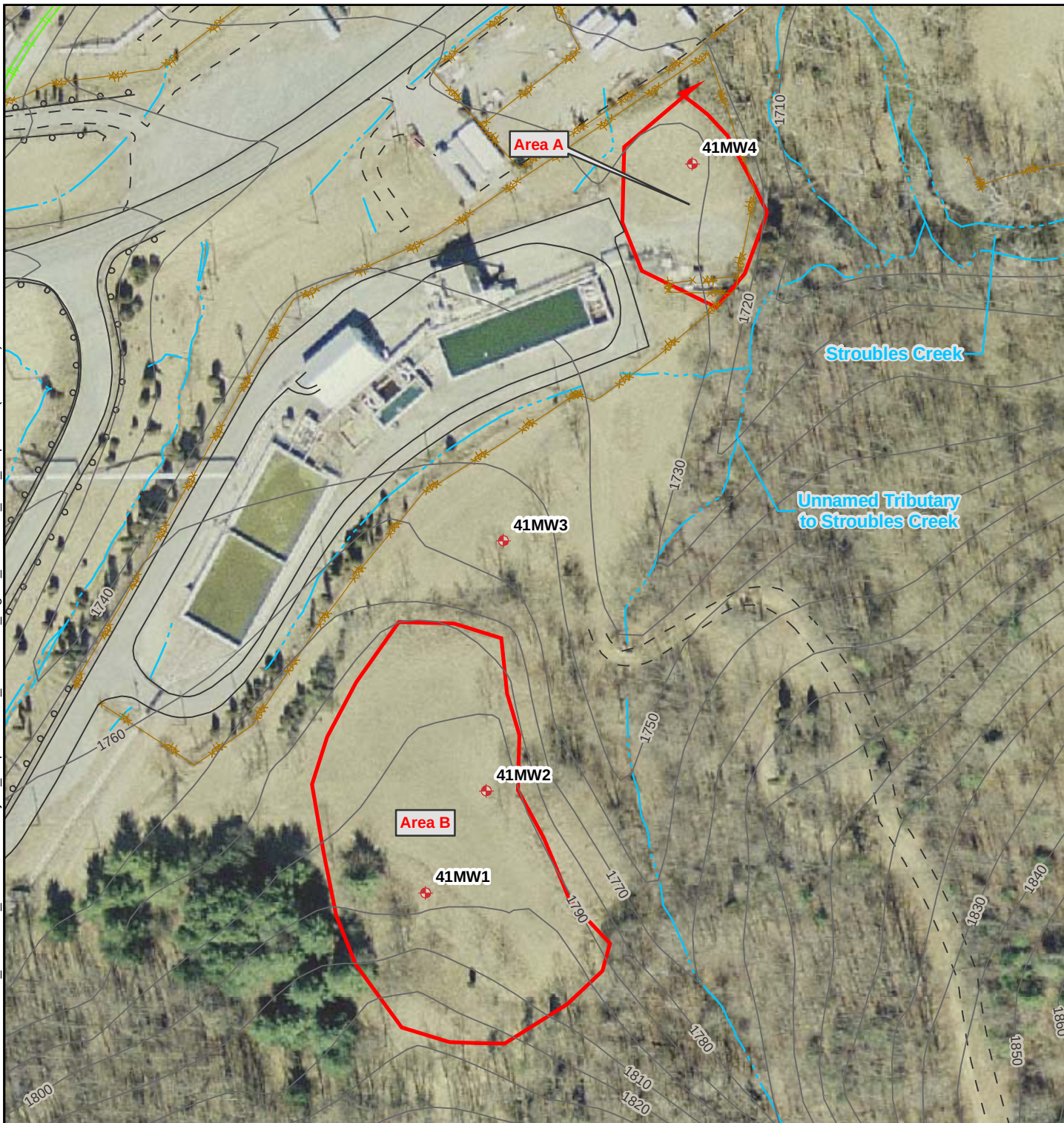
The closest structures to the site are two equalization basins located approximately 100 ft northwest of Area B and approximately 50 ft south-southwest of Area A (**Figure 2-2**). Each equalization basin consists of contiguous below grade reinforced concrete tanks. These units currently receive storm water from the inactive TNT Area (ATK, 2003).

The equalization basins subsequently discharge to the RFAAP Industrial Wastewater Treatment Plant (ATK, 2003). Piping and associated appurtenances from the equalization basins traverse along the southern boundary of Area A. Other structures near SWMU 41 include a maintenance shop area adjacent to the north of Area A comprised of several small structures and storage areas.

As illustrated on **Figure 2-1**, topography in the site area is characterized by gently to steeply sloping ridges and a general downward slope to the north. Area A is located approximately 100 ft west of Stroubles Creek at an elevation of approximately 1,730 to 1,735 feet above mean sea level (ft msl). The ground surface slopes steeply from the edge of Area A toward the north and east toward Stroubles Creek. The burial area in Area B is approximately 550 ft southwest of Area A and approximately 70 to 100 ft west of an unnamed tributary of Stroubles Creek. The ground surface in Area B slopes toward the north, northeast, and northwest from an elevation of approximately 1,800 ft msl to a minimum elevation of approximately 1,776 ft msl. The land east and northwest of Area B slopes steeply toward a drainage ditch and an unnamed tributary of Stroubles Creek, respectively.

2.2 Site History and Operations

The RCRA Facility Assessment conducted by the USEPA in 1987 identified the site as having the potential to release contaminants into the environment. The site is included in the RFAAP RCRA Permit for Corrective Action (USEPA, 2000a). From approximately 1967 to 1974 and again from 1983 to 1986, RFAAP manufactured TNT by the continuous-type process (ATK, 2003), which employed chemical recycling and resulted in a smaller quantity of more concentrated waste than older batch-type operations. In TNT manufacture, a red-colored wastewater known as “red water” is produced (Department of the Army, 1987). Red water ash is identified as a USEPA hazardous waste (K047) solely for its reactivity (40 CFR 261.32).

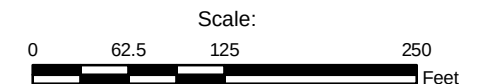


LEGEND

-  Monitoring Well
-  Dirt Road
-  Paved Road
-  Railroad
-  Water Feature
-  Fence
-  10 ft Contour Line
-  SWMU 41 Boundary

Notes:

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



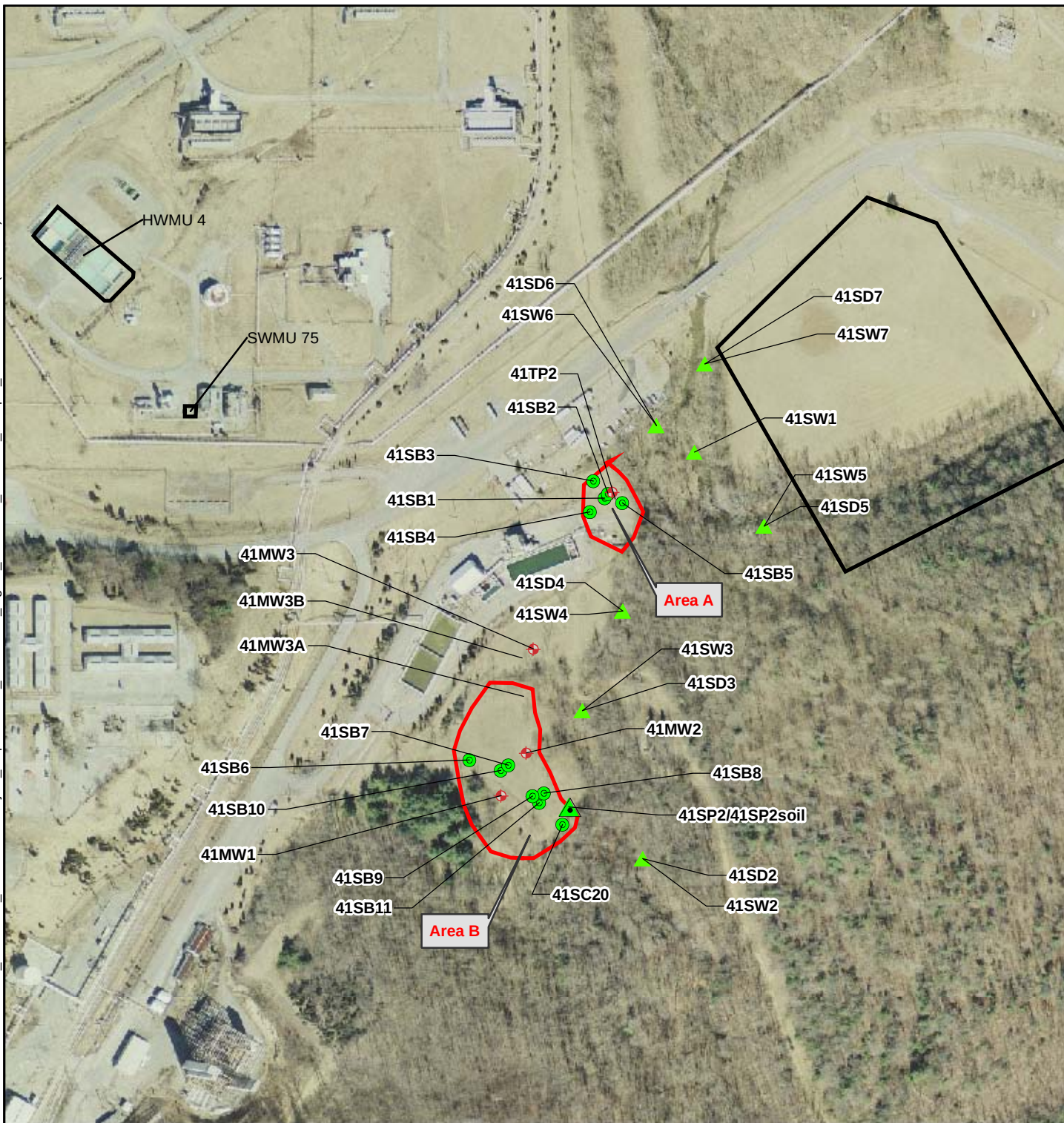
U.S. Army Corps of Engineers



Shaw Environmental, Inc.

FIGURE 2-1
SWMU 41 Site Map

Radford Army Ammunition Plant,
Radford, VA

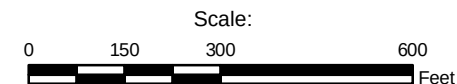


LEGEND

-  Monitoring Well
-  Previous Investigation Soil Sample Location
-  Previous Investigation Seep Sample Location
-  Previous Investigation Surface Water and/or Sediment Sample Location
-  SWMU 41 Boundary
-  Other SWMU Boundary

Notes:

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



U.S. Army Corps of Engineers



FIGURE 2-2
SWMU 41 Previous Investigation
Sample Locations
 Radford Army Ammunition Plant,
 Radford, VA

Red water generated from continuous-type TNT manufacturing (versus batch-type manufacture) at RFAAP was concentrated by evaporation and the residue burned in rotary kilns located in the former TNT manufacturing area (USATHMA, 1976). The ash produced from these kilns was disposed of in SWMU 41 from 1967 to 1971. Beginning in 1972, the red water was concentrated by evaporation to a 35%- liquor and sold to the paper industry (USATHMA, 1976).

A sample of the ash was collected during the RFI field effort by URS Corporation (URS) in 2004 and submitted for analysis of full Toxicity Characteristic Leaching Procedure (TCLP) parameters, nitroglycerin, and pentaerythritol tetranitrate (PETN). All detected TCLP concentrations were below regulatory limits. Detected constituents included: barium [0.32 milligrams per liter (mg/L)], lead (0.044 mg/L), methyl ethyl ketone (0.18 mg/L), and vinyl chloride (0.026 mg/L). Explosives were not detected in the sample.

2.3 Site Soil

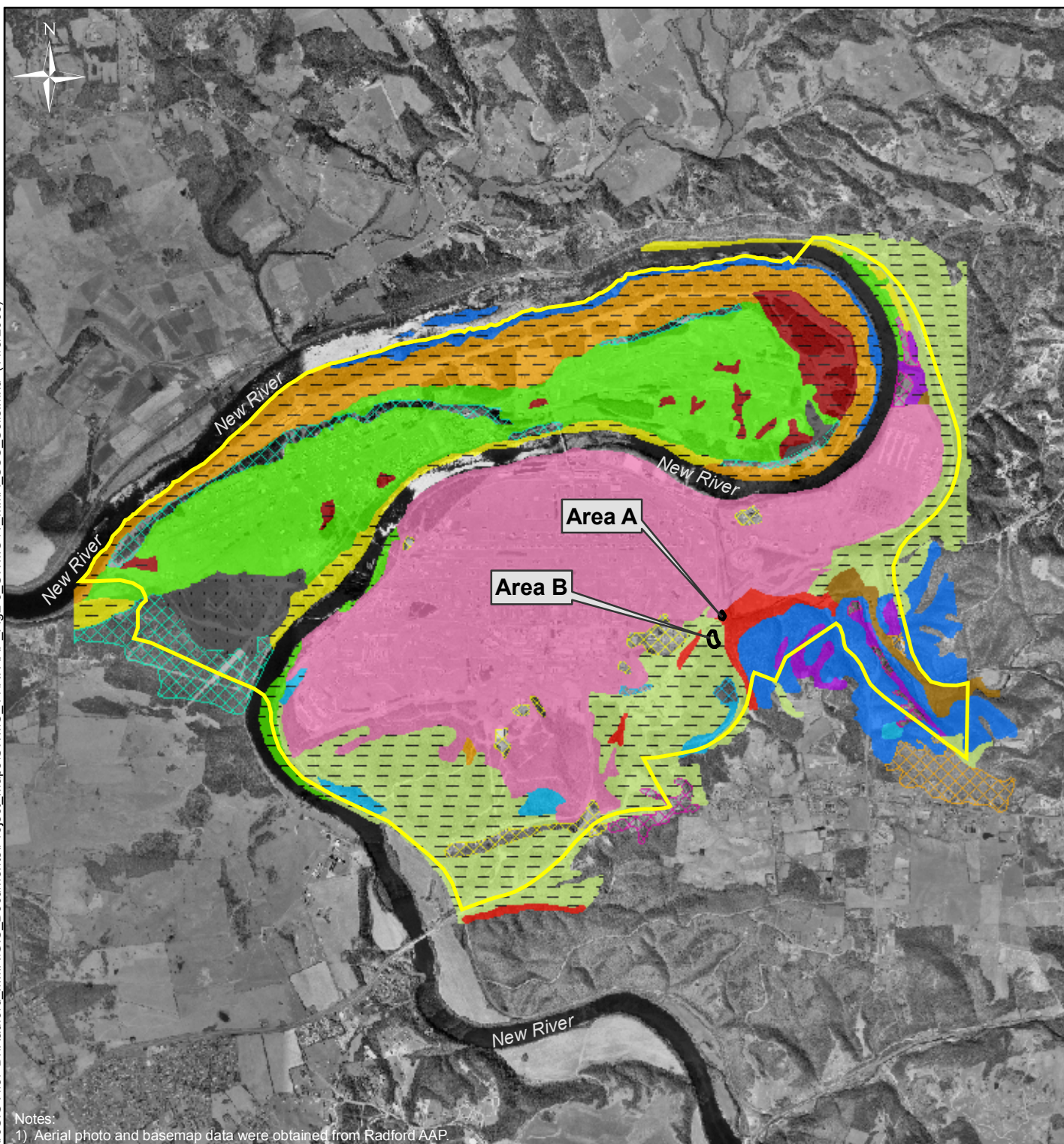
Caneyville-Opequon-Rock Outcrop Complex is mapped within upland areas of the site and the Weaver soil is mapped along the floodplain of Stroubles Creek (URS, 2003) (**Figure 2-3**). Weaver soils are found at Area A and the Caneyville-Opequon-Rock Outcrop soil type is found at Area B. The Caneyville-Opequon-Rock Outcrop Complex (25 to 60% slopes) consists of shallow, dominantly plastic clay soil with moderate organic content, slow to moderate permeability, and strongly acidic to neutral reaction. Weaver soil is present along the floodplain of Stroubles Creek and consists of moderately well drained and deep silt and clay loam soil, with low to moderate organic content, moderate permeability, and neutral to moderately alkaline reaction. A seasonally high water table occurs in the Weaver soil and the depth to bedrock is greater than 40 inches.

Historical site activities have resulted in disturbance of native soil and placement of clayey fill [lean clay (CL) to fat clay (CH)] within Areas A and B. Fill material and residual soil at the site primarily consists of brown to reddish-yellow lean to fat clay (CL and CH) containing variable sand and gravel. The thickness of fill material at Area A is approximately 15 ft or less. At Area A, the original geology consisted of natural clay and saprolite on top of the bedrock. Additional fill material was placed over the existing clay to build the area up into a relatively flat area. At Area B, the thickness of fill ranges from 7 to approximately 20 ft with an increased thickness toward the north and northwest following the slope of bedrock and surface topography. The waste at Area B was placed on natural clay, and clayey fill was placed on top of the waste material. Soil samples collected from Area A and B indicate that the clay fill is acidic to slightly alkaline pH (4.9 to 7.9 with distilled water) with a low permeability (2.0E-07 to 1.2E-08 centimeters per second). Total organic content of the soil ranges from 2.5 to 5.1%.

A layer of clayey gravel (GC) or residual soil with saprolitic texture was encountered above bedrock in several borings completed at the site. A burial area of red water ash is present within Area B below approximately 4 to 9 ft of soil cover (clay). The observed thickness of red water ash ranges from approximately 0.1 to 4 ft.

2.4 Site Geology

Site geologic conditions were characterized during the 2005 RFI by completing 11 direct-push soil borings at Area A [16 to 33 ft below ground surface (bgs)] and 29 direct-push soil borings at Area B (1 to 30 ft bgs) and physical testing of four soil samples. Five of the borings at Area A and 19 of the borings at Area B were completed to refusal (presumed bedrock). A previous



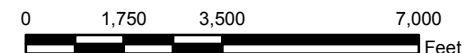
Notes:

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

LEGEND

- SWMU 41 Boundary
- 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 POPLIMTO
 - GUERNSEY SILT LOAM
 - HAYTER LOAM
 - LOWELL SILT LOAM
 - McGARY AND PURDY SOILS
 - ROCK OUTCROP-NEWBERN-CARBO COMPLEX
 - ROSS SOILS
 - UDORTHERTS AND URBAN LAND
 - UNISON AND BRADDOCK SOILS
 - UNISON-URBAN LAND COMPLEX
 - WEAVER SOILS
 - WHEELING SANDY LOAM
 - WURNO-NEWBERN-FAYWOOD SILT LOAMS

Scale:



U.S. Army Corps of Engineers



Shaw Environmental, Inc.

FIGURE 2-3

SCS Soil Types at the
Main Manufacturing Area
Radford Army Ammunition Plant,
Radford, VA

Verification Investigation (VI) was conducted at the site in 1992 by Dames and Moore and included the completion of six borings (15 to 125 ft bgs), installation of bedrock monitoring wells in three of the borings (41MW1, 41MW2, and 41MW3), and physical testing of two soil samples. Subsurface data from site borings were used to construct two geologic cross-sections. **Figure 2-4** shows all the borings, including those only completed for stratigraphic purposes.

A plan view of the cross section lines is presented on **Figure 2-5**. Cross-section A-A' is orientated northeast southwest across the site (**Figure 2-6**) and cross-section B-B' is orientated northwest southeast across Area B (**Figure 2-7**). Well construction diagrams and boring logs for the wells are presented in **Appendix B-1**.

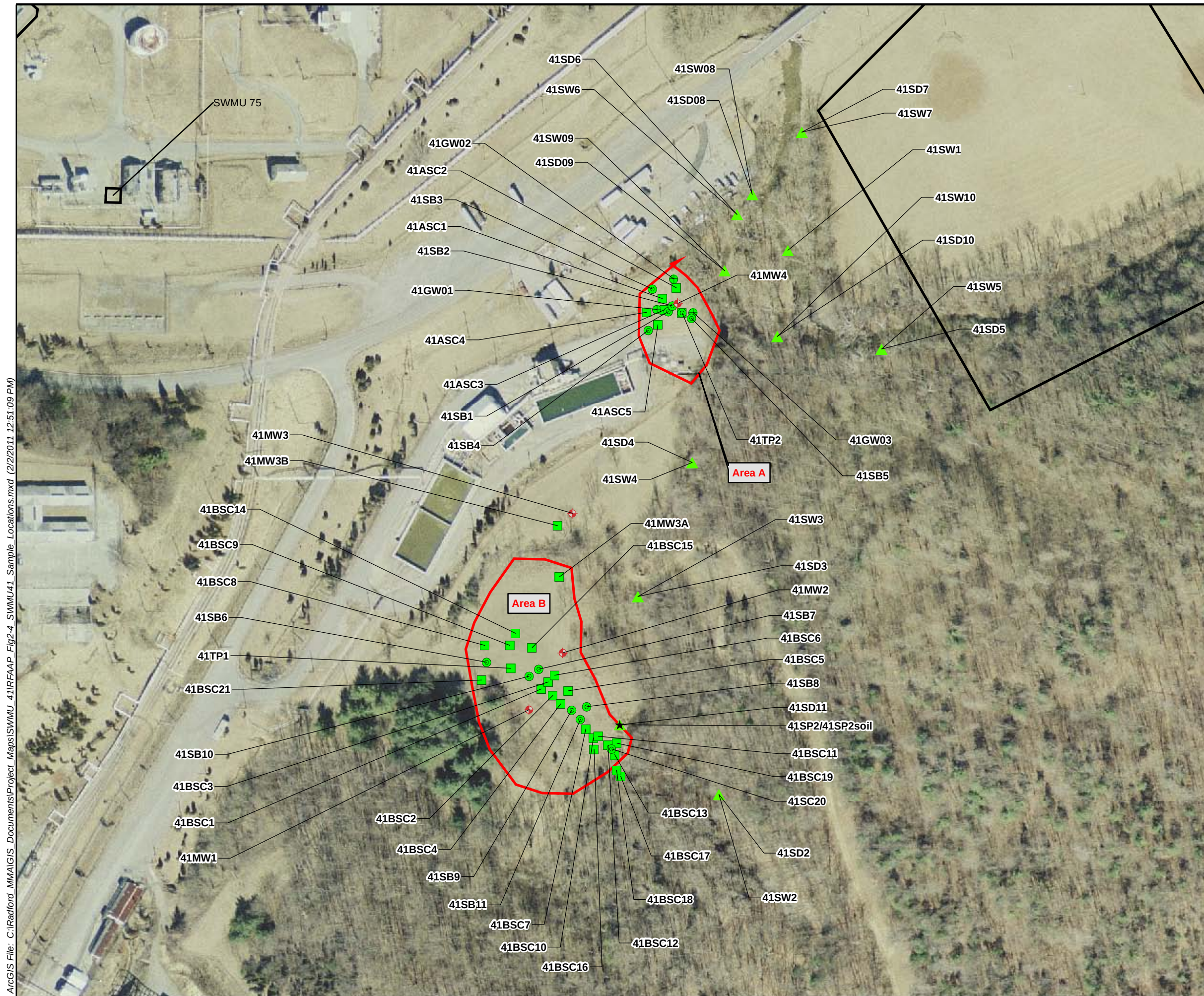
The site is underlain by the Cambrian Elbrook Formation, which consists of medium-gray, limestone and dolomite (collectively, carbonate rock). Bedrock cores in site borings were described as an interbedded argillaceous gray limestone and dolomite, with greenish-gray shale encountered in the uppermost 13 ft of bedrock in borings 41MW3 and 41MW3B. This shale was variably weathered with calcite veins and occasional layers of siltstone and pitted limestone.

The limestone and dolomite has brecciated and conglomeratic zones and vuggy and pitted surfaces. Evidence of faulting and deformation of the limestone/dolomite bedrock is found in rock core samples and nearby road cuts, and is likely the result of intense deformation associated with the geologic thrust sheet fenster located immediately south and southeast of SWMU 41 (Dames and Moore, 1992). Bedrock outcrops south of Area B and along the access road northwest of Area B. The Draft Geologic Map of the Radford North Quadrangle indicates that the strike of bedrock at the southern outcrop near Area B is N45°W with an 80-degree dip (DMR, 2000). The bedrock surface slopes from the outcrop toward the north and northwest (**Figures 2-6 and 2-7**), and the depth to bedrock also increases in the same direction to a maximum observed depth of 32.5 ft in Area A and 30 ft bgs in Area B.

2.5 Site Hydrogeology

Groundwater at the site is present within fractured carbonate bedrock. Three bedrock monitoring wells (41MW1, 41MW2, and 41MW3) were installed within and downgradient of Area B as part of the 1992 VI conducted by Dames and Moore. Monitoring wells 41MW1 and 41MW2 were installed immediately upgradient and downgradient of the burial area, respectively, while 41MW3 was installed approximately 220 ft north of 41MW2. Well 41MW4 was installed in the northern part of Area A in 2010. Stabilized potentiometric levels measured during both the 2007 RFI (August 2007) and 2010 sampling of 41MW4 ranged from 1,702 ft msl (41GW01) to 1,750 ft msl (41MW1) (**Figure 2-8**). At Area B, the potentiometric surface was approximately 28 to 30 ft below the top of bedrock, and downgradient of Area B it was approximately 4 ft below the elevation of bedrock at 41MW3. Local groundwater flow patterns are likely a reflection of surface topography with local discharge occurring at Stroubles Creek and its unnamed tributary, which are perennial streams that receive their base flow from groundwater discharge.

At Area A, approximately 32 ft of fine-grained clayey and silty material overlie the carbonate bedrock. In 2007, three direct-push borings were advanced to the top of bedrock to characterize the groundwater under the site. No water was present in the borings during boring advancement. These borings were allowed to stay open for several days to collect enough water to sample, which resulted in highly turbid samples of perched water.



LEGEND

- ★ Previous Investigation Seep Sample Location
- ⛶ Monitoring Well
- Groundwater Sample Location
- Soil Boring Location with Chemical Analysis
- Stratigraphic Boring Location
- ▲ Previous Investigation Surface Water and/or Sediment Sample Location
- SWMU 41 Boundary
- Other SWMU Boundary

Notes:

- 1) Aerial photo, dated 2005, was obtained from Montgomery County, VA Planning & GIS Services.
- 2) 41TP2B1 was completed as a soil boring with chemical analysis and 41TP2B2 was completed as a stratigraphic soil boring.



Scale:

0 75 150 300

Feet



U.S. Army Corps of Engineers

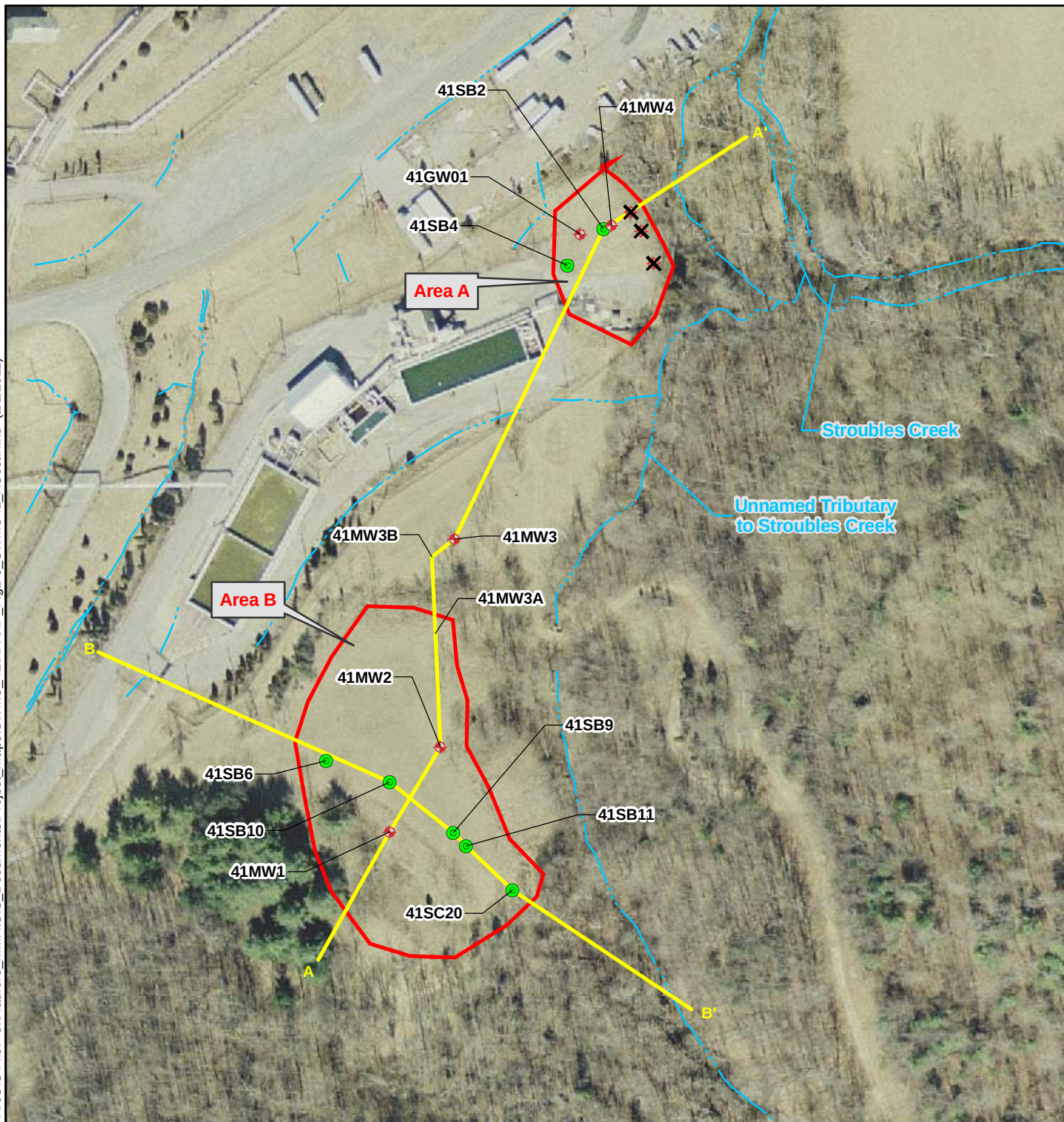


® Shaw Environmental, Inc.

FIGURE 2-4

SWMU 41 Sample Locations

Radford Army Ammunition Plant,
Radford, VA

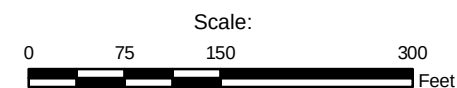


LEGEND

-  Groundwater Sample Location
-  Failed Attempt to Drill a Monitoring Well in 2009
-  Previous Investigation Soil Sample Location
-  Water Feature
-  SWMU 41 Boundary

Notes:

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

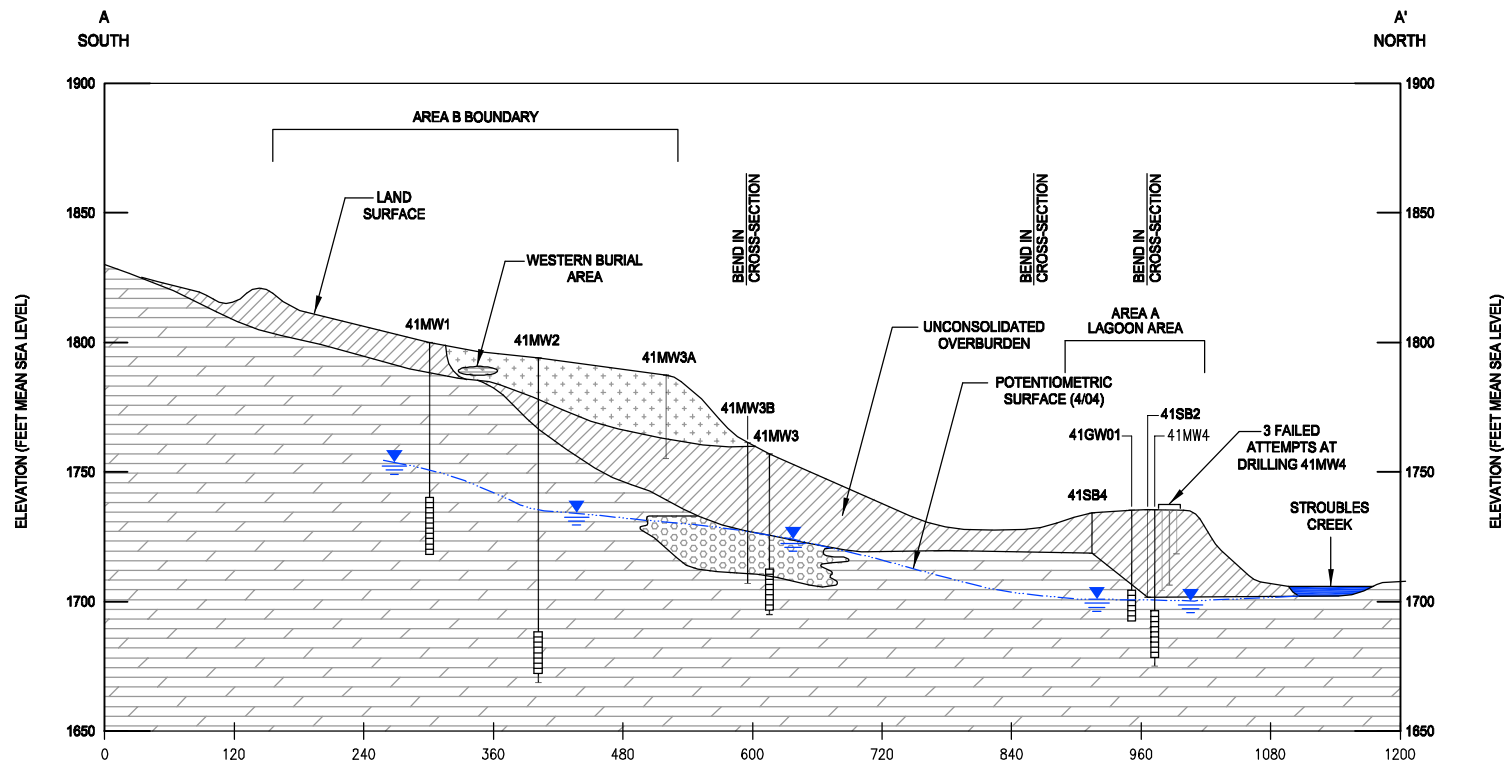


U.S. Army Corps of Engineers



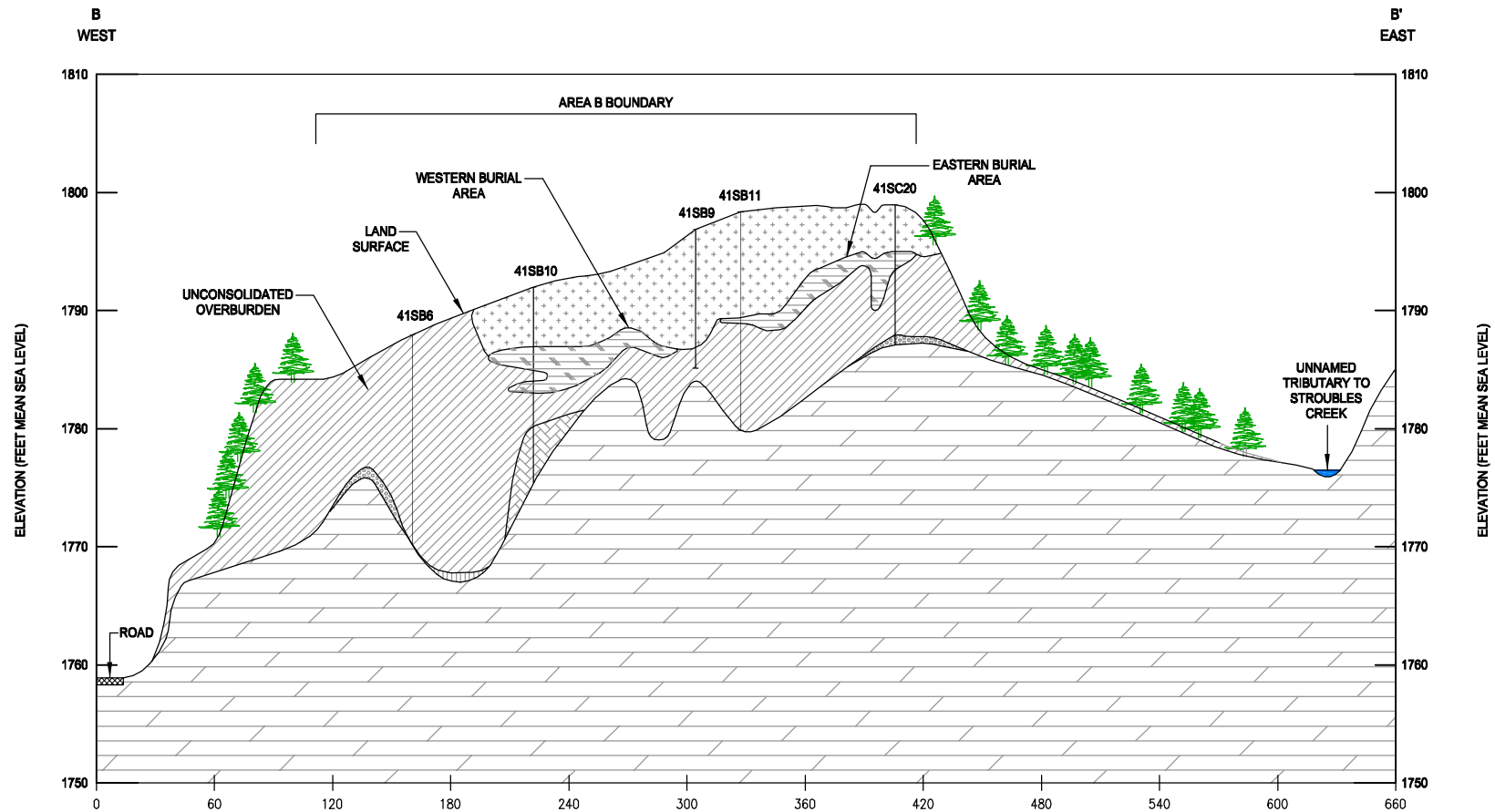
FIGURE 2-5
SWMU 41 Geologic Cross Section
 Radford Army Ammunition Plant,
 Radford, VA

File: O:\Shaw Offices - CAD Files\Edgewood, NY\123461\SWMU 41\Cad files 1-11-11\FIG 2-6 SWMU 41.dwg



RADFORD AAP		FIGURE 2-6
PREPARED BY: SHAW	TASK NO: 12346113000001	SWMU 41 GEOLOGIC CROSS SECTION A-A'
CHECKED BY: B. Snyder	SHAW DWG NO: FIG 2-6 SWMU 41	
DATE: JAN. 2011		

File: O:\Shaw Offices - CAD Files\Edgewood, MY\123461\SWMU 41\Cad files 1-11-11\FIG 2-7 SWMU 41.dwg



LEGEND

-  CLAYEY FILL MATERIAL
-  NATURAL CLAY (CL/CH)
-  ASH
-  SILTY GRAVEL (GM)
-  CLAYEY GRAVEL (GC)
-  GRAY LIMESTONE/DOLOMITE BEDROCK
-  SAPROLITE

REFERENCE:

1. RCRA FACILITY INVESTIGATION REPORT FOR
SOLID WASTE MANAGEMENT UNIT 41 (URS, 2005)

HORIZ. SCALE: 0 30 60

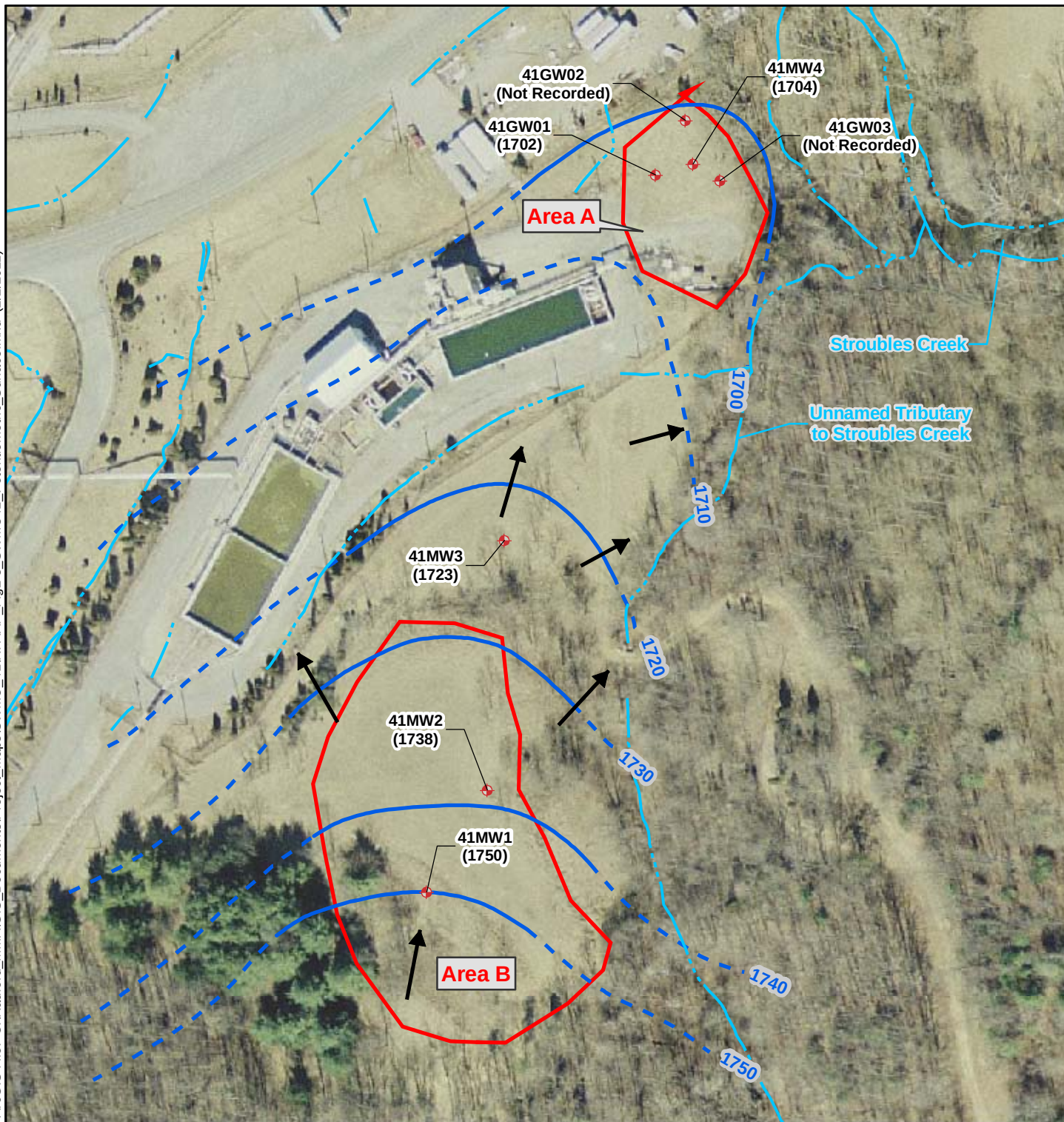
VERT. SCALE: 0 5 10

RADFORD AAP

PREPARED BY: SHAW	TASK NO: 1234613000001
CHECKED BY: B. Snyder	SHAW DWG NO: FIG 2-7 SWMU 41
DATE: JAN. 2011	

FIGURE 2-7

SWMU 41
GEOLOGIC CROSS
SECTION B-B'

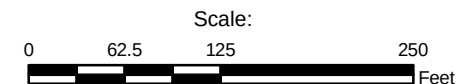


LEGEND

-  Groundwater Sample Location
-  Water Feature
-  Inferred Groundwater Contour
-  Groundwater Contour
-  Groundwater Flow Direction
-  SWMU 41 Boundary
- (1703) Groundwater Elevation (feet above mean sea level)

Notes:

- 1) Aerial photo, dated 2005, was obtained from Montgomery County, VA Planning & GIS Services.
- 2) Groundwater elevations taken August, 2007, except for 41MW04 which was taken Oct 2010.



U.S. Army Corps of Engineers



Shaw Environmental, Inc.

FIGURE 2-8
SWMU 41 Potentiometric Surface Map

Radford Army Ammunition Plant,
Radford, VA

After a record rainfall in the spring of 2009, an attempt was made to install a monitoring well at Area A so that a proper groundwater sample could be collected to replace the low quality direct-push sample. Three attempts were made using a hollow stem auger drill rig; however, water was not encountered in any of the boreholes. During all three attempts, solid unweathered bedrock was hit approximately 30 ft bgs. The hollow stem auger was used instead of a bedrock drilling technique (i.e., air rotary) because the CSM for Area A suggests that groundwater at the site would be more likely to infiltrate and discharge into the unnamed tributary than infiltrate through the thick clay layer into a bedrock aquifer. These three attempts are shown on **Figure 2-5**. Finally, in October 2010 a well was successfully drilled in the northern section of Area A. Based on these failed drilling attempts and knowledge of site conditions at Area A, it appears that precipitation falling on the site runs down the steep slope to the north towards the unnamed tributary of Stroubles Creek. This conclusion is also supported by the information presented in cross-section A-A' (**Figure 2-6**). As illustrated on the cross section, the groundwater level is at the top of bedrock below Area A, which is the same elevation of Stroubles Creek. Based on the depth to groundwater under Area A, runoff would go towards the creek. If the precipitation were infiltrating, the water level under Area A would be higher than the stream and the water table would generally follow the land surface contours.

2.6 Previous Investigations

Four previous investigations have been conducted at SWMU 41. In 1992, Environmental Photographic Interpretation Center (EPIC) provided aerial photographic analysis of SWMU 41. Also in 1992, in accordance with the 1989 RCRA permit requirements, Dames & Moore performed RFI sampling to evaluate potential contamination resulting from site activities. In 2002, a geophysical survey was performed by Argonne National Laboratory (ANL) to characterize both the lateral and vertical extent of the former burial area (Area B). In 2004, an RFI was conducted by URS that attempted to define the nature and extent of previous waste management practices through the collection and analysis of soil, groundwater, surface water, and sediment samples.

Table 2-1 lists all previous investigation samples collected and analyses performed. **Figure 2-2** shows the sample locations from all the previous investigations. The previous investigations are summarized below.

2.6.1 Installation Assessment (Aerial Photo Interpretation), 1992

Under the direction of USEPA, EPIC performed an assessment of multiple SWMUs at RFAAP (including SWMU 41) using selected aerial photographs from 1937 to 1986 (USEPA, 1992). Activity at SWMU 41 was first noted in a 1970 photograph and reportedly continued through the 1986 photographs (USEPA, 1992). A trench, a possible trench scar, and mounded material were visible on the 1971 photographs. The report noted that, "The trench appears to be empty at this time" (USEPA, 1992). "Between 1975 and 1981, the lagoon in the northern portion of this site had undergone filling and by 1981, [no more than] a small ground scar was visible in the southern portion of the site, which was undergoing revegetation" (USEPA, 1992). It was also noted that, "Between 1981 and 1986, the southern area had received a considerable amount of fill material" (USEPA, 1992). The 1986 photograph indicated that the majority of the site was "devoid of vegetation and significant filling appeared to have taken place" (USEPA, 1992).

Table 2-1
Previous Investigations Samples and Analyses

Media	Sample ID	Depth (ft bgs)	Analyses
1992 Verification Investigation, Dames & Moore			
Soil	41SB1 (RVFS*44)	8-10	TAL metals, SVOCs, and Explosives
	48SB1 (RVFS*45)	14-15	TAL metals, SVOCs, and Explosives
Surface Water	41SW1 (RDWC*76)	na	TAL metals, SVOCs, Explosives, TOC, TOX, and pH
Groundwater	41MW1 (RDWC*69)	na	TAL metals, SVOCs, Explosives, TOC, TOX, and pH
	41MW2 (RDWC*70)	na	TAL metals, SVOCs, Explosives, TOC, TOX, and pH
	41MW3 (RDWC*68)	na	TAL metals, SVOCs, Explosives, TOC, TOX, and pH
	41MW3 (RDWC*71)	na	TAL metals, SVOCs, Explosives, TOC, TOX, and pH
2005 RCRA Facility Investigation, URS Corporation			
Surface Soil	41SB2A	0-0.5	TAL metals, Cyanide, Pesticides, PCBs, Herbicides, VOCs, SVOCs, PAHs, and Explosives
	41SB3A	0-0.5	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SB4A	0-0.5	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SB5A	0-1	TAL metals, Cyanide, Pesticides, PCBs, Herbicides, VOCs, SVOCs, PAHs, and Explosives
	41SB6A	0-1	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SB7A	0-1	TAL metals, Cyanide, Pesticides, PCBs, Herbicides, VOCs, SVOCs, PAHs, and Explosives
	41SB8A	0-1	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SB9A	0-1	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SB10A	0-1	TAL metals, Cyanide, Pesticides, PCBs, Herbicides, VOCs, SVOCs, PAHs, and Explosives
	41SB11A	0-1	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SC20A	0-1	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SP2soil	0-1	TAL metals, Cyanide, Pesticides, PCBs, Herbicides, VOCs, SVOCs, Dioxins/Furans, PAHs, and Explosives
	41TP2A	0-1	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives

Table 2-1 (Continued)
Previous Investigations Samples and Analyses

Media	Sample ID	Depth (ft bgs)	Analyses
Subsurface Soil	41SB2B	7.5-8.5	TAL metals, Cyanide, VOCs, SVOCs, Dioxins/Furans, PAHs, and Explosives
	41SB2C	31-32.9	TAL metals, Cyanide, VOCs, SVOCs, Dioxins/Furans, PAHs, and Explosives
	41SB3B	9.8-10.5	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SB3C	29.4-30.4	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SB4B	7-8	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SB4C	15-16	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SB5B	15-16	TAL metals, Cyanide, VOCs, SVOCs, Dioxins/Furans, PAHs, and Explosives
	41SB5C	28-29	TAL metals, Cyanide, VOCs, SVOCs, Dioxins/Furans, PAHs, and Explosives
	41SB6B	0.7-2.1	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SB6C	21-21.5	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SB7B	14-16	TAL metals, Cyanide, VOCs, SVOCs, Dioxins/Furans, PAHs, and Explosives
	41SB7C	23-24	TAL metals, Cyanide, VOCs, SVOCs, Dioxins/Furans, PAHs, and Explosives
	41SB8B	8-12	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SB8C	18-21	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SB9B	8-12	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SB9C	11.5-12.5	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SB10B	8.5-11	TAL metals, Cyanide, VOCs, SVOCs, Dioxins/Furans, PAHs, and Explosives
	41SB10C	15-16	TAL metals, Cyanide, VOCs, SVOCs, Dioxins/Furans, PAHs, and Explosives
	41SB11B	8-12	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SB11C	16-18.4	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41SC20B	4.2-5.1	TAL metals, Filtered TAL metals, Cyanide, Pesticides, PCBs, Herbicides, VOCs, SVOCs, PAHs, and Explosives
	41SC20C	11-11.6	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41TP2B	11-13	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives
	41TP2C	30.5-31.9	TAL metals, Cyanide, VOCs, SVOCs, PAHs, and Explosives

Table 2-1 (Continued)
Previous Investigations Samples and Analyses

Media	Sample ID	Depth (ft bgs)	Analyses
Surface Water	41SW2	na	TAL metals, Filtered TAL metals, VOCs, SVOCs, PAHs, Explosives, and Perchlorate
	41SW3	na	TAL metals, Filtered TAL metals, VOCs, SVOCs, PAHs, Explosives, and Perchlorate
	41SW4	na	TAL metals, Filtered TAL metals, VOCs, SVOCs, PAHs, Explosives, and Perchlorate
	41SW5	na	TAL metals, Filtered TAL metals, VOCs, SVOCs, PAHs, Explosives, and Perchlorate
	41SW6	na	TAL metals, Filtered TAL metals, VOCs, SVOCs, PAHs, Explosives, and Perchlorate
	41SW7	na	TAL metals, Filtered TAL metals, VOCs, SVOCs, PAHs, Explosives, and Perchlorate
	41SP2	na	TAL metals, Filtered TAL metals, VOCs, SVOCs, PAHs, Explosives, and Perchlorate
Sediment	41SD2	0-1	TAL metals, Pesticides, PCBs, Herbicides, VOCs, SVOCs, PAHs, and Explosives
	41SD3	0-1	TAL metals, Pesticides, PCBs, Herbicides, VOCs, SVOCs, PAHs, and Explosives
	41SD4	0-1	TAL metals, Pesticides, PCBs, Herbicides, VOCs, SVOCs, PAHs, and Explosives
	41SD5	0-1	TAL metals, Pesticides, PCBs, Herbicides, VOCs, SVOCs, PAHs, and Explosives
	41SD6	0-1	TAL metals, Pesticides, PCBs, Herbicides, VOCs, SVOCs, PAHs, and Explosives
	41SD7	0-1	TAL metals, Pesticides, PCBs, Herbicides, VOCs, SVOCs, PAHs, and Explosives
Groundwater	41MW1	na	TAL metals, Filtered TAL metals, VOCs, SVOCs, PAHs, Explosives, and Perchlorate
	41MW2	na	TAL metals, Filtered TAL metals, VOCs, SVOCs, PAHs, Explosives, and Perchlorate
	41MW3	na	TAL metals, Filtered TAL metals, VOCs, SVOCs, PAHs, Explosives, and Perchlorate

2.6.2 VI, Dames and Moore, 1992

The VI completed by Dames and Moore in 1992 included sampling of soil, surface water, and groundwater as described below. Sample locations are shown on **Figure 2-2**.

Soil. One soil boring (41SB1) was completed to a depth 15 ft bgs near the center of Area A (**Figure 2-2** and **Table 2-2**), and two soil samples were collected from this boring for chemical analysis of target analyte list (TAL) metals, semivolatile organic compounds (SVOCs), and explosives. Fill material described as potential red water ash was encountered in 41SB1 from approximately 6-13 ft bgs (Dames and Moore, 1992). One soil sample was collected at a depth of 8-10 ft bgs from this material and a second soil sample was collected below this material at the boring termination (14-15 ft bgs). Detected constituents included 16 metals and two tentatively identified compounds in the SVOC library scan.

Aluminum, chromium, manganese, and vanadium were detected at concentrations above current (April 2009) adjusted USEPA Region III residential screening levels (r-SLs), and arsenic and iron were detected at concentrations above current adjusted USEPA Region III industrial screening levels (i-SLs). However, metals concentrations were below their RFAAP facility-wide background point estimates [95% upper tolerance limits (UTLs)].

Surface Water. The VI sampling program at Area A included the collection of a surface water sample from a seep along the bank of Area A prior to the seep entering Stroubles Creek.

However, this seep was not active during the VI program, so a substitute sample of surface water was collected from Stroubles Creek for analysis of TAL metals, SVOCs, explosives, total organic carbon (TOC), total organic halides (TOX), and pH. Detected constituents included seven metals, 2,4,6-trinitrotoluene (2,4,6-TNT), TOC, and TOX (**Table 2-3**).

TNT was detected at a concentration [1.38 micrograms per liter (µg/L)] above its current (April 2009) adjusted tap water screening level (tw-SL). Metals concentrations were below adjusted tw-SLs and applicable maximum contaminant levels (MCLs).

Groundwater. Three monitoring wells (41MW1, 41MW2, and 41MW3) were installed at Area B to evaluate the potential impact of buried red water ash on the groundwater quality. Monitoring wells 41MW1 and 41MW2 were installed immediately south and north of the burial area, respectively, and 41MW3 was installed approximately 220 ft north of 41MW2 (**Figure 2-3**). Groundwater samples were collected from these monitoring wells for analysis of TAL metals, SVOCs, explosives, TOC, TOX, and pH. Constituents detected in one or more groundwater samples included 11 metals, bis(2-Ethylhexyl)phthalate, TOC, and TOX (**Table 2-4**). Concentrations of antimony, vanadium and bis(2-Ethylhexyl)phthalate in sample 41MW2 were above their adjusted tw-SLs. Antimony was also above its MCL in the sample from 41MW2.

2.6.3 Geophysical Survey, ANL, 2002

ANL performed a geophysical survey of Area B during August and September 2002 to assist in the delineation of potential red water ash burial locations within Area B. Subsurface information obtained by the geophysical surveys was used to refine the CSM and focus RFI field investigations on characterizing the nature and extent of burial areas at Area B. Surface geophysical surveys were conducted using two-dimensional resistivity profiling, seismic refraction tomography, and electromagnetic-31 (EM-31) terrain-conductivity mapping. Vertical seismic profiles were also conducted in existing monitoring wells 41MW1, 41MW2, and

Table 2-2
Analytes Detected in SWMU 41 Area A Soil Samples - 1992 VI

Analyte	Sample ID Sample Date Sample Depth			41SB1 (RVFS*44) 10/25/91 8-10		41SB1 (RVFS*45) 10/25/91 14-16	
	i-SL	r-SL	Background	Result	Lab Q	Result	Lab Q
SVOCs (ug/kg)				None detected			
Explosives (mg/kg)				None detected			
Metals (mg/kg)							
Aluminum	99000	7700	40041	25400		20600	
Arsenic	1.6	0.39	15.8	8.1		11.5	
Barium	19000	1500	209	140		84.4	
Calcium	na	na	na	62800		821	
Chromium	1400	280	65.3	32.6		60	
Cobalt	30	2.3	72.3	12.8		15.9	
Copper	4100	310	53.5	19.7		21.8	
Iron	72000	5500	50962	24400		40000	
Lead	800	400	26.8	<u>74.7</u>		<u>37.3</u>	
Magnesium	na	na	na	40800		4950	
Manganese	2300	180	2543	1560		885	
Nickel	2000	160	62.8	20.8		25.2	
Potassium	na	na	na	2080		1440	
Sodium	na	na	na	2040		887	
Vanadium	720	55	108	48.7		54.3	
Zinc	31000	2300	202	<u>241</u>		87.7	

12

Bold, underlined font indicates a background exceedance.

SL = Screening Level (Source: ORNL Regional Screening Table, April 2009).

Lead screening values from Technical Review Workgroup for Lead: Guidance Document (USEPA, 1999b).

mg/kg = milligrams per kilogram (parts per million)

ug/kg = micrograms per kilogram (parts per billion)

Lab Q = Lab Data Qualifier

NA = not applicable

SVOC = Semivolatile Organic Compound

Table 2-3
Analytes Detected in SWMU 41 Area A Surface Water Samples - 1992 VI

Analyte	Sample ID Sample Date		41SW1 (RDWC*76) 3/10/92	
	MCL	tw-SL	Result	Lab Q
SVOCs (ug/L) None detected				
Explosives (ug/L)				
2,4,6-Trinitrotoluene	na	0.22	1.38	
Metals (ug/L)				
Barium	2000	730	55.9	
Calcium	na	na	58500	
Iron	300	2600	199	
Magnesium	na	na	29200	
Manganese	50	88	27.8	
Potassium	na	na	1850	
Sodium	na	na	14900	
Misc.				
Total Organic Carbon	na	na	6010	
Total Organic Halides	na	na	82.4	
pH	na	na	7.99	

12

Bold outline indicates a tw-SL exceedance

Secondary MCLs were used for iron and manganese.

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, April 2009).

ug/L = micrograms per liter (parts per billion)

NA = not applicable

Lab Q = Lab Data Qualifier

Table 2-4
Analytes Detected in SWMU 41 Groundwater Samples - 1992 VI

Analyte	Sample ID Sample Date Sample Depth		41MW1 (RDWC*69) 3/3/92 65-65		41MW2 (RDWC*70) 3/3/92 100-100		41MW3 (RDWC*68) 3/4/92 45-45		41MW3 (RDWC*71) 3/4/92 45-45	
	MCL	tw-SL	Result	Lab Q	Result	Lab Q	Result	Lab Q	Result	Lab Q
SVOCs (ug/L)										
bis(2-Ethylhexyl)phthalate	6	4.8	4.8	U	5.6		4.8	U	4.8	U
Explosives (ug/L)										
Metals (ug/L)										
Antimony	6	1.5	38	U	68		38	U	38	U
Barium	2000	730	19.9		81.8		16.5		15.7	
Calcium	na	na	24000		232000		121000		122000	
Lead	15	na	1.26	U	1.41		1.26	U	3.58	
Magnesium	na	na	31400		214000		64000		65000	
Manganese	50	88	45.4		39		10.1		10.2	
Potassium	na	na	938		1710		2560		2940	
Silver	100	18	0.321		0.962		0.25	U	0.25	U
Sodium	na	na	960000		6500000		221000		224000	
Vanadium	na	26	11	U	34.1		14.6		15.3	
Zinc	5000	1100	21.1	U	31.8		21.1	U	21.1	U
Misc.										
Total Organic Carbon	na	na	NT		82100		24400		23300	
Total Organic Halides	na	na	NT		89.2		36.1		95	
pH	na	na	7.87		7.08		7.07		7.13	

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

Table 2-4
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, April 2009).

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.

41MW3 at Area B to assist in guiding the seismic interpretations. USACE, New England District personnel collected downhole electrical and natural-gamma logs to aid in constraining the resistivity models. The ANL geophysical report detailing the results of the surveys and methods used is included in **Appendix B-3** of this report. **Appendix B-3, Figure C.4.2** identifies two anomaly areas of higher electrical conductivity interpreted by ANL in their report as potential red water ash burial areas. The western anomaly area is approximately 120 ft in length and 20 to 30 ft in width and is orientated along a north-northwest south-southeast axis. The eastern area is approximately 30 ft in diameter.

ANL estimated a depth of 10 ft or less for the buried material based on the results of the conductivity survey and two-dimensional resistivity profiling. Seismic refraction profiling results mapped bedrock at Area B as a surface sloping towards the north and northwest, with a slight decrease in velocity in the 50X and 115X on seismic profile 41-Seis-L1, which is also observed on seismic profile 41-Seis-L2. ANL interpreted this velocity change as a potential lithologic or structural break (consistent with a weaker bedrock zone modeled by 2D-ERI profile 41-Resist-L1). Other significant structural features were not indicated for the bedrock.

2.6.4 RFI, URS Corporation, 2005

The draft RFI was submitted to the Army, but the report was never submitted to the regulatory agencies. The RFI was designed to characterize chemical concentrations in soil at Areas A and B and the nature and extent of buried red water ash at Area B, evaluate potential releases to groundwater, surface water, and sediment in the site area, and evaluate potential risks to human health and the environment from identified chemicals of potential concern (COPCs). The chemical sampling and analysis program at Area A included 15 soil samples and three surface water/sediment sample pairs from nearby Stroubles Creek. At Area B, the chemical sampling and analysis program included: 22 samples of soil and buried material, three groundwater samples from existing monitoring wells 41MW1, 41MW2, and 41MW3, and three surface water/sediment samples from the nearby unnamed tributary of Stroubles Creek. Results from these samples are presented in **Tables 2-5 through 2-11**.

Nature and Extent Assessment at Area A

URS found that the COPCs identified in Area A soil were aluminum, arsenic, barium, manganese, 1,1,2,2-tetrachloroethane (1,1,2,2-TCA), trichloroethene (TCE), and 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) equivalents concentration.

Detections above the adjusted r-SLs for organic chemicals at Area A were limited to PCB-1254 in surface soil sample 41SB2A (0-0.5 ft bgs) and 2,3,7,8-TCDD TE in sample 41SB2B at 7.5-8.0 ft bgs. Vertical delineation of 2,3,7,8-TCDD TE at this location indicated that concentrations were well below the r-SL in sample 41SB2C at 15-16.5 ft bgs.

Other metal COPC concentrations were below their background point estimates, except for aluminum and arsenic in one terminal depth sample. 1,1,2,2-TCA and TCE were identified as COPCs based on single detections in soil samples at concentrations above their USEPA Region III default soil transfer-to-groundwater screening level (SSL). It was concluded that 1,1,2,2-TCA and TCE were unlikely to leach to groundwater at levels of concern based on the lack of detections above calculated site-specific SSLs. Low-level organic detections and metal COPC concentrations in site soil were not indicative of significant impact from historical red water ash washout activities in the lagoon. No evidence of residual waste in the former lagoon area was

observed in the 13 soil borings completed within Area A. Well-defined concentration patterns or trends were not apparent from the COPC data. Surface water and sediment data from Stroubles Creek proximate to Area A were not indicative of significant impact from previous site activities at Area A. Human health COPCs were not identified in surface water samples, and metals COPCs were detected in sediment samples at concentrations below their soil background point estimates except for one time where arsenic was found slightly above its background point estimate.

Nature and Extent Assessment at Area B

URS found that 4 to 9 ft of low permeability clay caps an estimated 509 cubic yards of buried red water ash material within two adjacent burial areas with a combined area of 7,168 ft² (0.16 acre).

At the northeast corner of Area B, a small area of buried material (less than 1 foot thick and 3 ft wide) is exposed underneath an overhang of fill material where a small area of fill material has slumped away. This exposed area has a seep, which intermittently flows after prolonged heavy precipitation events. A sample of the buried material (ash) was collected from this location and from other discrete samples of ash at the site. Similar results were reported for the ash samples. volatile organic compounds (VOCs), SVOCs, and 2,3,7,8-TCDD concentrations were below r-SLs. Arsenic and manganese were the only metals detected at concentrations above screening levels (SLs). Explosives, polychlorinated biphenyls (PCBs), and herbicides were not detected in the ash samples. A sample of the seep did not indicate detectable levels of organic constituents leaching from the buried material or levels of dissolved metals at concentrations above adjusted tw-SLs.

COPCs identified in Area B soil and/or buried material were aluminum, arsenic, iron, manganese, 1,2-dibromo-3-propane (SSL), 1,3-dichlorobenzene (SSL), benzene (SSL), TCE (SSL), and total 2,3,7,8-TCDD TE. Metals were the primary COPCs in soil with the highest concentrations detected in intermediate depth samples that contained buried material and at the same depth interval adjacent to the burial areas. One sample (41SB10B at 8.5-11 ft bgs) of buried material was detected above the adjusted r-SL for 2,3,7,8-TCDD TE. COPCs identified in groundwater samples collected from Area B were arsenic and thallium; these metals were detected in the two groundwater samples collected from the burial area at concentrations above their adjusted tw-SLs, but below MCLs. COPCs detected in soil at concentrations above default SSLs were not detected in groundwater; this data coupled with the lack of detections above calculated site-specific SSLs and/or vertical bounding of default SSL exceedances indicated that leaching of organic constituents to groundwater was unlikely to occur at levels of concern. Dissolved arsenic and thallium concentrations in groundwater in the immediate burial area were potentially attributable to leaching from soil or buried material based on soil data and the lack of detections of these COPCs in the groundwater sample collected downgradient of Area B. Comparison of the 1992 VI and 2005 RFI groundwater sample results indicated stable or decreasing chemical concentrations in groundwater. Surface water and sediment samples collected from the unnamed tributary of Stroubles Creek proximate to Area B were not indicative of significant impact from former site activities at Area B. Dissolved metals COPCs were not identified in surface water and organic COPCs related to the site were not identified.

Human Health Risk Assessment

An HHRA was performed by URS to evaluate the potential human health effects associated with previous activities at the site. Media evaluated for the HHRA included soil, groundwater, surface water, and sediment. Receptors evaluated for HHRA included: current/future maintenance worker, future excavation worker, future adult resident, and the future child resident. The total risk calculated for each receptor was below or within USEPA's acceptable risk range for Superfund sites ($1\text{E}-06$ to $1\text{E}-04$), and the total hazard indices (HIs) for all receptors except the future Area A and Area B child residents were equal to or below the USEPA reference HI of $1\text{E}+00$.

Both Area A and Area B passed margin of exposure evaluations for iron for the future child resident scenario. When excluding metals COPCs detected below background at Area A, the HI decreased to less than $1\text{E}+00$ for the future excavation worker and future adult resident and decreased to $2\text{E}+00$ for future child resident. Target organ HIs for the future child resident at Area A were below $1\text{E}+00$. When excluding metals COPCs detected below background at Area B, the HI decreased to less than $1\text{E}+00$ for the future adult resident. Target organ HIs for the future child resident at Area B were $3\text{E}+00$ for blood and $2\text{E}+00$ gastrointestinal (GI) tract, with the remaining HIs less than or equal to $1\text{E}+00$. When incorporating the passing margin of exposure results for iron into the hazard calculation at Area B, the child resident HI decreased from $5\text{E}+00$ to $3\text{E}+00$; the segregated HIs for blood, liver, and GI tract were reduced to $1\text{E}+00$ or less, with skin and vascular remaining at $2\text{E}+00$. In summary for Area A, the results of the HHRA indicate that the calculated cancer risks and hazards are within USEPA acceptable ranges for each of the receptors evaluated when considering background and target organs. Thus, the risk assessment results would support future commercial/industrial or residential use of Area A without restriction. At Area B, the results of the risk assessment indicate that the calculated cancer risks and hazards are within USEPA acceptable ranges for each of the receptors evaluated, except for the future child resident, when considering background and target organs. Thus, the risk assessment results would support future commercial/industrial use of Area B without restriction; however, future development of Area B for residential use would require implementation of measures to limit exposure of future residents.

Screening Level Ecological Risk Assessment

A SLERA was performed by URS to evaluate potential ecological risks associated with previous activities at the site. Direct contact and wildlife ingestion pathways were evaluated for soil, surface water, and sediment. Terrestrial receptors evaluated included: soil invertebrates and microbes, American robin, red-tailed hawk, meadow vole, fox, and short-tailed shrew. Aquatic and semi-aquatic receptors evaluated included: aquatic macroinvertebrates, benthic invertebrates, mallard duck, belted kingfisher, and raccoon. The SLERA did not identify any elevated risks [hazard quotient (HQ) > 1] to ecological receptors in Area A. After consideration of chemical bioavailability, spatial distribution of data at the site and mean concentrations, the only chemical/receptor combination with an HQ of greater than 1 was exposure of the short-tail shrew to arsenic in surface soil in Area B. The HQs for the 95% upper confidence limit (UCL) and mean site arsenic concentrations were 2.9 and 2.6, respectively. When arsenic bioavailability was considered, the mean HQ value was reduced to 2.5. Based on the spatial distribution of the data and fill characteristics, the arsenic levels in surface soil at Area B were potentially ambient levels contained in the off-site fill material used to cap the 1.08-acre area rather than related to historical waste disposal activities. Based on this information, the potential for lower adverse

effects to the shrew, lack of potential risk to higher trophic level receptors, and severe short-term disruption of habitat from remedial activities, the SLERA recommended no action be taken to remediate soil at Area B to mitigate potential risks posed by arsenic in soil.

Table 2-5
Analytes Detected in SWMU 41 Area A Soil Samples - 2005 RFI
Page 1 of 4

Analyte	Sample ID Sample Date Sample Depth			41SB2A 3/30/04 0-1					41SB2B 3/30/04 7.5-8.5					41SB2C 3/30/04 31-32.9					41SB3A 3/31/04 0-1					41SB3B 3/31/04 9.8-10.5					41SB3C 3/31/04 29.4-30.4					41SB4A 3/31/04 0-1					41SB4B 3/31/04 7-8				
	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)																																											
1,1,2,2-Tetrachloroethane	2900	590	na	0.033	U		0.084	5	5	5	U		0.084	5	5	5	U		0.084	5	5	5	U		0.084	5	5	5	U		0.084	5	5	5	U		0.084	5					
1,2,4-Trichlorobenzene	40000	8700	na	0.033	U		0.101	5	5	5	U		0.101	5	5	5	U		0.101	5	5	5	U		0.101	5	5	5	U		0.101	5	5	5	U		0.101	5					
2-Butanone	19000000	2800000	na	0.033	J	B	0.393	10	4.6	5	J	B	0.393	10	2.1	J	B	0.393	10	5.8	J		0.393	10	5.3	J		0.393	10	14	14	J		0.393	10								
Acetone	61000000	6100000	na	0.066	J		18.5	60	26	J		18.5	60	55	J		18.5	60	31	J	J		18.5	60	28	J	J	18.5	60	50	J	J	18.5	60									
Benzene	5600	1100	na	0.066	J		0.136	5	1.2	J		0.136	5	5	U		0.136	5	0.52	J		0.136	5	0.59	J		0.136	5	0.22	J		0.136	5										
Bromomethane	3500	790	na	0.066	U		0.158	5	5	U		0.158	5	5	U		0.158	5	5	U		0.158	5	5	U		0.158	5	5	U		0.158	5										
Carbon disulfide	300000	67000	na	0.066	J		0.172	5	3.7	J		0.172	5	3.4	J		0.172	5	2.1	J		0.172	5	0.46	J		0.172	5	2.7	J		0.172	5										
cis-1,2-Dichloroethene	1000000	78000	na	0.066	U		0.123	5	5	U		0.123	5	1.2	J		0.123	5	5	U		0.123	5	5	U		0.123	5	5	U		0.123	5										
Methylene chloride	54000	11000	na	0.066	U		0.857	5	5	U		0.857	5	5	U		0.857	5	5	U		0.857	5	5	U		0.857	5	5	U		0.857	5										
Tetrachloroethene	2700	570	na	0.033	U		0.129	5	5	U		0.129	5	5	U		0.129	5	5	U		0.129	5	5	U		0.129	5	5	U		0.129	5										
Toluene	4600000	500000	na	0.066	J		0.122	5	1.2	J		0.122	5	5	U		0.122	5	0.49	J		0.122	5	0.55	J		0.122	5	0.37	J		0.122	5										
Trichloroethene	14000	2800	na	0.066	U		0.154	5	5	U		0.154	5	5	U		0.154	5	5	U		0.154	5	5	U		0.154	5	5	U		0.154	5										
Trichlorofluoromethane	340000	80000	na	0.066	U		0.1	5	5	U		0.1	5	5	U		0.1	5	5	U		0.1	5	0.36	J		0.1	5	5	U		0.1	5										
Vinyl chloride	1700	60	na	0.033	U		0.115	5	5	U		0.115	5	5	U		0.115	5	5	U		0.115	5	5	U		0.115	5	5	U		0.115	5										
Xylenes (total)	260000	60000	na	0.033	U		0.139	5	1.3	J		0.139	5	5	U		0.139	5	0.41	J		0.139	5	5	U		0.139	5	5	U		0.139	5										
PAHs (ug/kg)																																											
Fluoranthene	2200000	230000	na	6.4	J		1.87	21	21	U		2.04	21	21	U		2.04	21	21	U		2.04	21	21	U		1.87	21	21	U		1.87	21										
Pyrene	1700000	170000	na	3.8	J		0.99	21	21	U		1.08	21	21	U		1.08	21	21	U		1.08	21	21	U		0.99	21	21	U		0.99	21										
SVOCs (ug/kg)																																											
2,4-Dinitrotoluene	120000	12000	na	0.033	U		11	170	24	J		12	170	170	U		12	170	170	U		12	170	170	U		11	170	170	U		11	170										
2,6-Dinitrotoluene	62000	6100	na	0.033	U		10.9	170	170	U		11.9	170	170	U		11.9	170	170	U		11.9	170	170	U		10.9	170	170	U		10.9	170										
4-Chloro-3-methylphenol	na	na	na	170	U		7.28	170	170	U		7.94	170	170	U		7.94	170	170	U		7.94	170	170	U		8.61	170	8	J	7.28	170											
bis(2-Ethylhexyl)phthalat	120000	35000	na	200			10.4	170	99	J		11.3	170	26	J		11.3	170	22	J		11.3	170	22	J		10.4	170	38	J	10.4	170											
Butylbenzylphthalat	910000	260000	na	170	U		8.69	170	170	U		9.48	170	170	U		9.48	170	170	U		9.48	170	170	U		10.3	170	170	U		8.69	170										
Di-n-butylphthalate	6200000	610000	na	36	J		7.82	170	25	J		8.53	170	60	J		8.53	170	50	J		8.53	170	34	J		7.82	170	55	J	9.24	170											
Fluoranthene	2200000	230000	na	7	J		4.83	170	170	U		5.27	170	170	U		5.27	170	170	U		5.27	170	170	U		5.71	170	170	U		4.83	170										
Pyrene	1700000	170000	na	6	J		5.61	170	170	U		6.12	170	170	U		6.12	170	170	U		6.12	170	170	U		5.61	170	170	U		5.61	170										
Pesticides (ug/kg)																																											
4,4'-DDT	7000	1700	na	1.2	J	J	0.538	20	NT			NT					NT					NT					NT					NT											
alpha-Chlordane	na	na	na	1.5	J	J	0.449	20	NT			NT					NT					NT					NT					NT											
Dieldrin	110	30	na	1.4	J	J	0.471	20	NT			NT					NT					NT					NT					NT											
Endosulfan II	na	na	na	1	J	J	0.315	20	NT			NT					NT					NT					NT					NT											
Endrin ketone	na	na	na	1.7	J	J	0.457	20	NT			NT					NT					NT					NT					NT											
Endrin	18000	1800	na	6.4	J	J	0.5	20	NT			NT					NT					NT					NT					NT											
Heptachlor epoxide	190	53	na	1.8	J	J	0.692	20	NT			NT					NT					NT					NT					NT											
PCBs (mg/kg)																																											
PCB-1254	0.74	0.022	na	0.15			7.48	33	NT			NT					NT					NT					NT					NT											
Explosives (mg/kg) None detected																																											
Herbicides (ug/kg) None detected																																											
Metals (mg/kg)																																											
Aluminum	99000	7700	40041	31100			21	250	27100			21	250	25900			21	250	23600			4.2	50	22200			4.2	50	27400			21	250	29600			42	500					
Antimony	41	3.1	na	1.5			0.0386	0.5	0.24	J		0.0386	0.5	0.2	J		0.0386	0.5	0.36	J		0.0386	0.5	0.34	J		0.0386	0.5	0.29	J		0.0386	0.5	0.44	J		0.0386	0.5					
Arsenic	1.6	0.39	15.8	12			0.058	0.4	4.3			0.058	0.4	2.8			0.058	0.4	7.5			0.058	0.4	6.5		0.058	0.4	11			0.058	0.4	9.8			0.058	0.4						
Barium	19000	1500	209	113			0.103	5	100			0.103	5	100			0.103	5	432			0.103	5	318		0.103	5	136			0.103	5	124			0.103	5						
Beryllium	200	16	1.02	0.73	J		0.0267	1	0.48	J		0.0267	1	1.1			0.0267	1	0.57	J		0.0267	1	0.79	J	0.0267	1	1.1			0.0267	1	1.2			0.0267	1						
Cadmium	81	7	0.69	2.2			0.25	1	1.7			0.25	1	1.6			0.25	1	2.4			0.25	1	1.9		0.25	1	1.7			0.25	1	2.6			0.25	1						
Calcium	na	na	na	59600			87.5	1250	23800			87.5	1250	1790			87.5	1250	115000			17.5	2500	83500		17.5	2500	53700			17.5	2500	53700			17.5	2500						
Chromium	1400	280	65.3	23			0.998	5	22			0.998	5	32			0.998	5	17			0.998	5	18		0.998	5	30			0.998	5	23			0.998	5						
Cobalt	30	2.3	72.3	11	J		0.233	1	12	J		0.233	1	13	J		0.233	1	8.7	J		0.233	1	12	J	0.233	1	21	J		0.233	1	14	J		0.233	1						
Copper	4100	310	53.5	69			0.516	5	18			0.516	5	26			0.516	5	27			0.516	5	16		0.516	5	33			0.516	5	35			0.516	5						
Iron	72000	5500	50962	43200			36.6	500	29100			36.6	500	20300			36.6	500	28600			18.3	250	21100		18.3	250	35400			36.6	500	37900			36.6	500						
Lead	800	400	26.8	125			1.94	25	37			0.0776	1	25			0.0776	1	143			1.94	25	58		0.0776	10	36			0.0776	1	99			1.94	25						
Magnesium	na	na	na	33300			38.4	1250	14200			7.67	250	9350			7.67	250	60100			76.7	2500	32700		76.7	2500	12300			76.7	250	34000			76.7	2500						
Manganese	2300	180	2543	517			0.474	5	961			0.474	5	92			0.474	5	649			0.474	5	1170		2.37	25	873			0.474	5	826			0.474	5						
Nickel	2000	160	62.8	21			0.0775	0.5	15			0.0775	0.5	24			0.0775	0.5	21			0.0775	0.5	21		0.0775	0.5	31			0.0775	0.5	26			0.0775	0.5						
Potassium	na	na	na	2200			7.79	100	1650			7.79	100	2600			7																										

Table 2-5
Analytes Detected in SWMU 41 Area A Soil Samples - 2005 RFI
Page 2 of 4

Analyte	Sample ID Sample Date Sample Depth			41SB2A 3/30/04 0-1					41SB2B 3/30/04 7.5-8.5					41SB2C 3/30/04 31-32.9					41SB3A 3/31/04 0-1					41SB3B 3/31/04 9.8-10.5					41SB3C 3/31/04 29.4-30.4					41SB4A 3/31/04 0-1					41SB4B 3/31/04 7-8				
	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					
Dioxins/Furans (ng/kg)																																											
2,3,7,8-TCDF	na	na	na	NT					4.65			0.154	1.24	1.1	U		0.136	1.1	NT					NT					NT					NT					NT				
2,3,7,8-TCDD	18	4.5	na	NT					0.327	J		0.117	1.24	1.1	U		0.104	1.1	NT					NT					NT					NT					NT				
1,2,3,7,8-PECDD	na	na	na	NT					1.78	J		0.332	6.2	5.5	U		0.294	5.5	NT					NT					NT					NT					NT				
1,2,3,4,7,8-HXCDD	460	100	na	NT					2.89	J		0.267	6.2	5.5	U		0.237	5.5	NT					NT					NT					NT					NT				
1,2,3,6,7,8-HXCDD	460	100	na	NT					7.09			0.455	6.2	0.482	J		0.404	5.5	NT					NT					NT					NT					NT				
1,2,3,7,8,9-HXCDD	460	100	na	NT					7.13			0.558	6.2	1.11	J		0.495	5.5	NT					NT					NT					NT					NT				
1,2,3,4,6,7,8-HPCDD	na	na	na	NT					159			0.422	6.2	6.7			0.374	5.5	NT					NT					NT					NT					NT				
OCDD	na	na	na	NT					2790	E	J	1.12	12.4	245			0.992	11	NT					NT					NT					NT					NT				
1,2,3,7,8-PECDF	na	na	na	NT					1.88	J		0.193	6.2	5.5	U		0.171	5.5	NT					NT					NT					NT					NT				
2,3,4,7,8-PECDF	na	na	na	NT					3.46	J		0.232	6.2	5.5	U		0.206	5.5	NT					NT					NT					NT					NT				
1,2,3,4,7,8-HXCDF	na	na	na	NT					2.07	J		0.229	6.2	5.5	U		0.203	5.5	NT					NT					NT					NT					NT				
1,2,3,6,7,8-HXCDF	na	na	na	NT					1.38	J		0.116	6.2	5.5	U		0.103	5.5	NT					NT					NT					NT					NT				
2,3,4,6,7,8-HXCDF	na	na	na	NT					1.84	J		0.45	6.2	5.5	U		0.4	5.5	NT					NT					NT					NT					NT				
1,2,3,7,8,9-HXCDF	na	na	na	NT					6.2	U		0.553	6.2	5.5	U		0.491	5.5	NT					NT					NT					NT					NT				
1,2,3,4,6,7,8-HPCDF	na	na	na	NT					29.2			0.488	6.2	5.5	U		0.433	5.5	NT					NT					NT					NT					NT				
1,2,3,4,7,8,9-HPCDF	na	na	na	NT					1.86	J		0.435	6.2	5.5	U		0.386	5.5	NT					NT					NT					NT					NT				
OCDF	na	na	na	NT					143			0.708	12.4	11	U		0.628	11	NT					NT					NT					NT					NT				
TOTAL TCDD	na	na	na	NT					12.5			0.117	1.24	1.1	U		0.104	1.1	NT					NT					NT					NT					NT				
TOTAL PECDD	na	na	na	NT					16.2			0.332	6.2	0.671	J		0.294	5.5	NT					NT					NT					NT					NT				
TOTAL HXCDD	na	na	na	NT					47.6			0.267	6.2	7.21			0.237	5.5	NT					NT					NT					NT					NT				
TOTAL HPCDD	na	na	na	NT					278			0.422	6.2	19.9			0.374	5.5	NT					NT					NT					NT					NT				
TOTAL TCDF	na	na	na	NT					70.9			0.153	1.24	1.1	U		0.136	1.1	NT					NT					NT					NT					NT				
TOTAL PECDF	na	na	na	NT					31.8			0.193	6.2	5.5	U		0.171	5.5	NT					NT					NT					NT					NT				
TOTAL HXCDF	na	na	na	NT					40.6			0.116	6.2	0.244	J		0.103	5.5	NT					NT					NT					NT					NT				
TOTAL HPCDF	na	na	na	NT					128			0.435	6.2	5.5	U		0.386	5.5	NT					NT					NT					NT					NT				
2,3,7,8-TCDD TE	18	4.5	na	NT					8.687					0.2997					NT					NT					NT					NT					NT				
Misc. (mg/kg)																																											
Cyanide	2000	160	na	0.05	J	B	0.009	0.5	0.35	J		0.009	0.5	0.02	J	B	0.009	0.5	0.07	J		0.009	0.5	0.42	J		0.009	0.5	0.05	J	B	0.009	0.5	0.06	J	B	0.009	0.5	0.02	J	B	0.009	0.5

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

Table 2-5
Analytes Detected in SWMU 41 Area A Soil Samples - 2005 RFI
Page 3 of 4

Analyte	Sample ID Sample Date Sample Depth			41SB4C 3/31/04 15-16					41SB5A 3/31/04 0-1					41SB5B 3/31/04 15-16					41SB5C 3/31/04 28-29					41TP2A 4/8/04 0-1					41TP2B 4/8/04 11-13					41TP2C 4/8/04 30.5-31.9				
	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)																																						
1,1,2,2-Tetrachloroethane	2900	590	na	5	U		0.084	5	0.033	U		0.084	5	5	U		0.084	5	5	U		0.084	5	5	U		0.084	5	5	U		0.084	5	5	U		0.084	5
1,2,4-Trichlorobenzene	40000	8700	na	5	U		0.101	5	0.033	U		0.101	5	5	U		0.101	5	5	U		0.101	5	3.4	J	B	0.101	5	5	U		0.101	5	3.5	J	B	0.101	5
2-Butanone	19000000	2800000	na	13			0.393	10	0.033	J		0.393	10	8	J		0.393	10	3.8	J		0.393	10	38		B	0.393	10	16		B	0.393	10	28		B	0.393	10
Acetone	61000000	6100000	na	74		J	18.5	60	0.066	J	J	18.5	60	41	J	J	18.5	60	60	U		18.5	60	24	J		18.5	60	57	J	J	18.5	60	60	U		18.5	60
Benzene	5600	1100	na	0.25	J		0.136	5	0.066	J		0.136	5	0.2	J		0.136	5	5	U		0.136	5	5	U		0.136	5	0.26	J		0.136	5	5	U		0.136	5
Bromomethane	3500	790	na	2.7	J		0.158	5	0.066	U		0.158	5	5	U		0.158	5	5	U		0.158	5	5	U		0.158	5	5	U		0.158	5	1.3	J	B	0.158	5
Carbon disulfide	300000	67000	na	2.4	J		0.172	5	0.066	J		0.172	5	5	U		0.172	5	5	U		0.172	5	5		B	0.172	5	5.7			0.172	5	5	U		0.172	5
cis-1,2-Dichloroethene	1000000	78000	na	5	U		0.123	5	0.066	U		0.123	5	5	U		0.123	5	5	U		0.123	5	11			0.123	5	5	U		0.123	5	5	U		0.123	5
Methylene chloride	54000	11000	na	5	U		0.857	5	0.066	U		0.857	5	5	U		0.857	5	5	U		0.857	5	5.9		B	0.857	5	3.6	J	B	0.857	5	9.1		B	0.857	5
Tetrachloroethene	2700	570	na	5	U		0.129	5	0.033	U		0.129	5	5	U		0.129	5	5	U		0.129	5	5.1			0.129	5	5	U		0.129	5	5	U		0.129	5
Toluene	4600000	500000	na	0.82	J		0.122	5	0.033	J		0.122	5	0.22	J		0.122	5	5	U		0.122	5	0.28	J		0.122	5	1.3	J		0.122	5	0.15	J		0.122	5
Trichloroethene	14000	2800	na	5	U		0.154	5	0.066	U		0.154	5	5	U		0.154	5	5	U		0.154	5	0.89	J		0.154	5	5	U		0.154	5	1.4	J		0.154	5
Trichlorofluoromethane	340000	80000	na	5	U		0.1	5	0.066	U		0.1	5	5	U		0.1	5	5	U		0.1	5	0.57	J		0.1	5	0.64	J		0.1	5	0.73	J		0.1	5
Vinyl chloride	1700	60	na	5	U		0.115	5	0.066	U		0.115	5	5	U		0.115	5	5	U		0.115	5	1.2	J		0.115	5	5	U		0.115	5	5	U		0.115	5
Xylenes (total)	260000	60000	na	5	U		0.139	5	0.033	U		0.139	5	5	U		0.139	5	5	U		0.139	5	5	U		0.139	5	0.67	J		0.139	5	5	U		0.139	5
PAHs (ug/kg)																																						
Fluoranthene	2200000	230000	na	21	U		2.38	21		U		1.87	21	21	U		2.04	21	21	U		2.04	21	21	U		2.04	21	21	U		2.04	21	21	U		2.04	21
Pyrene	1700000	170000	na	21	U		1.26	21		U		0.99	21	21	U		1.08	21	21	U		1.08	21	21	U		1.08	21	21	U		1.08	21	21	U		1.08	21
SVOCs (ug/kg)																																						
2,4-Dinitrotoluene	120000	12000	na	170	U		14	170	0.066	U		11	170	170	U		12	170	170	U		10	170	170	U		12	170	170	U		12	170	170	U		12	170
2,6-Dinitrotoluene	62000	6100	na	170	U		13.9	170	170	U		10.9	170	170	U		11.9	170	170	U		9.94	170	170	U		11.9	170	170	U		11.9	170	170	U		11.9	170
4-Chloro-3-methylphenol	na	na	na	170	U		9.27	170	170	U		7.28	170	170	U		7.94	170	170	U		6.62	170	170	U		7.94	170	170	U		7.94	170	170	U		7.94	170
bis(2-Ethylhexyl)phthalate	120000	35000	na	29	J		13.2	170	19	J		10.4	170	23	J		11.3	170	15	J		9.44	170	16	J		11.3	170	13	J		11.3	170	17	J		11.3	170
Butylbenzylphthalate	910000	260000	na	170	U		11.1	170	170	U		8.69	170	170	U		9.48	170	10	J		7.9	170	170	U		9.48	170	170	U		9.48	170	170	U		9.48	170
Di-n-butylphthalate	6200000	610000	na	36	J		9.95	170	40	J		7.82	170	33	J		8.53	170	38	J		7.11	170	210			8.53	170	24	J		8.53	170	200			8.53	170
Fluoranthene	2200000	230000	na	170	U		6.15	170	170	U		4.83	170	170	U		5.27	170	170	U		4.39	170	170	U		5.27	170	170	U		5.27	170	170	U		5.27	170
Pyrene	1700000	170000	na	170	U		7.14	170	170	U		5.61	170	170	U		6.12	170	170	U		5.1	170	170	U		6.12	170	170	U		6.12	170	170	U		6.12	170
Pesticides (ug/kg)																																						
4,4'-DDT	7000	1700	na	NT					20	U		0.538	20	NT					NT										20	U		0.646	20	NT				
alpha-Chlordane	na	na	na	NT					20	U		0.449	20	NT					NT										20	U		0.539	20	NT				
Dieldrin	110	30	na	NT					20	U		0.471	20	NT					NT										20	U		0.565	20	NT				
Endosulfan II	na	na	na	NT					20	U		0.315	20	NT					NT										20	U		0.378	20	NT				
Endrin ketone	na	na	na	NT					20	U		0.457	20	NT					NT										20	U		0.548	20	NT				
Endrin	18000	1800	na	NT					20	U		0.5	20	NT					NT										20	U		0.6	20	NT				
Heptachlor epoxide	190	53	na	NT					20	U		0.692	20	NT					NT										20	U		0.83	20	NT				
PCBs (mg/kg)																																						
PCB-1254	0.74	0.022	na	NT					0.033	U		7.48	33	NT					NT										0.066	U		8.16	66	NT				
Explosives (mg/kg)																																						
None detected																																						
Herbicides (ug/kg)																																						
None detected																																						
Metals (mg/kg)																																						
Aluminum	99000	7700	40041	40600				42	500			4.2	50	22700			4.2	50	20000			4.2	50	25900			21	250	24400			4.2	50	22400			4.2	50
Antimony	41	3.1	na	0.64			0.0386	0.5	0.33	J		0.0386	0.5	0.77			0.0386	0.5	0.18	J		0.0386	0.5	0.21	J		0.0386	0.5	0.4	J		0.0386	0.5	0.089	J		0.0386	0.5
Arsenic	1.6	0.39	15.8	19			0.058	0.4	6.9			0.058	0.4	11			0.058	0.4	7.3			0.058	0.4	6	J	0.058	0.4	8.2	J	0.058	0.4	3.5	J	0.058	0.4			
Barium	19000	1500	209	74			0.103	5	553			0.515	25	293			0.103	5	118			0.103	5	110		0.103	5	72		0.103	5	89		0.103	5			
Beryllium	200	16	1.02	1.8			0.0267	1	0.34	J		0.0267	1	0.93	J		0.0267	1	0.93	J		0.0267	1	0.44	J	0.0267	1	0.49	J	0.0267	1	0.81	J	0.0267	1			
Cadmium	81	7	0.69	3			0.25	1	2.6			0.25	1	2.2			0.25	1	2			0.25	1	2.9		0.25	1	2.5		0.25	1	2.2		0.25	1			
Calcium	na	na	na	1720			17.5	250	156000			438	6250	77400			17.5	2500	2360			17.5	250	33100		87.5	1250	15400		17.5	250	1180		17.5	250			
Chromium	1400	280	65.3	35			0.998	5	13			0.998	5	19			0.998	5	22			0.998	5	25		0.998	5	25		0.998	5	29		0.998	5			
Cobalt	30	2.3	72.3	12		J	0.233	1	7.8		J	0.233	1	15		J	0.233	1	17		J	0.233	1	11		0.233	1	14		0.233	1	13		0.233	1			
Copper	4100	310	53.5	63			0.516	5	40			0.516	5	29			0.516	5	24			0.516	5	26		0.516	5	19		0.516	5	23		0.516	5			
Iron	72000	5500	50962	75500			73.1	1000	24300			36.6	500	37400			36.6	5000	28200			36.6	500	30600		73.1	1000	30200		73.1	1000	22400		73.1	1000			
Lead	800	400	26.8	49			0.077																															

Table 2-5
Analytes Detected in SWMU 41 Area A Soil Samples - 2005 RFI
Page 4 of 4

Analyte	Sample ID Sample Date Sample Depth			41SB4C 3/31/04 15-16				41SB5A 3/31/04 0-1				41SB5B 3/31/04 15-16				41SB5C 3/31/04 28-29				41TP2A 4/8/04 0-1				41TP2B 4/8/04 11-13				41TP2C 4/8/04 30.5-31.9										
	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					
Dioxins/Furans (ng/kg)																																						
2,3,7,8-TCDF	na	na	na	NT					NT					1.15	U		0.141	1.15	1.21	U		0.149	1.21	NT					0.176	J		0.154	1.24	NT				
2,3,7,8-TCDD	18	4.5	na	NT					NT					1.15	U		0.108	1.15	1.21	U		0.114	1.21	NT					0.157	J		0.118	1.24	NT				
1,2,3,7,8-PECDD	na	na	na	NT					NT					5.73	U		0.307	5.73	6.03	U		0.322	6.03	NT					0.371	J		0.333	6.22	NT				
1,2,3,4,7,8-HXCDD	460	100	na	NT					NT					5.73	U		0.247	5.73	6.03	U		0.26	6.03	NT					0.68	J		0.268	6.22	NT				
1,2,3,6,7,8-HXCDD	460	100	na	NT					NT					5.73	U		0.421	5.73	6.03	U		0.442	6.03	NT					0.886	J		0.457	6.22	NT				
1,2,3,7,8,9-HXCDD	460	100	na	NT					NT					10.5			0.516	5.73	1.21	J		0.542	6.03	NT					2.67	J		0.56	6.22	NT				
1,2,3,4,6,7,8-HPCDD	na	na	na	NT					NT					11.2			0.39	5.73	9.79			0.41	6.03	NT					44.1			0.423	6.22	NT				
OCDD	na	na	na	NT					NT					1200			1.03	11.5	394			1.09	12.1	NT					6520	E	J	1.12	12.4	NT				
1,2,3,7,8-PCDF	na	na	na	NT					NT					5.73	U		0.178	5.73	6.03	U		0.187	6.03	NT					6.22	U		0.194	6.22	NT				
2,3,4,7,8-PCDF	na	na	na	NT					NT					5.73	U		0.214	5.73	6.03	U		0.225	6.03	NT					6.22	U		0.233	6.22	NT				
1,2,3,4,7,8-HXCDF	na	na	na	NT					NT					5.73	U		0.212	5.73	6.03	U		0.222	6.03	NT					6.22	U		0.23	6.22	NT				
1,2,3,6,7,8-HXCDF	na	na	na	NT					NT					5.73	U		0.107	5.73	6.03	U		0.113	6.03	NT					0.189	J			6.22	NT				
2,3,4,6,7,8-HXCDF	na	na	na	NT					NT					5.73	U		0.417	5.73	6.03	U		0.438	6.03	NT					6.22	U		0.452	6.22	NT				
1,2,3,7,8,9-HXCDF	na	na	na	NT					NT					5.73	U		0.511	5.73	6.03	U		0.537	6.03	NT					6.22	U		0.555	6.22	NT				
1,2,3,4,6,7,8-HPCDF	na	na	na	NT					NT					5.73	U		0.452	5.73	6.03	U		0.475	6.03	NT					0.769	J			6.22	NT				
1,2,3,4,7,8,9-HPCDF	na	na	na	NT					NT					5.73	U		0.402	5.73	6.03	U		0.423	6.03	NT					6.22	U		0.436	6.22	NT				
OCDF	na	na	na	NT					NT					11.5	U		0.654	11.5	12.1	U		0.688	12.1	NT					2.09	J			12.4	NT				
TOTAL TCDD	na	na	na	NT					NT					1.15	U		0.108	1.15	1.21	U		0.114	1.21	NT					0.157	J			1.24	NT				
TOTAL PECDD	na	na	na	NT					NT					0.619	J		0.307	5.73	0.528	J		0.322	6.03	NT					0.747	J			6.22	NT				
TOTAL HXCDD	na	na	na	NT					NT					12.7			0.247	5.73	11.8			0.26	6.03	NT					15.3				6.22	NT				
TOTAL HPCDD	na	na	na	NT					NT					25.4			0.39	5.73	30.5			0.41	6.03	NT					102				6.22	NT				
TOTAL TCDF	na	na	na	NT					NT					1.15	U		0.141	1.15	1.21	U		0.149	1.21	NT					0.172	J			1.24	NT				
TOTAL PCDF	na	na	na	NT					NT					5.73	U		0.178	5.73	6.03	U		0.187	6.03	NT					0.48	J			6.22	NT				
TOTAL HXCDF	na	na	na	NT					NT					0.346	J		0.107	5.73	0.248	J		0.113	6.03	NT					0.896	J			6.22	NT				
TOTAL HPCDF	na	na	na	NT					NT					5.73	U		0.402	5.73	6.03	U		0.423	6.03	NT					0.769	J			6.22	NT				
2,3,7,8-TCDD TE	18	4.5	na	NT					NT					1.522			0.108	1.15	0.3371					NT					3.393					NT				
Misc. (mg/kg)																																						
Cyanide	2000	160	na	0.03	J	B	0.009	0.5	0.06	J		0.009	0.5	0.07	J	B	0.009	0.5	0.01	J	B	0.009	0.5	0.06	J	B	0.009	0.5	0.01	J	B	0.009	0.5	0.03	J	B	0.009	0.5

**Refer to legend immediately following this table for a list of definitions and table 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.
<u>12</u>	<u>J</u>	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, April 2009).

Lead screening values from Technical Review Workgroup for Lead: Guidance Document (USEPA, 1999b).

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 2-6 Analytes Detected in SWMU 41 Area B Soil Samples - 2005 RFI Page 1 of 6																																												
Analyte	Sample ID Sample Date Sample Depth			41SB6A 4/2/04 0-1					41SB6B 4/2/04 0.7-2.1					41SB6C 4/2/04 21-21.5					41SB7A 3/30/04 0-1					41SB7B 3/30/04 14-16					41SB7C 3/30/04 23-24					41SB8A 4/1/04 0-1					41SB8B 4/1/04 8-12					
	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	Result	Lab Q	Val Q	MDL	MRL	
VOCs (ug/kg)																																												
1,1,2,2-Tetrachloroethane	2900	590	na	5.8		B	0.084	5	5	U		0.084	5	5	U		0.084	5	5	U		0.084	5	5	U		0.084	5	5	U		0.084	5	5	U		0.084	5	5	U		0.084	5	
1,2,4-Trichlorobenzene	40000	8700	na	4.3	J	B	0.101	5	3.6	J	B	0.101	5	4.4	J	B	0.101	5	5	U		0.101	5	5	U		0.101	5	5	U		0.101	5	0.3	J	B	0.101	5	5	U		0.101	5	
1,2-Dibromo-3-chloropropane	73	5.6	na	9.4	J	B	0.307	10	10	U		0.307	10	10	U	UJ	0.307	10	10	U		0.307	10	10	U		0.307	10	10	U		0.307	10	10	U		0.307	10	10	U		0.307	10	
1,2-Dibromoethane (EDB)	170	34	na	0.96	J	B	0.134	5	5	U		0.134	5	5	U		0.134	5	5	U		0.134	5	5	U		0.134	5	5	U		0.134	5	5	U		0.134	5	5	U		0.134	5	
1,2-Dichloroethane	2200	450	na	0.57	J	B	0.18	5	5	U		0.18	5	5	U		0.18	5	5	U		0.18	5	5	U		0.18	5	5	U		0.18	5	5	U	UJ	0.18	5	5	U	UJ	0.18	5	
2-Butanone	19000000	2800000	na	27	J		0.393	10	29		J	0.393	10	28		B	0.393	10	2.9	J	B	0.393	10	2.9	J	B	0.393	10	9.5	J		0.393	10	7.1	J	J	0.393	10	16		J	0.393	10	
2-Hexanone	na	na	na	10			0.37	10	10	U		0.37	10	10	U		0.37	10	10	U		0.37	10	10	U		0.37	10	10	U		0.37	10	10	U		0.37	10	10	U		0.37	10	
4-Methyl-2-pentanone	5200000	530000	na	7.7	J		0.181	10	10	U		0.181	10	10	U		0.181	10	10	U		0.181	10	10	U		0.181	10	10	U		0.181	10	10	U	UJ	0.181	10	10	U	UJ	0.181	10	
Acetone	61000000	6100000	na	60	U		18.5	60	120			18.5	60	60	U	UJ	18.5	60	60	U		18.5	60	60	U		18.5	60	41	J		18.5	60	31	J	J	18.5	60	88		J	18.5	60	
Benzene	5600	1100	na	0.26	J	B	0.136	5	0.72	J	B	0.136	5	5	U		0.136	5	0.86	J		0.136	5	5	U		0.136	5	5	U		0.136	5	1.1	J		0.136	5	1.2	J		0.136	5	
Bromoform	220000	61000	na	1.2	J	B	0.101	5	5	U		0.101	5	5	U		0.101	5	5	U		0.101	5	5	U		0.101	5	5	U		0.101	5	5	U		0.101	5	5	U		0.101	5	
Bromomethane	3500	790	na	1.7	J	B	0.158	5	1.5	J	B	0.158	5	1.6	J	B	0.158	5	5	U		0.158	5	5	U		0.158	5	5	U		0.158	5	1.9	J	B	0.158	5	1.8	J	B	0.158	5	
Carbon disulfide	300000	67000	na	5	U	UJ	0.172	5	9.4		B	0.172	5	5	U		0.172	5	1.1	J		0.172	5	5	U		0.172	5	5	U		0.172	5	1.2	J	B	0.172	5	17		J	0.172	5	
Chlorobenzene	150000	31000	na	0.28	J	B	0.0475	5	5	U		0.0475	5	5	U		0.0475	5	5	U		0.0475	5	5	U		0.0475	5	5	U		0.0475	5	5	U		0.0475	5	5	U		0.0475	5	
cis-1,2-Dichloroethene	1000000	78000	na	5	U		0.123	5	5	U		0.123	5	5	U		0.123	5	5	U		0.123	5	5	U		0.123	5	5	U		0.123	5	5	U		0.123	5	5	U		0.123	5	
cis-1,3-Dichloropropene	na	na	na	0.32	J	B	0.0423	5	5	U		0.0423	5	5	U		0.0423	5	5	U		0.0423	5	5	U		0.0423	5	5	U		0.0423	5	5	U		0.0423	5	5	U		0.0423	5	
Dibromochloromethane	21000	5800	na	0.55	J	B	0.0527	5	5	U		0.0527	5	5	U		0.0527	5	5	U		0.0527	5	5	U		0.0527	5	5	U		0.0527	5	5	U		0.0527	5	5	U		0.0527	5	
Ethylbenzene	29000	5700	na	0.2	J	B	0.145	5	5	U		0.145	5	0.25	J		0.145	5	5	U		0.145	5	5	U		0.145	5	5	U		0.145	5	5	U		0.145	5	5	U		0.145	5	
Methylene chloride	54000	11000	na	2.8	J	B	0.857	5	5	U		0.857	5	4.2	J	B	0.857	5	5	U		0.857	5	5	U		0.857	5	5	U		0.857	5	5	U	UJ	0.857	5	5	U	UJ	0.857	5	
Styrene	3800000	650000	na	2.7	J	B	0.128	5	5	U		0.128	5	5	U		0.128	5	5	U		0.128	5	5	U		0.128	5	5	U		0.128	5	5	U		0.128	5	5	U		0.128	5	
Tetrachloroethene	2700	570	na	5	U		0.129	5	5	U		0.129	5	5	U		0.129	5	5	U		0.129	5	5	U		0.129	5	5	U		0.129	5	5	U		0.129	5	5	U		0.129	5	
Toluene	4600000	500000	na	0.23	J	B	0.122	5	0.66	J	B	0.122	5	5	U		0.122	5	0.94	J		0.122	5	5	U		0.122	5	5	U		0.122	5	1.2	J		0.122	5	1.2	J		0.122	5	
trans-1,3-Dichloropropene	na	na	na	0.46	J	B	0.159	5	5	U		0.159	5	5	U		0.159	5	5	U		0.159	5	5	U		0.159	5	5	U		0.159	5	5	U		0.159	5	5	U		0.159	5	
Trichloroethene	14000	2800	na	5	U		0.154	5	5	U		0.154	5	5	U		0.154	5	5	U		0.154	5	5	U		0.154	5	5	U		0.154	5	5	U		0.154	5	5	U		0.154	5	
Trichlorofluoromethane	340000	80000	na	5	U		0.1	5	5	U		0.1	5	0.91	J		0.1	5	5	U		0.1	5	5	U		0.1	5	5	U		0.1	5	0.17	J		0.1	5	5	U		0.1	5	
Xylenes (total)	260000	60000	na	0.71	J	B	0.139	5	0.51	J	B	0.139	5	0.83	J		0.139	5	0.49	J		0.139	5	5	U		0.139	5	5	U		0.139	5	0.86	J		0.139	5	5	U		0.139	5	
PAHs (ug/kg)																																												
Acenaphthene	3300000	340000	na	100	U		11.3	100	100	U		11.3	100	100	U		14.1	100	100	U		13.2	100	100	U		13.2	100	100	U		13.2	100	100	U		11.3	100	20	J		11.3	100	
Anthracene	17000000	1700000	na	21	U		0.84	21	21	U		0.84	21	21	U		1.05	21	21	U		0.98	21	21	U		0.98	21	21	U		0.98	21	21	U		0.84	21	1.3	J		0.84	21	
Benzo(a)anthracene	2100	150	na	21	U		0.96	21	21	U		0.96	21	21	U		1.2	21	21	U		1.12	21	21	U		1.12	21	21	U		1.12	21	21	U		0.96	21	39			0.96	21	
Benzo(a)pyrene	210	15	na	21	U	</																																						

Table 2-6
Analytes Detected in SWMU 41 Area B Soil Samples - 2005 RFI
Page 2 of 6

Analyte	Sample ID Sample Date Sample Depth			41SB6A 4/2/04 0-1				41SB6B 4/2/04 0.7-2.1				41SB6C 4/2/04 21-21.5				41SB7A 3/30/04 0-1				41SB7B 3/30/04 14-16				41SB7C 3/30/04 23-24				41SB8A 4/1/04 0-1				41SB8B 4/1/04 8-12												
	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						
Explosives (mg/kg)	None detected																																											
Herbicides (ug/kg)	None detected																																											
Metals (mg/kg)																																												
Aluminum	99000	7700	40041	22500			4.2	50	17000			4.2	50	32500			42	500	26500			21	250	42400		21	250	20500			4.2	50	17300			4.2	50	24100			21	250		
Antimony	41	3.1	na	0.54		B	0.0386	0.5	0.57		B	0.0386	0.5	0.69		B	0.0386	0.5	0.66			0.0386	0.5	1.2		0.0386	0.5	0.94			0.0386	0.5	0.7		B	0.0386	0.5	1.1			0.0386	0.5		
Arsenic	1.6	0.39	15.8	14			0.058	0.4	18			0.058	0.4	17			0.058	0.4	21			0.058	0.4	31		0.058	0.4	27			0.058	0.4	19			0.058	0.4	13			0.058	0.4		
Barium	19000	1500	209	143			0.103	5	156			0.103	5	147			0.103	5	85			0.103	5	178		0.103	5	139			0.103	5	58			0.103	5	165			0.103	5		
Beryllium	200	16	1.02	0.81	J		0.0267	1	0.68	J		0.0267	1	1.6			0.0267	1	0.77	J		0.0267	1	0.92		J		0.0267	1	1.4			0.0267	1	0.57	J		0.0267	1	1			0.0267	1
Cadmium	81	7	0.69	1.6			0.25	1	2.1			0.25	1	2.7			0.25	1	2.3			0.25	1	0.6		J	L	0.25	1	3.2			0.25	1	3			0.25	1	2.5			0.25	1
Calcium	na	na	na	28400			175	2500	20700			17.5	250	5350			17.5	250	88700		J	175	2500	751		17.5	250	6230			17.5	250	138000			87.5	12500	44700			87.5	1250		
Chromium	1400	280	65.3	19		K	0.998	5	16		K	0.998	5	26		K	0.998	5	22			0.998	5	23		0.998	5	39			0.998	5	15		K	0.998	5	23		K	0.998	5		
Cobalt	30	2.3	72.3	11			0.233	1	11			0.233	1	18			0.233	1	11		J	0.233	1	18		0.233	1	13		J	0.233	1	7.5			0.233	1	20			0.233	1		
Copper	4100	310	53.5	38			0.516	5	38			0.516	5	41			0.516	5	55			0.516	5	47		0.516	5	43			0.516	5	42			0.516	5	41			0.516	5		
Iron	72000	5500	50962	31700			36.6	500	29000			36.6	500	47100			73.1	1000	45200			73.1	1000	66200		73.1	1000	47000			36.6	500	34000			36.6	500	36400			36.6	500		
Lead	800	400	26.8	41			0.0776	1	39			0.0776	1	132			1.94	25	44			0.0776	1	86		0.776	10	230			1.94	25	33			0.0776	1	143			1.94	25		
Magnesium	na	na	na	20900		K	7.67	250	13100		K	7.67	250	17300		K	7.67	250	40300			38.4	1250	1970		7.67	250	9660			7.67	250	57100		K	38.4	1250	23200		K	7.67	250		
Manganese	2300	180	2543	912			0.474	5	873			2.37	25	1110			2.37	25	1630			2.37	25	1500		2.37	25	1200			2.37	25	1190			2.37	25	1420			2.37	25		
Mercury	2.4	0.43	0.13	0.24			0.0077	0.1	0.65			0.0077	0.1	0.065	J	B	0.0077	0.1	0.08	J		0.0077	0.1	0.19		0.0077	0.1	0.23			0.0077	0.1	0.066	J	B	0.0077	0.1	0.3			0.0077	0.1		
Nickel	2000	160	62.8	17			0.0775	0.5	18			0.0775	0.5	25			0.0775	0.5	27			0.0775	0.5	20		0.0775	0.5	41			0.0775	0.5	16			0.0775	0.5	19			0.0775	0.5		
Potassium	na	na	na	1400			7.79	100	1120			7.79	100	1170			7.79	100	1190			7.79	100	924		7.79	100	839			7.79	100	664			7.79	100	1440			7.79	100		
Selenium	510	39	na	0.61	J		0.0486	1	0.68	J		0.0486	1	0.47	J		0.0486	1	0.9	J		0.0486	1	0.42		J		0.0486	1	1.4			0.0486	1	0.5	J		0.0486	1	0.62	J		0.0486	1
Silver	510	39	na	0.083	J		0.0178	3	0.076	J		0.0178	3	0.089	J		0.0178	3	0.13	J		0.0178	3	0.067		J		0.0178	3	0.16	J		0.0178	3	0.064	J		0.0178	3	0.093	J		0.0178	3
Sodium	na	na	na	98	J	L	31.4	100	198			31.4	100	432			31.4	100	103			31.4	100	2140		157	500	48	J	L	31.4	100	122			31.4	100	1550			157	500		
Thallium	6.6	0.51	2.11	0.27	J		0.0733	0.5	0.17	J		0.0733	0.5	0.25	J		0.0733	0.5	0.13	J		0.0733	0.5	0.27		J		0.0733	0.5	0.34	J		0.0733	0.5	0.5	U		0.0733	0.5	0.26	J		0.0733	0.5
Vanadium	720	55	108	47			0.401	1.2	36			0.401	1.2	59			0.401	1.2	42			0.401	1.2	70				68			0.401	1.2	29			0.401	1.2	53			0.401	1.2		
Zinc	31000	2300	202	110		K	3.95	20	96		K	3.95	20	521		K	7.89	40	218			3.95	20	357		3.95	20	1440			39.5	200	156		K	3.95	20	140		K	3.95	20		
Dioxins/Furans (ng/kg)																																												
2,3,7,8-TCDF	na	na	na	NT					NT					NT					NT					1.42	U		0.175	1.42	1.19	U		0.147	1.19	NT					NT					
2,3,7,8-TCDD	18	4.5	na	NT					NT					NT					NT					1.42	U		0.134	1.42	1.19	U		0.113	1.19	NT					NT					
1,2,3,7,8-PECDD	na	na	na	NT					NT					NT					NT					7.09	U		0.379	7.09	5.97	U		0.319	5.97	NT					NT					
1,2,3,4,7,8-HXCDD	na	na	na	NT					NT					NT					NT					7.09	U		0.306	7.09	0.44	J		0.258	5.97	NT					NT					
1,2,3,6,7,8-HXCDD	na	na	na	NT					NT					NT					NT					7.09	U		0.52	7.09	5.97	U		0.438	5.97	NT					NT					
1,2,3,7,8,9-HXCDD	na	na	na	NT					NT					NT					NT					1.05	J		0.638	7.09	0.98	J		0.538	5.97	NT					NT					
1,2,3,4,6,7,8-HPCDD	na	na	na	NT					NT					NT					NT					20.8			0.482	7.09	13.1			0.406	5.97	NT					NT					
OCDD	na	na	na	NT					NT					NT					NT					3590	E	J	1.28	14.2	1490			1.08	11.9	NT					NT					
1,2,3,7,8-PECDF	na	na	na	NT					NT					NT					NT					7.09	U		0.22	7.09	5.97	U		0.186	5.97	NT					NT					
2,3,4,7,8-PECDF	na	na	na	NT					NT					NT					NT					7.09	U		0.265	7.09	5.97	U		0.223	5.97	NT					NT					
1,2,3,4,7,8-HXCDF	na	na	na	NT					NT					NT					NT					7.09	U		0.262	7.09	5.97	U		0.221	5.97	NT					NT					
1,2,3,6,7,8-HXCDF	na	na	na	NT					NT					NT					NT					7.09	U		0.133	7.09	5.97	U		0.112	5.97	NT					NT					
2,3,4,6,7,8-HXCDF	na	na	na	NT					NT					NT					NT					7.09	U		0.515	7.09	5.97	U		0.434	5.97	NT					NT					
1,2,3,7,8,9-HXCDF	na	na	na	NT					NT					NT					NT					7.09	U		0.632</																	

Table 2-6 Analytes Detected in SWMU 41 Area B Soil Samples - 2005 RFI Page 3 of 6																																											
Analyte	Sample ID Sample Date Sample Depth			41SB8C 4/1/04 18-21				41SB9A 4/1/04 0-1				41SB9B 4/1/04 8-12				41SB9C 4/1/04 11.5-12.5				41SB10A 3/30/04 0-1				41SB10B 3/30/04 8.5-11				41SB10C 3/30/04 15-16				41SB11A 4/1/04 0-1											
	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)																																											
1,1,2,2-Tetrachloroethane	2900	590	na	5	U		0.084	5	5	U		0.084	5	5	U		0.084	5	5	U		0.084	5	0.033	U		0.084	5	5	U		0.084	5	5	U		0.084	5	5	U		0.084	5
1,2,4-Trichlorobenzene	40000	8700	na	5	U		0.101	5	5	U		0.101	5	3.9	J	B	0.101	5	3.5	J	B	0.101	5	0.033	U		0.101	5	5	U		0.101	5	5	U		0.101	5	5	U		0.101	5
1,2-Dibromo-3-chloropropane	73	5.6	na	10	U		0.307	10	10	U		0.307	10	6.9	J	B	0.307	10	10	U		0.307	10	0.033	U		0.307	10	10	U		0.307	10	10	U		0.307	10	10	U		0.307	10
1,2-Dibromoethane (EDB)	170	34	na	5	U		0.134	5	5	U		0.134	5	5	U	UJ	0.134	5	5	U		0.134	5	0.033	U		0.134	5	5	U		0.134	5	5	U		0.134	5	5	U		0.134	5
1,2-Dichloroethane	2200	450	na	5	U	UJ	0.18	5	5	U	UJ	0.18	5	5	U	UJ	0.18	5	5	U	UJ	0.18	5	0.066	U		0.18	5	5	U		0.18	5	5	U		0.18	5	5	U	UJ	0.18	5
2-Butanone	19000000	2800000	na	23		J	0.393	10	8.8	J	J	0.393	10	8	J		0.393	10	12			0.393	10	0.033	J	B	0.393	10	15			0.393	10	6.6	J	B	0.393	10	7.3	J	J	0.393	10
2-Hexanone	na	na	na	10	U		0.37	10	10	U		0.37	10	10	U		0.37	10	10	U		0.37	10	0.066	U		0.37	10	10	U		0.37	10	10	U		0.37	10	10	U		0.37	10
4-Methyl-2-pentanone	5200000	530000	na	10	U	UJ	0.181	10	10	U	UJ	0.181	10	10	U		0.181	10	10	U		0.181	10	0.066	U		0.181	10	10	U		0.181	10	10	U		0.181	10	10	U	UJ	0.181	10
Acetone	61000000	6100000	na	95		J	18.5	60	32	J	J	18.5	60	60	U	UJ	18.5	60	36	J	J	18.5	60	0.066	J	J	18.5	60	78		J	18.5	60	96			18.5	60	28	J	J	18.5	60
Benzene	5600	1100	na	0.3	J		0.136	5	0.84	J		0.136	5	0.92	J		0.136	5	5	U		0.136	5	0.066	J		0.136	5	0.32	J		0.136	5	12			0.136	5	1.1	J		0.136	5
Bromoform	220000	61000	na	5	U		0.101	5	5	U		0.101	5	5	U		0.101	5	5	U		0.101	5	0.033	U		0.101	5	5	U		0.101	5	5	U		0.101	5	5	U		0.101	5
Bromomethane	3500	790	na	1.9	J	B	0.158	5	1.7	J	B	0.158	5	1.6	J	B	0.158	5	1.4	J	B	0.158	5	0.066	U		0.158	5	2.1	J		0.158	5	5	U		0.158	5	1.8	J	B	0.158	5
Carbon disulfide	300000	67000	na	2.7	J	J	0.172	5	1.1	J	B	0.172	5	5.1			0.172	5	12			0.172	5	0.066	J		0.172	5	1.1	J		0.172	5	5	U		0.172	5	1	J	B	0.172	5
Chlorobenzene	150000	31000	na	5	U		0.0475	5	5	U		0.0475	5	5	U		0.0475	5	5	U		0.0475	5	0.066	U		0.0475	5	5	U		0.0475	5	5	U		0.0475	5	5	U		0.0475	5
cis-1,2-Dichloroethene	1000000	78000	na	5	U		0.123	5	5	U		0.123	5	5	U		0.123	5	5	U		0.123	5	0.023	U		0.123	5	5	U		0.123	5	5	U		0.123	5	5	U		0.123	5
cis-1,3-Dichloropropene	na	na	na	5	U		0.0423	5	5	U		0.0423	5	5	U		0.0423	5	5	U		0.0423	5	0.066	U		0.0423	5	5	U		0.0423	5	5	U		0.0423	5	5	U		0.0423	5
Dibromochloromethane	21000	5800	na	5	U		0.0527	5	5	U		0.0527	5	5	U		0.0527	5	5	U		0.0527	5	0.066	U		0.0527	5	5	U		0.0527	5	5	U		0.0527	5	5	U		0.0527	5
Ethylbenzene	29000	5700	na	5	U		0.145	5	5	U		0.145	5	0.3	J		0.145	5	5	U		0.145	5	0.033	U		0.145	5	5	U		0.145	5	1.7	J		0.145	5	5	U		0.145	5
Methylene chloride	54000	11000	na	5	U	UJ	0.857	5	5	U	UJ	0.857	5	1.2	J		0.857	5	5	U		0.857	5	0.066	U		0.857	5	5	U		0.857	5	0.98	J		0.857	5	5	U	UJ	0.857	5
Styrene	3800000	650000	na	5	U		0.128	5	5	U		0.128	5	5	U		0.128	5	5	U		0.128	5	0.066	U		0.128	5	5	U		0.128	5	5	U		0.128	5	5	U		0.128	5
Tetrachloroethene	2700	570	na	5	U		0.129	5	5	U		0.129	5	5	U		0.129	5	5	U		0.129	5	0.033	U		0.129	5	0.51	J		0.129	5	5	U		0.129	5	5	U		0.129	5
Toluene	4600000	500000	na	0.44	J		0.122	5	0.76	J		0.122	5	58		J	0.122	5	1	J		0.122	5	0.033	J		0.122	5	5	U		0.122	5	15			0.122	5	1	J		0.122	5
trans-1,3-Dichloropropene	na	na	na	5	U		0.159	5	5	U		0.159	5	5	U		0.159	5	5	U		0.159	5	0.066	U		0.159	5	5	U		0.159	5	5	U		0.159	5	5	U		0.159	5
Trichloroethene	14000	2800	na	5	U		0.154	5	5	U		0.154	5	4.3	J		0.154	5	0.22	J		0.154	5	0.066	U		0.154	5	2.5	J		0.154	5	5	U		0.154	5	5	U		0.154	5
Trichlorofluoromethane	340000	80000	na	5	U		0.1	5	5	U		0.1	5	0.55	J		0.1	5	0.23	J		0.1	5	0.066	U		0.1	5	5	U		0.1	5	5	U		0.1	5	5	U		0.1	5
Xylenes (total)	260000	60000	na	5	U		0.139	5	5	U		0.139	5	1.1	J	J	0.139	5	5	U		0.139	5	0.033	J		0.139	5	5	U		0.139	5	6.3			0.139	5	0.7	J		0.139	5
PAHs (ug/kg)																																											
Acenaphthene	3300000	340000	na	100	U		11.3	100	100	U		11.3	100	100	U		12.2	100	100	U		11.3	100	100	U		13.2	100	100	U		12.2	100	100	U		11.3	100	100	U		11.3	100
Anthracene	17000000	1700000	na	21	U		0.84	21	21	U		0.84	21	21	U		0.91	21	21	U		0.84	21	21	U		0.98	21	21	U		0.91	21	21	U		0.84	21	21	U		0.84	21
Benz(a)anthracene	2100	150	na	21	U		0.96	21	21	U		0.96	21	21	U		1.04	21	21	U		0.96	21	21	U		1.12	21	21	U		1.04	21	21	U		0.96	21	21	U		0.96	21

Table 2-6
Analytes Detected in SWMU 41 Area B Soil Samples - 2005 RFI
Page 4 of 6

Analyte	Sample ID Sample Date Sample Depth			41SB8C 4/1/04 18-21				41SB9A 4/1/04 0-1				41SB9B 4/1/04 8-12				41SB9C 4/1/04 11.5-12.5				41SB10A 3/30/04 0-1				41SB10B 3/30/04 8.5-11				41SB10C 3/30/04 15-16				41SB11A 4/1/04 0-1											
	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					
Explosives (mg/kg)	None detected																																										
Herbicides (ug/kg)	None detected																																										
Metals (mg/kg)																																											
Aluminum	99000	7700	40041	14400			42	500	21500			4.2	50	23900		J	21	250	39000			42	500	24300			210	2500	35500			21	250	2770			4.2	50	14400			4.2	50
Antimony	41	3.1	na	0.76		B	0.0386	0.5	0.59		B	0.0386	0.5	0.98			0.0386	0.5	0.55		B	0.0386	0.5	0.47	J		0.0386	0.5	1.3			0.0386	0.5	0.5			0.0386	0.5	0.56		B	0.0386	0.5
Arsenic	1.6	0.39	15.8	20			0.058	0.4	22			0.058	0.4	32			0.058	0.4	14			0.058	0.4	14			0.058	0.4	29			0.058	0.4	13			0.058	0.4	23			0.058	0.4
Barium	19000	1500	209	215			0.103	5	79			0.103	5	204			0.103	5	145			0.103	5	82			0.103	5	130			0.103	5	35			0.103	5	64			0.103	5
Beryllium	200	16	1.02	1.1			0.0267	1	0.97	J		0.0267	1	0.996	J		0.0267	1	1			0.0267	1	0.44	J		0.0267	1	1.1			0.0267	1	0.057	J	B	0.0267	1	0.097	J	B	0.0267	1
Cadmium	81	7	0.69	2.2			0.25	1	2.7			0.25	1	2.9			0.25	1	3			0.25	1	1.8			0.25	1	1.9			0.25	1	1.7			0.25	1	2.8			0.25	1
Calcium	na	na	na	1550			17.5	250	107000			175	2500	51500		J	175	2500	26100			175	2500	70700			875	12500	4940			17.5	250	185000			438	6250	154000			438	6250
Chromium	1400	280	65.3	20		K	0.998	5	17		K	0.998	5	19		K	0.998	5	26		K	0.998	5	23			0.998	5	20		U	0.998	5	5			0.998	5	12		K	0.998	5
Cobalt	30	2.3	72.3	20			0.233	1	7.9			0.233	1	10	J		0.233	1	17			0.233	1	12		J	0.233	1	12			0.233	1	5.8		J	0.233	1	7.2			0.233	1
Copper	4100	310	53.5	29			0.516	5	57			0.516	5	54			0.516	5	52			0.516	5	38			0.516	5	66			0.516	5	12			0.516	5	37			0.516	5
Iron	72000	5500	50962	27600			366	5000	39300			73.1	1000	43300			73.1	1000	42600			73.1	1000	39500			366	5000	61400			73.1	1000	12500			18.3	250	29500			36.6	500
Lead	800	400	26.8	70			1.94	25	34			0.0776	1	62		J	0.0776	10	149			1.94	25	41			0.0776	1	55			0.0776	10	22			0.0776	1	38			0.0776	1
Magnesium	na	na	na	1470		K	7.67	250	45700		K	76.7	2500	30500		K	76.7	2500	25800		K	76.7	2500	24700			384	12500	3540			7.67	250	107000			192	6250	58000		K	192	6250
Manganese	2300	180	2543	3140			4.74	50	1360			2.37	25	1070			2.37	25	776			4.74	50	1020			2.37	25	637			4.74	50	472			4.74	50	1080			2.37	25
Mercury	2.4	0.43	0.13	0.047	J	B	0.0077	0.1	0.095	J	B	0.0077	0.1	0.11		B	0.0077	0.1	0.078	J	B	0.0077	0.1	0.036	J		0.0077	0.1	0.12			0.0077	0.1	0.12			0.0077	0.1	0.06	J	B	0.0077	0.1
Nickel	2000	160	62.8	11			0.0775	0.5	19			0.0775	0.5	20			0.0775	0.5	27			0.0775	0.5	22			0.0775	0.5	26			0.0775	0.5	8.4			0.0775	0.5	16			0.0775	0.5
Potassium	na	na	na	456			7.79	100	944			7.79	100	862		J	7.79	100	3920			7.79	100	1130			7.79	100	1210			7.79	100	198			7.79	100	546			7.79	100
Selenium	510	39	na	0.68	J		0.0486	1	0.58	J		0.0486	1	0.87	J		0.0486	1	0.74	J		0.0486	1	0.76	J		0.0486	1	0.74	J		0.0486	1	0.96	J		0.0486	1	0.56	J		0.0486	1
Silver	510	39	na	0.071	J		0.0178	3	0.088	J		0.0178	3	0.086	J		0.0178	3	0.15	J		0.0178	3	0.067	J		0.0178	3	0.083	J		0.0178	3	0.072	J		0.0178	3	0.079	J		0.0178	3
Sodium	na	na	na	100	U	UL	31.4	100	86	J	L	31.4	100	2000			157	500	2260			157	500	647			31.4	100	24200			785	2500	6290			314	1000	143			31.4	100
Thallium	6.6	0.51	2.11	0.25	J		0.0733	0.5	0.095	J		0.0733	0.5	0.26	J		0.0733	0.5	0.31	J		0.0733	0.5	0.19	J		0.0733	0.5	0.32	J		0.0733	0.5	0.092	J		0.0733	0.5	0.5	U		0.0733	0.5
Vanadium	720	55	108	37			0.401	1.2	34			0.401	1.2	53			0.401	1.2	64			0.401	1.2	44			0.401	1.2	60			0.401	1.2	16			0.401	1.2	26			0.401	1.2
Zinc	31000	2300	202	85		K	0.789	4	179		K	3.95	20	186		K	3.95	20	295		K	3.95	20	138			3.95	20	380			3.95	20	357			7.89	40	174		K	3.95	20
Dioxins/Furans (ng/kg)																																											
2,3,7,8-TCDF	na	na	na	NT					NT					NT					NT					NT					4.14			0.175	1.41	1.06	U		0.131	1.06	NT				
2,3,7,8-TCDD	18	4.5	na	NT					NT					NT					NT					NT					0.22	J	J	0.133	1.41	1.06	U		0.1	1.06	NT				
1,2,3,7,8-PECDD	na	na	na	NT					NT					NT					NT					NT					0.882	J		0.377	7.05	5.31	U		0.284	5.31	NT				
1,2,3,4,7,8-HXCDD	na	na	na	NT					NT					NT					NT					NT					1.53	J		0.304	7.05	5.31	U		0.229	5.31	NT				
1,2,3,6,7,8-HXCDD	na	na	na	NT					NT					NT					NT					NT					3.71	J		0.517	7.05	5.31	U		0.39	5.31	NT				
1,2,3,7,8,9-HXCDD	na	na	na	NT					NT					NT					NT					NT					3.91	J		0.634	7.05	1.45	J		0.478	5.31	NT				
1,2,3,4,6,7,8-HPCDD	na	na	na	NT					NT					NT					NT					NT					98.5			0.479	7.05	3.1	J		0.361	5.31	NT				
OCDD	na	na	na	NT					NT					NT					NT					NT					3930	E	J	1.27	14.1	245			0.958	10.6	NT				
1,2,3,7,8-PECDF	na	na	na	NT					NT					NT					NT					NT					0.984	J		0.219	7.05	5.31	U		0.165	5.31	NT				
2,3,4,7,8-PECDF	na	na	na	NT					NT					NT					NT					NT					1.29	J		0.264	7.05	5.31	U		0.199	5.31	NT				
1,2,3,4,7,8-HXCDF	na	na	na	NT					NT					NT					NT					NT					2.01	J		0.26	7.05	5.31	U		0.196	5.31	NT				
1,2,3,6,7,8-HXCDF	na	na	na	NT					NT					NT					NT					NT					1.41	J		0.132	7.05	5.31	U		0.0993	5.31					

Table 2-6
Analytes Detected in SWMU 41 Area B Soil Samples - 2005 RFI
Page 5 of 6

Analyte	Sample ID Sample Date Sample Depth			41SB11B 4/1/04 8-12					41SB11C 4/1/04 16-18.4					41SC20A 4/8/04 0-1					41SC20B 4/8/04 4.2-5.1					41SC20C 4/8/04 11-11.6					41SP2soil 4/14/04 0-1				
	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)																																	
1,1,2,2-Tetrachloroethane	2900	590	na	5	U		0.084	5	5	U		0.084	5	5	U		0.084	5	83	U		39.1	83	5	U		0.084	5	5	U		0.084	5
1,2,4-Trichlorobenzene	40000	8700	na	5	U		0.101	5	5	U		0.101	5	3.6	J	B	0.101	5	260		B	189	83	5	U		0.101	5	4.4	J	B	0.101	5
1,2-Dibromo-3-chloropropane	73	5.6	na	10	U		0.307	10	10	U		0.307	10	10	U		0.307	10	83	U		342	83	10	U	UJ	0.307	10	10	U		0.307	10
1,2-Dibromoethane (EDB)	170	34	na	5	U		0.134	5	5	U		0.134	5	5	U		0.134	5	5	U	UJ	0.134	5	5	U		0.134	5	5	U		0.134	5
1,2-Dichloroethane	2200	450	na	5	U	UJ	0.18	5	5	U	UJ	0.18	5	5	U		0.18	5	5	U	UJ	0.18	5	5	U		0.18	5	5	U		0.18	5
2-Butanone	19000000	2800000	na	16		J	0.393	10	14		J	0.393	10	40		B	0.393	10	30		B	0.393	10	16		B	0.393	10	33		B	0.393	10
2-Hexanone	na	na	na	10	U		0.37	10	10	U		0.37	10	10	U	UJ	0.37	10	10	U	UJ	0.37	10	10	U		0.37	10	10	U	UJ	0.37	10
4-Methyl-2-pentanone	5200000	530000	na	10	U	UJ	0.181	10	10	U	UJ	0.181	10	10	U	UJ	0.181	10	10	U	UJ	0.181	10	10	U		0.181	10	10	U	UJ	0.181	10
Acetone	61000000	6100000	na	52	J	J	18.5	60	56	J	J	18.5	60	60	U		18.5	60	88		J	18.5	60	47	J	J	18.5	60	73			18.5	60
Benzene	5600	1100	na	0.65	J		0.136	5	5	U		0.136	5	0.6	J		0.136	5	5.2		J	0.136	5	0.45	J		0.136	5	2.8	J		0.136	5
Bromoform	220000	61000	na	5	U		0.101	5	5	U		0.101	5	5	U		0.101	5	5	U	UJ	0.101	5	5	U		0.101	5	5	U		0.101	5
Bromomethane	3500	790	na	1.9	J	B	0.158	5	1.9	J	B	0.158	5	5	U		0.158	5	1.7	J	B	0.158	5	5	U		0.158	5	5	U		0.158	5
Carbon disulfide	300000	67000	na	0.96	J	B	0.172	5	1.1	J	B	0.172	5	4.2	J	B	0.172	5	5.8		J	0.172	5	3.6	J		0.172	5	6		B	0.172	5
Chlorobenzene	150000	31000	na	5	U		0.0475	5	5	U		0.0475	5	5	U		0.0475	5	5	U	UJ	0.0475	5	5	U		0.0475	5	5	U		0.0475	5
cis-1,2-Dichloroethene	1000000	78000	na	5	U		0.123	5	5	U		0.123	5	0.78	J		0.123	5	5	U	UJ	0.123	5	5	U		0.123	5	5	U		0.123	5
cis-1,3-Dichloropropene	na	na	na	5	U		0.0423	5	5	U		0.0423	5	5	U		0.0423	5	5	U	UJ	0.0423	5	5	U		0.0423	5	5	U		0.0423	5
Dibromochloromethane	21000	5800	na	5	U		0.0527	5	5	U		0.0527	5	5	U		0.0527	5	5	U	UJ	0.0527	5	5	U		0.0527	5	5	U		0.0527	5
Ethylbenzene	29000	5700	na	5	U		0.145	5	5	U		0.145	5	5	U		0.145	5	5	U	UJ	0.145	5	0.15	J		0.145	5	5	U		0.145	5
Methylene chloride	54000	11000	na	5	U	UJ	0.857	5	5	U	UJ	0.857	5	4.4	J	B	0.857	5	2.1	J	B	0.857	5	1.6	J	B	0.857	5	4.7	J	B	0.857	5
Styrene	3800000	650000	na	5	U		0.128	5	5	U		0.128	5	5	U		0.128	5	5	U	UJ	0.128	5	5	U		0.128	5	5	U		0.128	5
Tetrachloroethene	2700	570	na	5	U		0.129	5	5	U		0.129	5	5	U		0.129	5	5	U	UJ	0.129	5	5	U		0.129	5	5	U		0.129	5
Toluene	4600000	500000	na	0.26	J		0.122	5	5	U		0.122	5	0.53	J		0.122	5	6.5		J	0.122	5	12			0.122	5	3.3	J		0.122	5
trans-1,3-Dichloropropene	na	na	na	5	U		0.159	5	5	U		0.159	5	5	U		0.159	5	5	U	UJ	0.159	5	5	U		0.159	5	5	U		0.159	5
Trichloroethene	14000	2800	na	5	U		0.154	5	5	U		0.154	5	5	U		0.154	5	1.5	J	J	0.154	5	5	U		0.154	5	5	U		0.154	5
Trichlorofluoromethane	340000	80000	na	0.87	J		0.1	5	5	U		0.1	5	0.52	J		0.1	5	0.47	J	J	0.1	5	0.45	J		0.1	5	0.44	J		0.1	5
Xylenes (total)	260000	60000	na	5	U		0.139	5	5	U		0.139	5	0.54	J		0.139	5	2.8	J	J	0.139	5	0.55	J		0.139	5	1.9	J		0.139	5
PAHs (ug/kg)																																	
Acenaphthene	3300000	340000	na	100	U		11.3	100	100	U		13.2	100	100	U		11.3	100	100	U		16	100	100	U		9.4	100	100	U		14.1	100
Anthracene	17000000	1700000	na	21	U		0.84	21	21	U		0.98	21	21	U		0.84	21	21	U		1.19	21	21	U		0.7	21	21	U		1.05	21
Benz(a)anthracene	2100	150	na	21	U		0.96	21	21	U		1.12	21	21	U		0.96	21	21	U		1.36	21	21	U		0.8	21	21	U		1.2	21
Benzo(a)pyrene	210	15	na	21	U		1.2	21	21	U		1.4	21	21	U		1.2	21	21	U		1.7	21	21	U		1	21	21	U		1.5	21
Benzo(b)fluoranthene	2100	150	na	21	U		1.56	21	21	U		1.82	21	21	U		1.56	21	21	U		2.21	21	21	U		1.3	21	21	U		1.95	21
Benzo(g,h,i)perylene	1700000	170000	na	60	U		15	60	60	U		17.5	60	60	U		15	60	60	U		21.3	60	60	U		12.5	60	60	U		18.8	60
Benzo(k)fluoranthene	21000	1500	na	21	U		1.2	21	21	U		1.4	21	21	U		1.2	21	21	U		1.7	21	21	U		1	21	21	U		1.5	21
Chrysene	210000	15000	na	21	U		1.44	21	21	U		1.68	21	21	U		1.44	21	21	U		2.04	21	21	U		1.2	21	21	U		1.8	21
Fluoranthene	2200000	230000	na	21	U		2.04	21	21	U		2.38	21	21	U		2.04	21	21	U		2.89	21	21	U		1.7	21	21	U		2.55	21
Indeno(1,2,3-cd)pyrene	2100	150	na	21	U		0.84	21	21	U		0.98	21	21	U		0.84	21	21	U		1.19	21	21	U		0.7	21	21	U		1.05	21
Phenanthrene	1700000	170000	na	1.7	J		0.72	21	21	U		0.84	21	21	U		0.72	21	21	U		1.02	21	21	U		0.6	21	21	U		0.9	21
Pyrene	1700000	170000	na	3.2	J		1.08	21	21	U		1.26	21	21	U		1.08	21	21	U		1.53	21	21	U		0.9	21	21	U		1.35	21
SVOCs (ug/kg)																																	
2-Methylnaphthalene	410000	31000	na	170	U		10.6	170	170	U		12.4	170	170	U		10.6	170	170	U		15	170	170	U		8.84	170	170	U		13.3	170
4-Chloro-3-methylphenol	na	na	na	10	J		7.94	170	12	J		9.27	170	170	U		7.94	170	170	U		11.3	170	170	U		6.62	170	170	U		9.93	170
4-Methylphenol	310000	31000	na	170	U		4.62	170	170	U		5.39	170	170	U		4.62	170	170	U		6.55	170	170	U		3.85	170	170	U		5.78	170
Benz(a)anthracene	2100	150	na	170	U																												

Table 2-6
Analytes Detected in SWMU 41 Area B Soil Samples - 2005 RFI
Page 6 of 6

Analyte	Sample ID Sample Date Sample Depth			41SB11B 4/1/04 8-12					41SB11C 4/1/04 16-18.4					41SC20A 4/8/04 0-1					41SC20B 4/8/04 4.2-5.1					41SC20C 4/8/04 11-11.6					41SP2soil 4/14/04 0-1					
	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	
Explosives (mg/kg)	None detected																																	
Herbicides (ug/kg)	None detected																																	
Metals (mg/kg)																																		
Aluminum	99000	7700	40041	23900			4.2	50	26400			21	250	15300			4.2	50	16700			4.2	2500	23200			4.2	50	21100			105	1250	
Antimony	41	3.1	na	0.42	J	B	0.0386	0.5	1			0.0386	0.5	0.52			0.0386	0.5	0.49	J		0.0386	0.5	0.11	J		0.0386	0.5	0.499	J		0.0386	0.5	
Arsenic	1.6	0.39	15.8	6.5			0.058	0.4	24			0.058	0.4	20	J		0.058	0.4	21	J		0.058	0.4	3.2	J		0.058	0.4	21			0.058	0.4	
Barium	19000	1500	209	100			0.103	5	335			0.103	5	84			0.103	5	326	J		0.515	25	102			0.103	5	281			0.103	125	
Beryllium	200	16	1.02	0.74	J		0.0267	1	1.4			0.0267	1	0.18	J		0.0267	1	0.56	J	J	0.0267	1	0.97	J		0.0267	1	0.95	J		0.0267	1	
Cadmium	81	7	0.69	2.5			0.25	1	3.2			0.25	1	3.5			0.25	1	1.3			0.25	1	2.3			0.25	1	3.5			0.25	1	
Calcium	na	na	na	78700			175	2500	30100			87.5	1250	140000			1750	25000	39000		J	175	2500	1290			17.5	250	68800			438	6250	
Chromium	1400	280	65.3	23		K	0.998	5	22		K	0.998	5	14			0.998	5	23			0.998	5	30			0.998	5	22			0.998	5	
Cobalt	30	2.3	72.3	12			0.233	1	10			0.233	1	7.6			0.233	1	12			0.233	1	13			0.233	1	12			0.233	1	
Copper	4100	310	53.5	30			0.516	5	48			0.516	5	50			0.516	5	27			0.516	5	25			0.516	5	31			0.516	5	
Iron	72000	5500	50962	28100			36.6	500	43700			73.1	1000	33500			73.1	1000	35800			73.1	1000	24700			73.1	1000	39400			73.1	1000	
Lead	800	400	26.8	45			0.0776	1	57			0.0776	1	42			0.0776	1	74		J	1.94	25	21			0.0776	1	75			1.94	25	
Magnesium	na	na	na	33900		K	76.7	2500	20300		K	7.67	250	39200			38.4	1250	20400			76.7	2500	8120			7.67	250	36000			192	6250	
Manganese	2300	180	2543	671			0.474	5	1390			2.37	25	1430			2.37	25	2660	J		4.74	50	99			0.474	5	2340			11.9	125	
Mercury	2.4	0.43	0.13	0.045	J	B	0.0077	0.1	0.12		B	0.0077	0.1	0.082	J		0.0077	0.1	0.043	J		0.0077	0.1	0.046	J		0.0077	0.1	0.053	J		0.0077	0.1	
Nickel	2000	160	62.8	18			0.0775	0.5	21			0.0775	0.5	17		J	0.0775	0.5	18		J	0.0775	0.5	20		J	0.0775	0.5	20			0.0775	0.5	
Potassium	na	na	na	2300			7.79	100	913			7.79	100	711			7.79	100	990		J	7.79	100	2040			7.79	100	1440			7.79	100	
Selenium	510	39	na	0.58	J		0.0486	1	0.93	J		0.0486	1	0.54	J		0.0486	1	0.74	J		0.0486	1	0.44	J		0.0486	1	0.65	J		0.0486	1	
Silver	510	39	na	0.05	J		0.0178	3	0.15	J		0.0178	3	0.22	J		0.0178	3	0.25	J		0.0178	3	0.17	J		0.0178	3	0.075	J		0.0178	3	
Sodium	na	na	na	1730			157	500	4660			785	2500	99.6	J	J	31.4	100	2960		J	314	1000	1270		J	157	500	3730			785	2500	
Thallium	6.6	0.51	2.11	0.18	J		0.0733	0.5	0.25	J		0.0733	0.5	0.092	J	L	0.0733	0.5	0.16	J	L	0.0733	0.5	0.19	J	L	0.0733	0.5	0.17	J		0.0733	0.5	
Vanadium	720	55	108	47			0.401	1.2	56			0.401	1.2	28			0.401	1.2	38			0.401	1.2	35			0.401	1.2	43			0.401	1.2	
Zinc	31000	2300	202	126		K	3.95	20	126		K	3.95	20	159			3.95	20	187		J	3.95	20	81			0.789	4	234			19.7	100	
Dioxins/Furans (ng/kg)																																		
2,3,7,8-TCDF	na	na	na	NT					NT					NT					0.458	J		0.239	1.93	NT						0.322	J		0.186	1.5
2,3,7,8-TCDD	18	4.5	na	NT					NT					NT					1.93	U		0.183	1.93	NT						0.168	J		0.142	1.5
1,2,3,7,8-PECDD	na	na	na	NT					NT					NT					9.66	U		0.516	9.66	NT						7.5	U		0.401	7.5
1,2,3,4,7,8-HXCDD	na	na	na	NT					NT					NT					0.464	J		0.416	9.66	NT						7.5	U		0.323	7.5
1,2,3,6,7,8-HXCDD	na	na	na	NT					NT					NT					9.66	U		0.708	9.66	NT						7.5	U		0.55	7.5
1,2,3,7,8,9-HXCDD	na	na	na	NT					NT					NT					2.03	J		0.869	9.66	NT						2.6	J		0.675	7.5
1,2,3,4,6,7,8-HPCDD	na	na	na	NT					NT					NT					14.2			0.657	9.66	NT						20.3			0.51	7.5
OCDD	na	na	na	NT					NT					NT					1040			1.74	19.3	NT						2010			1.35	15
1,2,3,7,8-PECDF	na	na	na	NT					NT					NT					9.66	U		0.3	9.66	NT						0.258	J		0.233	7.5
2,3,4,7,8-PECDF	na	na	na	NT					NT					NT					9.66	U		0.361	9.66	NT						7.5	U		0.281	7.5
1,2,3,4,7,8-HXCDF	na	na	na	NT					NT					NT					9.66	U		0.357	9.66	NT						0.294	J		0.277	7.5
1,2,3,6,7,8-HXCDF	na	na	na	NT					NT					NT					0.29	J		0.181	9.66	NT						0.261	J		0.261	7.5
2,3,4,6,7,8-HXCDF	na	na	na	NT					NT					NT					9.66	U		0.702	9.66	NT						7.5	U		0.545	7.5
1,2,3,7,8,9-HXCDF	na	na	na	NT					NT					NT					9.66	U		0.861	9.66	NT						7.5	U		0.669	7.5
1,2,3,4,6,7,8-HPCDF	na	na	na	NT					NT					NT					1.3	J		0.761	9.66	NT						1.93	J		0.591	7.5
1,2,3,4,7,8,9-HPCDF	na	na	na	NT					NT					NT					9.66	U		0.677	9.66	NT						7.5	U		0.526	7.5
OCDF	na	na	na	NT					NT					NT					3.05	J		1.1	19.3	NT						5.17	J		0.856	15
TOTAL TCDD	na	na	na	NT					NT					NT					1.93	U		0.183	1.93	NT						0.168	J		0.142	1.5
TOTAL PECDD	na	na	na	NT					NT					NT					9.66	U		0.516	9.66	NT						0.714	J		0.401	7.5
TOTAL HXCDD	na	na	na	NT					NT					NT					7.51	J		0.416	9.66	NT						6.49	J		0.323	7.5
TOTAL HPCDD	na	na	na	NT					NT					NT					29.9			0.657	9.66	NT						41.4			0.51	7.5
TOTAL TCDF	na	na	na	NT					NT					NT					2.17			0.238	1.93	NT						0.948	J		0.185	1.5
TOTAL PECDF	na	na	na	NT					NT					NT					1.65	J		0.3	9.66	NT						1.33	J		0.233	7.5
TOTAL HXCDF	na	na	na	NT					NT					NT					2.26	J		0.181	9.66	NT						2.44	J		0.14	7.5
TOTAL HPCDF	na	na	na	NT					NT					NT					3.06	J		0.677	9.66	NT						5.16	J</			

**Table 2-6
Legend**

12	J	Shading and black font indicate an industrial SL exceedance.
12	J	Bold outline indicates a residential SL exceedance.
<u>12</u>	<u>J</u>	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, April 2009).

Lead screening values from Technical Review Workgroup for Lead: Guidance Document (USEPA, 1999b).

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 2-7
Analytes Detected in SWMU 41 Area A Surface Water Samples - 2005 RFI

Analyte	Sample ID Sample Date		41SW5 4/6/04					41SW6 4/6/04					41SW7 4/6/04				
	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)			None detected														
PAHs (ug/L)			None detected														
SVOCs (ug/L)																	
Diethylphthalate	na	2900	0.18	J	B	0.15	5	0.18	J	B	0.15	5	0.21	J	B	0.15	5
Explosives (ug/L)			None detected														
Metals. Total (ug/L)																	
Aluminum	50	3700	200	U	UL	41.1	200	83	J	L	41.1	200	200	U	UL	41.1	200
Barium	2000	730	48			4.69	20	59			4.69	20	50			4.69	20
Calcium	na	na	40000			464	5000	53000			464	5000	41000			464	5000
Chromium	100	11	0.9	J		0.261	1	0.9	J		0.261	1	0.98	J		0.261	1
Iron	300	2600	66	J		7.72	100	200			7.72	100	54	J		7.72	100
Lead	15	na	1	U		0.231	1	0.3	J		0.231	1	1	U		0.231	1
Magnesium	na	na	18000			318	2500	32000			635	5000	18000			318	2500
Manganese	50	88	2.1	J	L	1.64	10	10		L	1.64	10	10	U	UL	1.64	10
Potassium	na	na	2000			51.5	200	1500			51.5	200	2100			51.5	200
Sodium	na	na	15000			1160	3500	11000			462	1400	16000			1160	3500
Metals, Dissolved (ug/L)																	
Antimony	6	1.5	2	U		0.682	2	2	U		0.682	2	2	U		0.682	2
Arsenic	10	0.045	1	U		0.209	1	1	U		0.209	1	1	U		0.209	1
Barium	2000	730	49			4.69	20	59			4.69	20	45			4.69	20
Beryllium	4	7.3	4	U		0.27	4	4	U		0.27	4	4	U		0.27	4
Cadmium	5	1.8	0.5	U		0.0568	0.5	0.5	U		0.0568	0.5	0.5	U		0.0568	0.5
Calcium	na	na	40000			464	5000	54000			464	5000	37000			464	5000
Chromium	100	11	1.1			0.261	1	0.9	J		0.261	1	1.1			0.261	1
Cobalt	na	1.1	10	U	UL	2.58	10	10	U	UL	2.58	10	10	U	UL	2.58	10
Copper	1300	150	20	U		6.6	20	20	U		6.6	20	20	U		6.6	20
Iron	300	2600	100	U		7.72	100	100	U		7.72	100	100	U		7.72	100
Lead	15	na	0.3	J		0.231	1	0.3	J		0.231	1	1	U		0.231	1
Magnesium	na	na	18000			318	2500	32000			635	5000	16000			318	2500
Manganese	50	88	10	U	UL	1.64	10	10	U	UL	1.64	10	10	U	UL	1.64	10
Nickel	na	73	1	U	UL	0.23	1	1	U	UL	0.23	1	1	U	UL	0.23	1
Potassium	na	na	2100		J	51.5	200	1600		J	51.5	200	1900		J	51.5	200
Selenium	50	18	2	U		0.249	2	2	U		0.249	2	2	U		0.249	2
Silver	100	18	0.5	U		0.0631	0.5	0.5	U		0.0631	0.5	0.5	U		0.0631	0.5
Sodium	na	na	15000			1160	3500	11000			462	1400	14000			1160	3500
Thallium	2	0.24	1	U		0.041	1	1	U		0.041	1	1	U		0.041	1
Vanadium	na	26	25	U		7.93	25	25	U		7.93	25	25	U		7.93	25
Zinc	5000	1100	20	U	UL	4.44	20	9.9	J	L	4.44	20	7	J	L	4.44	20
Misc.																	
Perchlorate	na	2.6	1	U		0.1	1	1	U		0.1	1	1	U		0.1	1
Hardness	na	na	161000			1620	5000	261000			1620	5000	165000			1620	5000
Cyanide	200	73	2	J	B	0.9	10	2	J	B	0.9	10	3	J	B	0.9	10

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

Table 2-7
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, April 2009).

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.

Table 2-8
Analytes Detected in SWMU 41 Area B Surface Water Samples - 2005 RFI

Analyte	Sample ID Sample Date		41SP2 4/13/04					41SW2 4/6/04					41SW3 4/6/04					41SW4 4/6/04				
	MCL	tw-SL	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/L)																						
Chloroform	80	0.19	1	U		0.241	1	0.59	J		0.241	1	0.35	J		0.241	1	0.3	J		0.241	1
PAHs (ug/L)																						
None detected																						
SVOCs (ug/L)																						
Diethylphthalate	na	2900	5	U		0.15	5	0.32	J	B	0.15	5	0.21	J	B	0.15	5	0.23	J	B	0.15	5
Explosives (ug/L)																						
None detected																						
Metals, Total (ug/L)																						
Aluminum	50	3700	9270			82.2	400	110	J		41.1	200	110	J		41.1	200	170	J		41.1	200
Arsenic	10	0.045	7.1			0.209	1	0.24	J		0.209	1	1	U		0.209	1	0.22	J		0.209	1
Barium	2000	730	230			4.69	20	60			4.69	20	62			4.69	20	62			4.69	20
Beryllium	4	7.3	0.6	J	L	0.27	4	4	U		0.27	4	4	U		0.27	4	4	U		0.27	4
Cadmium	5	1.8	0.3	J		0.0568	0.5	0.5	U		0.0568	0.5	0.5	U		0.0568	0.5	0.5	U		0.0568	0.5
Calcium	na	na	89000			1160	12500	49000			464	5000	52000			464	5000	51000			464	5000
Chromium	100	11	9.4			0.261	1	0.7	J		0.261	1	1.1			0.261	1	1.1			0.261	1
Copper	1300	150	19	J		6.6	20	20	U		6.6	20	20	U		6.6	20	20	U		6.6	20
Iron	300	2600	10400			193	2500	280			7.72	100	230			7.72	100	350			7.72	100
Lead	15	na	29			0.231	1	0.4	J		0.231	1	0.3	J		0.231	1	0.6	J		0.231	1
Magnesium	na	na	32000			635	5000	30000			635	5000	31000			635	5000	31000			635	5000
Manganese	50	88	410			1.64	10	24			1.64	10	20		L	1.64	10	29			1.64	10
Nickel	na	73	10			0.23	1	1	U	UL	0.23	1	1	U	UL	0.23	1	1	U	UL	0.23	1
Potassium	na	na	1100		J	51.5	200	1500			51.5	200	1600			51.5	200	1600			51.5	200
Selenium	50	18	0.4	J		0.249	2	2	U		0.249	2	2	U		0.249	2	2	U		0.249	2
Sodium	na	na	13000			462	1400	4300			231	700	7600			231	700	9200			231	700
Thallium	2	0.24	0.09	J		0.041	1	1	U		0.041	1	1	U		0.041	1	1	U		0.041	1
Vanadium	na	26	17	J		7.93	25	25	U		7.93	25	25	U		7.93	25	25	U		7.93	25
Zinc	5000	1100	75			4.44	20	20	U		4.44	20	20	U		4.44	20	20	U		4.44	20
Metals, Dissolved (ug/L)																						
Antimony	6	1.5	2	U		0.682	2	2	U		0.682	2	2	U		0.682	2	2	U		0.682	2
Arsenic	10	0.045	1	U		0.209	1	1	U		0.209	1	1	U		0.209	1	1	U		0.209	1
Barium	2000	730	110			4.69	20	60			4.69	20	65			4.69	20	62			4.69	20
Beryllium	4	7.3	4	U	UL	0.27	4	4	U		0.27	4	4	U		0.27	4	4	U	UL	0.27	4
Cadmium	5	1.8	0.5	U		0.0568	0.5	0.5	U		0.0568	0.5	0.5	U		0.0568	0.5	0.5	U		0.0568	0.5
Calcium	na	na	65000			464	5000	51000			464	5000	52000			464	5000	53000			464	5000
Chromium	100	11	0.6	J	K	0.261	1	0.99	J		0.261	1	0.8	J		0.261	1	0.7	J		0.261	1
Cobalt	na	1.1	10	U	UL	2.58	10	10	U	UL	2.58	10	10	U	UL	2.58	10	10	U	UL	2.58	10
Copper	1300	150	20	U		6.6	20	20	U		6.6	20	20	U		6.6	20	20	U		6.6	20
Iron	300	2600	23	J	K	7.72	100	100	U		7.72	100	100	U		7.72	100	100	U		7.72	100
Lead	15	na	1	U		0.231	1	0.3	J		0.231	1	1	U		0.231	1	0.3	J		0.231	1
Magnesium	na	na	21000			635	5000	32000			635	5000	33000			635	5000	32000			635	5000
Manganese	50	88	10	U	UL	1.64	10	10	U	UL	1.64	10	10	U	UL	1.64	10	10	U	UL	1.64	10
Nickel	na	73	1	U		0.23	1	0.4	J	B	0.23	1	1	U	UL	0.23	1	1	U	UL	0.23	1
Potassium	na	na	180	J	L	51.5	200	1600		J	51.5	200	1600		J	51.5	200	1700		L	51.5	200
Selenium	50	18	2	U		0.249	2	2	U		0.249	2	2	U		0.249	2	2	U		0.249	2
Silver	100	18	0.5	U		0.0631	0.5	0.5	U		0.0631	0.5	0.5	U		0.0631	0.5	0.5	U		0.0631	0.5
Sodium	na	na	15000			1160	3500	4400			231	700	7900			231	700	9800			231	700
Thallium	2	0.24	1	U		0.041	1	1	U		0.041	1	1	U		0.041	1	1	U		0.041	1
Vanadium	na	26	25	U		7.93	25	25	U		7.93	25	25	U		7.93	25	25	U		7.93	25
Zinc	5000	1100	14	J	B	4.44	20	20	U		4.44	20	4.5	J		4.44	20	7	J	L	4.44	20
Misc.																						
Perchlorate	na	2.6	1	U		0.1	1	1	U		0.1	1	1	U		0.1	1	1	U		0.1	1
Hardness	na	na	NT					253000			1620	5000	251000			1620	5000	255000			1620	5000
Cyanide	200	73	2	J	B	0.9	10	2	J	B	0.9	10	2	J	B	0.9	10	2	J	B	0.9	10

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

Table 2-8
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, April 2009).

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.

Table 2-9
Analytes Detected in SWMU 41 Area A Sediment Samples - 2005 RFI
Page 1 of 2

Analyte	Sample ID Sample Date Sample Depth			41SD5 4/6/04 0-1					41SD6 4/6/04 0-1					41SD7 4/6/04 0-1				
	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
VOCs (ug/kg)																		
1,2,4-Trichlorobenzene	40000	8700	na	5	U		0.732	5	3.9	J	B	0.732	5	4.4	J	B	0.732	5
2-Butanone	19000000	2800000	na	30		B	2.91	10	27		B	2.91	10	26		B	2.91	10
Benzene	5600	1100	na	0.28	J		0.178	5	0.2	J		0.178	5	0.28	J		0.178	5
Bromomethane	3500	790	na	5	U		0.154	5	5	U		0.154	5	1.5	J	B	0.154	5
Carbon disulfide	300000	67000	na	6.7		B	0.0742	5	5	U		0.0742	5	5.5		B	0.0742	5
Chloroform	1500	300	na	5	U		0.0915	5	0.54	J		0.0915	5	5	U		0.0915	5
Methylene chloride	54000	11000	na	3.8	J	B	0.117	5	7.8		B	0.117	5	5.2		B	0.117	5
Toluene	4600000	500000	na	1.1	J		0.258	5	0.26	J		0.258	5	0.48	J		0.258	5
PAHs (ug/kg)																		
Acenaphthene	3300000	340000	na	17	J		14.1	100	100	U		13.2	100	100	U		14.1	100
Anthracene	17000000	1700000	na	19	J		1.05	21	1.1	J		0.98	21	1.9	J		1.05	21
Benz(a)anthracene	2100	150	na	67			1.2	21	18	J		1.12	21	17	J		1.2	21
Benzo(a)pyrene	210	15	na	79			1.5	21	20	J		1.4	21	17	J		1.5	21
Benzo(b)fluoranthene	2100	150	na	78			1.95	21	21			1.82	21	21	U		1.95	21
Benzo(g,h,i)perylene	1700000	170000	na	100			18.8	60	32	J		17.5	60	31	J		18.8	60
Benzo(k)fluoranthene	21000	1500	na	47			1.5	21	9.1	J		1.4	21	8.4	J		1.5	21
Chrysene	210000	15000	na	67			1.8	21	19	J		1.68	21	19	J		1.8	21
Fluoranthene	2200000	230000	na	200			2.55	21	34			2.38	21	50			2.55	21
Fluorene	2200000	230000	na	10	J		1.95	21	21	U		1.82	21	21	U		1.95	21
Indeno(1,2,3-cd)pyrene	2100	150	na	52			1.05	21	17	J		0.98	21	15	J		1.05	21
Phenanthrene	1700000	170000	na	110			0.9	21	6.3	J		0.84	21	32			0.9	21
Pyrene	1700000	170000	na	150			1.35	21	28			1.26	21	33			1.35	21
SVOCs (ug/kg)																		
4-Chloro-3-methylphenol	na	na	na	17	J		9.93	170	170	U		9.27	170	170	U		9.93	170
Benz(a)anthracene	2100	150	na	42	J		13.6	170	170	U		12.7	170	170	U		13.6	170
Benzo(a)pyrene	210	15	na	42	J		18.5	170	170	U		17.2	170	170	U		18.5	170
Benzo(b)fluoranthene	2100	150	na	84	J		11.5	170	170	U		10.7	170	17	J		11.5	170
Benzo(g,h,i)perylene	1700000	170000	na	29	J		8.31	170	170	U		7.76	170	10	J		8.31	170
Benzo(k)fluoranthene	21000	1500	na	32	J		6.12	170	170	U		5.71	170	12	J		6.12	170
bis(2-Ethylhexyl)phthalate	120000	35000	na	47	J		14.2	170	23	J		13.2	170	33	J		14.2	170
Chrysene	210000	15000	na	54	J		11	170	170	U		10.3	170	14	J		11	170
Di-n-butylphthalate	6200000	610000	na	69	J		10.7	170	48	J		9.95	170	49	J		10.7	170
Fluoranthene	2200000	230000	na	100	J		6.59	170	10	J		6.15	170	25	J		6.59	170
Indeno(1,2,3-cd)pyrene	2100	150	na	21	J		9.5	170	170	U		8.86	170	170	U		9.5	170
Phenanthrene	1700000	170000	na	45	J		11.4	170	170	U		10.7	170	170	U		11.4	170
Pyrene	1700000	170000	na	120	J		7.65	170	9	J		7.14	170	29	J		7.65	170

Table 2-9
Analytes Detected in SWMU 41 Area A Sediment Samples - 2005 RFI
Page 2 of 2

Analyte	Sample ID Sample Date Sample Depth			41SD5 4/6/04 0-1					41SD6 4/6/04 0-1					41SD7 4/6/04 0-1				
	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
Pesticides (ug/kg)																		
4,4'-DDT	7000	1700	na	20	U		3.93	20	1.04	J	J	3.66	20	1.98	J	J	0.807	20
Endrin aldehyde	na	na	na	20	U		3.17	20	20	U		2.95	20	2.45	J	J	0.651	20
PCBs (mg/kg) None detected																		
Explosives (mg/kg)																		
Nitroglycerin	6.2	0.61	na	10	U		1.82	10	5.8			1.69	10	10	U		1.82	10
Herbicides (ug/kg) None detected																		
Metals (mg/kg)																		
Aluminum	99000	7700	40041	7460			4.2	50	14600			4.2	50	15500			4.2	50
Antimony	41	3.1	na	0.18	J		0.0386	0.5	0.45	J		0.0386	0.5	0.38	J		0.0386	0.5
Arsenic	1.6	0.39	15.8	5.2		J	0.058	0.4	18	J		0.058	0.4	6.8		J	0.058	0.4
Barium	19000	1500	209	83			0.103	5	195			0.103	5	130			0.103	5
Beryllium	200	16	1.02	0.23	J		0.0267	1	0.86	J		0.0267	1	0.72	J		0.0267	1
Cadmium	81	7	0.69	0.56	J		0.25	1	2.2			0.25	1	2.1			0.25	1
Calcium	na	na	na	10100		J	17.5	250	19200		J	17.5	250	14700		J	17.5	250
Chromium	1400	280	65.3	12		L	0.998	5	33		L	0.998	5	22		L	0.998	5
Cobalt	30	2.3	72.3	9.1			0.233	1	20			0.233	1	14			0.233	1
Copper	4100	310	53.5	13			0.516	5	26			0.516	5	24			0.516	5
Iron	72000	5500	50962	20900			18.3	250	47900			73.1	1000	31000			73.1	1000
Lead	800	400	26.8	15			0.0776	1	28			0.0776	1	35			0.0776	1
Magnesium	na	na	na	4720		J	7.67	250	10900		J	7.67	250	10700		J	7.67	250
Manganese	2300	180	2543	359			0.474	5	1640			2.37	25	935			0.474	5
Mercury	2.4	0.43	0.13	0.03	J		0.0077	0.1	0.024	J		0.0077	0.1	0.033	J		0.0077	0.1
Nickel	2000	160	62.8	15		J	0.0775	0.5	25		J	0.0775	0.5	19		J	0.0775	0.5
Potassium	na	na	na	968			7.79	100	1630			7.79	100	1820			7.79	100
Selenium	510	39	na	0.34	J		0.0486	1	0.37	J		0.0486	1	0.38	J		0.0486	1
Silver	510	39	na	0.16	J		0.0178	3	0.12	J		0.0178	3	0.13	J		0.0178	3
Sodium	na	na	na	36	J		31.4	100	54	J		31.4	100	66	J		31.4	100
Thallium	6.6	0.51	2.11	0.5	U	UL	0.0733	0.5	0.088	J	L	0.0733	0.5	0.13	J	L	0.0733	0.5
Vanadium	720	55	108	13		L	0.401	1.2	36		L	0.401	1.2	29		L	0.401	1.2
Zinc	31000	2300	202	58			0.789	4	121			3.95	20	94			0.789	4
Misc. (mg/kg)																		
Cyanide	2000	160	na	0.08	J	B	0.009	0.5	0.13	J	B	0.009	0.5	0.13	J	B	0.009	0.5

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

**Table 2-9
Legend**

12	J	Shading and black font indicate an industrial SL exceedance.
12	J	Bold outline indicates a residential SL exceedance.
<u>12</u>	<u>J</u>	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, April 2009).

Lead screening values from Technical Review Workgroup for Lead: Guidance Document (USEPA, 1999b).

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 2-10
Analytes Detected in SWMU 41 Area B Sediment Samples - 2005 RFI
Page 1 of 2

Analyte	Sample ID Sample Date Sample Depth			41SD2 4/6/04 0-1					41SD3 4/6/04 0-1					41SD4 4/6/04 0-1				
	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
VOCs (ug/kg)																		
2-Butanone	19000000	2800000	na	0.033		B	2.91	10	16		B	2.91	10	27		B	2.91	10
Benzene	5600	1100	na	0.066	J		0.178	5	0.22	J		0.178	5	5	U		0.178	5
Carbon disulfide	300000	67000	na	0.066	U		0.0742	5	5.7		B	0.0742	5	5	U		0.0742	5
Chloroform	1500	300	na	1.8	J		0.0915	5	5	U		0.0915	5	5	U		0.0915	5
Methylene chloride	54000	11000	na	4.2	J	B	0.117	5	7.1		B	0.117	5	4.5	J	B	0.117	5
Toluene	4600000	500000	na	5	U		0.258	5	0.31	J		0.258	5	5	U		0.258	5
PAHs (ug/kg)																		
Phenanthrene	1700000	170000	na	21	U		0.84	21	21	U		0.9	21	1.6	J		0.84	21
SVOCs (ug/kg)																		
bis(2-Ethylhexyl)phthalate	120000	35000	na	30	J		13.2	170	44	J		14.2	170	22	J		13.2	170
Butylbenzylphthalate	910000	260000	na	170	U		11.1	170	14	J		11.9	170	170	U		11.1	170
Di-n-butylphthalate	6200000	610000	na	44	J		9.95	170	240			10.7	170	57	J		9.95	170
Fluoranthene	2200000	230000	na	170	U		6.15	170	8	J		6.59	170	170	U		6.15	170
Pyrene	1700000	170000	na	170	U		7.14	170	13	J		7.65	170	170	U		7.14	170
Pesticides (ug/kg)																		
4,4'-DDT	7000	1700	na	20	U		0.753	20	3.23	J	J	0.807	20	20	U		3.71	20
Endrin aldehyde	na	na	na	1.74	J	J	0.608	20	2.19	J	J	0.651	20	20	U		2.99	20
PCBs (mg/kg)																		
PCB-1254	0.74	0.022	na	0.066	U		9.52	66	0.023	J		10.2	66	0.066	U		9.52	66
Explosives (mg/kg) None detected																		
Herbicides (ug/kg) None detected																		
Metals (mg/kg)																		
Aluminum	99000	7700	40041	15900			4.2	50	14600			4.2	50	14700			210	2500
Antimony	41	3.1	na	0.36	J		0.0386	0.5	0.25	J		0.0386	0.5	0.23	J		0.0386	0.5
Arsenic	1.6	0.39	15.8	13		J	0.058	0.4	13		J	0.058	0.4	15		J	0.058	0.4
Barium	19000	1500	209	183			0.103	5	136			0.103	5	146			0.103	5
Beryllium	200	16	1.02	0.66	J		0.0267	1	0.69	J		0.0267	1	0.73	J		0.0267	1
Cadmium	81	7	0.69	1.7			0.25	1	2.2			0.25	1	2.5			0.25	1
Calcium	na	na	na	9330		J	17.5	250	31900		J	87.5	1250	35200		J	175	2500
Chromium	1400	280	65.3	32		L	0.998	5	31		L	0.998	5	32		L	0.998	5
Cobalt	30	2.3	72.3	20			0.233	1	16			0.233	1	17			0.233	1
Copper	4100	310	53.5	30			0.516	5	29			0.516	5	30			0.516	5
Iron	72000	5500	50962	40000			73.1	1000	35900			73.1	1000	42800			73.1	1000
Lead	800	400	26.8	26			0.0776	1	31			0.0776	1	42			0.0776	1
Magnesium	na	na	na	6840		J	7.67	250	18500		J	7.67	250	19000		J	76.7	2500
Manganese	2300	180	2543	2100			2.37	25	1600			2.37	25	2100			23.7	250

Table 2-10
Analytes Detected in SWMU 41 Area B Sediment Samples - 2005 RFI
Page 2 of 2

Analyte	Sample ID Sample Date Sample Depth			41SD2 4/6/04 0-1					41SD3 4/6/04 0-1					41SD4 4/6/04 0-1				
	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
Mercury	2.4	0.43	0.13	0.037	J		0.0077	0.1	0.031	J		0.0077	0.1	0.037	J		0.0077	0.1
Nickel	2000	160	62.8	21		J	0.0775	0.5	22		J	0.0775	0.5	17		J	0.0775	0.5
Potassium	na	na	na	1880			7.79	100	1750			7.79	100	1660			7.79	100
Selenium	510	39	na	0.68	J		0.0486	1	0.5	J		0.0486	1	0.54	J		0.0486	1
Silver	510	39	na	0.11	J		0.0178	3	0.11	J		0.0178	3	0.1	J		0.0178	3
Sodium	na	na	na	51	J		31.4	100	71	J		31.4	100	79	J		31.4	100
Thallium	6.6	0.51	2.11	0.11	J	L	0.0733	0.5	0.12	J	L	0.0733	0.5	0.13	J	L	0.0733	0.5
Vanadium	720	55	108	29		L	0.401	1.2	32		L	0.401	1.2	39		L	0.401	1.2
Zinc	31000	2300	202	96			0.789	4	107			3.95	20	155			3.95	20
Misc. (mg/kg)																		
Cyanide	2000	160	na	2			0.009	0.5	0.15	J	B	0.009	0.5	0.17	J		0.009	0.5

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

Table 2-10
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, April 2009).

Lead screening values from Technical Review Workgroup for Lead: Guidance Document (USEPA, 1999b).

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 2-11
Analytes Detected in SWMU 41 Groundwater Samples - 2005 RFI
Page 1 of 2

Analyte	Sample ID Sample Date		41MW1 4/13/04					41MW2 4/13/04					41MW3 4/14/04				
	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)																	
1,2,4-Trichlorobenzene	70	0.82	1	U		0.223	1	1	U		0.223	1	0.59	J		0.223	1
PAHs (ug/L) None detected																	
SVOCs (ug/L)																	
bis(2-Ethylhexyl)phthalate	6	4.8	5	U		1.07	5	2.7	J		1.07	5	5	U		1.07	5
Diethylphthalate	na	2900	0.66	J		0.15	5	0.3	J		0.15	5	0.24	J		0.15	5
Explosives (ug/L) None detected																	
Metals, Total (ug/L)																	
Aluminum	50	3700	200	U	UL	41.1	200	200	U	UL	41.1	200	99	J	L	41.1	200
Arsenic	10	0.045	1.7			0.209	1	3.2			0.209	1	1	U		0.209	1
Barium	2000	730	20			4.69	20	8	J		4.69	20	24			4.69	20
Calcium	na	na	48000			464	5000	134000			1160	12500	126000			1160	12500
Chromium	100	11	4			0.261	1	5.3			0.261	1	3.1			0.261	1
Copper	1300	150	20	U		6.6	20	11	J		6.6	20	20	U		6.6	20
Iron	300	2600	110			7.72	100	220			7.72	100	240			7.72	100
Lead	15	na	0.7	J		0.231	1	1.5			0.231	1	2.4			0.231	1
Magnesium	na	na	67000			635	50000	130000			1590	12500	66000			635	5000
Manganese	50	88	48			1.64	10	28			1.64	10	10	U	UL	1.64	10
Nickel	na	73	5.3			0.23	1	7			0.23	1	5.6			0.23	1
Potassium	na	na	990		J	51.5	200	2400		J	51.5	200	2100		J	51.5	200
Selenium	50	18	0.9	J		0.249	2	2	U		0.249	2	0.5	J		0.249	2
Sodium	na	na	1300000			46200	140000	3950000			231000	700000	182000			5780	17500
Thallium	2	0.24	0.3 J			0.041	1	0.5 J			0.041	1	1	U		0.041	1
Zinc	5000	1100	6	J	B	4.44	20	15	J	B	4.44	20	18	J	B	4.44	20
Metals, Dissolved (ug/L)																	
Antimony	6	1.5	2	U		0.682	2	2	U		0.682	2	2	U		0.682	2
Arsenic	10	0.045	0.95 J			0.209	1	3.7			0.209	1	1	U		0.209	1
Barium	2000	730	28			4.69	20	7	J		4.69	20	18	J		4.69	20
Beryllium	4	7.3	4	U	UL	0.27	4	4	U	UL	0.27	4	4	U	UL	0.27	4
Cadmium	5	1.8	0.5	U		0.0568	0.5	0.5	U		0.0568	0.5	0.5	U		0.0568	0.5
Calcium	na	na	53000			464	5000	137000			1160	12500	124000			1160	12500
Chromium	100	11	1.9			0.261	1	2.1			0.261	1	1.7			0.261	1
Cobalt	na	1.1	10	U	UL	2.58	10	10	U	UL	2.58	10	10	U	UL	2.58	10
Copper	1300	150	20	U		6.6	20	14	J		6.6	20	20	U		6.6	20
Iron	300	2600	23	J	K	7.72	100	25	J	K	7.72	100	51	J	K	7.72	100

Table 2-11
Analytes Detected in SWMU 41 Groundwater Samples - 2005 RFI
Page 2 of 2

Analyte	Sample ID Sample Date		41MW1 4/13/04					41MW2 4/13/04					41MW3 4/14/04				
	MCL	tw-SL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Lead	15	na	1	U		0.231	1	0.3	J		0.231	1	0.5	J		0.231	1
Magnesium	na	na	65000			635	5000	132000			1590	12500	68000			635	5000
Manganese	50	88	23		L	1.64	10	27			1.64	10	10	U	UL	1.64	10
Nickel	na	73	3.2			0.23	1	5.4			0.23	1	4.7			0.23	1
Potassium	na	na	730		J	51.5	200	2100		J	51.5	200	2000		J	51.5	200
Selenium	50	18	0.7	J		0.249	2	2	U		0.249	2	0.7	J		0.249	2
Silver	100	18	0.5	U		0.0631	0.5	0.5	U		0.0631	0.5	0.5	U		0.0631	0.5
Sodium	na	na	916000			23100	70000	4150000			231000	700000	185000			5780	17500
Thallium	2	0.24	0.2	J		0.041	1	0.5 J			0.041	1	1	U		0.041	1
Vanadium	na	26	25	U		7.93	25	25	U		7.93	25	25	U		7.93	25
Zinc	5000	1100	11	J	B	4.44	20	12	J	B	4.44	20	21		B	4.44	20
Misc. (ug/L)																	
Perchlorate	na	2.6	5	U		0.5	5	15	U		1.5	15	2	U		0.2	2
Cyanide	200	73	2	J	B	0.9	10	4	J	B	0.9	10	2	J	B	0.9	10

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

Table 2-11
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, April 2009).

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.

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. Another monitoring well (41MW4) was installed and sampled in 2010 in order to replace the highly turbid Area A samples of 2007. As shown in **Table 3-1**, surface water, sediment, and direct-push groundwater samples were collected at Area A. At Area B, groundwater samples were collected from the existing wells and a sediment sample was collected from the dry seep. Soil at Areas A and B and surface water/sediment in the unnamed tributary to Stroubles Creek at Area B were considered sufficiently characterized to complete the RFI. As described in *Section 2.5*, an attempt was made after the initial field investigation in August 2007 to collect additional groundwater data at Area A.

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*.

Table 3-1
2007 RFI and 2010 Samples and Analyses

Media	Sampling ID	Location at SWMU	Analytes
Surface Water	41SW08	Area A, downgradient stream	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, perchlorate
	41SW09	Area A, downgradient stream	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, perchlorate
	41SW10	Area A, downgradient stream	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, perchlorate
Sediment	41SD08	Area A, downgradient stream	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans
	41SD09	Area A, downgradient stream	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans
	41SD10	Area A, downgradient stream	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans
	41SD11	Area B, seep	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans
Groundwater	41GW01	Area A, direct push	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, perchlorate
	41GW02	Area A, direct push	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, perchlorate
	41GW03	Area A, direct push	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, perchlorate
	41MW1	Area B, existing upgradient well	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, perchlorate
	41MW2	Area B, existing upgradient well	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, perchlorate
	41MW3	Area B, existing upgradient well	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, perchlorate
	41MW4	Area A, new well	TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, perchlorate

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

3.1 RFI, Shaw, 2007 and 2010

3.1.1 Surface Water

As presented in **Table 3-1**, three surface water samples (41SW08, 41SW09, and 41SW10) were collected for chemical analysis. Additional surface water samples that were contemporaneous with the groundwater samples were recommended in order to attain an analysis of the relationship between groundwater and the adjacent creek. The surface water samples were collected from the unnamed tributary to Stroubles Creek where groundwater from Area A is expected to discharge. Sample locations are depicted on **Figure 3-1**. As shown in **Table 3-1**, the surface water samples were analyzed for target compound list (TCL) VOCs, SVOCs, polynuclear aromatic hydrocarbons (PAHs), pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, and perchlorate. Surface water detections above SLs are illustrated on **Figure 3-2**.

3.1.2 Sediment

Four sediment samples (41SD08, 41SD09, 41SD10, and 41SD11) were collected for chemical analysis. Samples 41SD08, 41SD09, and 41SD10 were collocated with the surface water samples in the unnamed tributary north of Area A. One sediment sample (41SD11) was collected from the dry seep at Area B of SWMU 41 (**Figure 3-1**). As shown in **Table 3-1**, the sediment samples were analyzed for TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans. Sediment detections above SLs are illustrated on **Figure 3-3**.

3.1.3 Groundwater

Six groundwater samples (41GW01, 41GW02, 41GW03, 41MW1, 41MW2, and 41MW3) were collected for chemical analysis in 2007. Samples 41GW01, 41GW02, and 41GW03 were extremely turbid direct-push samples collected from Area A in 2007. Borings were originally attempted with a direct-push (geoprobe) rig. Water was not encountered during this attempt at any of the three locations. A hollow stem auger and hydropunch were used during a second attempt to obtain water from the base of the overburden. The hydropunches were dry when installed; however, in order to allow more time to obtain water, a 10-ft screen was placed in the hole and left for approximately 3 days. After that time, there was enough turbid water to collect a sample from 41GW02. 41MW1, 41MW2, and 41MW3 were from existing Area B downgradient wells (**Figure 3-1**). In 2010, it was decided that an additional monitoring well should be installed at Area A so that a better representative groundwater sample (with less sediment in the samples) could be attained from the groundwater below Area A. After three unsuccessful attempts, an additional monitoring well was installed at Area A (41MW4) (**Figure 3-1**).

As shown in **Table 3-1**, 2007 and 2010 groundwater samples were analyzed for TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, and perchlorate. Groundwater detections above SLs are illustrated on **Figure 3-4**.

Boring logs and well construction diagrams for the existing and temporary direct-push wells are presented in **Appendix B-1**. The well purging/field water quality measurement forms for the August 2007 and October 2010 sampling events are included in **Appendix B-2**.

3.1.4 Global Positioning System Activities

Sample location coordinates and elevations were obtained for surface water samples 41SW08, 41SW09, and 41SW10; sediment sample 41SD11; and groundwater samples 41GW01, 41GW02, 41GW03, 41MW2, 41MW3, and 41MW4 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**.

3.1.5 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**.

3.1.6 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. Adjustments to *MWP Addendum 019* (Shaw, 2007) were necessary during sampling activities at SWMU 41, as described below.

Surface Water. The seep at Area B was dry when sampling was attempted. Therefore, proposed surface water sample 41SW11 was not collected. However, collocated sediment sample 41SD11 was collected from the dry seep.

Groundwater. In August 2007, three direct-push borings were advanced to the top of bedrock at Area A to characterize the groundwater under the site. No water was present in the borings during boring advancement. Then, a hollow stem auger and hydropunch methods were used on a second attempt to obtain water from the overburden. A 10-ft screen was placed in the holes and left for approximately 3 days. After that time, there was enough water in the holes to sample, which resulted in highly turbid samples of perched water.

After a record rainfall in the spring of 2009, an attempt was made in June 2009 to install a monitoring well at Area A so that a higher quality groundwater sample could be collected to replace the low quality direct-push sample. Three attempts were made; however, water was not encountered in any of the boreholes. Therefore, a permanent monitoring well was not installed.

In October 2010, a monitoring well was successfully installed just north of the center of Area A and sampled shortly thereafter. The data from this well was to be used in the risk assessment to replace the 2007 highly-turbid direct-push samples (41GW01, 41GW02, and 41GW03).

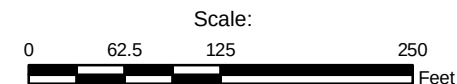


LEGEND

-  Groundwater Sample Location
-  Failed Attempt to Drill a Monitoring Well in 2009
-  Previous Investigation Surface Water and/or Sediment Sample Location
-  Water Feature
-  SWMU 41 Boundary
-  Other SWMU Boundary

Notes:

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



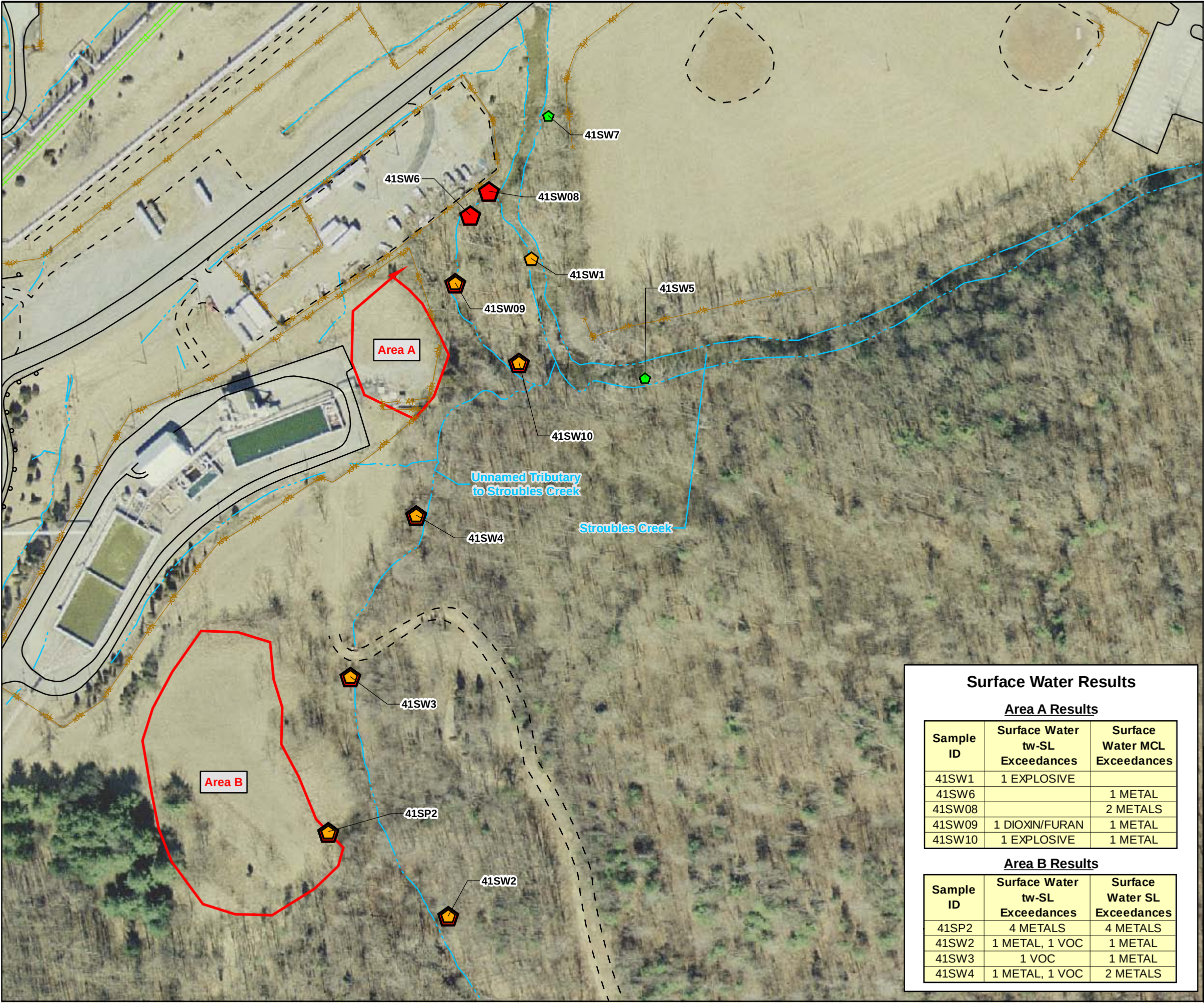
U.S. Army Corps of Engineers



Shaw Environmental, Inc.

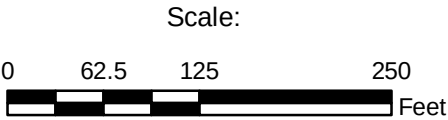
FIGURE 3-1
SWMU 41 2007 and 2010
Investigation Sample Locations
 Radford Army Ammunition Plant,
 Radford, VA

ArcGIS File: C:\Radford_MMA\GIS_Documents\Project_Maps\SWMU_41\RAAP_Fig3-2_SWMU41_SW_Sample_Results.mxd (2/2/2011 2:17:41 PM)



LEGEND

- SW Sample Location
Result < tw-SL and MCL
- Surface Water Sample Location
Result >= tw-SL
- Surface Water Sample Location
Result >= MCL
- Water Feature
- Dirt Road
- Paved Road
- Railroad
- Fence
- SWMU 41 Boundary



- Notes:
- 1) Aerial photo, dated 2005, was obtained from Montgomery County, VA Planning & GIS Services.
 - 2) Metals exceedances only occurred in total metals analyses. There were no exceedances in dissolved metals analyses.
 - 3) Surface water MCL values were obtained from the 2006 edition of the Drinking Water Standards and Health Advisories. Surface water tw-SLs are from the ORNL Regional Screening Table, April 2009.



U.S. Army Corps of Engineers



Shaw Environmental, Inc.

FIGURE 3-2

Surface Water Results at SWMU 41
Radford Army Ammunition Plant,
Radford, VA

Surface Water Results

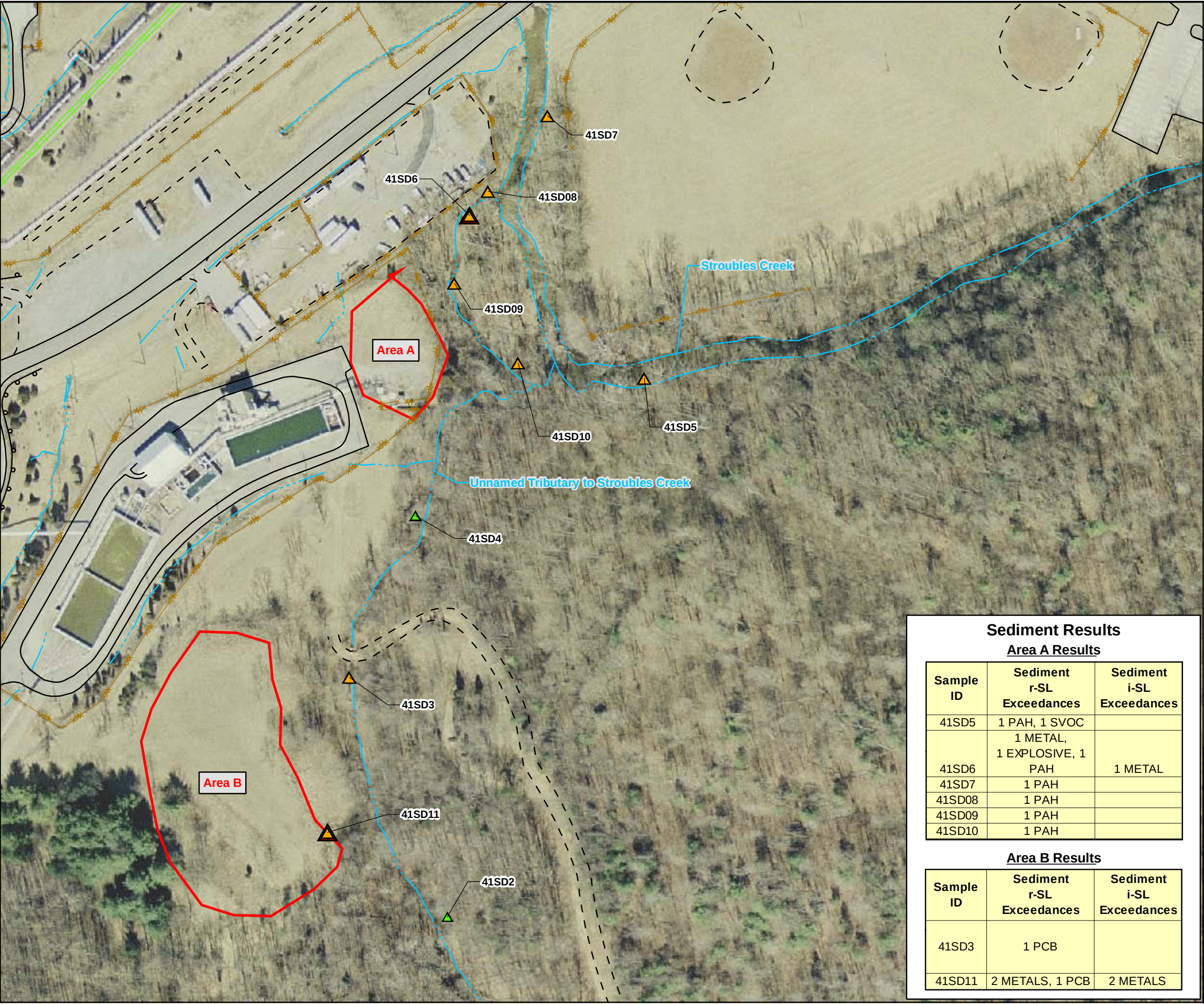
Area A Results

Sample ID	Surface Water tw-SL Exceedances	Surface Water MCL Exceedances
41SW1	1 EXPLOSIVE	
41SW6		1 METAL
41SW08		2 METALS
41SW09	1 DIOXIN/FURAN	1 METAL
41SW10	1 EXPLOSIVE	1 METAL

Area B Results

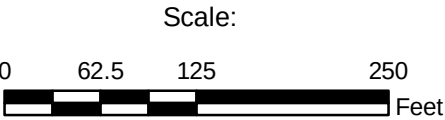
Sample ID	Surface Water tw-SL Exceedances	Surface Water SL Exceedances
41SP2	4 METALS	4 METALS
41SW2	1 METAL, 1 VOC	1 METAL
41SW3	1 VOC	1 METAL
41SW4	1 METAL, 1 VOC	2 METALS

ArcGIS File: C:\Radford MMA\GIS Documents\Project_Maps\SWMU 41\FAAP_Fig3-3_SWMU41_SD_Sample_Results.mxd (2/2/2011 2:42:14 PM)

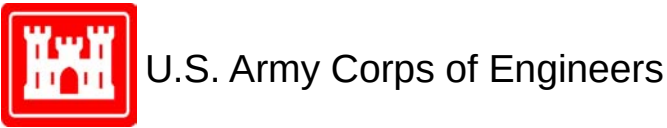


LEGEND

- Sediment Sample Location
Result < r-SL and i-SL
- Sediment Sample Location
Result >= r-SL
- Sediment Sample Location
Result >= i-SL
- Water Feature
- Fence
- Dirt Road
- Paved Road
- Railroad
- SWMU 41 Boundary
- Fence



- Notes:
- 1) Aerial photo, dated 2005, was obtained from Montgomery County, VA Planning & GIS Services.
 - 2) Soil SLs were used for sediment and were obtained from the ORNL Regional Screening Table, April 2009.

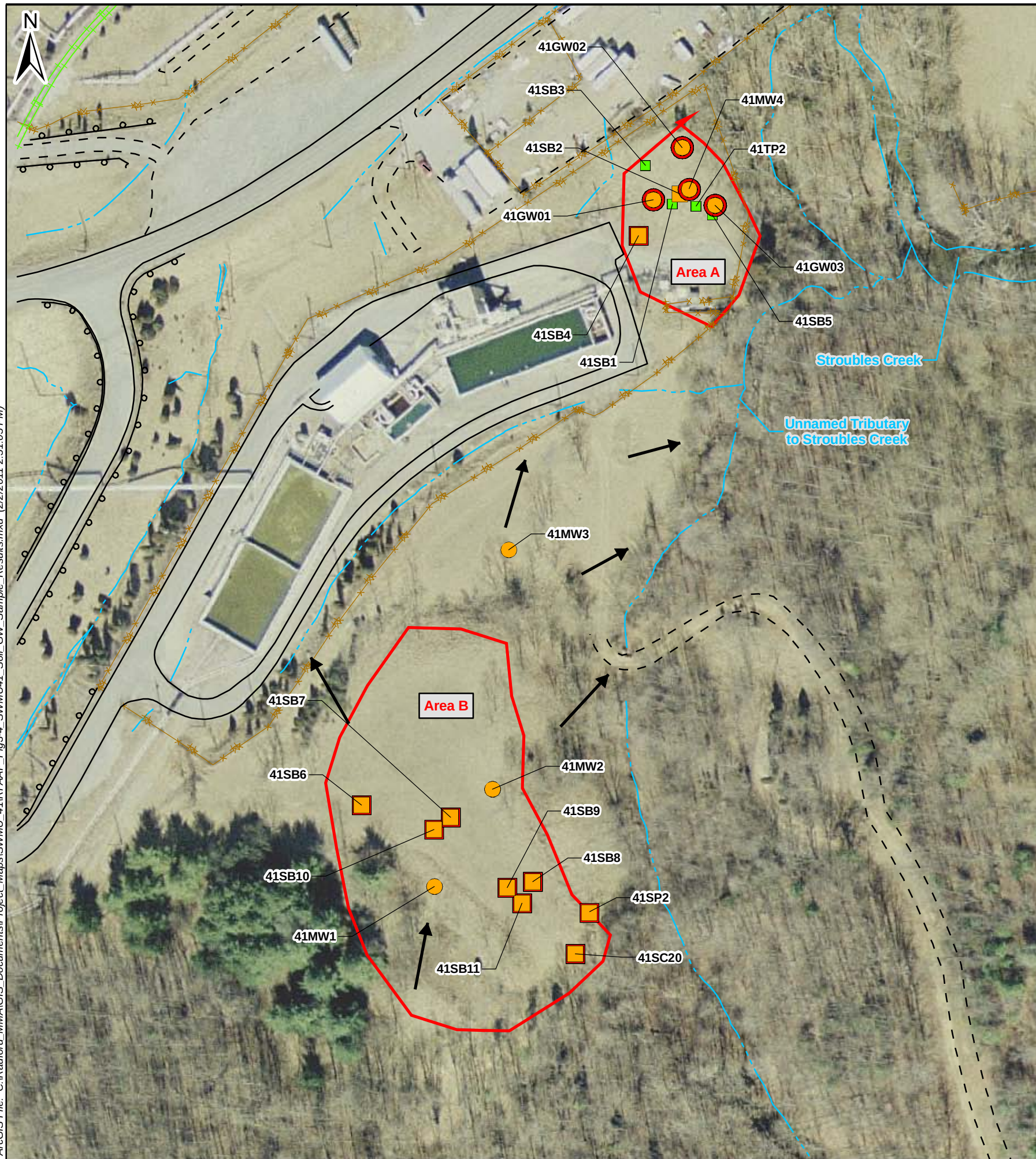


Sediment Results		
Area A Results		
Sample ID	Sediment r-SL Exceedances	Sediment i-SL Exceedances
41SD5	1 PAH, 1 SVOC	
41SD6	1 METAL, 1 EXPLOSIVE, 1 PAH	1 METAL
41SD7	1 PAH	
41SD08	1 PAH	
41SD09	1 PAH	
41SD10	1 PAH	

Area B Results		
Sample ID	Sediment r-SL Exceedances	Sediment i-SL Exceedances
41SD3	1 PCB	
41SD11	2 METALS, 1 PCB	2 METALS

FIGURE 3-3
Sediment Results at SWMU 41
Radford Army Ammunition Plant,
Radford, VA

ArcGIS File: C:\Radford_MMA\GIS_Documents\Project_Maps\SWMU_41\RAAP_Fig3-4_SWMU41_Soil_GW_Sample_Results.mxd (2/2/2011 2:51:05 PM)



Soil and Groundwater Results

Area A Soil Results

Sample ID	Soil r-SL Exceedances	Soil i-SL Exceedances
41SB2A	1 PCB	
41SB2B	2 METALS, TCDD TE	
41SB4C	3 METALS	2 METALS

Area B Soil Results

Sample ID	Soil r-SL Exceedances	Soil i-SL Exceedances
41SB6A	1 VOC	
41SB6B	2 METALS	1 METAL
41SB6C	1 METAL	1 METAL
41SB7A	1 METAL	1 METAL
41SB7B	3 METALS	1 METAL
41SB7C	1 METAL	1 METAL
41SB8A	1 METAL	1 METAL
41SB8C	2 METALS	2 METALS
41SB9A	1 METAL	1 METAL
41SB9B	1 METAL, 1 VOC	1 METAL
41SB9C	1 SVOC	
41SB10A	1 PCB	
41SB10B	2 METALS, TCDD TE	1 METAL
41SB11A	1 METAL	1 METAL
41SB11C	1 METAL	1 METAL
41SC20A	1 METAL	1 METAL
41SC20B	2 METALS	2 METALS
41SP2soil	1 METAL	1 METAL

Area A Groundwater Results

Sample ID	Groundwater tw-SL Exceedances	Groundwater MCL Exceedances
41GW01	10 METALS, 1 EXPLOSIVE	5 METALS
41GW02	15 METALS, TCDD TE	7 METALS
41GW03	12 METALS, TCDD TE, 1 VOC	7 METALS, TCDD TE
41MW4	1 PEST, 4 SVOCs, 1 VOC	2 METALS

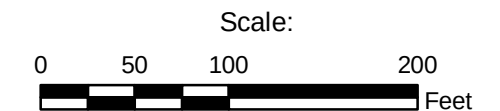
* 41GW1, 41GW2, and 41GW3 had high turbidity results and were not used in the risk assessment; they were replaced new data collected at 41MW4.

Area B Groundwater Results

Sample ID	Groundwater tw-SL Exceedances	Groundwater MCL Exceedances
41MW1	1 METAL, 1 VOC	
41MW2	2 METALS, 1 VOC	
41MW3	1 VOC	

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
- Groundwater Flow Direction
- Water Feature
- Dirt Road
- Paved Road
- Railroad
- Fence
- SWMU 41 Boundary



Notes:

- 1) Aerial photo, dated 2005, was obtained from Montgomery County, VA Planning & GIS Services.
- 2) Although total metals were found above SLs in 41GW01, 02, and 03, dissolved metals results indicated that only 2 metals were above SLs in only sample 41GW03 (see Table 4-4).
- 3) Groundwater results are from August 2007.
- 4) Groundwater MCL values were obtained from the 2006 edition of the Drinking Water Standards and Health Advisories. Groundwater tw-SLs are from the ORNL Regional Screening Table, April 2009.
- 5) Soil SLs were obtained from the ORNL Regional Screening Table, April 2009.



U.S. Army Corps of Engineers



Shaw Environmental, Inc.

FIGURE 3-4
Soil and Groundwater Results
at SWMU 41
Radford Army Ammunition Plant,
Radford, VA

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 SWMU 41. The 2007 RFI sampling locations and the sampling point of the new 2010 well are illustrated on **Figure 3-1**. A summary of the results from the samples are portrayed on **Figures 3-2 through 3-4**. The distribution and concentrations of chemicals and parameter groups (i.e., VOCs, SVOCs, etc.) are evaluated for source locations, migration pathways, and potential hotspots. Areas A and B are evaluated separately for the nature and extent assessment given the different nature of the waste disposal areas and the 550 ft separation between these areas.

Surface Water/Groundwater Screening. Surface water and groundwater sampling results are compared to the 2009 Edition of the Drinking Water Standards and Health Advisories (i.e., MCLs and secondary MCLs) (USEPA, 2009b) and adjusted Oak Ridge National Laboratory (ORNL) regional SLs (USEPA, 2009a). tw-SLs were adjusted downward to an HI of 0.1 for non-carcinogenic compounds to ensure that chemicals with additive effects are not prematurely eliminated during screening. Analytes detected in SWMU 41 surface water and groundwater are presented for comparison against screening criteria in **Table 4-1** (surface water) and **Tables 4-4 and 4-5** (groundwater). Surface water and groundwater results from the 2007 RFI are presented in *Section 4.1*.

Sediment Screening. Chemical results from sediment samples are compared to adjusted ORNL regional i-SLs and r-SLs (USEPA, 2009a) and other regulatory criteria. i-SLs and r-SLs were adjusted downward to an HI of 0.1 for non-carcinogenic compounds to ensure that chemicals with additive effects are not prematurely eliminated during screening. Current (April 2009) SL screening values for analytes detected in sediment at SWMU 41 are presented in **Table 4-2**. Sediment results from the 2007 RFI are presented in *Section 4.1*.

4.1 RFI, Shaw, 2007 and 2010

4.1.1 Surface Water Analytical Results

Three surface water samples (41SW08, 41SW09, and 41SW10) were collected at Area A and analyzed for TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, and perchlorate. No samples were collected from Area B. The detected results are presented in **Table 4-1** and illustrated on **Figure 3-2**.

VOCs. VOCs were not detected in any of the three surface water samples.

PAHs. PAHs were not detected in any of the three surface water samples.

SVOCs. SVOCs were not detected in any of the three surface water samples.

Pesticides. Pesticides were not detected in any of the three surface water samples.

PCBs. PCBs were not detected in any of the three surface water samples.

Explosives. One explosive (2,4,6-TNT) was detected above its tw-SL in one surface water sample (41SW10). Two explosives [2-amino-4,6-dinitrotoluene (DNT) and 4-amino-2,6-DNT] were detected in all three surface water samples, but not above SLs.

Table 4-1
Analytes Detected in SWMU 41 Area A Surface Water Samples - 2007 RFI
Page 1 of 2

Analyte	Sample ID Sample Date		41SW08 7/18/07					41SW09 7/18/07					41SW10 7/18/07				
	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)			None detected														
PAHs (ug/L)			None detected														
SVOCs (ug/L)			None detected														
Pesticides (ug/L)			None detected														
PCBs (ug/L)			None detected														
Explosives (ug/L)																	
2,4,6-Trinitrotoluene	na	0.22	0.2	U		0.079	0.2	0.2	U		0.08	0.2	1.3			0.08	0.2
2-amino-4,6-Dinitrotoluene	na	7.3	0.27			0.069	0.2	0.76			0.07	0.2	1.1			0.07	0.2
4-amino-2,6-Dinitrotoluene	na	7.3	0.87			0.079	0.2	1.7			0.08	0.2	2.5			0.08	0.2
Herbicides (ug/L)			None detected														
Metals (ug/L)																	
Aluminum	50	3700	208		L	18	200	170	J	B	18	200	235		L	18	200
Barium	2000	730	64.9	J	J	5	200	62.6	J	J	5	200	63.3	J	J	5	200
Calcium	na	na	50100			42	1000	52700			42	1000	53000			42	1000
Copper	1300	150	1	U		1	25	1	U		1	25	1.2	J	B	1	25
Iron	300	2600	88.1	J	B	15	300	15	U		15	300	52.7	J	B	15	300
Magnesium	na	na	23800			4.3	5000	28100			4.3	5000	30200			4.3	5000
Manganese	50	88	61.9			1.5	15	21.1			1.5	15	39.5			1.5	15
Nickel	na	73	1.2	J	B	1	40	1	U		1	40	1.1	J	B	1	40
Potassium	na	na	4300	J	B	100	10000	4020	J	B	100	10000	4060	J	B	100	10000
Sodium	na	na	14300			500	10000	15900			500	10000	16600			500	10000
Vanadium	na	26	1.1	J	J	1.1	50	1.4	J	J	1.1	50	1.3	J	J	1.1	50
Zinc	5000	1100	5.5	J	J	1.6	20	6.7	J	J	1.6	20	2.6	J	J	1.6	20
Dioxins/Furans (ng/L)																	
2,3,7,8-TCDF	na	na	0.00525	U		0.00105	0.00105	0.00147	A	J	NA	NA	0.00128	U		0.00128	0.00128
2,3,7,8-TCDD	0.03	0.00052	0.00164	U		0.00164	0.00164	0.00257	A, EMPC	J	0.00114	0.00114	0.00179	U		0.00179	0.00179
1,2,3,7,8-PECDD	na	na	0.00525	UQ	UJ	0.00525	0.00525	0.00607	A	J	NA	NA	0.00538	U		0.00538	0.00538
1,2,3,4,7,8-HXCDD	na	na	0.00525	U		0.00525	0.00525	0.00468	A	J	NA	NA	0.00689	U		0.00689	0.00689
1,2,3,6,7,8-HXCDD	na	na	0.00525	U		0.00525	0.00525	0.00475	A	J	NA	NA	0.00702	U		0.00702	0.00702
1,2,3,7,8,9-HXCDD	na	na	0.00525	U		0.00525	0.00525	0.00495	A	J	NA	NA	0.00712	U		0.00712	0.00712
1,2,3,4,6,7,8-HPCDD	na	na	0.00525	U		0.00525	0.00525	0.00564	A	J	NA	NA	0.00538	U		0.00538	0.00538
OCDD	na	na	0.0219	A	J	NA	NA	0.0292	A	J	NA	NA	0.0618	A	J	NA	NA
1,2,3,7,8-PECDF	na	na	0.00525	U		0.00525	0.00525	0.00662	A	J	NA	NA	0.00538	U		0.00538	0.00538
2,3,4,7,8-PECDF	na	na	0.00525	UQ	UJ	0.00525	0.00525	0.00589	A	J	NA	NA	0.00538	U		0.00538	0.00538
1,2,3,4,7,8-HXCDF	na	na	0.00525	U		0.00525	0.00525	0.00532	A	J	NA	NA	0.00538	U		0.00538	0.00538
1,2,3,6,7,8-HXCDF	na	na	0.00525	U		0.00525	0.00525	0.00509	A	J	NA	NA	0.00538	U		0.00538	0.00538

Table 4-1
Analytes Detected in SWMU 41 Area A Surface Water Samples - 2007 RFI
Page 2 of 2

Analyte	Sample ID Sample Date		41SW08 7/18/07					41SW09 7/18/07					41SW10 7/18/07				
	MCL	tw-SL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
2,3,4,6,7,8-HXCDF	na	na	0.00525	U		0.00525	0.00525	0.00409	A	J	NA	NA	0.00538	U		0.00538	0.00538
1,2,3,7,8,9-HXCDF	na	na	0.00525	U		0.00525	0.00525	0.00501	A	J	NA	NA	0.00538	U		0.00538	0.00538
1,2,3,4,6,7,8-HPCDF	na	na	0.00525	U		0.00525	0.00525	0.00536	A, EMPC	J	0.00509	0.00509	0.00538	U		0.00538	0.00538
1,2,3,4,7,8,9-HPCDF	na	na	0.00525	U		0.00525	0.00525	0.00402	A	J	NA	NA	0.00538	U		0.00538	0.00538
OCDF	na	na	0.0105	U		0.0105	0.0105	0.00874	A	J	NA	NA	0.0108	U		0.0108	0.0108
TOTAL TCDD	na	na	0.00525	U		0.00164	0.00164	0.00257			0.00114	0.00114	0.00179	U		0.00179	0.00179
TOTAL PECDD	na	na	0.00525	UQ	UJ	0.00525	0.00525	0.00607			NA	NA	0.00538	U		0.00538	0.00538
TOTAL HXCDD	na	na	0.00525	U		0.00525	0.00525	0.0144			NA	NA	0.00712	U		0.00712	0.00712
TOTAL HPCDD	na	na	0.00525	U		0.00525	0.00525	0.00564			NA	NA	0.00538	U		0.00538	0.00538
TOTAL TCDF	na	na	0.00525	U		0.00105	0.00105	0.00147			NA	NA	0.00128	U		0.00128	0.00128
TOTAL PECDF	na	na	0.00525	UQ	UJ	0.00525	0.00525	0.0125			NA	NA	0.00538	U		0.00538	0.00538
TOTAL HXCDF	na	na	0.00525	U		0.00525	0.00525	0.0195			NA	NA	0.00538	U		0.00538	0.00538
TOTAL HPCDF	na	na	0.00525	U		0.00525	0.00525	0.00955		J	NA	NA	0.00538	U		0.00538	0.00538
2,3,7,8-TCDD TE	0.03	0.00052	0.00000657					0.01430					0.00001854				
Misc. (ug/L)																	
Perchlorate	na	2.6	0.168	J	J	0.112	0.2	0.142	J	J	0.112	0.2	0.135	J	J	0.112	0.2

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

Table 4-1
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, April 2009).

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.

Herbicides. Herbicides were not detected in any of the three surface water samples.

TAL Inorganics. Twelve (12) metals were detected in site surface water samples. Two metals (aluminum and manganese) were detected at concentrations above their MCLs.

Dioxins/Furans. Twenty-five (25) dioxin/furan congeners were detected in the samples. 2,3,7,8-TCDD and the calculated 2,3,7,8-TCDD TE were detected above the adjusted tw-SL, but below the MCL, in sample 41SW09.

Misc. Perchlorate was detected in all three surface water samples. However, detected concentrations were below applicable SLs.

4.1.2 Sediment Analytical Results

Three sediment samples (41SD08, 41SD09, and 41SD10) were collected with collocated surface water samples (41SW08, 41SW09, and 41SW10) at Area A. Sample 41SD11 was collected from the dry seep at Area B. All sediment samples were analyzed for TCL VOCs, SVOCs, PAHs, pesticides/PCBs, herbicides, explosives, TAL metals, and dioxins/furans. Detected Area A sediment results are presented in **Table 4-2** and Area B results in **Table 4-3**.

VOCs. At Area A, two VOCs (2-butanone and acetone) were detected in sample 41SD08. However, neither of the VOCs was detected above applicable SLs. VOCs were not detected in the Area B sediment sample.

PAHs. At Area A, ten PAHs were detected in the sediment samples. However, only one PAH [benzo(a)pyrene] was detected above its r-SL (but below i-SLs) in the three sediment samples. PAHs were not detected in the Area B sediment sample.

SVOCs. Non-PAH SVOCs were not detected in Area A or Area B sediment samples.

Pesticides. Pesticides were not detected in any of the Area A or Area B sediment samples.

PCBs. PCBs were not detected in the Area A sediment samples. One PCB (PCB-1254) was detected above its r-SL (but below i-SL) in the Area B sediment sample.

Explosives. Explosives were not detected in any of the Area A or Area B sediment samples.

Herbicides. Herbicides were not detected in any of the Area A or Area B sediment samples.

TAL Inorganics. Twenty-one (21) metals were detected in both the Area A and Area B sediment samples. No metals were found above their applicable SLs at Area A. However, at Area B, two metals (arsenic and manganese) were found above their i-SLs and r-SLs in the one sample.

Dioxins/Furans. Twenty-five (25) dioxin/furan congeners were detected in the Area A sediment samples. However, none of the congeners or TCDD TE were detected above applicable SLs. Twenty-one (21) dioxins/furans were detected in the Area B sediment samples. However, none of the congeners or TCDD TE were detected above applicable SLs.

4.1.3 Groundwater Analytical Results

Three groundwater samples (41MW1, 41MW2, and 41MW3) were collected from the existing Area B wells and three samples (41GW01, 41GW02, and 41GW03) were collected from temporary direct-push groundwater wells at Area A and analyzed for TCL VOCs, SVOCs, pesticides/PCBs, herbicides, explosives, TAL metals, dioxins/furans, and perchlorate (see **Table 3-1**). 2007 detected groundwater well results for SWMU 41 are presented in **Table 4-4**.

Table 4-2
Analytes Detected in SWMU 41 Area A Sediment Samples - 2007 RFI
Page 1 of 2

Analyte	Sample ID Sample Date Sample Depth			41SD08 7/18/07 0-0.5					41SD09 7/18/07 0-0.5					41SD10 7/18/07 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
VOCs (ug/kg)																		
2-Butanone	19000000	2800000	na	48.8	J	J	35	86	28	U		11	28	37	U		15	37
Acetone	61000000	6100000	na	253		J	86	170	55	U	UJ	28	55	73	U		37	73
PAHs (ug/kg)																		
Benz(a)anthracene	2100	150	na	50.9	J	J	36	140	17.4	J	L	16	65	46.3	J	J	17	66
Benzo(a)pyrene	210	15	na	72	J	J	36	140	22.9	J	L	16	65	67.3			17	66
Benzo(b)fluoranthene	2100	150	na	120	J	J	36	140	40.2	J	L	16	65	113			17	66
Benzo(g,h,i)perylene	1700000	170000	na	62.2	J	J	36	140	20	J	L	16	65	53.9	J	J	17	66
Benzo(k)fluoranthene	21000	1500	na	66.9	J	J	36	140	24.2	J	L	16	65	64.7	J	J	17	66
Chrysene	210000	15000	na	98.2	J	J	36	140	34	J	L	16	65	90.1			17	66
Fluoranthene	2200000	230000	na	174	J	J	130	720	320	U		57	320	154	J	J	58	330
Indeno(1,2,3-cd)pyrene	2100	150	na	67.1	J	J	36	140	21	J	L	16	65	57.2	J	J	17	66
Phenanthrene	1700000	170000	na	720	U		110	720	320	U		49	320	60.2	J	J	50	330
Pyrene	1700000	170000	na	135	J	J	130	720	320	U		57	320	141	J	J	58	330
SVOCs (ug/kg) None detected																		
Pesticides (ug/kg) None detected																		
PCBs (mg/kg) None detected																		
Explosives (mg/kg) None detected																		
Herbicides (ug/kg) None detected																		
Metals (mg/kg)																		
Aluminum	99000	7700	40041	13300			3	27	10000			1.3	12	6170			1.4	13
Antimony	41	3.1	na	0.72	U	UL	0.72	8.1	1.4	J	B	0.31	3.5	0.5	J	B	0.33	3.8
Arsenic	1.6	0.39	15.8	5.2			0.53	1.1	5.9			0.23	0.46	3.7			0.25	0.51
Barium	19000	1500	209	134			0.68	27	102			0.29	12	63			0.32	13
Beryllium	200	16	1.02	0.88			0.14	0.68	0.76			0.058	0.29	0.54			0.063	0.32
Calcium	na	na	na	25600			7.7	680	5590			3.3	290	10200			3.6	320
Chromium	1400	280	65.3	15.5			0.12	1.4	13.6			0.052	0.58	9.6			0.057	0.63
Cobalt	30	2.3	72.3	10.4			0.14	6.8	13.4			0.058	2.9	6.9			0.063	3.2
Copper	4100	310	53.5	24.8			0.12	3.4	20			0.052	1.4	12.7			0.057	1.6
Iron	72000	5500	50962	18200			1.6	14	24900			0.69	5.8	12500			0.76	6.3
Lead	800	400	26.8	20.1		K	0.27	14	10.4		K	0.12	5.8	15.4		K	0.13	6.3
Magnesium	na	na	na	6440			1	680	4900			0.43	290	3680			0.47	320
Manganese	2300	180	2543	299			0.081	2	854			0.17	4.3	547			0.19	4.7
Mercury	2.4	0.43	0.13	0.1	J	B	0.017	0.22	0.03	J	B	0.007	0.091	0.027	J	B	0.007	0.093
Nickel	2000	160	62.8	17.7			0.14	5.4	24			0.058	2.3	10			0.063	2.5
Potassium	na	na	na	1890		B	14	1400	939		B	5.8	580	731		B	6.3	630

Table 4-2
Analytes Detected in SWMU 41 Area A Sediment Samples - 2007 RFI
Page 2 of 2

Analyte	Sample ID Sample Date Sample Depth			41SD08 7/18/07 0-0.5					41SD09 7/18/07 0-0.5					41SD10 7/18/07 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
Selenium	510	39	na	3.3	J	B	0.27	14	7.7		K	0.12	5.8	2.9	J	B	0.13	6.3
Silver	510	39	na	0.12	U		0.12	1.4	0.052	U		0.052	0.58	0.072	J	J	0.057	0.63
Sodium	na	na	na	475	J	B	110	1400	173	J	B	48	580	199	J	B	52	630
Vanadium	720	55	108	23.3			0.081	6.8	15.4			0.035	2.9	12.1			0.038	3.2
Zinc	31000	2300	202	89.5			0.18	2.7	81.5			0.075	1.2	57.9			0.082	1.3
Dioxins/Furans (ng/kg)																		
2,3,7,8-TCDF	na	na	na	0.00155	A, EMPC	J	NA	NA	0.000866	A	J	NA	NA	0.00158	A	J	NA	NA
2,3,7,8-TCDD	18	4.5	na	0.000748	A, EMPC	J	NA	NA	0.00028	A, EMPC	J	NA	NA	0.000573	A, EMPC	J	NA	NA
1,2,3,7,8-PECDD	na	na	na	0.00143	U		0.00143	0.00143	0.000259	A, EMPC	J	NA	NA	0.000601	A	J	NA	NA
1,2,3,4,7,8-HXCDD	na	na	na	0.00143	U		0.00143	0.00143	0.000316	A	J	NA	NA	0.000805	A, EMPC	J	NA	NA
1,2,3,6,7,8-HXCDD	na	na	na	0.00143	U		0.00143	0.00143	0.000595	A, EMPC	J	NA	NA	0.00141	A, EMPC	J	NA	NA
1,2,3,7,8,9-HXCDD	na	na	na	0.00318	A	J	NA	NA	0.00101	A	J	NA	NA	0.00171	A	J	NA	NA
1,2,3,4,6,7,8-HPCDD	na	na	na	0.0467			NA	NA	0.0208			NA	NA	0.0445			NA	NA
OCDD	na	na	na	2.08			NA	NA	0.897			NA	NA	1.79			NA	NA
1,2,3,7,8-PECDF	na	na	na	0.0029	A	J	NA	NA	0.00115	A	J	NA	NA	0.00268	A	J	NA	NA
2,3,4,7,8-PECDF	na	na	na	0.0014	A	J	NA	NA	0.000633	A	J	NA	NA	0.00127	A	J	NA	NA
1,2,3,4,7,8-HXCDF	na	na	na	0.00837	A	J	NA	NA	0.00307	A	J	NA	NA	0.00744	A	J	NA	NA
1,2,3,6,7,8-HXCDF	na	na	na	0.00478	A	J	NA	NA	0.00188	A	J	NA	NA	0.0046	A	J	NA	NA
2,3,4,6,7,8-HXCDF	na	na	na	0.00149	A	J	NA	NA	0.000482	A	J	NA	NA	0.00168	A	J	NA	NA
1,2,3,7,8,9-HXCDF	na	na	na	0.00143	U		0.00143	0.00143	0.000189	A, EMPC	J	NA	NA	0.000541	A	J	NA	NA
1,2,3,4,6,7,8-HPCDF	na	na	na	0.0622			0.00143	0.00143	0.0222			NA	NA	0.0586			NA	NA
1,2,3,4,7,8,9-HPCDF	na	na	na	0.00126	A	J	0.00143	0.00143	0.000498	A	J	NA	NA	0.00106	A	J	NA	NA
OCDF	na	na	na	0.0539			NA	NA	0.0208			NA	NA	0.0484			NA	NA
TOTAL TCDD	na	na	na	0.00352	A, EMPC	J	NA	NA	0.00028	A, EMPC	J	NA	NA	0.00193	A, EMPC	J	NA	NA
TOTAL PECDD	na	na	na	0.00457			NA	NA	0.00215	A, EMPC	J	NA	NA	0.00437	A, EMPC	J	NA	NA
TOTAL HXCDD	na	na	na	0.0135	A, EMPC	J	NA	NA	0.00676	A, EMPC	J	NA	NA	0.0144	A, EMPC	J	NA	NA
TOTAL HPCDD	na	na	na	0.099			NA	NA	0.0444			NA	NA	0.0963			NA	NA
TOTAL TCDF	na	na	na	0.0276	A, EMPC	J	NA	NA	0.0103	A, EMPC	J	NA	NA	0.0193	A, EMPC	J	NA	NA
TOTAL PECDF	na	na	na	0.0326	A, EMPC	J	NA	NA	0.013	A, EMPC	J	NA	NA	0.0281	A, EMPC	J	NA	NA
TOTAL HXCDF	na	na	na	0.0453	A, EMPC	J	NA	NA	0.0163			NA	NA	0.041			NA	NA
TOTAL HPCDF	na	na	na	0.0756			NA	NA	0.0272			NA	NA	0.0692			NA	NA
2,3,7,8-TCDD TE	18	4.5	na	0.004934					0.002315					0.005205				

**Refer to legend immediately following this table for a list of definitions and table 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, April 2009).

Lead screening values from Technical Review Workgroup for Lead: Guidance Document (USEPA, 1999b).

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 41 Area B Sediment Samples - 2007 RFI

Analyte	Sample ID Sample Date Sample Depth			41SD11 7/19/07 0-0.5				
	i-SL	r-SL	Background	Result	Lab Q	Val Q	MDL	MRL
VOCs (ug/kg)	None detected							
PAHs (ug/kg)	None detected							
SVOCs (ug/kg)	None detected							
Pesticides (ug/kg)	None detected							
PCBs (mg/kg)								
PCB-1254	0.74	0.022	na	0.0902			0.0096	0.019
Explosives (mg/kg)	None detected							
Herbicides (ug/kg)	None detected							
Metals (mg/kg)								
Aluminum	99000	7700	40041	14300			1.2	11
Antimony	41	3.1	na	1.1	J	B	0.3	3.4
Arsenic	1.6	0.39	15.8	16.6			0.22	0.45
Barium	19000	1500	209	219			0.28	11
Beryllium	200	16	1.02	1			0.056	0.28
Calcium	na	na	na	20100			3.2	280
Chromium	1400	280	65.3	20.4			0.051	0.56
Cobalt	30	2.3	72.3	13.4			0.056	2.8
Copper	4100	310	53.5	38.4			0.051	1.4
Iron	72000	5500	50962	25900			0.68	5.6
Lead	800	400	26.8	59.3			0.11	5.6
Magnesium	na	na	na	12500			0.42	280
Manganese	2300	180	2543	2800			0.68	17
Mercury	2.4	0.43	0.13	0.056	J	B	0.006	0.083
Nickel	2000	160	62.8	13.4			0.056	2.3
Potassium	na	na	na	1010		B	5.6	560
Selenium	510	39	na	5.4	J	K	0.11	5.6
Sodium	na	na	na	2150			47	560
Thallium	6.6	0.51	2.11	1.1	J	B	0.52	2.2
Vanadium	720	55	108	33			0.034	2.8
Zinc	31000	2300	202	108			0.073	1.1
Dioxins/Furans (ng/kg)								
2,3,7,8-TCDF	na	na	na	0.000492	A	B	NA	NA
2,3,7,8-TCDD	18	4.5	na	0.000181	U		0.00018	0.00018
1,2,3,7,8-PECDD	na	na	na	0.000594	U		0.00059	0.00059
1,2,3,4,7,8-HXCDD	na	na	na	0.000214	A	J	NA	NA
1,2,3,6,7,8-HXCDD	na	na	na	0.000537	A	J	NA	NA
1,2,3,7,8,9-HXCDD	na	na	na	0.00127	A	J	NA	NA
1,2,3,4,6,7,8-HPCDD	na	na	na	0.0279			NA	NA
OCDD	na	na	na	1.71			NA	NA
1,2,3,7,8-PECDF	na	na	na	0.000235	A	J	NA	NA
2,3,4,7,8-PECDF	na	na	na	0.000356	A, EMPC	J	0.00059	0.00059
1,2,3,4,7,8-HXCDF	na	na	na	0.000801	A	B	NA	NA
1,2,3,6,7,8-HXCDF	na	na	na	0.000297	A	J	NA	NA
2,3,4,6,7,8-HXCDF	na	na	na	0.000342	A, EMPC	J	0.00059	0.00059
1,2,3,7,8,9-HXCDF	na	na	na	0.000594	U		0.00059	0.00059
1,2,3,4,6,7,8-HPCDF	na	na	na	0.0042	A	B	NA	NA
1,2,3,4,7,8,9-HPCDF	na	na	na	0.000361	A	J	NA	NA
OCDF	na	na	na	0.0112	A	B	NA	NA
TOTAL TCDD	na	na	na	0.000181	U		0.00018	0.00018
TOTAL PECDD	na	na	na	0.000268			NA	NA
TOTAL HXCDD	na	na	na	0.00865			NA	NA
TOTAL HPCDD	na	na	na	0.0659			NA	NA
TOTAL TCDF	na	na	na	0.00255	A, EMPC	J	NA	NA
TOTAL PECDF	na	na	na	0.0031	A, EMPC	J	NA	NA
TOTAL HXCDF	na	na	na	0.00508	A, EMPC	J	NA	NA
TOTAL HPCDF	na	na	na	0.0105			NA	NA
2,3,7,8-TCDD TE	18	4.5	na	0.00135				

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

**Table 4-3
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, April 2009).

Lead screening values from Technical Review Workgroup for Lead: Guidance Document (USEPA, 1999b).

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 4-4
Analytes Detected in SWMU 41 Groundwater Samples - 2007 RFI

Analyte	Sample ID		41MW1					41MW2					41MW3				
	Sample Date		8/27/07					8/27/07					8/27/07				
	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)																	
Tetrachloroethene	5	0.11	0.35	J	J	0.25	1	1.7			0.25	1	0.8	J	J	0.25	1
Toluene	1000	230	1	U	UL	0.27	1	0.3	J	L	0.27	1	1	U		0.27	1
PAHs (ug/L) None detected																	
SVOCs (ug/L) None detected																	
Pesticides (ug/L) None detected																	
PCBs (ug/L) None detected																	
Explosives (ug/L) None detected																	
Herbicides (ug/L) None detected																	
Metals (ug/L)																	
Arsenic	10	0.045	5	J	J	3.7	10	7.9	J	J	3.7	10	3.7	U		3.7	10
Barium	2000	730	29.5	J	J	5	200	10	J	J	5	200	24.8	J	J	5	200
Calcium	na	na	69700			100	1000	121000			100	1000	98200			100	1000
Chromium	100	5500	10.8			0.92	10	6.1	J	J	0.92	10	2.9	J	J	0.92	10
Cobalt	na	1.1	1	U		1	50	7	J	J	1	50	1	U		1	50
Copper	1300	150	7.1	J	J	1.2	25	9.9	J	J	1.2	25	1.2	U		1.2	25
Lead	15	na	4.2	J	B	2.1	5	3.1	J	B	2.1	5	4.5	J	B	2.1	5
Magnesium	na	na	76600			100	5000	115000			100	5000	61500			100	5000
Manganese	50	88	47.1			1	15	42.3			1	15	4.2	J	J	1	15
Nickel	na	73	6.2	J	J	1	40	6	J	J	1	40	2.5	J	J	1	40
Potassium	na	na	3900	J	B	100	10000	8570	J	B	100	10000	10600		K	100	10000
Sodium	na	na	751000			25000	50000	3030000			25000	50000	110000			1000	20000
Vanadium	na	0.26	1.3	J	J	1.1	50	2	J	J	1.1	50	1.1	U		1.1	50
Zinc	5000	1100	12.9	J	J	5	20	9.5	J	J	5	20	14.5	J	J	5	20
Dioxins/Furans (ng/L) None detected																	
Misc. (ug/L)																	
Perchlorate	na	2.6	0.294		J	0.112	0.2	2.5		J	0.112	0.2	0.978			0.112	0.2

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

Table 4-4
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, April 2009).

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.

The results of the direct-push groundwater samples that will be eliminated from the HHRA because of high turbidity are presented in **Table 4-5**. The October 2010 detected groundwater results for newly-installed well 41MW4 that will be replacing the highly-turbid Area A direct-push samples in the risk assessment are presented in **Table 4-6**.

VOCs. Three VOCs [chloroform, tetrachloroethene (PCE), and toluene] were detected in SWMU 41 groundwater samples. Chloroform was detected above its tw-SL in two samples (41GW03 and 41MW4), but it was B-flagged in the 41GW03 sample, indicating possible laboratory blank contamination. PCE was found greater than its tw-SL in three samples (41MW1-3). Toluene was not detected at a concentration greater than its SLs in any sample.

PAHs. In the 2010 sample (41MW4), four PAHs [benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] were detected above their tw-SLs. However, none of these were detected in the duplicate sample (41TM4). Given the low solubility of PAHs in groundwater, their presence in the groundwater is likely to be due to binding of the PAHs on particulates in the groundwater. This leads to the assumption that a soil particulate in the sample may have been the cause of these detections.

SVOCs. One non-PAH SVOC (diethylphthalate) was detected in two of the six 2007 groundwater samples. However, it was not detected above its SLs.

Pesticides. One pesticide (heptachlor) was detected above its tw-SL in the 2010 groundwater sample (41MW4).

PCBs. PCBs were not detected in any of the groundwater samples.

Explosives. Seven explosives (1,3,5-trinitrobenzene; 2,4,6-TNT; 2,6-DNT; 2-amino-4,6-DNT; 4-amino-2,6-DNT; HMX; and RDX) were detected in the SWMU 41 groundwater samples. However, only one explosive (2,4,6-TNT) was greater than its tw-SL in one sample, 41GW01.

Herbicides. Herbicides were not detected in any of the groundwater samples.

TAL Inorganics. Sixteen (16) metals (aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, vanadium, and zinc) were detected above SLs. However, in filtered samples, only two metals (cobalt and manganese) were detected above SLs only in sample 41GW03. In the 2010 sample that replaced the 2007 turbid samples in the risk assessment, only aluminum and iron were detected above their MCLs.

Dioxins/Furans. Twenty-three (23) dioxins/furan congeners were detected in the groundwater samples. However, the most toxic 2,3,7,8-TCDD was not detected in any of the groundwater samples. Calculated 2,3,7,8-TCDD TE concentrations were above the tw-SL in unfiltered groundwater samples 41GW02 and 41GW03 and above the MCL in 41GW03.

Misc. Perchlorate was detected in the six groundwater samples. However, concentrations were not found above 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.

Table 4-5
2007 Direct-Push Groundwater Results To Be Eliminated from Risk Assessment
Page 1 of 2

Analyte	Sample ID Sample Date		41GW01 8/28/07					41GW02 8/28/07					41GW03 8/22/07				
	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)																	
Chloroform	80	0.19	1	U		0.21	1	0.0014	U		0.21	1	0.84	JB	B	0.21	1
PAHs (ug/L)																	
None detected																	
SVOCs (ug/L)																	
Diethylphthalate	na	2900	2.5	J	J	2.2	5.6	0.00127	U		2.5	6.3	4.4	J	J	2.2	5.6
Pesticides (ug/L)																	
None detected																	
PCBs (ug/L)																	
None detected																	
Explosives (ug/L)																	
1,3,5-Trinitrobenzene	na	110	0.00222			0.072	0.22	0.00525	U		0.072	0.22	0.57		J	0.072	0.22
2,4,6-Trinitrotoluene	na	0.22	0.172			0.056	0.22	0.00525	U		0.056	0.22	0.17	J	J	0.056	0.22
2,6-Dinitrotoluene	na	3.7	0.0557		J	0.079	0.22	0.00525	U		0.079	0.22	0.22	U		0.079	0.22
2-amino-4,6-Dinitrotoluene	na	7.3	0.00671			0.072	0.22	0.00525	U		0.072	0.22	0.48			0.072	0.22
4-amino-2,6-Dinitrotoluene	na	7.3	0.0032			0.062	0.22	0.00525	U		0.062	0.22	2.2			0.062	0.22
HMX	na	180	0.00529	U		0.057	0.22	0.0219		K	0.057	0.22	0.22	U		0.057	0.22
RDX	na	0.61	0.00529	U		0.067	0.22	0.00525	J	J	0.067	0.22	0.22	U		0.067	0.22
Herbicides (ug/L)																	
None detected																	
Metals, Total (ug/L)																	
Aluminum	50	3700	0.00557			79	200	0.0105			79	200	105000			79	200
Arsenic	10	0.045	0.0726			3.7	10	0.00257			3.7	10	25.5			3.7	10
Barium	2000	730	38.2			5	200	0.00607			5	200	931			5	200
Beryllium	4	7.3	1.01	J	J	1	4	0.00468			1	4	6.6		B	1	4
Cadmium	5	1.8	0.00639	J	J	1	5	0.00475	J	J	1	5	3.3	J	J	1	5
Calcium	na	na	0.232		J	1000	10000	0.00589		J	100	1000	1980000			1000	10000
Chromium	100	11	10.7			0.92	10	0.00495			0.92	10	117			0.92	10
Cobalt	na	1.1	0.0109	J	J	1	50	0.00564			1	50	67.4			1	50
Copper	1300	150	2.43			1.2	25	0.0292			1.2	25	137			1.2	25
Iron	300	2600	8.14		L	15	300	0.00525			15	300	145000			15	300
Lead	15	na	0.0549		J	2.1	5	0.00525		J	2.1	5	1200			2.1	5
Magnesium	na	na	0.395			100	5000	0.00525			100	5000	1070000		J	1000	50000
Manganese	50	88	0.042			1	15	0.00509			4	60	6900			10	150
Mercury	2	0.057	0.632	J	L	0.11	1	0.00501	J	L	0.11	1	0.8	J	L	0.11	1
Nickel	na	73	0.158		J	1	40	0.00525		J	1	40	121			1	40
Potassium	na	na	0.0285		J	100	10000	0.00525		J	100	10000	43700			100	10000
Selenium	50	18	0.00639	U	UL	80	100	0.00532			4	10	160	U		160	200
Silver	100	18	0.0313	U		0.77	10	0.00525	U		0.77	10	0.86	J	J	0.77	10
Sodium	na	na	0.0218			500	10000	0.00409			2000	40000	61100			500	10000
Vanadium	na	26	0.013			1.1	50	0.00147			1.1	50	148			1.1	50
Zinc	5000	1100	0.107		J	5	20	0.00662		J	5	20	2730			5	20
Metals, Dissolved (ug/L)																	
Aluminum	50	3700	0.00479	U	UL	79	200	0.00128	U	UL	79	200	79	U		79	200
Antimony	6	1.5	0.00959	U		6.6	12	0.0108	U		6.6	12	6.6	U		6.6	12
Arsenic	10	0.045	0.00959	U		3.7	10	0.00179	U		3.7	10	3.7	U		3.7	10
Barium	2000	730	0.00479	J	J	5	200	0.00538	J	J	5	200	215			5	200
Beryllium	4	7.3	0.00479	U		1	4	0.00712	U		1	4	1.2	J	B	1	4
Cadmium	5	1.8	0.00479	U		1	5	0.00538	U		1	5	1	U		1	5
Calcium	na	na	0.00508		J	100	1000	0.00551		J	100	1000	408000			100	1000

Table 4-5
2007 Direct-Push Groundwater Results To Be Eliminated from Risk Assessment
Page 2 of 2

Analyte	Sample ID Sample Date		41GW01 8/28/07					41GW02 8/28/07					41GW03 8/22/07				
	MCL	tw-SL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Chromium	100	11	0.00479	U		0.92	10	0.00128	U		0.92	10	0.92	U		0.92	10
Cobalt	na	1.1	0.00479	U		1	50	0.00538	U		1	50	2.5	J	J	1	50
Copper	1300	150	0.00479	U		1.2	25	0.00538	U		1.2	25	1.2	U		1.2	25
Iron	300	2600	0.00479	U		15	300	0.00538	U		15	300	600	U		600	1200
Lead	15	na	0.00479	J	B	2.1	5	0.00538	U		2.1	5	2.1	U		2.1	5
Magnesium	na	na	0.00479			100	5000	0.00538			100	5000	61200		J	100	5000
Manganese	50	88	0.00479			1	15	0.00538	J	J	1	15	1090			1	15
Mercury	2	0.057	0.00508	U	UL	0.11	1	0.00551	U	UL	0.11	1	0.11	U		0.11	1
Nickel	na	73	0.00479	J	J	1	40	0.00538	J	J	1	40	7.9	J	J	1	40
Potassium	na	na	0.00479	J	B	100	10000	0.00538	J	B	100	10000	11900			100	10000
Selenium	50	18	0.00508	U		16	20	0.00551	U		16	20	80	U		80	100
Silver	100	18	0.00479	U		0.77	10	0.00538	U		0.77	10	0.77	U		0.77	10
Sodium	na	na	0.00486			500	10000	0.00551			1000	20000	53100			500	10000
Thallium	2	0.24	0.00424	U		6.5	10	0.00538	U		6.5	10	6.5	U		6.5	10
Vanadium	na	26	0.00486	U		1.1	50	0.00538	U		1.1	50	1.1	U		1.1	50
Zinc	5000	1100	0.00424	J	J	5	20	0.00179	U		5	20	52.8			5	20
Dioxins/Furans (ng/L)																	
2,3,7,8-TCDF	na	na	0.00168	U		0.00168	0.00168	0.00557	A	J	NA	NA	0.0132			NA	NA
2,3,7,8-TCDD	0.03	0.00052	0.0021	U		0.0021	0.0021	0.00249	U		0.00249	0.00249	0.00317	U		0.00317	0.00317
1,2,3,7,8-PECDD	na	na	0.00551	U		0.00551	0.00551	0.00645	U		0.00645	0.00645	0.00639	U		0.00639	0.00639
1,2,3,4,7,8-HXCDD	na	na	0.00551	U		0.00551	0.00551	0.0032	A	J	NA	NA	0.00639	U		0.00639	0.00639
1,2,3,6,7,8-HXCDD	na	na	0.00551	U		0.00551	0.00551	0.00671	A	J	NA	NA	0.0109	A	J	NA	NA
1,2,3,7,8,9-HXCDD	na	na	0.00551	U		0.00551	0.00551	0.0557	A	J	NA	NA	0.013	A	J	NA	NA
1,2,3,4,6,7,8-HPCDD	na	na	0.00551	U		0.00551	0.00551	0.172			NA	NA	0.0726			NA	NA
OCDD	na	na	0.0963	A	J	NA	NA	8.14			NA	NA	2.53			NA	NA
1,2,3,7,8-PECDF	na	na	0.00551	UQ	UJ	0.00551	0.00551	0.00359	A	B	NA	NA	0.232			NA	NA
2,3,4,7,8-PECDF	na	na	0.00551	U		0.00551	0.00551	0.0055	A	J	NA	NA	0.479			NA	NA
1,2,3,4,7,8-HXCDF	na	na	0.00551	U		0.00551	0.00551	0.00529	A	J	NA	NA	10.7			NA	NA
1,2,3,6,7,8-HXCDF	na	na	0.00551	U		0.00551	0.00551	0.00335	A	B	NA	NA	2.43			NA	NA
2,3,4,6,7,8-HXCDF	na	na	0.00551	U		0.00551	0.00551	0.00222	A	J	NA	NA	0.632			NA	NA
1,2,3,7,8,9-HXCDF	na	na	0.00551	U		0.00551	0.00551	0.00792	A	J	NA	NA	0.107			NA	NA
1,2,3,4,6,7,8-HPCDF	na	na	0.00551	U		0.00551	0.00551	0.029	A	J	NA	NA	38.2	E	J	NA	NA
1,2,3,4,7,8,9-HPCDF	na	na	0.00551	UQ	UJ	0.00551	0.00551	0.00529	A, EMPC	J	0.00645	0.00645	1.01			NA	NA
OCDF	na	na	0.011	U		0.011	0.011	0.0549	A	J	NA	NA	34			NA	NA
TOTAL TCDD	na	na	0.0021	U		0.0021	0.0021	0.00333			NA	NA	0.0224	A, EMPC	J	0.00317	0.00317
TOTAL PECDD	na	na	0.00551	U		0.00551	0.00551	0.0313	A, EMPC	J	NA	NA	0.116	A, EMPC	J	NA	NA
TOTAL HXCDD	na	na	0.00551	U		5.35	5.35	0.158			NA	NA	0.119	A, EMPC	J	NA	NA
TOTAL HPCDD	na	na	0.00551	U		0.00551	0.00551	0.395			NA	NA	0.151			NA	NA
TOTAL TCDF	na	na	0.00231	A, EMPC	J	0.00168	0.00168	0.0431	A, EMPC	J	NA	NA	0.429	A, EMPC	J	NA	NA
TOTAL PECDF	na	na	0.00551	UQ	UJ	0.00551	0.00551	0.0218	A, EMPC	J	NA	NA	3.7			NA	NA
TOTAL HXCDF	na	na	0.00551	U		0.00551	0.00551	0.0285			NA	NA	21.3	A, EMPC	J	NA	NA
TOTAL HPCDF	na	na	0.00551	UQ	UJ	0.00551	0.00551	0.042			NA	NA	42.9			NA	NA
Misc. (ug/L)																	
Perchlorate	na	2.6	0.362		J	0.0663	0.2	0.00508		J	0.0663	0.2	0.00551			0.112	0.2

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

Table 4-5
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, April 2009).

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.

Table 4-6
Analytes Detected in SWMU 41 Groundwater Samples - 2010

Analyte	Sample ID Sample Date		41MW04 10/7/10					41TM04 10/7/10				
	MCL	tw-SL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
VOCs (ug/L)												
Chloroform	80	0.19	4.8	J		0.01	0.4	4.6			0.01	0.4
Chloromethane	na	1.8	0.066	JB	B	0.026	0.4	0.46	B	B	0.026	0.4
PAHs (ug/L)												
Samples were not tested for this group.												
SVOCs (ug/L)												
Benzo(a)pyrene	0.2	0.0029	0.026	J	J	0.015	0.058	0.058	U		0.015	0.058
Benzo(b)fluoranthene	na	0.029	0.035	J	J	0.015	0.058	0.058	U		0.015	0.058
Benzo(g,h,i)perylene	na	110	0.044	J	J	0.014	0.058	0.058	U		0.014	0.058
Benzo(k)fluoranthene	na	0.29	0.024	J	J	0.016	0.058	0.058	U		0.016	0.058
bis(2-Ethylhexyl)phthalate	6	4.8	1	J	J	0.51	4.7	4.7	U		0.51	4.7
Chrysene	na	2.9	0.029	J	J	0.017	0.058	0.058	U		0.017	0.058
Dibenz(a,h)anthracene	na	0.0029	0.037	J	J	0.024	0.058	0.058	U		0.024	0.058
Fluoranthene	na	150	0.03	J	J	0.017	0.058	0.058	U		0.017	0.058
Indeno(1,2,3-cd)pyrene	na	0.029	0.04	J	J	0.021	0.058	0.058	U		0.021	0.058
Phenanthrene	na	110	0.03	J	J	0.017	0.058	0.058	U		0.017	0.058
Pyrene	na	110	0.042	J	J	0.019	0.058	0.058	U		0.019	0.058
Pesticides (ug/L)												
alpha-Chlordane	2	na	0.034	JP	J	0.01	0.047	0.036	JP	J	0.01	0.047
Heptachlor	0.4	0.015	0.07	P	J	0.007	0.028	0.086	P	J	0.007	0.028
PCBs (ug/L)												
None detected												
Explosives (ug/L)												
1,3,5-Trinitrobenzene	na	110	27			0.23	1.2	27			0.23	1.2
2-amino-4,6-Dinitrotoluene	na	7.3	1.2	P	J	0.24	1.2	1.2	P	J	0.24	1.2
4-amino-2,6-Dinitrotoluene	na	7.3	2			0.28	1.2	1.9			0.28	1.2
Herbicides (ug/L)												
None detected												
Metals (ug/L)												
Aluminum	50	3700	1580	J	J	30	50	1800	J	J	30	50
Barium	2000	730	58.5			1.2	2	56.3			1.2	2
Beryllium	4	7.3	0.106	J	J	0.2	0.5	0.103	J	J	0.2	0.5
Calcium	na	na	57500			1300	2000	59900			1300	2000
Chromium	100	11	4	U		4	10	6.8	J	B	4	10
Cobalt	na	1.1	0.797	J	J	0.2	1	0.81	J	J	0.2	1
Copper	1300	150	6.08		B	0.66	1	5.83		B	0.66	1
Iron	300	2600	2140	J	J	66	100	2410	J	J	66	100
Lead	15	na	13			1	2	10.6			1	2
Magnesium	na	na	24500			10	15	24800			10	15
Manganese	50	88	22.1			2	5	23			2	5
Mercury	2	0.057	0.05	J	J	0.04	0.14	0.1	J	J	0.04	0.14
Nickel	na	73	2.36		J	1	2	6.51		J	1	2
Potassium	na	na	2460	J	J	160	300	2560	J	J	160	300
Sodium	na	na	87300			1600	2500	93800			1600	2500
Zinc	5000	1100	58.1	J	J	6	10	59.8	J	J	6	10
Dioxins/Furans (ng/L)												
OCDD	na	na	0.00558	J	B	2.16	117	0.0124	J	B	4.74	120
Misc. (ug/L)												
Perchlorate	na	2.6	0.393			0.05	0.2	0.355			0.05	0.2

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

Table 4-6
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, April 2009).

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.

4.2 Soil Screening Level Comparison

Tables 4-7 and 4-8 present the chemical results from all the SWMU 41 Areas A and B soil investigations, respectively, compared with the current (April 2009) ORNL Regional SSL soil transfer to groundwater values, using a dilution attenuation factor of 20 (USEPA, 2009a).

In all the SWMU 41 Area A soil samples (**Table 4-7**), three VOCs (1,1,2,2-TCA, PCE, and vinyl chloride), one pesticide (heptachlor epoxide), one PCB (PCB-1254), two metals (arsenic and iron), and 2,3,7,8-TCDD TE were detected at concentration above applicable SSLs. The three VOCs were each only detected once above their SSLs. The majority of maximum concentrations were found in sample 41TP2A. Heptachlor epoxide and PCB-1254 were only detected at concentrations greater than their SSLs in one surface soil sample (41SB2A) at Area A. Two metals (arsenic and iron) were each detected once at concentrations greater than their SSLs and background levels in one sample (41SB4C). The calculated concentration of 2,3,7,8-TCDD TE was above the SSL in two subsurface soil samples. However, it should be noted that the most toxic dioxin/furan congener (2,3,7,8-TCDD) was not detected above its SSL in any of the soil samples collected from Area A.

In all the SWMU 41 Area B soil samples collected throughout the investigations (**Table 4-8**), five VOCs (1,1,2,2-TCA; 1,2,4-trichlorobenzene; 1,2-dibromo-3-chloropropane; 1,2-dibromomethane; and benzene), one PCB (PCB-1254), and three metals (arsenic, iron, and manganese) were found to be greater than their SSLs. 1,1,2,2-TCA was only detected in one surface soil sample (41SB6A). 1,2,4-trichlorobenzene was only detected above its SSL in one sample (41SC20B). 1,2-dibromo-3-chloropropane was only detected above its SSL in two samples (41SB6A and 41SB9B). As shown in **Table 4-8**, arsenic was detected above its SSL in 15 samples, while iron and manganese were each only detected twice above SSLs. Consistent with Area A, concentrations of 2,3,7,8-TCDD were not detected above its SSL.

While SSL exceedances indicate a theoretical potential for impact to groundwater, empirical evidence in the form of actual groundwater chemical data, soil boring characterization and chemical analyses, soil characteristics/chemistry, and fate and transport analysis offer more concrete evidence of site conditions and potential impact to groundwater.

Of these detections above their SSLs, only one VOC (PCE) and one metal (manganese - dissolved) was also detected in groundwater at concentrations above SLs. SWMU 41 was used as a disposal area (Areas A and B) for red water ash. PCE and manganese are not indicative of constituents resulting from the disposal of red water ash and are not considered a concern at the site. Based upon the high percentage of clay particles contained in the fill material, the low permeability ($2.0\text{E-}07$ to $1.2\text{E-}08$ cm/sec) of the clay fill material, and the thickness of the fill material at both Area A and B, it is very unlikely that constituents resulting from the burial of red water ash could migrate downward and negatively affect groundwater.

Table 4-7
Overall SSL Transfer Exceedance Summary for SWMU 41 Area A
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)									
1,1,2,2-Tetrachloroethane	na	0.56	na	1	1	15	0.97	0.97	41SB3B
1,2,4-Trichlorobenzene	na	260	na	0	2	15	3.4	3.5	41TP2C
2-Butanone	na	30000	na	0	15	15	2.1	38	41TP2A
Acetone	na	88000	na	0	12	15	24	74	41SB4C
Benzene	na	4.6	na	0	10	15	0.2	1.2	41SB2B
Bromomethane	na	44	na	0	2	15	1.3	2.7	41SB4C
Carbon disulfide	na	5400	na	0	11	15	0.46	5.7	41TP2B
cis-1,2-Dichloroethene	na	2200	na	0	2	15	1.2	11	41TP2A
Methylene chloride	na	24	na	0	3	15	3.6	9.1	41TP2C
Tetrachloroethene	na	1.04	na	1	1	15	5.1	5.1	41TP2A
Toluene	na	34000	na	0	12	15	0.15	1.3	41TP2B
Trichloroethene	na	12.2	na	0	2	15	0.89	1.4	41TP2C
Trichlorofluoromethane	na	16800	na	0	5	15	0.36	0.73	41TP2C
Vinyl chloride	na	0.112	na	1	1	15	1.2	1.2	41TP2A
Xylenes (total)	na	4600	na	0	3	15	0.41	1.3	41SB2B
PAHs (ug/kg)									
Fluoranthene	na	4200000	na	0	1	15	6.4	6.4	41SB2A
Pyrene	na	3000000	na	0	1	15	3.8	3.8	41SB2A
SVOCs (ug/kg)									
2,4-Dinitrotoluene	na	1360	na	0	1	17	24	24	41SB2B
2,6-Dinitrotoluene	na	680	na	0	1	17	18	18	41SB3B
4-Chloro-3-methylphenol	na	na	na	na	2	17	8	8	41SB4A
bis(2-Ethylhexyl)phthalate	na	32000	na	0	15	17	13	200	41SB2A
Butylbenzylphthalate	na	13400	na	0	1	17	10	10	41SB5C
Di-n-butylphthalate	na	220000	na	0	15	17	24	210	41TP2A
Fluoranthene	na	4200000	na	0	1	17	7	7	41SB2A
Pyrene	na	3000000	na	0	1	17	6	6	41SB2A
Pesticides (ug/kg)									
4,4'-DDT	na	1740	na	0	1	3	1.2	1.2	41SB2A
alpha-Chlordane	na	na	na	na	1	3	1.5	1.5	41SB2A
Dieldrin	na	1.8	na	0	1	3	1.4	1.4	41SB2A
Endosulfan II	na	na	na	na	1	3	1	1	41SB2A

Table 4-7
Overall SSL Transfer Exceedance Summary for SWMU 41 Area A
Page 2 of 3

Analyte	Background	SSL Transfer	# of Background Exceedances	# of SSL Transfer Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
Endrin ketone	na	na	na	na	1	3	1.7	1.7	41SB2A
Endrin	na	4600	na	0	1	3	6.4	6.4	41SB2A
Heptachlor epoxide	na	1.58	na	1	1	3	1.8	1.8	41SB2A
PCBs (mg/kg)									
PCB-1254	na	0.102	na	1	1	3	0.15	0.15	41SB2A
Explosives (mg/kg)		None detected							
Herbicides (ug/kg)		None detected							
Metals (mg/kg)									
Aluminum	40041	1100000	1	0	17	17	18800	40600	41SB4C
Antimony	na	13.2	na	0	15	17	0.089	1.5	41SB2A
Arsenic	15.8	0.026	1	1	17	17	2.8	19	41SB4C
Barium	209	6000	4	0	17	17	72	553	41SB5A
Beryllium	1.02	1160	4	0	15	17	0.34	1.8	41SB4C
Cadmium	0.69	28	15	0	15	17	1.5	3	41SB4C
Calcium	na	na	na	na	17	17	1180	156000	41SB5A
Chromium	65.3	42	0	0	17	17	13	35	41SB4C
Cobalt	72.3	9.8	0	0	17	17	7.8	21	41SB3C
Copper	53.5	1020	2	0	17	17	16	69	41SB2A
Iron	50962	12800	1	1	17	17	20300	75500	41SB4C
Lead	26.8	na	14	na	17	17	20	234	41TP2B
Magnesium	na	na	na	na	17	17	2700	82800	41SB5A
Manganese	2543	1140	0	0	17	17	92	1700	41SB4B
Nickel	62.8	960	0	0	17	17	15	35	41SB5B
Potassium	na	na	na	na	17	17	1180	3420	41SB3B
Selenium	na	19	na	0	15	17	0.4	1.3	41SB4C
Silver	na	32	na	0	15	17	0.068	0.81	41TP2C
Sodium	na	na	na	na	16	17	36	1730	41SB2A
Thallium	2.11	3.4	0	0	15	17	0.14	0.44	41SB4C
Vanadium	108	5200	0	0	17	17	29	69	41SB4C
Zinc	202	13600	6	0	17	17	65	1490	41SB2A

Table 4-7
Overall SSL Transfer Exceedance Summary for SWMU 41 Area A
Page 3 of 3

Analyte	Background	SSL Transfer	# of Background Exceedances	# of SSL Transfer Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
<i>Dioxins/Furans (ng/kg)</i>									
2,3,7,8-TCDF	na	na	na	na	2	5	0.176	4.65	41SB2B
2,3,7,8-TCDD	na	3	na	0	2	5	0.157	0.327	41SB2B
1,2,3,7,8-PECDD	na	na	na	na	2	5	0.371	1.78	41SB2B
1,2,3,4,7,8-HXCDD	na	na	na	na	2	5	0.68	2.89	41SB2B
1,2,3,6,7,8-HXCDD	na	na	na	na	3	5	0.482	7.09	41SB2B
1,2,3,7,8,9-HXCDD	na	na	na	na	5	5	1.11	10.5	41SB5B
1,2,3,4,6,7,8-HPCDD	na	na	na	na	5	5	6.7	159	41SB2B
OCDD	na	na	na	na	5	5	245	6520	41TP2B
1,2,3,7,8-PECDF	na	na	na	na	1	5	1.88	1.88	41SB2B
2,3,4,7,8-PECDF	na	na	na	na	1	5	3.46	3.46	41SB2B
1,2,3,4,7,8-HXCDF	na	na	na	na	1	5	2.07	2.07	41SB2B
1,2,3,6,7,8-HXCDF	na	na	na	na	2	5	0.189	1.38	41SB2B
2,3,4,6,7,8-HXCDF	na	na	na	na	1	5	1.84	1.84	41SB2B
1,2,3,4,6,7,8-HPCDF	na	na	na	na	2	5	0.769	29.2	41SB2B
1,2,3,4,7,8,9-HPCDF	na	na	na	na	1	5	1.86	1.86	41SB2B
OCDF	na	na	na	na	2	5	2.09	143	41SB2B
TOTAL TCDD	na	na	na	na	2	5	0.157	12.5	41SB2B
TOTAL PECDD	na	na	na	na	5	5	0.528	16.2	41SB2B
TOTAL HXCDD	na	na	na	na	5	5	7.21	47.6	41SB2B
TOTAL HPCDD	na	na	na	na	5	5	19.9	278	41SB2B
TOTAL TCDF	na	na	na	na	2	5	0.172	70.9	41SB2B
TOTAL PECDF	na	na	na	na	2	5	0.48	31.8	41SB2B
TOTAL HXCDF	na	na	na	na	5	5	0.244	40.6	41SB2B
TOTAL HPCDF	na	na	na	na	2	5	0.769	128	41SB2B
2,3,7,8-TCDD TE	na	3	na	2	5	5	0.2997	8.687	41SB2B
<i>Misc. (mg/kg)</i>									
Cyanide	na	148	na	0	15	15	0.01	0.42	41SB3B

Table 4-8
Overall SSL Transfer Exceedance Summary for SWMU 41 Area B
Page 1 of 4

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)									
1,1,2,2-Tetrachloroethane	na	0.56	na	1	1	22	5.8	5.8	41SB6A
1,2,4-Trichlorobenzene	na	260	na	1	9	22	0.3	260	41SC20B
1,2-Dibromo-3-chloropropane	na	0.003	na	2	2	22	6.9	9.4	41SB6A
1,2-Dibromoethane (EDB)	na	0.038	na	1	1	22	0.96	0.96	41SB6A
1,2-Dichloroethane	na	0.88	na	0	1	22	0.57	0.57	41SB6A
2-Butanone	na	30000	na	0	22	22	2.9	40	41SC20A
2-Hexanone	na	na	na	na	1	22	10	10	41SB6A
4-Methyl-2-pentanone	na	8800	na	0	1	22	7.7	7.7	41SB6A
Acetone	na	88000	na	0	16	22	28	120	41SB6B
Benzene	na	4.6	na	2	17	22	0.26	12	41SB10C
Bromoform	na	46	na	0	1	22	1.2	1.2	41SB6A
Bromomethane	na	44	na	0	14	22	1.4	2.1	41SB10B
Carbon disulfide	na	5400	na	0	17	22	0.96	17	41SB8B
Chlorobenzene	na	1360	na	0	1	22	0.28	0.28	41SB6A
cis-1,2-Dichloroethene	na	2200	na	0	1	22	0.78	0.78	41SC20A
cis-1,3-Dichloropropene	na	na	na	na	1	22	0.32	0.32	41SB6A
Dibromochloromethane	na	4.4	na	0	1	22	0.55	0.55	41SB6A
Ethylbenzene	na	38	na	0	5	22	0.15	1.7	41SB10C
Methylene chloride	na	24	na	0	8	22	0.98	4.7	41SP2soil
Styrene	na	40000	na	0	1	22	2.7	2.7	41SB6A
Tetrachloroethene	na	1.04	na	0	1	22	0.51	0.51	41SB10B
Toluene	na	34000	na	0	17	22	0.23	58	41SB9B
trans-1,3-Dichloropropene	na	na	na	na	1	22	0.46	0.46	41SB6A
Trichloroethene	na	12.2	na	0	4	22	0.22	4.3	41SB9B
Trichlorofluoromethane	na	16800	na	0	9	22	0.17	0.91	41SB6C
Xylenes (total)	na	4600	na	0	13	22	0.49	6.3	41SB10C
PAHs (ug/kg)									
Acenaphthene	na	540000	na	0	1	22	20	20	41SB8B
Anthracene	na	9000000	na	0	1	22	1.3	1.3	41SB8B
Benz(a)anthracene	na	280	na	0	1	22	39	39	41SB8B

Table 4-8
Overall SSL Transfer Exceedance Summary for SWMU 41 Area B
Page 2 of 4

Analyte	Background	SSL Transfer	# of Background Exceedances	# of SSL Transfer Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
Benzo(a)pyrene	na	92	na	0	1	22	13	13	41SB8B
Benzo(b)fluoranthene	na	940	na	0	1	22	16	16	41SB8B
Benzo(g,h,i)perylene	na	3000000	na	0	1	22	25	25	41SB8B
Benzo(k)fluoranthene	na	9200	na	0	1	22	8.4	8.4	41SB8B
Chrysene	na	28000	na	0	1	22	14	14	41SB8B
Fluoranthene	na	4200000	na	0	4	22	2.4	33	41SB8B
Indeno(1,2,3-cd)pyrene	na	3200	na	0	1	22	13	13	41SB8B
Phenanthrene	na	3000000	na	0	5	22	1.7	12	41SB8B
Pyrene	na	3000000	na	0	4	22	3.2	21	41SB8B
SVOCs (ug/kg)									
2-Methylnaphthalene	na	18000	na	0	1	22	16	16	41SB6B
4-Chloro-3-methylphenol	na	na	na	na	4	22	10	20	41SB9A
4-Methylphenol	na	3800	na	0	1	22	6	6	41SB8C
Benz(a)anthracene	na	280	na	0	1	22	12	12	41SB6A
Benzo(b)fluoranthene	na	940	na	0	2	22	14	19	41SB8B
Benzo(g,h,i)perylene	na	3000000	na	0	2	22	7	9	41SB8B
Benzo(k)fluoranthene	na	9200	na	0	2	22	7	9	41SB8B
bis(2-Ethylhexyl)phthalate	na	32000	na	0	21	22	10	460	41SB10B
Butylbenzylphthalate	na	13400	na	0	1	22	20	20	41SB8C
Chrysene	na	28000	na	0	2	22	11	16	41SB8B
Diethylphthalate	na	260000	na	0	5	22	13	33	41SB6B
Di-n-butylphthalate	na	220000	na	0	21	22	19	480	41SB9C
Fluoranthene	na	4200000	na	0	2	22	18	23	41SB8B
Indeno(1,2,3-cd)pyrene	na	3200	na	0	1	22	170	170	41SB9C
Phenanthrene	na	3000000	na	0	2	22	16	19	41SB6A
Pyrene	na	3000000	na	0	2	22	26	32	41SB8B
Pesticides (ug/kg)									
alpha-Chlordane	na	na	na	na	1	4	3.8	3.8	41SB10A
Endosulfan II	na	na	na	na	2	4	0.42	0.44	41SP2soil
Endrin aldehyde	na	na	na	na	2	4	0.6	0.69	41SP2soil
Endrin ketone	na	na	na	na	1	4	0.86	0.86	41SP2soil

Table 4-8
Overall SSL Transfer Exceedance Summary for SWMU 41 Area B
Page 3 of 4

Analyte	Background	SSL Transfer	# of Background Exceedances	# of SSL Transfer Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
Heptachlor	na	32	na	0	1	4	0.51	0.51	41SB7A
Methoxychlor	na	3200	na	0	1	4	1.1	1.1	41SB10A
PCBs (mg/kg)									
PCB-1254	na	0.102	na	1	1	4	0.041	0.041	41SB10A
Explosives (mg/kg) None detected									
Herbicides (ug/kg) None detected									
Metals (mg/kg)									
Aluminum	40041	1100000	1	0	22	22	2770	42400	41SB7B
Antimony	na	13.2	na	0	22	22	0.11	1.3	41SB10B
Arsenic	15.8	0.026	15	15	22	22	3.2	32	41SB9B
Barium	209	6000	4	0	22	22	35	335	41SB11C
Beryllium	1.02	1160	5	0	22	22	0.057	1.6	41SB6C
Cadmium	0.69	28	21	0	22	22	0.6	3.5	41SC20A
Calcium	na	na	na	na	22	22	751	185000	41SB10C
Chromium	65.3	42	0	0	21	22	12	39	41SB7C
Cobalt	72.3	9.8	0	0	22	22	5.8	20	41SB8B
Copper	53.5	1020	4	0	22	22	12	66	41SB10B
Iron	50962	12800	2	2	22	22	12500	66200	41SB7B
Lead	26.8	na	20	na	22	22	21	230	41SB7C
Magnesium	na	na	na	na	22	22	1470	107000	41SB10C
Manganese	2543	1140	2	2	22	22	99	3140	41SB8C
Nickel	62.8	960	0	0	22	22	8.4	41	41SB7C
Potassium	na	na	na	na	22	22	198	3920	41SB9C
Selenium	na	19	na	0	22	22	0.42	1.4	41SB7C
Silver	na	32	na	0	22	22	0.05	0.25	41SC20B
Sodium	na	na	na	na	21	22	48	24200	41SB10B
Thallium	2.11	3.4	0	0	20	22	0.092	0.34	41SB7C
Vanadium	108	5200	0	0	22	22	16	70	41SB7B
Zinc	202	13600	8	0	22	22	81	1440	41SB7C

Table 4-8
Overall SSL Transfer Exceedance Summary for SWMU 41 Area B
Page 4 of 4

Analyte	Background	SSL Transfer	# of Background Exceedances	# of SSL Transfer Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
<i>Dioxins/Furans (ng/kg)</i>									
2,3,7,8-TCDF	na	na	na	na	3	6	0.322	4.14	41SB10B
2,3,7,8-TCDD	na	3	na	0	2	6	0.168	0.22	41SB10B
1,2,3,7,8-PECDD	na	na	na	na	1	6	0.882	0.882	41SB10B
1,2,3,4,7,8-HXCDD	na	na	na	na	3	6	0.44	1.53	41SB10B
1,2,3,6,7,8-HXCDD	na	na	na	na	1	6	3.71	3.71	41SB10B
1,2,3,7,8,9-HXCDD	na	na	na	na	6	6	0.98	3.91	41SB10B
1,2,3,4,6,7,8-HPCDD	na	na	na	na	6	6	3.1	98.5	41SB10B
OCDD	na	na	na	na	6	6	245	3930	41SB10B
1,2,3,7,8-PECDF	na	na	na	na	2	6	0.258	0.984	41SB10B
2,3,4,7,8-PECDF	na	na	na	na	1	6	1.29	1.29	41SB10B
1,2,3,4,7,8-HXCDF	na	na	na	na	2	6	0.294	2.01	41SB10B
1,2,3,6,7,8-HXCDF	na	na	na	na	3	6	0.261	1.41	41SB10B
2,3,4,6,7,8-HXCDF	na	na	na	na	1	6	1.51	1.51	41SB10B
1,2,3,4,6,7,8-HPCDF	na	na	na	na	3	6	1.3	31.5	41SB10B
1,2,3,4,7,8,9-HPCDF	na	na	na	na	1	6	1.78	1.78	41SB10B
OCDF	na	na	na	na	3	6	3.05	88.8	41SB10B
TOTAL TCDD	na	na	na	na	2	6	0.168	0.22	41SB10B
TOTAL PECDD	na	na	na	na	2	6	0.714	2.62	41SB10B
TOTAL HXCDD	na	na	na	na	6	6	3.09	25.3	41SB10B
TOTAL HPCDD	na	na	na	na	6	6	5.75	172	41SB10B
TOTAL TCDF	na	na	na	na	3	6	0.948	20.5	41SB10B
TOTAL PECDF	na	na	na	na	3	6	1.33	13.8	41SB10B
TOTAL HXCDF	na	na	na	na	3	6	2.26	40.8	41SB10B
TOTAL HPCDF	na	na	na	na	3	6	3.06	99.2	41SB10B
2,3,7,8-TCDD TE	na	3	na	0	6	6	0.2495	5.864	41SB10B
<i>Misc. (mg/kg)</i>									
Cyanide	na	148	na	0	22	22	0.03	4.9	41SB10B

4.3 Nature and Extent Summary and Conclusions

4.3.1 Soil

4.3.1.1 Area A

The soil at SWMU 41 Area A was investigated during the 1992 sampling event and then again in 2004 in support of draft RFIs. A summary of all analytes detected in soil during all investigations of SWMU 41 Area A can be found in **Table 4-9**.

The SWMU 41 Area A data set from all soil investigations indicates that one PCB (PCB-1254) and three metals (aluminum, arsenic, and iron) were each detected only once at concentrations above their r-SLs in soil samples collected for this site. The calculated concentration of 2,3,7,8-TCDD TE was found to exceed its r-SL in only one sample collected at Area A. Arsenic concentrations were detected above the i-SL in one single sample.

Although there were single detections of three metals, one PCB, and 2,3,7,8-TCDD TE at concentrations above the r-SL, the only constituent that can be attributed to the disposal of rinsate from ash-transport vehicle rinsing at this former lagoon is 2,3,7,8-TCDD. Although the calculated TE concentration was above the r-SL in one single sample, the single occurrence above the r-SL is not a concern at the site. In addition, the high percentage of clay contained in the 15 ft of fill material overlying Area A will hinder the fate and transport of constituents contained in the soil. Therefore, based on the nature and extent of contamination and comparison with chemical-specific screening levels, the chemicals detected in site soil do not appear to represent a concern at Area A. However, the Human Health and Ecological Risk Assessments have been conducted and the results of these assessments are included in *Sections 6 and 7* of the report, respectively.

4.3.1.2 Area B

The soil at SWMU 41 Area B was investigated during the 2004 sampling event in support of a draft RFI. A summary of all analytes detected in soil during the investigation of SWMU 41 Area B can be found in **Table 4-10**.

The only constituents to be detected greater than their screening criteria in 2004 soil samples were one VOC (1,2-dibromo-3-chloropropane), one SVOC [indeno (1,2,3-cd) pyrene], one PCB (PCB-1254), five metals (aluminum, arsenic, iron, manganese, and mercury), and 2,3,7,8-TCDD TE, which were all well spread-out between the 2004 samples.

Indeno(1,2,3-cd)pyrene, PCB-1254, aluminum, and 2,3,7,8-TCDD TE were each only detected once above their r-SLs and were below i-SLs in all samples. The calculated concentration of 2,3,7,8-TCDD TE was below the SSL soil transfer to groundwater value in all Area B soil samples. 1,2-dibromo-3-chloropropane, iron, and manganese were present at concentrations above r-SLs in two samples each. Manganese concentrations also exceeded its i-SL in the same two samples. Arsenic concentrations were present above r-SLs and i-SLs in 15 out of 22 samples.

Area B was used as a red water ash disposal area. Clayey fill has been placed in an approximately 1.08-acre area at Area B. The clay fill emplaced at the site acts as a soil cap at Area B, preventing downward migration of the constituents present in soil as a result of former disposal activities. Sampling results from the soil investigations at Area B indicate that the subsurface soil has been minimally impacted at one location by dioxins/furans. Sample results

Table 4-9
Overall Soil Summary for SWMU 41 Area A
Page 1 of 2

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)											
1,1,2,2-Tetrachloroethane	2900	590	na	0	0	na	1	15	0.97	0.97	41SB3B
1,2,4-Trichlorobenzene	40000	8700	na	0	0	na	2	15	3.4	3.5	41TP2C
2-Butanone	19000000	2800000	na	0	0	na	15	15	2.1	38	41TP2A
Acetone	61000000	6100000	na	0	0	na	12	15	24	74	41SB4C
Benzene	5600	1100	na	0	0	na	10	15	0.2	1.2	41SB2B
Bromomethane	3500	790	na	0	0	na	2	15	1.3	2.7	41SB4C
Carbon disulfide	300000	67000	na	0	0	na	11	15	0.46	5.7	41TP2B
cis-1,2-Dichloroethene	1000000	78000	na	0	0	na	2	15	1.2	11	41TP2A
Methylene chloride	54000	11000	na	0	0	na	3	15	3.6	9.1	41TP2C
Tetrachloroethene	2700	570	na	0	0	na	1	15	5.1	5.1	41TP2A
Toluene	4600000	500000	na	0	0	na	12	15	0.15	1.3	41TP2B
Trichloroethene	14000	2800	na	0	0	na	2	15	0.89	1.4	41TP2C
Trichlorofluoromethane	340000	80000	na	0	0	na	5	15	0.36	0.73	41TP2C
Vinyl chloride	1700	60	na	0	0	na	1	15	1.2	1.2	41TP2A
Xylenes (total)	260000	60000	na	0	0	na	3	15	0.41	1.3	41SB2B
PAHs (ug/kg)											
Fluoranthene	2200000	230000	na	0	0	na	1	15	6.4	6.4	41SB2A
Pyrene	1700000	170000	na	0	0	na	1	15	3.8	3.8	41SB2A
SVOCs (ug/kg)											
2,4-Dinitrotoluene	120000	12000	na	0	0	na	1	15	24	24	41SB2B
2,6-Dinitrotoluene	62000	6100	na	0	0	na	1	15	18	18	41SB3B
4-Chloro-3-methylphenol	na	na	na	na	na	na	2	15	8	8	41SB4A
bis(2-Ethylhexyl)phthalate	120000	35000	na	0	0	na	15	15	13	200	41SB2A
Butylbenzylphthalate	910000	260000	na	0	0	na	1	15	10	10	41SB5C
Di-n-butylphthalate	6200000	610000	na	0	0	na	15	15	24	210	41TP2A
Fluoranthene	2200000	230000	na	0	0	na	1	15	7	7	41SB2A
Pyrene	1700000	170000	na	0	0	na	1	15	6	6	41SB2A
Pesticides (ug/kg)											
4,4'-DDT	7000	1700	na	0	0	na	1	3	1.2	1.2	41SB2A
alpha-Chlordane	na	na	na	na	na	na	1	3	1.5	1.5	41SB2A
Dieldrin	110	30	na	0	0	na	1	3	1.4	1.4	41SB2A
Endosulfan II	na	na	na	na	na	na	1	3	1	1	41SB2A
Endrin ketone	na	na	na	na	na	na	1	3	1.7	1.7	41SB2A
Endrin	18000	1800	na	0	0	na	1	3	6.4	6.4	41SB2A
Heptachlor epoxide	190	53	na	0	0	na	1	3	1.8	1.8	41SB2A
PCBs (mg/kg)											
PCB-1254	0.74	0.022	na	0	1	na	1	3	0.15	0.15	41SB2A
Explosives (mg/kg) None detected											
Herbicides (ug/kg) None detected											
Metals (mg/kg)											
Aluminum	99000	7700	40041	0	1	1	17	17	18800	40600	41SB4C
Antimony	41	3.1	na	0	0	na	15	17	0.089	1.5	41SB2A
Arsenic	1.6	0.39	15.8	1	1	1	17	17	2.8	19	41SB4C
Barium	19000	1500	209	0	0	4	17	17	72	553	41SB5A
Beryllium	200	16	1.02	0	0	4	15	17	0.34	1.8	41SB4C
Cadmium	81	7	0.69	0	0	15	15	17	1.5	3	41SB4C
Calcium	na	na	na	na	na	na	17	17	821	156000	41SB5A

Table 4-9
Overall Soil Summary for SWMU 41 Area A
Page 2 of 2

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
Chromium	1400	280	65.3	0	0	0	17	17	13	60	41SB1 (RVFS*45)
Cobalt	30	2.3	72.3	0	0	0	17	17	7.8	21	41SB3C
Copper	4100	310	53.5	0	0	2	17	17	16	69	41SB2A
Iron	72000	5500	50962	1	1	1	17	17	20300	75500	41SB4C
Lead	800	400	26.8	0	0	14	17	17	20	234	41TP2B
Magnesium	na	na	na	na	na	na	17	17	2700	82800	41SB5A
Manganese	2300	180	2543	0	0	0	17	17	92	1700	41SB4B
Nickel	2000	160	62.8	0	0	0	17	17	15	35	41SB5B
Potassium	na	na	na	na	na	na	17	17	1180	3420	41SB3B
Selenium	510	39	na	0	0	na	15	17	0.4	1.3	41SB4C
Silver	510	39	na	0	0	na	15	17	0.068	0.81	41TP2C
Sodium	na	na	na	na	na	na	16	17	36	2040	41SB1 (RVFS*44)
Thallium	6.6	0.51	2.11	0	0	0	15	17	0.14	0.44	41SB4C
Vanadium	720	55	108	0	0	0	17	17	29	69	41SB4C
Zinc	31000	2300	202	0	0	6	17	17	65	1490	41SB2A
Dioxins/Furans (ng/kg)											
2,3,7,8-TCDF	na	na	na	na	na	na	2	5	0.176	4.65	41SB2B
2,3,7,8-TCDD	18	4.5	na	0	0	na	2	5	0.157	0.327	41SB2B
1,2,3,7,8-PECDD	na	na	na	na	na	na	2	5	0.371	1.78	41SB2B
1,2,3,4,7,8-HXCDD	na	na	na	na	na	na	2	5	0.68	2.89	41SB2B
1,2,3,6,7,8-HXCDD	na	na	na	na	na	na	3	5	0.482	7.09	41SB2B
1,2,3,7,8,9-HXCDD	na	na	na	na	na	na	5	5	1.11	10.5	41SB5B
1,2,3,4,6,7,8-HPCDD	na	na	na	na	na	na	5	5	6.7	159	41SB2B
OCDD	na	na	na	na	na	na	5	5	245	6520	41TP2B
1,2,3,7,8-PECDF	na	na	na	na	na	na	1	5	1.88	1.88	41SB2B
2,3,4,7,8-PECDF	na	na	na	na	na	na	1	5	3.46	3.46	41SB2B
1,2,3,4,7,8-HXCDF	na	na	na	na	na	na	1	5	2.07	2.07	41SB2B
1,2,3,6,7,8-HXCDF	na	na	na	na	na	na	2	5	0.189	1.38	41SB2B
2,3,4,6,7,8-HXCDF	na	na	na	na	na	na	1	5	1.84	1.84	41SB2B
1,2,3,4,6,7,8-HPCDF	na	na	na	na	na	na	2	5	0.769	29.2	41SB2B
1,2,3,4,7,8,9-HPCDF	na	na	na	na	na	na	1	5	1.86	1.86	41SB2B
OCDF	na	na	na	na	na	na	2	5	2.09	143	41SB2B
TOTAL TCDD	na	na	na	na	na	na	2	5	0.157	12.5	41SB2B
TOTAL PECDD	na	na	na	na	na	na	5	5	0.528	16.2	41SB2B
TOTAL HXCDD	na	na	na	na	na	na	5	5	7.21	47.6	41SB2B
TOTAL HPCDD	na	na	na	na	na	na	5	5	19.9	278	41SB2B
TOTAL TCDF	na	na	na	na	na	na	2	5	0.172	70.9	41SB2B
TOTAL PECDF	na	na	na	na	na	na	2	5	0.48	31.8	41SB2B
TOTAL HXCDF	na	na	na	na	na	na	5	5	0.244	40.6	41SB2B
TOTAL HPCDF	na	na	na	na	na	na	2	5	0.769	128	41SB2B
2,3,7,8-TCDD TE	18	4.5	na	0	1	na	5	5	0.2997	8.687	41SB2B
Misc. (mg/kg)											
Cyanide	2000	160	na	0	0	na	15	15	0.01	0.42	41SB3B

Table 4-10
Overall Soil Summary for SWMU 41 Area B
Page 1 of 3

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)											
1,1,2,2-Tetrachloroethane	2900	590	na	0	0	na	1	22	5.8	5.8	41SB6A
1,2,4-Trichlorobenzene	40000	8700	na	0	0	na	9	22	0.3	260	41SC20B
1,2-Dibromo-3-chloropropane	73	5.6	na	0	2	na	2	22	6.9	9.4	41SB6A
1,2-Dibromoethane (EDB)	170	34	na	0	0	na	1	22	0.96	0.96	41SB6A
1,2-Dichloroethane	2200	450	na	0	0	na	1	22	0.57	0.57	41SB6A
2-Butanone	19000000	2800000	na	0	0	na	22	22	2.9	40	41SC20A
2-Hexanone	na	na	na	na	na	na	1	22	10	10	41SB6A
4-Methyl-2-pentanone	5200000	530000	na	0	0	na	1	22	7.7	7.7	41SB6A
Acetone	61000000	6100000	na	0	0	na	16	22	28	120	41SB6B
Benzene	5600	1100	na	0	0	na	17	22	0.26	12	41SB10C
Bromoform	220000	61000	na	0	0	na	1	22	1.2	1.2	41SB6A
Bromomethane	3500	790	na	0	0	na	14	22	1.4	2.1	41SB10B
Carbon disulfide	300000	67000	na	0	0	na	17	22	0.96	17	41SB8B
Chlorobenzene	150000	31000	na	0	0	na	1	22	0.28	0.28	41SB6A
cis-1,2-Dichloroethene	1000000	78000	na	0	0	na	1	22	0.78	0.78	41SC20A
cis-1,3-Dichloropropene	na	na	na	na	na	na	1	22	0.32	0.32	41SB6A
Dibromochloromethane	21000	5800	na	0	0	na	1	22	0.55	0.55	41SB6A
Ethylbenzene	29000	5700	na	0	0	na	5	22	0.15	1.7	41SB10C
Methylene chloride	54000	11000	na	0	0	na	8	22	0.98	4.7	41SP2soil
Styrene	3800000	650000	na	0	0	na	1	22	2.7	2.7	41SB6A
Tetrachloroethene	2700	570	na	0	0	na	1	22	0.51	0.51	41SB10B
Toluene	4600000	500000	na	0	0	na	17	22	0.23	58	41SB9B
trans-1,3-Dichloropropene	na	na	na	na	na	na	1	22	0.46	0.46	41SB6A
Trichloroethene	14000	2800	na	0	0	na	4	22	0.22	4.3	41SB9B
Trichlorofluoromethane	340000	80000	na	0	0	na	9	22	0.17	0.91	41SB6C
Xylenes (total)	260000	60000	na	0	0	na	13	22	0.49	6.3	41SB10C
PAHs (ug/kg)											
Acenaphthene	3300000	340000	na	0	0	na	1	22	20	20	41SB8B
Anthracene	17000000	1700000	na	0	0	na	1	22	1.3	1.3	41SB8B
Benz(a)anthracene	2100	150	na	0	0	na	1	22	39	39	41SB8B
Benzo(a)pyrene	210	15	na	0	0	na	1	22	13	13	41SB8B
Benzo(b)fluoranthene	2100	150	na	0	0	na	1	22	16	16	41SB8B
Benzo(g,h,i)perylene	1700000	170000	na	0	0	na	1	22	25	25	41SB8B
Benzo(k)fluoranthene	21000	1500	na	0	0	na	1	22	8.4	8.4	41SB8B
Chrysene	210000	15000	na	0	0	na	1	22	14	14	41SB8B
Fluoranthene	2200000	230000	na	0	0	na	4	22	2.4	33	41SB8B
Indeno(1,2,3-cd)pyrene	2100	150	na	0	0	na	1	22	13	13	41SB8B
Phenanthrene	1700000	170000	na	0	0	na	5	22	1.7	12	41SB8B
Pyrene	1700000	170000	na	0	0	na	4	22	3.2	21	41SB8B
SVOCs (ug/kg)											
2-Methylnaphthalene	410000	31000	na	0	0	na	1	22	16	16	41SB6B
4-Chloro-3-methylphenol	na	na	na	na	na	na	4	22	10	20	41SB9A
4-Methylphenol	310000	31000	na	0	0	na	1	22	6	6	41SB8C
Benz(a)anthracene	2100	150	na	0	0	na	1	22	12	12	41SB6A
Benzo(b)fluoranthene	2100	150	na	0	0	na	2	22	14	19	41SB8B
Benzo(g,h,i)perylene	1700000	170000	na	0	0	na	2	22	7	9	41SB8B
Benzo(k)fluoranthene	21000	1500	na	0	0	na	2	22	7	9	41SB8B
bis(2-Ethylhexyl)phthalate	120000	35000	na	0	0	na	21	22	10	460	41SB10B

Table 4-10
Overall Soil Summary for SWMU 41 Area B
Page 2 of 3

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
Butylbenzylphthalate	910000	260000	na	0	0	na	1	22	20	20	41SB8C
Chrysene	210000	15000	na	0	0	na	2	22	11	16	41SB8B
Diethylphthalate	49000000	4900000	na	0	0	na	5	22	13	33	41SB6B
Di-n-butylphthalate	6200000	610000	na	0	0	na	21	22	19	480	41SB9C
Fluoranthene	2200000	230000	na	0	0	na	2	22	18	23	41SB8B
Indeno(1,2,3-cd)pyrene	2100	150	na	0	1	na	1	22	170	170	41SB9C
Phenanthrene	1700000	170000	na	0	0	na	2	22	16	19	41SB6A
Pyrene	1700000	170000	na	0	0	na	2	22	26	32	41SB8B
Pesticides (ug/kg)											
alpha-Chlordane	na	na	na	na	na	na	1	4	3.8	3.8	41SB10A
Endosulfan II	na	na	na	na	na	na	2	4	0.42	0.44	41SP2soil
Endrin aldehyde	na	na	na	na	na	na	2	4	0.6	0.69	41SP2soil
Endrin ketone	na	na	na	na	na	na	1	4	0.86	0.86	41SP2soil
Heptachlor	380	110	na	0	0	na	1	4	0.51	0.51	41SB7A
Methoxychlor	310000	31000	na	0	0	na	1	4	1.1	1.1	41SB10A
PCBs (mg/kg)											
PCB-1254	0.74	0.022	na	0	1	na	1	4	0.041	0.041	41SB10A
Explosives (mg/kg) None detected											
Herbicides (ug/kg) None detected											
Metals (mg/kg)											
Aluminum	99000	7700	40041	0	1	1	22	22	2770	42400	41SB7B
Antimony	41	3.1	na	0	0	na	22	22	0.11	1.3	41SB10B
Arsenic	1.6	0.39	15.8	15	15	15	22	22	3.2	32	41SB9B
Barium	19000	1500	209	0	0	4	22	22	35	335	41SB11C
Beryllium	200	16	1.02	0	0	5	22	22	0.057	1.6	41SB6C
Cadmium	81	7	0.69	0	0	21	22	22	0.6	3.5	41SC20A
Calcium	na	na	na	na	na	na	22	22	751	185000	41SB10C
Chromium	1400	280	65.3	0	0	0	21	22	12	39	41SB7C
Cobalt	30	2.3	72.3	0	0	0	22	22	5.8	20	41SB8B
Copper	4100	310	53.5	0	0	4	22	22	12	66	41SB10B
Iron	72000	5500	50962	0	2	2	22	22	12500	66200	41SB7B
Lead	800	400	26.8	0	0	20	22	22	21	230	41SB7C
Magnesium	na	na	na	na	na	na	22	22	1470	107000	41SB10C
Manganese	2300	180	2543	2	2	2	22	22	99	3140	41SB8C
Nickel	2000	160	62.8	0	0	0	22	22	8.4	41	41SB7C
Potassium	na	na	na	na	na	na	22	22	198	3920	41SB9C
Selenium	510	39	na	0	0	na	22	22	0.42	1.4	41SB7C
Silver	510	39	na	0	0	na	22	22	0.05	0.25	41SC20B
Sodium	na	na	na	na	na	na	21	22	48	24200	41SB10B
Thallium	6.6	0.51	2.11	0	0	0	20	22	0.092	0.34	41SB7C
Vanadium	720	55	108	0	0	0	22	22	16	70	41SB7B
Zinc	31000	2300	202	0	0	8	22	22	81	1440	41SB7C
Dioxins/Furans (ng/kg)											
2,3,7,8-TCDF	na	na	na	na	na	na	3	6	0.322	4.14	41SB10B
2,3,7,8-TCDD	18	4.5	na	0	0	na	2	6	0.168	0.22	41SB10B
1,2,3,7,8-PECDD	na	na	na	na	na	na	1	6	0.882	0.882	41SB10B
1,2,3,4,7,8-HXCDD	na	na	na	0	0	na	3	6	0.44	1.53	41SB10B
1,2,3,6,7,8-HXCDD	na	na	na	na	na	na	1	6	3.71	3.71	41SB10B
1,2,3,7,8,9-HXCDD	na	na	na	na	na	na	6	6	0.98	3.91	41SB10B

Table 4-10
Overall Soil Summary for SWMU 41 Area B
Page 3 of 3

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
1,2,3,4,6,7,8-HPCDD	na	na	na	na	na	na	6	6	3.1	98.5	41SB10B
OCDD	na	na	na	na	na	na	6	6	245	3930	41SB10B
1,2,3,7,8-PCDF	na	na	na	na	na	na	2	6	0.258	0.984	41SB10B
2,3,4,7,8-PCDF	na	na	na	na	na	na	1	6	1.29	1.29	41SB10B
1,2,3,4,7,8-HXCDF	na	na	na	na	na	na	2	6	0.294	2.01	41SB10B
1,2,3,6,7,8-HXCDF	na	na	na	na	na	na	3	6	0.261	1.41	41SB10B
2,3,4,6,7,8-HXCDF	na	na	na	na	na	na	1	6	1.51	1.51	41SB10B
1,2,3,4,6,7,8-HPCDF	na	na	na	na	na	na	3	6	1.3	31.5	41SB10B
1,2,3,4,7,8,9-HPCDF	na	na	na	na	na	na	1	6	1.78	1.78	41SB10B
OCDF	na	na	na	na	na	na	3	6	3.05	88.8	41SB10B
TOTAL TCDD	na	na	na	na	na	na	2	6	0.168	0.22	41SB10B
TOTAL PCDD	na	na	na	na	na	na	2	6	0.714	2.62	41SB10B
TOTAL HxCDD	na	na	na	na	na	na	6	6	3.09	25.3	41SB10B
TOTAL HPCDD	na	na	na	na	na	na	6	6	5.75	172	41SB10B
TOTAL TCDF	na	na	na	na	na	na	3	6	0.948	20.5	41SB10B
TOTAL PCDF	na	na	na	na	na	na	3	6	1.33	13.8	41SB10B
TOTAL HxCDF	na	na	na	na	na	na	3	6	2.26	40.8	41SB10B
TOTAL HPCDF	na	na	na	na	na	na	3	6	3.06	99.2	41SB10B
2,3,7,8-TCDD TE	18	4.5	na	0	1	na	6	6	0.2495	5.864	41SB10B
Misc. (mg/kg)											
Cyanide	2000	160	na	0	0	na	22	22	0.03	4.9	41SB10B

from ash collected at Area B indicated that all detected TCLP concentrations were below regulatory limits and that explosives were not detected in any of the ash samples. Therefore, based on the nature and extent of contamination and comparison with chemical-specific screening levels, the chemicals detected in site soil do not appear to represent a concern at Area A. However, the Human Health and Ecological Risk Assessments have been conducted and the results of these assessments are included in *Sections 6 and 7* of the report, respectively.

4.3.2 Surface Water

4.3.2.1 Area A

The surface water at SWMU 41 Area A was investigated during the 1992, 2004, and 2007 sampling events in support of draft RFIs. A summary of all analytes detected in surface water during all investigations of SWMU 41 Area A can be found in **Table 4-11**.

The SWMU 41 Area A data set from all surface water investigations indicates that one explosive (2,4,6-TNT), two metals (aluminum and manganese), one dioxin/furan (2,3,7,8-TCDD), and the calculated 2,3,7,8-TCDD TE were found above their applicable screening levels in surface water samples collected for this site. 2,4,6-TNT was detected above its tw-SL in two samples. Total aluminum (4 samples) and manganese (1 sample) were detected at concentrations above their MCLs in site samples. However, aluminum and manganese were not detected in any dissolved metals analyses. 2,3,7,8-TCDD and the calculated 2,3,7,8-TCDD TE was only reported above the tw-SL in one sample, directly downgradient of Area A. These concentrations were well below the MCL and 2,3,7,8-TCDD was not detected in any other Area A surface water samples.

As discussed in *Section 2.5*, local groundwater flow patterns indicate local discharge occurring at Stroubles Creek and its unnamed tributary. Based on drilling attempts and knowledge of site conditions at Area A, it appears that precipitation falling on Area A runs down the steep slope to the north towards the unnamed tributary of Stroubles Creek. Based on surface water data from all three investigations, it does not appear that groundwater discharge or surface runoff from Area A to Stroubles Creek or its tributary has been significantly impacted as a result of the disposal activities at Area A. Therefore, based on the nature and extent of contamination and comparison with chemical-specific screening levels, the chemicals detected in site surface water do not appear to represent a concern at Area A. However, the Human Health and Ecological Risk Assessments have been conducted and the results of these assessments are included in *Sections 6 and 7* of the report, respectively.

4.3.2.2 Area B

The surface water at SWMU 41 Area B was only investigated during the 2004 sampling event in support of a draft RFI. A summary of all analytes detected in surface water during this investigation of SWMU 41 Area B can be found in **Table 4-12**.

The data set from the only Area B surface water investigation indicates that one VOC (chloroform) and five total metals (aluminum, arsenic, iron, lead, and manganese) were found above their applicable screening limits in surface water samples collected for this site. No dissolved metals concentrations were detected above applicable SLs. Chloroform was detected above its tw-SL in three of the four samples; however, concentrations were well below the MCL for chloroform.

Table 4-11
Overall Surface Water Summary for SWMU 41 Area A
Page 1 of 2

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) None detected									
PAHs (ug/L) None detected									
SVOCs (ug/L)									
Diethylphthalate	na	2900	na	0	3	7	0.18	0.21	41SW7
Pesticides (ug/L) None detected									
PCBs (ug/L) None detected									
Explosives (ug/L)									
2,4,6-Trinitrotoluene	na	0.22	na	2	2	7	1.3	1.38	41SW1 (RDWC*76)
2-amino-4,6-Dinitrotoluene	na	7.3	na	0	3	6	0.27	1.1	41SW10
4-amino-2,6-Dinitrotoluene	na	7.3	na	0	3	3	0.87	2.5	41SW10
Herbicides (ug/L) None detected									
Metals, Total (ug/L)									
Aluminum	50	3700	4	0	4	7	83	83	41SW6
Barium	2000	730	0	0	7	7	48	59	41SW6
Calcium	na	na	na	na	7	7	40000	58500	41SW1 (RDWC*76)
Chromium	100	11	0	0	3	7	0.9	0.98	41SW7
Copper	1300	150	0	0	1	7	na	na	na
Iron	300	2600	0	0	6	7	54	200	41SW6
Lead	15	na	0	na	1	7	0.3	0.3	41SW6
Magnesium	na	na	na	na	7	7	18000	32000	41SW6
Manganese	50	88	1	0	6	7	2.1	27.8	41SW1 (RDWC*76)
Nickel	na	73	na	0	2	7	na	na	na
Potassium	na	na	na	na	7	7	1500	2100	41SW7
Sodium	na	na	na	na	7	7	11000	16000	41SW7
Vanadium	na	26	na	0	3	7	na	na	na
Zinc	5000	1100	0	0	3	7	na	na	na
Metals, Dissolved (ug/L)									
Barium	2000	730	0	0	3	3	45	59	41SW6
Calcium	na	na	na	na	3	3	37000	54000	41SW6
Chromium	100	11	0	0	3	3	0.9	1.1	41SW5
Lead	15	na	0	na	2	3	0.3	0.3	41SW5
Magnesium	na	na	na	na	3	3	16000	32000	41SW6
Potassium	na	na	na	na	3	3	1600	2100	41SW5
Sodium	na	na	na	na	3	3	11000	15000	41SW5
Zinc	5000	1100	0	0	2	3	7	9.9	41SW6

Table 4-11
Overall Surface Water Summary for SWMU 41 Area A
Page 2 of 2

Analyte	MCL	tw-SL	# of MCL Exceedances	# of tw-SL Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
Dioxins/Furans (ng/L)									
2,3,7,8-TCDF	na	na	na	na	1	3	0.00147	0.00147	41SW09
2,3,7,8-TCDD	0.03	0.00052	0	1	1	3	0.00257	0.00257	41SW09
1,2,3,7,8-PECDD	na	na	na	na	1	3	0.00607	0.00607	41SW09
1,2,3,4,7,8-HXCDD	na	na	na	na	1	3	0.00468	0.00468	41SW09
1,2,3,6,7,8-HXCDD	na	na	na	na	1	3	0.00475	0.00475	41SW09
1,2,3,7,8,9-HXCDD	na	na	na	na	1	3	0.00495	0.00495	41SW09
1,2,3,4,6,7,8-HPCDD	na	na	na	na	1	3	0.00564	0.00564	41SW09
OCDD	na	na	na	na	3	3	0.0219	0.0618	41SW10
1,2,3,7,8-PECDF	na	na	na	na	1	3	0.00662	0.00662	41SW09
2,3,4,7,8-PECDF	na	na	na	na	1	3	0.00589	0.00589	41SW09
1,2,3,4,7,8-HXCDF	na	na	na	na	1	3	0.00532	0.00532	41SW09
1,2,3,6,7,8-HXCDF	na	na	na	na	1	3	0.00509	0.00509	41SW09
2,3,4,6,7,8-HXCDF	na	na	na	na	1	3	0.00409	0.00409	41SW09
1,2,3,7,8,9-HXCDF	na	na	na	na	1	3	0.00501	0.00501	41SW09
1,2,3,4,6,7,8-HPCDF	na	na	na	na	1	3	0.00536	0.00536	41SW09
1,2,3,4,7,8,9-HPCDF	na	na	na	na	1	3	0.00402	0.00402	41SW09
OCDF	na	na	na	na	1	3	0.00874	0.00874	41SW09
TOTAL TCDD	na	na	na	na	1	3	0.00257	0.00257	41SW09
TOTAL PECDD	na	na	na	na	1	3	0.00607	0.00607	41SW09
TOTAL HXCDD	na	na	na	na	1	3	0.0144	0.0144	41SW09
TOTAL HPCDD	na	na	na	na	1	3	0.00564	0.00564	41SW09
TOTAL TCDF	na	na	na	na	1	3	0.00147	0.00147	41SW09
TOTAL PECDF	na	na	na	na	1	3	0.0125	0.0125	41SW09
TOTAL HXCDF	na	na	na	na	1	3	0.0195	0.0195	41SW09
TOTAL HPCDF	na	na	na	na	1	3	0.00955	0.00955	41SW09
2,3,7,8-TCDD TE	0.03	0.00052	0	1	3	3	0.00000657	0.0143	41SW09
Misc.									
Perchlorate	na	2.6	na	0	3	6	0.135	0.168	41SW08
Hardness	na	na	na	na	3	3	161000	261000	41SW6
Cyanide	200	73	0	0	3	3	2	3	41SW7
Total Organic Carbon	na	na	na	na	1	1	6010	6010	41SW1 (RDWC*76)
Total Organic Halides	na	na	na	na	1	1	82.4	82.4	41SW1 (RDWC*76)
pH	na	na	na	na	1	1	7.99	7.99	41SW1 (RDWC*76)

Table 4-12
Overall Surface Water Summary for SWMU 41 Area B
Page 1 of 2

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)									
Chloroform	80	0.19	0	3	3	4	0.3	0.59	41SW2
PAHs (ug/L) None detected									
SVOCs (ug/L)									
Diethylphthalate	na	2900	na	0	3	4	0.21	0.32	41SW2
Explosives (ug/L) None detected									
Metals, Total (ug/L)									
Aluminum	50	3700	4	1	4	4	110	9270	41SP2
Arsenic	10	0.045	0	3	3	4	0.22	7.1	41SP2
Barium	2000	730	0	0	4	4	60	230	41SP2
Beryllium	4	7.3	0	0	1	4	0.6	0.6	41SP2
Cadmium	5	1.8	0	0	1	4	0.3	0.3	41SP2
Calcium	na	na	na	na	4	4	49000	89000	41SP2
Chromium	100	11	0	0	4	4	0.7	9.4	41SP2
Copper	1300	150	0	0	1	4	19	19	41SP2
Iron	300	2600	2	1	4	4	230	10400	41SP2
Lead	15	na	1	na	4	4	0.3	29	41SP2
Magnesium	na	na	na	na	4	4	30000	32000	41SP2
Manganese	50	88	1	1	4	4	20	410	41SP2
Nickel	na	73	na	0	1	4	10	10	41SP2
Potassium	na	na	na	na	4	4	1100	1600	41SW3
Selenium	50	18	0	0	1	4	0.4	0.4	41SP2
Sodium	na	na	na	na	4	4	4300	13000	41SP2
Thallium	2	0.24	0	0	1	4	0.09	0.09	41SP2
Vanadium	na	26	na	0	1	4	17	17	41SP2
Zinc	5000	1100	0	0	1	4	75	75	41SP2

Table 4-12
Overall Surface Water Summary for SWMU 41 Area B
Page 2 of 2

Analyte	MCL	tw-SL	# of MCL Exceedances	# of tw-SL Exceedances	# of Detections	# of Samples	Minimum Concentration	Maximum Concentration	Location of Maximum
<i>Metals, Dissolved (ug/L)</i>									
Antimony	6	1.5	0	0	0	4	na	na	na
Arsenic	10	0.045	0	0	0	4	na	na	na
Barium	2000	730	0	0	4	4	60	110	41SP2
Beryllium	4	7.3	0	0	0	4	na	na	na
Cadmium	5	1.8	0	0	0	4	na	na	na
Calcium	na	na	na	na	4	4	51000	65000	41SP2
Chromium	100	11	0	0	4	4	0.6	0.99	41SW2
Cobalt	na	1.1	na	0	0	4	na	na	na
Copper	1300	150	0	0	0	4	na	na	na
Iron	300	2600	0	0	1	4	23	23	41SP2
Lead	15	na	0	na	2	4	0.3	0.3	41SW2
Magnesium	na	na	na	na	4	4	21000	33000	41SW3
Manganese	50	88	0	0	0	4	na	na	na
Nickel	na	73	na	0	1	4	0.4	0.4	41SW2
Potassium	na	na	na	na	4	4	180	1700	41SW4
Selenium	50	18	0	0	0	4	na	na	na
Silver	100	18	0	0	0	4	na	na	na
Sodium	na	na	na	na	4	4	4400	15000	41SP2
Thallium	2	0.24	0	0	0	4	na	na	na
Vanadium	na	26	na	0	0	4	na	na	na
Zinc	5000	1100	0	0	3	4	4.5	14	41SP2
<i>Misc.</i>									
Perchlorate	na	2.6	na	0	0	4	na	na	na
Hardness	na	na	na	na	3	3	251000	255000	41SW4
Cyanide	200	73	0	0	4	4	2	2	41SP2

Based on the nature and extent of contamination and comparison with chemical-specific screening levels, the chemicals detected in site surface water do not appear to represent a concern at Area B. However, the Human Health and Ecological Risk Assessments have been conducted and the results of these assessments are included in *Sections 6 and 7* of the report, respectively.

4.3.3 Sediment

4.3.3.1 Area A

The sediment at SWMU 41 Area A was investigated during the 2004 and 2007 sampling events in support of draft RFIs. A summary of all analytes detected in sediment during all investigations of SWMU 41 Area A can be found in **Table 4-13**.

The SWMU 41 Area A data set from all sediment investigations indicates that one PAH [benzo(a)pyrene], one explosive (nitroglycerin), and one metal (arsenic) were found above their applicable screening limits in sediment samples collected for this site. Benzo(a)pyrene was detected above its r-SL in six samples. Nitroglycerin was detected at a concentration above its r-SL in one sample. Arsenic was detected above its r-SL and i-SL in one sample. 2,3,7,8-TCDD and 2,3,7,8-TCDD TE were well below the r-SL in all sediment samples.

Benzo(a)pyrene was not detected in any Area A soil, surface water, or groundwater samples and is not attributed to former disposal activities at Area A. It was not detected at concentrations above i-SLs in any sediment samples and, therefore, is not considered a concern in sediment at Area A. Nitroglycerin and arsenic were each detected in one single sample in sediment at Area A at concentrations above r-SLs. The single occurrences at concentrations above the r-SL are not a concern for sediment at the site. Based on the nature and extent of contamination and comparison with chemical-specific screening levels, the chemicals detected in site sediment do not appear to represent a concern at Area A. However, the Human Health and Ecological Risk Assessments have been conducted and the results of these assessments are included in *Sections 6 and 7* of the report, respectively.

4.3.3.2 Area B

The sediment at SWMU 41 Area B was investigated during the 2004 and 2007 sampling events in support of draft RFIs. A summary of all analytes detected in sediment during all investigations of SWMU 41 Area B can be found in **Table 4-14**.

The SWMU 41 Area B data set from all sediment investigations indicates that one PCB (PCB-1254) and two metals (arsenic and manganese) were detected above their applicable screening limits in sediment samples collected for this site. PCB-1254 was detected at concentrations above its r-SL in two samples. Arsenic and manganese were each detected at concentrations above their r-SL and i-SL in the sediment sample collected from the spring at Area B, which was dry during the 2007 sampling event. 2,3,7,8-TCDD was not detected in any Area B sediment samples.

Sediment results from Area B sediment investigations indicate that sediment at the Area B spring and the unnamed tributary to Stroubles Creek has not been significantly impacted by former disposal activities at the site. Based on the nature and extent of contamination and comparison with chemical-specific screening levels, the chemicals detected in site sediment do not appear to represent a concern at Area B. However, the Human Health and Ecological Risk Assessments have been conducted and the results of these assessments are included in *Sections 6 and 7* of the report, respectively.

Table 4-13
Overall Sediment Summary for SWMU 41 Area A
Page 1 of 3

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)											
1,2,4-Trichlorobenzene	40000	8700	na	0	0	na	2	3	3.9	4.4	41SD7
2-Butanone	1.9E+07	3E+06	na	0	0	na	4	6	26	48.8	41SD08
Acetone	6.1E+07	6E+06	na	0	0	na	1	6	253	253	41SD08
Benzene	5600	1100	na	0	0	na	3	6	0.2	0.28	41SD5
Bromomethane	3500	790	na	0	0	na	1	6	1.5	1.5	41SD7
Carbon disulfide	300000	67000	na	0	0	na	2	6	5.5	6.7	41SD5
Chloroform	1500	300	na	0	0	na	1	6	0.54	0.54	41SD6
Methylene chloride	54000	11000	na	0	0	na	3	6	3.8	7.8	41SD6
Toluene	4600000	500000	na	0	0	na	3	6	0.26	1.1	41SD5
PAHs (ug/kg)											
Acenaphthene	3300000	340000	na	0	0	na	1	6	17	17	41SD5
Anthracene	1.7E+07	2E+06	na	0	0	na	3	6	1.1	19	41SD5
Benz(a)anthracene	2100	150	na	0	0	na	6	6	17	67	41SD5
Benzo(a)pyrene	210	15	na	0	6	na	6	6	17	79	41SD5
Benzo(b)fluoranthene	2100	150	na	0	0	na	5	6	21	120	41SD08
Benzo(g,h,i)perylene	1700000	170000	na	0	0	na	6	6	20	100	41SD5
Benzo(k)fluoranthene	21000	1500	na	0	0	na	6	6	8.4	66.9	41SD08
Chrysene	210000	15000	na	0	0	na	6	6	19	98.2	41SD08
Fluoranthene	2200000	230000	na	0	0	na	5	6	34	200	41SD5
Fluorene	2200000	230000	na	0	0	na	1	6	10	10	41SD5
Indeno(1,2,3-cd)pyrene	2100	150	na	0	0	na	6	6	15	67.1	41SD08
Phenanthrene	1700000	170000	na	0	0	na	4	6	6.3	110	41SD5
Pyrene	1700000	170000	na	0	0	na	5	6	28	150	41SD5
SVOCs (ug/kg)											
4-Chloro-3-methylphenol	na	na	na	na	na	na	1	6	17	17	41SD5
Benz(a)anthracene	2100	150	na	0	0	na	1	3	42	42	41SD5
Benzo(a)pyrene	210	15	na	0	1	na	1	3	42	42	41SD5
Benzo(b)fluoranthene	2100	150	na	0	0	na	2	3	17	84	41SD5
Benzo(g,h,i)perylene	1700000	170000	na	0	0	na	2	3	10	29	41SD5
Benzo(k)fluoranthene	21000	1500	na	0	0	na	2	3	12	32	41SD5
bis(2-Ethylhexyl)phthalate	120000	35000	na	0	0	na	3	6	23	47	41SD5
Chrysene	210000	15000	na	0	0	na	2	3	14	54	41SD5

Table 4-13
Overall Sediment Summary for SWMU 41 Area A
Page 2 of 3

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
Di-n-butylphthalate	6200000	610000	na	0	0	na	3	6	48	69	41SD5
Fluoranthene	2200000	230000	na	0	0	na	3	3	10	100	41SD5
Indeno(1,2,3-cd)pyrene	2100	150	na	0	0	na	1	3	21	21	41SD5
Phenanthrene	1700000	170000	na	0	0	na	1	3	45	45	41SD5
Pyrene	1700000	170000	na	0	0	na	3	3	9	120	41SD5
Pesticides (ug/kg)											
4,4'-DDT	7000	1700	na	0	0	na	2	6	1.04	1.98	41SD7
Endrin aldehyde	na	na	na	na	na	na	1	6	2.45	2.45	41SD7
PCBs (mg/kg) None detected											
Explosives (mg/kg)											
Nitroglycerin	6.2	0.61	na	0	1	na	1	6	5.8	5.8	41SD6
Herbicides (ug/kg) None detected											
Metals (mg/kg)											
Aluminum	99000	7700	40041	0	0	0	6	6	6170	15500	41SD7
Antimony	41	3.1	na	0	0	na	5	6	0.18	1.4	41SD09
Arsenic	1.6	0.39	15.8	1	1	1	6	6	3.7	18	41SD6
Barium	19000	1500	209	0	0	0	6	6	63	195	41SD6
Beryllium	200	16	1.02	0	0	0	6	6	0.23	0.88	41SD08
Cadmium	81	7	0.69	0	0	2	3	6	0.56	2.2	41SD6
Calcium	na	na	na	na	na	na	6	6	5590	25600	41SD08
Chromium	1400	280	65.3	0	0	0	6	6	9.6	33	41SD6
Cobalt	30	2.3	72.3	0	0	0	6	6	6.9	20	41SD6
Iron	72000	5500	50962	0	0	0	6	6	12500	47900	41SD6
Lead	800	400	26.8	0	0	2	6	6	10.4	35	41SD7
Magnesium	na	na	na	na	na	na	6	6	3680	10900	41SD6
Manganese	2300	180	2543	0	0	0	6	6	299	1640	41SD6
Mercury	2.8	0.67	0.13	0	0	0	6	6	0.024	0.1	41SD08
Nickel	2000	160	62.8	0	0	0	6	6	10	25	41SD6
Potassium	na	na	na	na	na	na	6	6	731	1890	41SD08
Selenium	510	39	na	0	0	na	6	6	0.34	7.7	41SD09
Silver	510	39	na	0	0	na	4	6	0.072	0.16	41SD5
Sodium	na	na	na	na	na	na	6	6	36	475	41SD08
Thallium	6.6	0.51	2.11	0	0	0	2	6	0.088	0.13	41SD7

Table 4-13
Overall Sediment Summary for SWMU 41 Area A
Page 3 of 3

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
Vanadium	720	55	108	0	0	0	6	6	12.1	36	41SD6
Zinc	31000	2300	202	0	0	0	6	6	57.9	121	41SD6
Dioxins/Furans (ng/kg)											
2,3,7,8-TCDF	na	na	na	na	na	na	3	3	0.000866	0.00158	41SD10
2,3,7,8-TCDD	18	4.5	na	0	0	na	3	3	0.00028	0.000748	41SD08
1,2,3,7,8-PECDD	na	na	na	na	na	na	2	3	0.000259	0.000601	41SD10
1,2,3,4,7,8-HXCDD	na	na	na	na	na	na	2	3	0.000316	0.000805	41SD10
1,2,3,6,7,8-HXCDD	na	na	na	na	na	na	2	3	0.000595	0.00141	41SD10
1,2,3,7,8,9-HXCDD	na	na	na	na	na	na	3	3	0.00101	0.00318	41SD08
1,2,3,4,6,7,8-HPCDD	na	na	na	na	na	na	3	3	0.0208	0.0467	41SD08
OCDD	na	na	na	na	na	na	3	3	0.897	2.08	41SD08
1,2,3,7,8-PECDF	na	na	na	na	na	na	3	3	0.00115	0.0029	41SD08
2,3,4,7,8-PECDF	na	na	na	na	na	na	3	3	0.000633	0.0014	41SD08
1,2,3,4,7,8-HXCDF	na	na	na	na	na	na	3	3	0.00307	0.00837	41SD08
1,2,3,6,7,8-HXCDF	na	na	na	na	na	na	3	3	0.00188	0.00478	41SD08
2,3,4,6,7,8-HXCDF	na	na	na	na	na	na	3	3	0.000482	0.00168	41SD10
1,2,3,7,8,9-HXCDF	na	na	na	na	na	na	2	3	0.000189	0.000541	41SD10
1,2,3,4,6,7,8-HPCDF	na	na	na	na	na	na	3	3	0.0222	0.0622	41SD08
1,2,3,4,7,8,9-HPCDF	na	na	na	na	na	na	3	3	0.000498	0.00126	41SD08
OCDF	na	na	na	na	na	na	3	3	0.0208	0.0539	41SD08
TOTAL TCDD	na	na	na	na	na	na	3	3	0.00028	0.00352	41SD08
TOTAL PECDD	na	na	na	na	na	na	3	3	0.00215	0.00457	41SD08
TOTAL HXCDD	na	na	na	na	na	na	3	3	0.00676	0.0144	41SD10
TOTAL HPCDD	na	na	na	na	na	na	3	3	0.0444	0.099	41SD08
TOTAL TCDF	na	na	na	na	na	na	3	3	0.0103	0.0276	41SD08
TOTAL PECDF	na	na	na	na	na	na	3	3	0.013	0.0326	41SD08
TOTAL HXCDF	na	na	na	na	na	na	3	3	0.0163	0.0453	41SD08
TOTAL HPCDF	na	na	na	na	na	na	3	3	0.0272	0.0756	41SD08
2,3,7,8-TCDD TE	18	4.5	na	0	0	na	3	3	0.002315	0.005205	41SD10
Misc. (mg/kg)											
Cyanide	2000	160	na	0	0	na	3	3	0.08	0.13	41SD6

Table 4-14
Overall Sediment Summary for SWMU 41 Area B
Page 1 of 2

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)											
2-Butanone	1.9E+07	2800000	na	0	0	na	3	4	0.033	27	41SD4
Benzene	5600	1100	na	0	0	na	2	4	0.066	0.22	41SD3
Carbon disulfide	300000	67000	na	0	0	na	1	4	5.7	5.7	41SD3
Chloroform	1500	300	na	0	0	na	1	4	1.8	1.8	41SD2
Methylene chloride	54000	11000	na	0	0	na	3	4	4.2	7.1	41SD3
Toluene	4600000	500000	na	0	0	na	1	4	0.31	0.31	41SD3
PAHs (ug/kg) None detected											
Phenanthrene	1700000	170000	na	0	0	na	1	4	1.6	1.6	41SD4
SVOs (ug/kg)											
bis(2-Ethylhexyl)phthala	120000	35000	na	0	0	na	3	4	22	44	41SD3
Butylbenzylphthalate	910000	260000	na	0	0	na	1	4	14	14	41SD3
Di-n-butylphthalate	6200000	610000	na	0	0	na	3	4	44	240	41SD3
Fluoranthene	2200000	230000	na	0	0	na	2	6	8	8	41SD3
Pyrene	1700000	170000	na	0	0	na	2	6	13	13	41SD3
Pesticides (ug/kg)											
4,4'-DDT	7000	1700	na	0	0	na	1	4	3.23	3.23	41SD3
Endrin aldehyde	na	na	na	na	na	na	2	4	1.74	2.19	41SD3
PCBs (mg/kg)											
PCB-1254	0.74	0.022	na	0	2	na	2	4	0.023	0.0902	41SD11
Explosives (mg/kg) None detected											
Herbicides (ug/kg) None detected											
Metals (mg/kg)											
Aluminum	99000	7700	40041	0	0	0	4	4	14300	15900	41SD2
Antimony	41	3.1	na	0	0	na	4	4	0.23	1.1	41SD11
Arsenic	1.6	0.39	15.8	1	1	1	4	4	13	16.6	41SD11
Barium	19000	1500	209	0	0	1	4	4	136	219	41SD11
Beryllium	200	16	1.02	0	0	0	4	4	0.66	1	41SD11
Cadmium	81	7	0.69	0	0	3	3	4	1.7	2.5	41SD4
Calcium	na	na	na	na	na	na	4	4	9330	35200	41SD4
Chromium	1400	280	65.3	0	0	0	4	4	20.4	32	41SD2
Cobalt	30	2.3	72.3	0	0	0	4	4	13.4	20	41SD2
Copper	4100	310	53.5	0	0	0	4	4	29	38.4	41SD11
Iron	72000	5500	50962	0	0	0	4	4	25900	42800	41SD4
Lead	800	400	26.8	0	0	3	4	4	26	59.3	41SD11

Table 4-14
Overall Sediment Summary for SWMU 41 Area B
Page 2 of 2

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
Magnesium	na	na	na	na	na	na	4	4	6840	19000	41SD4
Manganese	2300	180	2543	1	1	1	4	4	1600	2800	41SD11
Mercury	2.4	0.43	0.13	0	0	0	4	4	0.031	0.056	41SD11
Nickel	2000	160	62.8	0	0	0	4	4	13.4	22	41SD3
Potassium	na	na	na	na	na	na	4	4	1010	1880	41SD2
Selenium	510	39	na	0	0	na	4	4	0.5	5.4	41SD11
Silver	510	39	na	0	0	na	3	4	0.1	0.11	41SD2
Sodium	na	na	na	na	na	na	4	4	51	2150	41SD11
Thallium	6.6	0.51	2.11	0	0	0	4	4	0.11	1.1	41SD11
Vanadium	720	55	108	0	0	0	4	4	29	39	41SD4
Zinc	31000	2300	202	0	0	0	4	4	96	155	41SD4
Dioxins/Furans (ng/kg)											
2,3,7,8-TCDF	na	na	na	na	na	na	1	1	0.000492	0.000492	41SD11
1,2,3,4,7,8-HxCDD	na	na	na	na	na	na	1	1	0.000214	0.000214	41SD11
1,2,3,6,7,8-HxCDD	na	na	na	na	na	na	1	1	0.000537	0.000537	41SD11
1,2,3,7,8,9-HxCDD	na	na	na	na	na	na	1	1	0.00127	0.00127	41SD11
1,2,3,4,6,7,8-HpCDD	na	na	na	na	na	na	1	1	0.0279	0.0279	41SD11
OCDD	na	na	na	na	na	na	1	1	1.71	1.71	41SD11
1,2,3,7,8-PECDF	na	na	na	na	na	na	1	1	0.000235	0.000235	41SD11
2,3,4,7,8-PECDF	na	na	na	na	na	na	1	1	0.000356	0.000356	41SD11
1,2,3,4,7,8-HxCDF	na	na	na	na	na	na	1	1	0.000801	0.000801	41SD11
1,2,3,6,7,8-HxCDF	na	na	na	na	na	na	1	1	0.000297	0.000297	41SD11
2,3,4,6,7,8-HxCDF	na	na	na	na	na	na	1	1	0.000342	0.000342	41SD11
1,2,3,4,6,7,8-HpCDF	na	na	na	na	na	na	1	1	0.0042	0.0042	41SD11
1,2,3,4,7,8,9-HpCDF	na	na	na	na	na	na	1	1	0.000361	0.000361	41SD11
OCDF	na	na	na	na	na	na	1	1	0.0112	0.0112	41SD11
TOTAL PCDD	na	na	na	na	na	na	1	1	0.000268	0.000268	41SD11
TOTAL HxCDD	na	na	na	na	na	na	1	1	0.00865	0.00865	41SD11
TOTAL HpCDD	na	na	na	na	na	na	1	1	0.0659	0.0659	41SD11
TOTAL TCDF	na	na	na	na	na	na	1	1	0.00255	0.00255	41SD11
TOTAL PECDF	na	na	na	na	na	na	1	1	0.0031	0.0031	41SD11
TOTAL HxCDF	na	na	na	na	na	na	1	1	0.00508	0.00508	41SD11
TOTAL HpCDF	na	na	na	na	na	na	1	1	0.0105	0.0105	41SD11
Misc. (mg/kg)											
Cyanide	2000	160	na	0	0	na	3	3	0.15	2	41SD2

4.3.4 Groundwater

Groundwater at SWMU 41 was investigated during previous investigations in 1992 and 2004. In 2007, groundwater samples were collected from the three existing Area B wells to assess current groundwater conditions. An additional well (41MW4) was installed and sampled in October 2010 in Area A to assess groundwater conditions beneath the site and to replace the highly turbid 2007 samples (41GW01, 41GW02, and 41GW03) in the risk assessment.

SWMU 41 groundwater results from the 1992 and 2004 sampling events indicated that five TAL metals (aluminum, antimony, arsenic, thallium, and vanadium) and one SVOC [bis(2-ethylhexyl)phthalate], only in 1992, were greater than their SLs in site groundwater samples.

The most recent rounds of groundwater sampling in 2007 and the addition of well 41MW4 in 2010 are the best indications of the current state of groundwater conditions. As shown in **Table 4-4**, the 2007 SWMU 41 groundwater well data (samples 41MW1, 41MW2, and 41MW3) indicated that the following were detected above their SLs:

- One VOC (PCE); and,
- Two total metals (cobalt and vanadium).

The direct-push samples from 2007 (41GW01, 41GW02, and 41GW03) were extremely turbid and therefore the results were eliminated from the HHRA and replaced by the groundwater results of the new 2010 well (41MW4). The results from the 2007 direct-push samples can be found in **Table 4-5** and showed the following chemicals above screening levels:

- One VOC (chloroform); and,
- Fourteen (14) total metals (aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, iron, lead, manganese, mercury, nickel, vanadium, and zinc). However, beryllium was b-flagged, indicating possible laboratory blank contamination. Cobalt and manganese were the only two metals to be detected above SLs of the dissolved metals.

For the 2010 groundwater well data that will replace the direct-push sample results in the risk assessment, the following chemicals were detected above screening levels:

- One VOC (chloroform);
- Four PAHs [benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene];
- One pesticide (heptachlor); and,
- Two metals (aluminum and iron).

The highest VOC concentrations of PCE were found at 1.7 µg/L in well 41MW2. Chloroform was only detected in samples 41GW03 and 41MW4, but with a “B” validation qualifier in 41GW03 – indicating that this compound was also detected in associated laboratory blanks. In filtered 2007 groundwater samples, only two metals (cobalt and manganese) were greater than their SLs in one direct-push sample. PAHs, pesticides, PCBs, and herbicides were not detected in 2007 site groundwater samples. PCBs and herbicides were not detected in the 2010 groundwater sample.

It should be noted that the three samples collected from Area A were collected from direct-push sample locations. These groundwater samples are collected without a sandpack, which increases the amount of sediment in the sample. It is likely that the high concentration of metals and dioxins/furans in these samples is due to the sediment entrained in the sample. Dioxin/furans are highly hydrophobic and it is unlikely that these concentrations are present in the groundwater. Dioxins/furans were not detected in any of the existing well samples from the site.

A theoretical soil concentration can be back-calculated using the octanol-water partition coefficient from the concentration detected in groundwater using the following equation:

$$\log P_{oct/wat} = \log \left(\frac{[solute]_{octanol}}{[solute]_{water}^{un-ionized}} \right)$$

where P = Partition Coefficient.

Octanol is used as a surrogate for the soil in this calculation because dioxins are relatively insoluble in water and soluble in octanol, much like their affinity for soil. Using a P value of 6.8 (ATSDR, 1998) and the actual total TCDD concentration in groundwater (0.00333 ng/L) results in a soil concentration of 21,010 nanograms per kilogram (ng/kg). The actual maximum concentration detected in soil was 12.5 ng/kg, approximately three orders of magnitude less than what would be required to result in that groundwater concentration. This indicates that the groundwater concentration is likely due to entrained sediment in the groundwater sample, and is not representative of actual groundwater concentrations.

Local groundwater flow patterns indicate local discharge occurring at Stroubles Creek and its unnamed tributary. Contemporaneous surface water sample data collected during the 2007 sampling event indicates that dioxins/furans were predominantly detected in one surface water sample (41SW09), which was collected immediately downgradient of Area A. As previously mentioned, the detected concentration of 2,3,7,8-TCDD (the most toxic congener) in 41SW09 was above the tw-SL, but well below the MCL. The only other dioxin/furan congener detected in surface water was OCDD. Collocated sediment sample data from Stroubles Creek indicates that dioxins/furans concentrations, including 2,3,7,8-TCDD TE, are well below r-SLs for sediment.

5.0 CONTAMINANT FATE AND TRANSPORT

This section presents a discussion of the fate and transport mechanisms for COPCs at SWMU 41. 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 SWMU 41 Area A and Area B is presented as *Section 5.1*.

No soil samples were collected at SWMU 41 in 2007 because the soil was already adequately characterized. However, for the soil samples collected at Area A in 2004, one PCB (PCB-1254), three metals (aluminum, arsenic, and iron) and 2,3,7,8-TCDD TE were detected at concentrations greater than their respective r-SLs in sample 41SB2A for the PCB, 41SB4C for the metals, and 41SB2B for 2,3,7,8-TCDD TE. Analytes detected above r-SLs in the 2004 Area B soil samples included one VOC (1,2-dibromo-3-chloropropane), one SVOC [indeno(1,2,3-cd)pyrene], one PCB (PCB-1254), four metals (aluminum, arsenic, iron, and manganese), and 2,3,7,8-TCDD TE. A generalized fate and transport discussion for those constituents identified as risk drivers in the HHRA are presented in *Section 5.2*.

5.1 Soil Properties Affecting Fate and Transport

The chemical and physical properties of the soil influence the fate and transport of constituents through the environment. Samples were collected from SWMU 41 in support of the 2005 RFI and analyzed for grain size distribution, pH, TOC, and additional physical parameters to assess these chemical and physical characteristics of the soil. Results from the geotechnical data are presented in **Table 5-1**. A summary of grain size distribution, pH, and TOC 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. Fill material covers both Areas A and B. As shown in **Table 5-1**, the fill material and residual soil at both Area A and B primarily consists of brown to reddish yellow lean to fat clay (CL and CH) contains variable sand and gravel. The thickness of fill material at Area A is approximately 15 ft or less. At Area B, the thickness of fill ranges from than 7 ft to approximately 20 ft with an increased thickness toward the north and northwest following the slope of bedrock and surface topography.

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. Based upon the high percentage of clay contained in the fill material overlying both Areas A and B, the permeability (2.0E-07 to 1.2E-08 cm/sec) of the soil cover is very low and the plastic index (11 to 40) is relatively high (**Table 5-1**).

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. Based upon the high percentage of clay particles contained in the fill material and the thickness of the fill material at both Area A and B, it is very unlikely that constituents

**Table 5-1
SWMU 41 Geotechnical Laboratory Data Summary**

Soil Sample					Physical Analyses															
Sample Identification	Location	Depth (feet) bgs	SWMU 41 Geologic Unit	USCS Soil Type	Water Content (D2216)	Liquid Limit (D4318)	Plastic Limit (D4318)	Plastic Ind. (D4318)	Sieve Minus No. 200 (D422)	Hydrometer % Minus 2 μ m (D422)	pH Distilled Water (D4972)	pH 0.01 M CaCl Solution (D4972)	Organic Content (D2974)	Soil Particle Density (D854)	Total Bulk Density (D2937)	Dry Bulk Density (D2937)	Hydraulic Conductivity (D5084)	Total Soil Porosity (Calculated)	Air-Filled Soil Porosity (Calculated)	Water-Filled Soil Porosity (Calculated)
					%	-	-	-	%	%	-	-	%	-	pcf	pcf	cm/sec	-	-	-
41GT1	41SB4	9.75	Residual Soil	CL	19.4	30	19	11	71.5		4.9	4.6	5.1	2.610	123.7	103.6	2.0E-07	0.36	0.02	0.34
41GT2	41SB5	13.55	Residual Soil	CL	28.8	48	23	25	56.8		7.9	6.9	2.8	2.720	118.8	92.3	1.4E-08	0.46	0.02	0.44
41GT3	41SB6	15.25	Residual Soil	CH	61.4	99	31	68	96.1		5.3	4.7	3.7	2.642	103.8	64.3	2.0E-08	0.61	0*	0.62
41GT4	41SB7	11.75	Residual Soil	CH	30.7	59	19	40	78.2		6.2	6.4	2.5	2.703	121.6	93.0	1.2E-08	0.45	0.00	0.45

Notes:

* = -0.01 Calculated

bgs = Below ground surface

pcf = Pounds per cubic foot

cm/s = centimeters per second

USCS = Unified Soil Classification System

CL = Low Plasticity Clay

CH = High Plasticity Clay

(D2216) = ASTM Test Method

-- = Unitless

resulting from the burial of red water ash could migrate downward and negatively affect groundwater.

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. As shown in **Table 5-1**, samples collected from SWMU 41 indicate that the fill material at Areas A and B is acidic to slightly alkaline pH (4.9 to 7.9). This indicates that the pH of the soil is in the range that would favor precipitation and adsorption of most metals (including the risk drivers aluminum, arsenic, iron, and manganese), rather than dissolution into the water phase.

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.

As shown in **Table 5-1**, the total organic content of the soil samples collected from Area A and B range from 2.5 to 5.1%. Due to the high clay content of the backfill emplaced at Area A and B, there is a very low available water capacity and infiltration rate in the soil; therefore, there is a very low organic matter content in the soil. As a result of the soil properties at Area A and B, constituents resulting from the burial of red water ash at the site are expected to adsorb to the clay particles in soil rather than dissolve into solution.

5.2 Fate and Transport of Analytes Detected Above Screening Levels

5.2.1 Inorganic Compounds

Four metals (aluminum, arsenic, iron, and manganese) were detected in soil above r-SLs and background concentrations at SWMU 41. Although aluminum, arsenic, iron, lead, and manganese were detected above SLs in surface water, none of these metals were present at

concentrations above SLs in dissolved metals analyses. Two metals (arsenic and manganese) were detected above soil r-SLs and background concentrations in sediment samples collected at Areas A and B. Similar to surface water, several total metals were detected in groundwater at concentrations above applicable groundwater SLs; however, only two dissolved metals (cobalt and manganese) were detected above groundwater SLs in filtered metals samples. In the 2010 groundwater sample, only two metals (aluminum and iron) were detected above SLs.

Specific characteristics of those these metals (aluminum, arsenic, cobalt, iron, and manganese), which were identified as risk drivers in the HHRA (*Section 6.0*) are discussed in more detail in the following sections.

5.2.2 Aluminum

Aluminum was detected above its r-SL (but below i-SL) and background concentrations in one subsurface soil sample at Area A and in one subsurface soil sample at Area B. Although total aluminum was detected above applicable SLs in surface water and groundwater, dissolved concentrations were below SLs in all filtered aqueous samples.

Aluminum occurs naturally in soil, water, and air. It is redistributed or moved by natural and human activities. High levels in the environment can be caused by the mining and processing of its ores and by the production of aluminum metal, alloys, and compounds (ATSDR, 2006). Small amounts of aluminum are released into the environment from coal-fired power plants and incinerators. Food, water, and air contain some aluminum, which nature is well adapted to handle (ATSDR, 2006).

Aluminum cannot be destroyed in the environment. It can change its form or become attached or separated from particles. Aluminum contained in wind-borne soil is generally found in larger particles. These particles settle to the ground or are washed out of the air by rain. Aluminum that is attached to very small particles may stay in the air for many days. Most aluminum will ultimately end up in the soil or sediment. Aluminum in soil is taken up into plants, which are eaten by animals. Aluminum is not known to bioaccumulate up the food chain and therefore, vegetables, fruits, fish, and meat will not generally contain high concentrations of aluminum (ATSDR, 2006). Because of the toxicity of dissolved aluminum to many aquatic organisms, including fish, these animals would die before the amount of aluminum in the animal became very high (ATSDR, 2006).

Most aluminum-containing compounds do not dissolve much in water unless the water is acidic. However, when acid rain falls, aluminum compounds in the soil may dissolve and enter lakes and streams. Because the affected bodies of water are often acidic themselves from the acid rain, the dissolved aluminum does not combine with other elements in the water and settle out as it would under normal (i.e., non-acidic) conditions. In this situation, abnormally high concentrations of aluminum may occur.

The low permeability clay backfill and thickness of the backfill at the site will likely limit the mobility of aluminum. Given the pH range measured in soil (4.9 to 7.9) and buried material (8.2), there is a low to moderate potential for aluminum to solubilize and become mobile in soil.

5.2.3 Arsenic

Arsenic was detected in one Area A subsurface soil and 15 Area B soil samples at concentrations above its r-SL, i-SL, and background. Although total arsenic was detected above applicable SLs in surface water and groundwater, dissolved concentrations were below SLs in all filtered

aqueous samples. Arsenic was also detected in one Area A and one Area B (dry seep) sediment sample at concentrations above its r-SL, i-SL, and background.

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, 2007).

Inorganic arsenic compounds are mainly used to preserve wood. Copper chromated 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, 2007).

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, 2007).

The low permeability clay backfill and thickness of the backfill at the site will likely limit the mobility of arsenic. The existence of arsenate or arsenite in soil would be dependent on the redox condition of the soil, with the observed pH range (4.9 to 7.9) of site soil being favorable for adsorption of the more soluble and toxic form of arsenic (arsenite). Low arsenic solubility is expected in Stroubles Creek and its tributary given the higher dissolved oxygen levels measured (9.79 to 13.35 mg/L) and short contact time with sediment contained arsenic. This condition is supported by the lack of detections of dissolved arsenic in surface water samples.

5.2.4 Cobalt

Total cobalt was detected at concentrations above the tw-SL (but below the MCL) in all three Area A direct-push groundwater sample and one existing well groundwater sample. Dissolved concentrations were below the tw-SL in every filtered sample except one Area A direct-push groundwater sample.

Cobalt occurs naturally in the earth's crust, and therefore, in soil. Low levels of cobalt also occur naturally in seawater and in some surface water and groundwater (Smith and Carson, 1981). However, elevated levels of cobalt in soil and water may result from anthropogenic activities such as the mining and processing of cobalt-bearing ores, the application of cobalt-containing sludge or phosphate fertilizers to soil, the disposal of cobalt-containing wastes, and atmospheric deposition from activities such as the burning of fossil fuels and smelting and refining of metals (Smith and Carson, 1981). Cobalt is released into the atmosphere from both anthropogenic and natural sources. However, emissions from natural sources are estimated to slightly exceed those from manufactured sources. Natural sources include windblown soil, seawater spray, volcanic eruptions, and forest fires. Primary anthropogenic sources include fossil fuel and waste combustion, vehicular and aircraft exhausts, processing of cobalt and cobalt-containing alloys, copper and nickel smelting and refining, and the manufacture and use of cobalt chemicals and fertilizers derived from phosphate rocks (Barceloux, 1999; Lantzy and Mackenzie, 1979; Nriagu, 1989; Smith and Carson, 1981).

Cobalt is a by-product or co-product of the refining of other mined metals such as copper and nickel. A major source of cobalt is food; as it concentrates in green, leafy vegetables and may be

as great as 0.5 milligrams per kilogram (mg/kg) dry weight. A few plant species accumulate cobalt above 100 mg/kg, the level that causes severe phytotoxicity. Hyperaccumulators of cobalt have been found which contain over 1 percent cobalt in dry leaves. Soil pH is very important in cobalt uptake and phytotoxicity. More acidic soil sorbs cobalt less strongly. In the process of weathering, cobalt may be taken into solution more readily than nickel. It is adsorbed to great extent by hydrolysate or oxidate sediments. Cobalt may be taken into solution in small amounts through bacteriological activity similar to that causing solution of manganese. The availability of cobalt is primarily regulated by pH and is usually found in soil as divalent cobalt. At a low pH, it is oxidized to trivalent cobalt and often found associated with iron. Adsorption of divalent cobalt on soil colloids is high between a pH 6 and 7, whereas leaching and plant uptake of cobalt are enhanced by a lower pH (Spectrum, 2003).

Minimal leaching of cobalt from soil to groundwater was indicated by the low concentrations of dissolved cobalt in site groundwater. The neutral to slightly alkaline pH of groundwater, surface water, and sediment at the site is not favorable for the existence of dissolved cobalt at elevated concentrations. This condition is supported by the lack of detections of dissolved cobalt in surface water and the lower concentrations detected in groundwater.

5.2.5 Iron

Iron was detected in one Area A subsurface soil at a concentrations above its r-SL, i-SL, and background and in two subsurface soil samples at Area B above its r-SL and background. Although total iron was detected above applicable SLs in surface water and groundwater, dissolved concentrations were below SLs in all filtered aqueous samples.

Iron, like most metals, is not found in the Earth's crust in an elemental state. Iron can be found in the crust only in combination with oxygen or sulfur. Most iron is found in various iron oxides, such as the minerals hematite, magnetite, and taconite. Iron is a major component of steel. Since buried steel containers and other items are of concern at the site, the following discussion focuses on the degradation of iron in the environment.

Corrosion (chemical and biological) of iron is an electrochemical phenomenon in which ions go into solution (anodic reaction) and the electrons generated by the reaction diffuse through the metal to the cathode where they are consumed (cathodic reaction). Biologically induced corrosion occurs when microorganisms are able to initiate, facilitate, or accelerate the corrosion reaction without changing the electrochemical nature of the process.

The low permeability clay backfill and thickness of the backfill at the site will likely limit the mobility of iron. Given the pH range measured in soil (4.9 to 7.9) and buried material (8.2), there is a low to moderate potential for iron to solubilize and become mobile in soil.

5.2.6 Manganese

Manganese was detected in two Area B soil samples at concentrations above its r-SL, i-SL, and background. Although total manganese was detected above applicable SLs in surface water and groundwater, dissolved concentrations were below SLs in all filtered aqueous samples. Manganese was also detected in the Area B dry seep sediment sample at a concentration above its r-SL, i-SL, and background.

Manganese is an essential element in trace amounts for plants and animals. It forms an essential part of the enzyme systems that metabolize proteins and energy in animals. In humans, manganese is involved in the digestion and absorption of food through peptidase activity, in the

synthesis of cholesterol and fatty acids, in glucose metabolism and in the use of biotin, thiamine, vitamin C and chlorine. In the divalent state (Mn^{++}), it appears to provide protection against oxygen free radicals as part of the enzyme superoxide dismutase. Insufficient dietary manganese may result in abnormal carbohydrate metabolism and impaired insulin productions in humans, and a host of ailments in experimental animals.

Manganese in rocks and minerals is naturally released into the environment from weathering. The primary concerns due to manganese in drinking water are its objectionable taste and its capacity to stain plumbing and laundry. In aquatic environments, manganese toxicity is slight to moderate and is influenced by several factors such as water hardness, salinity, pH, and the presence of other contaminants. The effect of water hardness on manganese toxicity is by far the most studied factor.

The low permeability clay backfill and thickness of the backfill at the site will likely limit the mobility of iron. Given the pH range measured in soil (4.9 to 7.9) and buried material (8.2), there is a low to moderate potential for iron to solubilize and become mobile in soil.

5.2.7 Organic Compounds

Seven groups of organic compounds, including VOCs, SVOCs, PAHs, PCBs, pesticides, explosives, and dioxins/furans were detected in SWMU 41 media above applicable SLs. One VOC (1,2-dibromo-3-chloropropane), one SVOC [indeno (1,2,3-cd)pyrene], one PCB (PCB-1254), and 2,3,7,8-TCDD TE were detected in soil above r-SLs at SWMU 41. The SWMU 41 surface water data set indicates that one VOC (chloroform), one explosive (2,4,6-TNT), one dioxin/furan (2,3,7,8-TCDD), and the calculated 2,3,7,8-TCDD TE were found above their applicable screening levels in surface water samples. The SWMU 41 sediment data set indicates that one PAH [benzo(a)pyrene], one PCB (PCB-1254), and one explosive (nitroglycerin) were found above their applicable screening limits in sediment samples. PCE was detected above its tw-SL in three 2007 groundwater samples. It also was detected above its SSL in one Area A 2005 surface soil sample (41TP2A). Four PAHs were detected above their SLs in the 2010 groundwater sample (benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene). However, they were not detected in the duplicate sample. One pesticide (heptachlor) and two metals (aluminum and iron) were also detected in the 2010 groundwater sample.

Specific characteristics of those organics [chloroform, heptachlor, and PAHs(benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene)] identified as risk drivers in the HHRA (*Section 6.0*) are discussed in more detail in the following sections.

5.2.7.1 Chloroform

Chloroform was detected above its tw-SL in the 2010 groundwater sample. Chloroform's presence is unlikely associated with the site. Chloroform is found uniformly in groundwater at RFAAP due to its drinking water treatment processes.

Chloroform is a colorless liquid with a pleasant, nonirritating odor and a slightly sweet taste. It will burn only when it reaches very high temperatures. In the past, chloroform was used as an inhaled anesthetic during surgery, but it is not used that way today. Today, chloroform is used to make other chemicals and can also be formed in small amounts when chlorine is added to water. Other names for chloroform are trichloromethane and methyl trichloride.

Chloroform evaporates easily into the air. Most of the chloroform in air breaks down eventually, but it is a slow process. The breakdown products in air include phosgene and hydrogen chloride, which are both toxic. It does not stick to soil very well and can travel through soil to groundwater. Chloroform dissolves easily in water and some of it may break down to other chemicals. Chloroform lasts a long time in groundwater (ATSDR, 1997).

5.2.7.2 Heptachlor

Heptachlor is the only pesticide that was detected above its tw-SL, in the 2010 groundwater sample. Heptachlor epoxide is not produced commercially, but rather is formed by the chemical and biological transformation of heptachlor in the environment. Heptachlor epoxide adsorbs strongly to soil and is extremely resistant to biodegradation, persisting for many years in the upper soil layers (HSDB, 2007). Both heptachlor and heptachlor epoxide were detected in soil samples, with analytical results summarized in the following for both chemicals.

Comparison of the heptachlor and heptachlor epoxide results indicates that the majority of the heptachlor present at the locations sampled has transformed to heptachlor epoxide; and therefore, minimal changes in heptachlor epoxide concentrations in soil are expected due to transformation from heptachlor. Heptachlor epoxide remaining in soil at the site is not expected to significantly biodegrade.

5.2.7.3 PAHs

Four PAHs [benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene] were detected above their tw-SLs in the 2010 groundwater sample, but not in the duplicate sample. Benzo(a)pyrene was also detected above its residential SL in three 2007 sediment samples.

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 SWMU 51 indicate that the present PAHs are not soluble in water. PAHs were not detected in groundwater samples collected downgradient of the site indicating that PAHs have not migrated from the trench sludge material.

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 SWMU 51 are nonpolar and hydrophobic and, as mentioned above, will tend to sorb to soil rather than partition into the polar water phase.

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 41A and **Appendix E-2** for SWMU 41B.

6.1 Data Summary and Selection of COPCs

6.1.1 Data Summary

Table 6-1 identifies the soil, surface water, sediment, and groundwater samples used in the HHRA for SWMUs 41A and 41B. 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:

- 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-*

Table 6-1
SWMU 41A and SWMU 41B
Sample Groupings

SURFACE SOIL ^a			
SWMU 41A	41SB2A	41SB4A	41TP2A
	41SB3A	41SB5A	
TOTAL SOIL ^b			
SWMU 41A	41SB1 RVFS-44	41SB3A	41SB5A
	41SB1 RVFS-45	41SB3B	41SB5B
	41SB2A	41SB4A	41TP2A
	41SB2B	41SB4B	41TP2B
		41SB4C	
SEDIMENT ^a			
SWMU 41A	41SD08	41SD10	41SD6
	41SD09	41SD5	41SD7
SURFACE WATER			
SWMU 41A	41SW08	41SW10	41SW6
	41SW09	41SW5	41SW7
GROUNDWATER			
SWMU 41A	41MW04_100710		
SURFACE SOIL ^a			
SWMU 41B	41SB10A	41SB6A	41SC20A
	41SB7A	41SB8A	41SP2soil
	41SB11A	41SB9A	
TOTAL SOIL ^b			
SWMU 41B	41SB10A	41SB11B	41SB9B
	41SB10B	41SB6A	41SB9C
	41SB10C	41SB6B	41SC20A
	41SB7A	41SB8A	41SC20B
	41SB7B	41SB8B	41SC20C
	41SB11A	41SB9A	41SP2soil
SEDIMENT ^a			
SWMU 41B	41SD2	41SD4	41SD11
	41SD3		
SURFACE WATER			
SWMU 41B	41SW2	41SW4	41SP2
	41SW3		
GROUNDWATER			
SWMU 41B	41MW1	41MW2	41MW3

(a) Surface soil and sediment samples consist of samples collected at depths of 0 to 1.0 feet.

(b) Total soil sample group includes all surface soil and subsurface soil samples from 0 to 15 ft. If soil sample depth straddled the 14 - 16 ft range, then it was also included in the data set for total soil.

dioxins and Dibenzofurans (CDDs and CDFs) (USEPA, 1989b, 1994b, and Vandenberg et al., 2006) to assess risks due to exposure to dioxins and/or furans. Each congener is assigned a toxicity equivalent factor (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, total soil, and groundwater in **Appendix E-3**. 2,3,7,8-TCDD equivalents are also calculated for surface water and sediment at SWMU 41A and for sediment at SWMU 41B.

- 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, sediment, surface water, and groundwater samples used in the HHRA is provided in *Sections 6.1.1.1 through 6.1.1.4*.

6.1.1.1 Surface Soil and Total Soil

The soil samples used for COPC screening of SWMU 41A were collected during sampling events in 1991 and 2004. The soil samples used for COPC screening of SWMU 41B were collected during sampling events in 2004. As presented in **Table 6-1**, the soil samples for SWMUs 41A and 41B have been divided into surface soil (0 to 1.0 ft bgs) and total soil (0 to 15 ft bgs). Two soil samples were collected at less than 8 ft (0.7 and 4.2 ft bgs). Six samples were collected between 14 and 16 ft. These samples were also included in the total soil data set. 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 five surface soil samples and eight subsurface soil samples were used in the HHRA for SWMU 41A. A total of eight surface soil samples and ten subsurface soil samples were used in the HHRA for SWMU 41B.

6.1.1.2 Sediment

A total of six sediment samples from nearby Stroubles Creek were collected during sampling events completed in 2004 and 2007 and used for the COPC screening for SWMU 41A. Four sediment samples were collected from the nearby unnamed tributary of Stroubles Creek during 2004 and 2007 and used for the COPC screening for SWMU 41B. These sample locations are listed in **Table 6-1**.

6.1.1.3 Surface Water

Surface water samples collected during sampling events completed in 2004 and 2007 were used for the COPC screening for SWMU 41A. A total of six surface water samples (with dissolved and total analytical results) were collected from nearby Stroubles Creek. Surface water samples collected during 2004 were used for the COPC screening for SWMU 41B. A total of four surface water samples (with dissolved and total analytical results) from the nearby unnamed tributary of Stroubles Creek were collected. These sample locations are listed in **Table 6-1**.

6.1.1.4 Groundwater

Groundwater samples at SWMU 41A were collected via direct-push methods during sampling events completed in 2007. Due to the turbidity of these samples, high concentrations of metals were detected and were not considered to be representative of exposure to groundwater at SWMU 41A. Based upon agreement with USEPA (U.S. Army, 2010), one subsequent sample and a corresponding duplicate were collected in October 2010. The new data were incorporated into this HHRA accordingly. Groundwater samples collected during 2007 were used for the COPC screening for SWMU 41B. A total of three groundwater samples were collected. These sample locations are listed in **Table 6-1**.

6.1.2 Identification of COPCs

COPCs were identified for the sites by comparing the maximum detected concentration (MDC) with the following risk-based SLs for each media: USEPA r-SLs (surface soil, total soil and sediment) and USEPA tw-SLs (surface water and groundwater) as presented in the April 2009 USEPA Regional Screening Tables (USEPA, 2009a). In accordance with USEPA regional guidance, SLs for non-carcinogenic chemicals were adjusted downward to an 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 41A and 41B 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).

For some COPCs without screening levels, the values used for screening were based on surrogate chemicals with similar structures and properties served as surrogates. The surrogates for this HHRA were based on proxy compounds as identified in VDEQ's Risk Assessment Guidance, Risk-Based Screening Levels Proxy Values (VDEQ, 2008).

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 or water 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, 1996a).

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), **E.1-4** (COPC Determination Detects-Total Soil), **E.1-6** (COPC Determination Detects-Sediment), **E.1-8** (COPC Determination Detects-Surface Water), and **E.1-10** (COPC Determination Detects-Groundwater) for SWMU 41A, and **Appendix E-2, Tables E.2-2** (COPC Determination Detects-Surface Soil), **E.2-4** (COPC Determination Detects-Total Soil), **E.2-6** (COPC Determination Detects-Sediment), **E.2-8** (COPC Determination Detects-Surface Water), and **E.2-10** (COPC Determination Detects-Groundwater) for SWMU 41B. The COPCs selected for each medium are summarized in **Table 6-2** for SWMU 41A and **Table 6-3** for SWMU 41B.

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 be above SLs. The maximum reporting limits for these constituents were compared with SLs. The results of these comparisons for SWMU 41A are shown in **Appendix E-1, Tables E.1-3** (Non-Detect Screening- Surface Soil), **E.1-5** (Non-Detect Screening-Total Soil), **E.1-7** (Non-Detect Screening-Sediment), **E.1-9** (Non-Detect Screening-Surface Water), and **E.1-11** (Non-Detect Screening-Groundwater) and for SWMU 41B in **Appendix E-2, Tables E.2-3** (Non-Detect Screening- Surface Soil), **E.2-5** (Non-Detect Screening-Total Soil), **E.2-7** (Non-Detect Screening-Sediment), **E.2-9** (Non-Detect Screening-Surface Water), and **E.2-11** (Non-Detect Screening-Groundwater). Detected constituents identified as COPCs were carried through the quantitative risk assessment. The reporting limits for constituents that were not detected in surface soil, total soil, sediment, surface water, or groundwater 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 CSMs for SWMUs 41A and 41B are presented on **Figures 6-1 through 6-4** for current and future exposure scenarios, respectively. SWMU41, the Red Water Ash Burial Ground, consists of two non-contiguous disposal areas, a backfilled lagoon (Area A) and a burial area (Area B). SWMUs 41A and 41B are located in the southeast section of the MMA at Radford. The only structures nearby are below-grade concrete equalization basins that receive stormwater runoff, and it is likely that the area will remain industrial in nature. The area surrounding RFAAP is not highly developed and land use in the vicinity of the facility is mostly rural, with

Table 6-2
Summary of Chemicals of Potential Concern at SWMU 41A

Chemical (a)	Surface Soil	Total Soil	Sediment	Surface Water	Groundwater
Organics					
Aroclor 1254	X	X			
Benzo(a)pyrene					X
Benzo(b)fluoranthene					X
Chloroform					X
Dibenz(a,h)anthracene					X
Heptachlor					X
Indeno(1,2,3-c,d)pyrene					X
Methylcyclohexane	X	X			
p-Chloro-m-cresol	X	X	X		
TCDD-Toxicity Equivalent		X		X	
Inorganics					
Aluminum	X	X			
Arsenic	X	X	X		
Cobalt	X	X			
Iron	X	X			
Manganese	X	X			
Sodium					X
Vanadium	X	X			

(a) Chemicals of Potential Concern detected in any media at SWMU 41A.

X = Selected as a COPC in this media.

Table 6-3
Summary of Chemicals of Potential Concern at SWMU 41B

Chemical (a)	Surface Soil	Total Soil	Sediment	Surface Water	Groundwater
Organics					
1,2-Dibromo-3-chloropropane	X	X			
2-Hexanone	X	X			
Methylcyclohexane	X	X			
p-Chloro-m-cresol	X	X			
TCDD-Toxicity Equivalent		X			
Tetrachloroethene					X
Inorganics					
Aluminum	X	X			
Arsenic	X	X	X	X	X
Cobalt	X	X			X
Iron	X	X			
Lead				X	
Manganese	X	X	X		
Sodium					X
Vanadium	X	X			

(a) Chemicals detected in all media at SWMU 41B.

Shaded cells indicate that the chemical lacks toxicity criteria and cannot be quantitatively evaluated.

X = Selected as a COPC in this media.

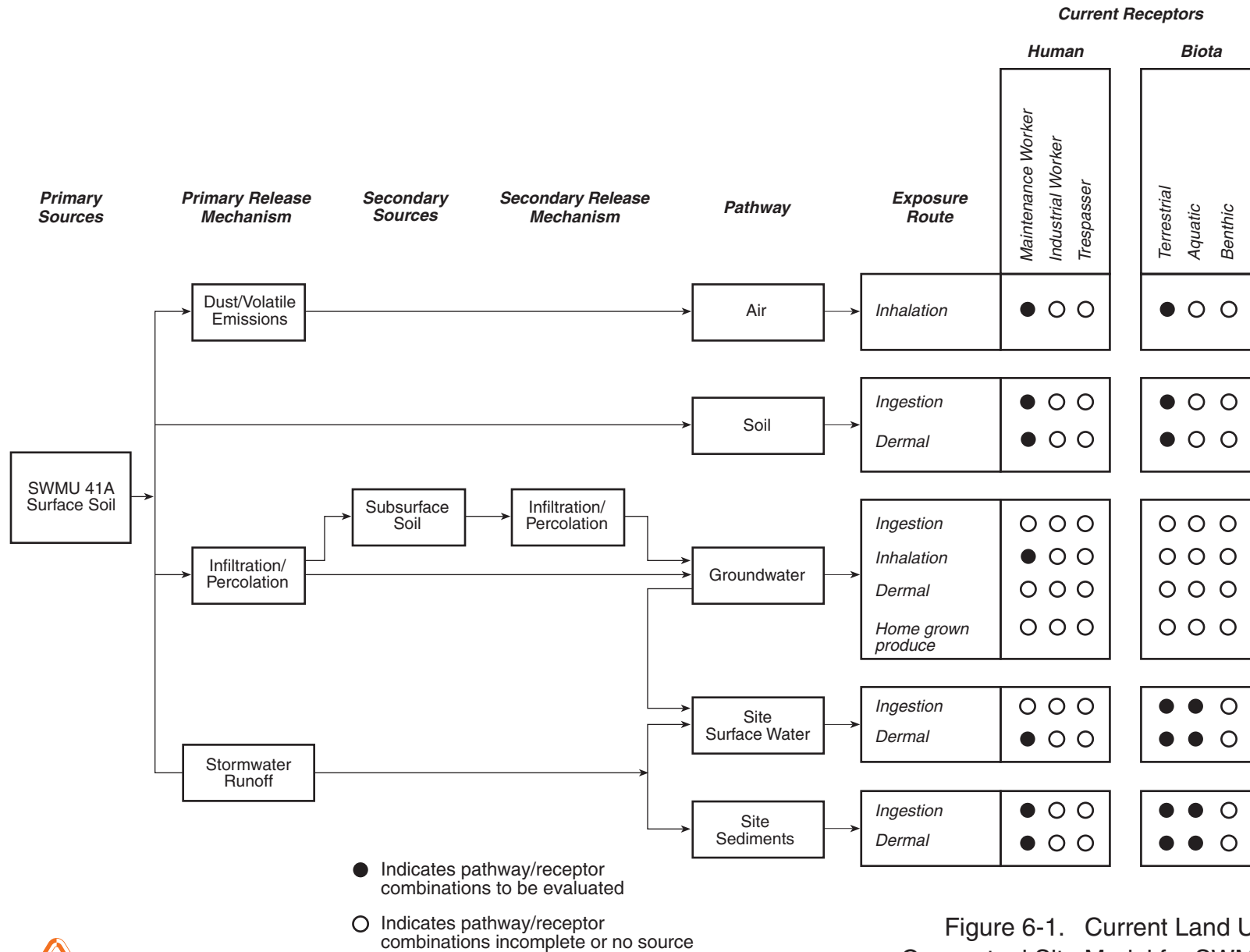


Figure 6-1. Current Land Use
Conceptual Site Model for SWMU 41A
Radford Army Ammunition Plant, Virginia

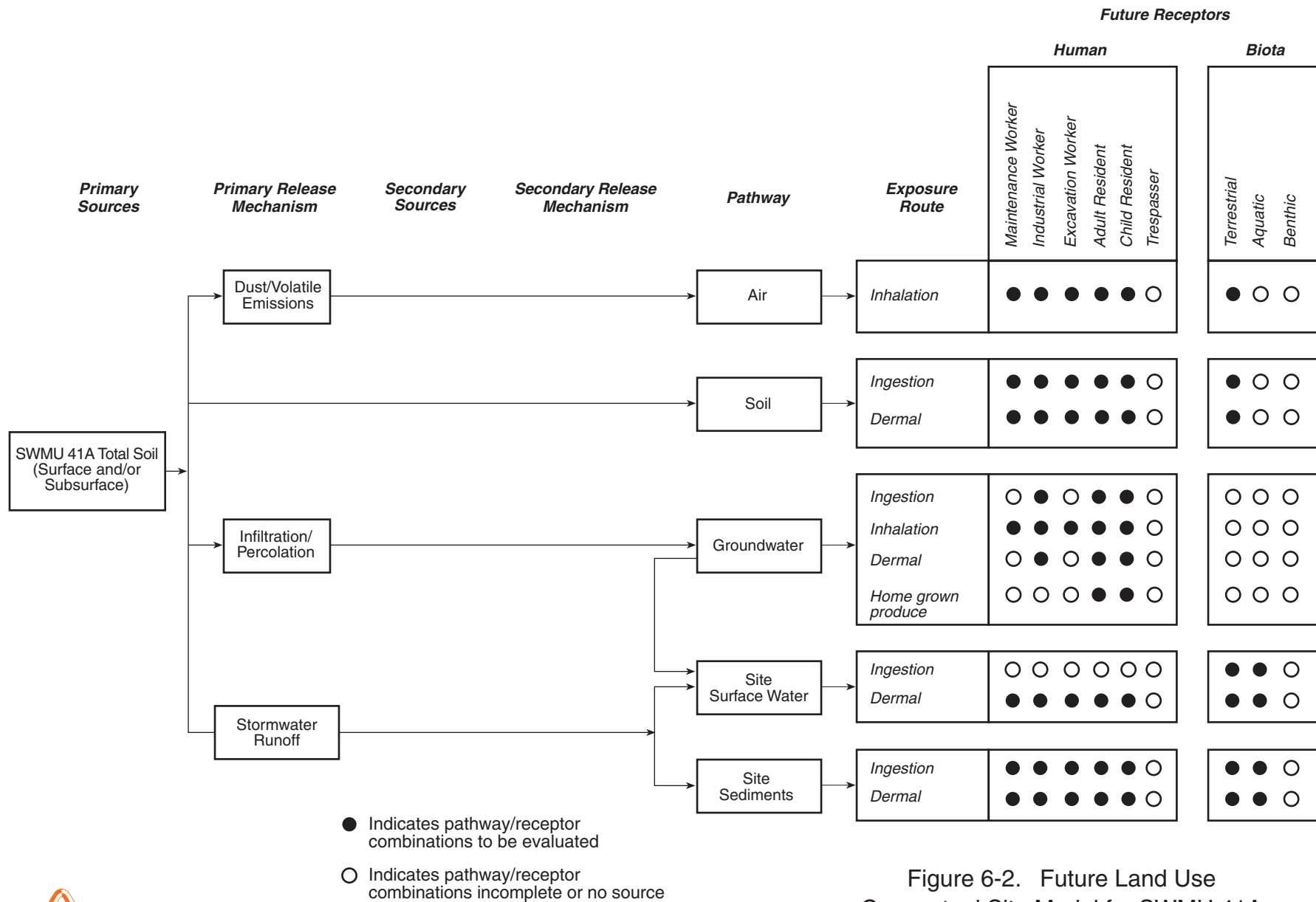


Figure 6-2. Future Land Use
Conceptual Site Model for SWMU 41A
Radford Army Ammunition Plant, Virginia

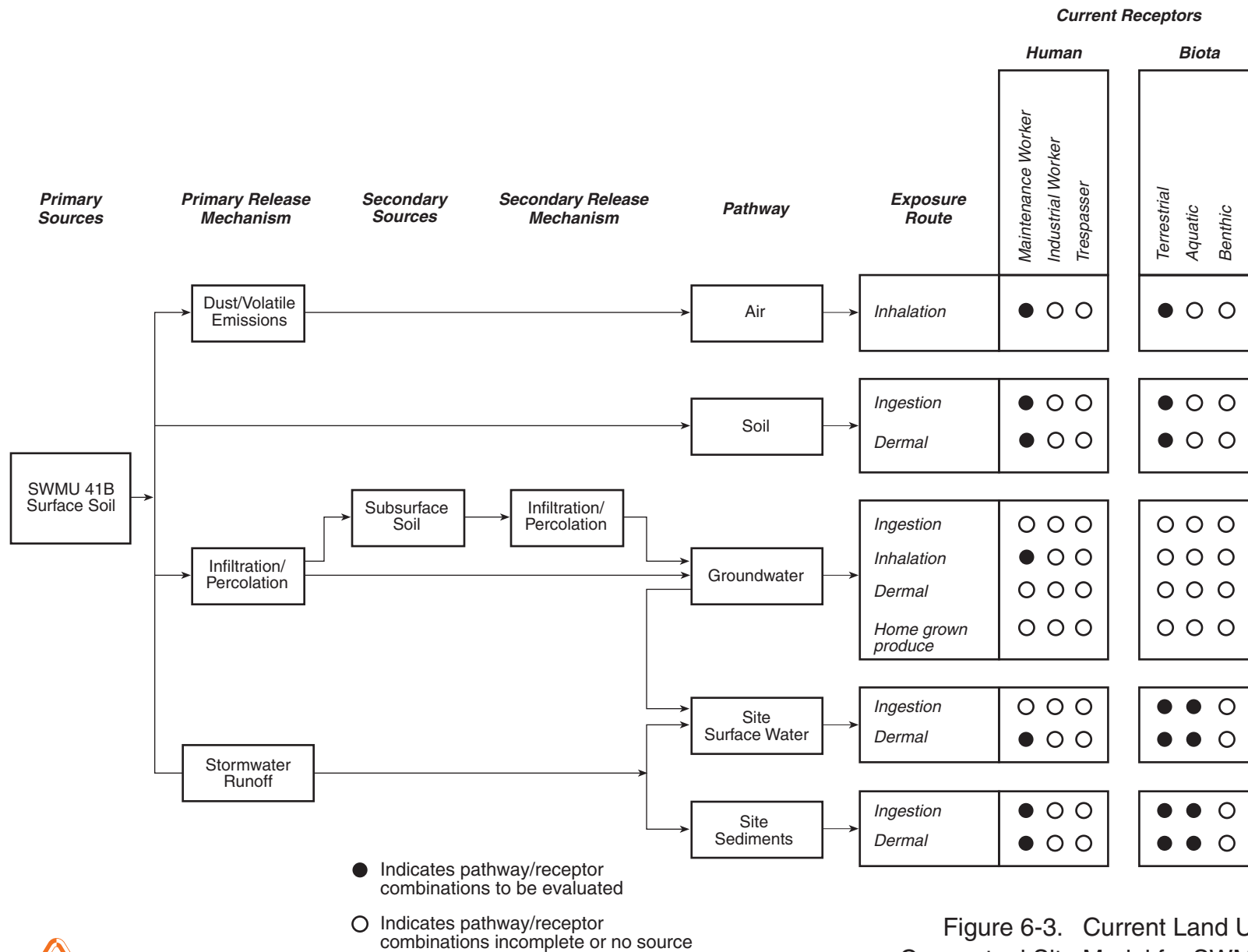


Figure 6-3. Current Land Use
Conceptual Site Model for SWMU 41B
Radford Army Ammunition Plant, Virginia

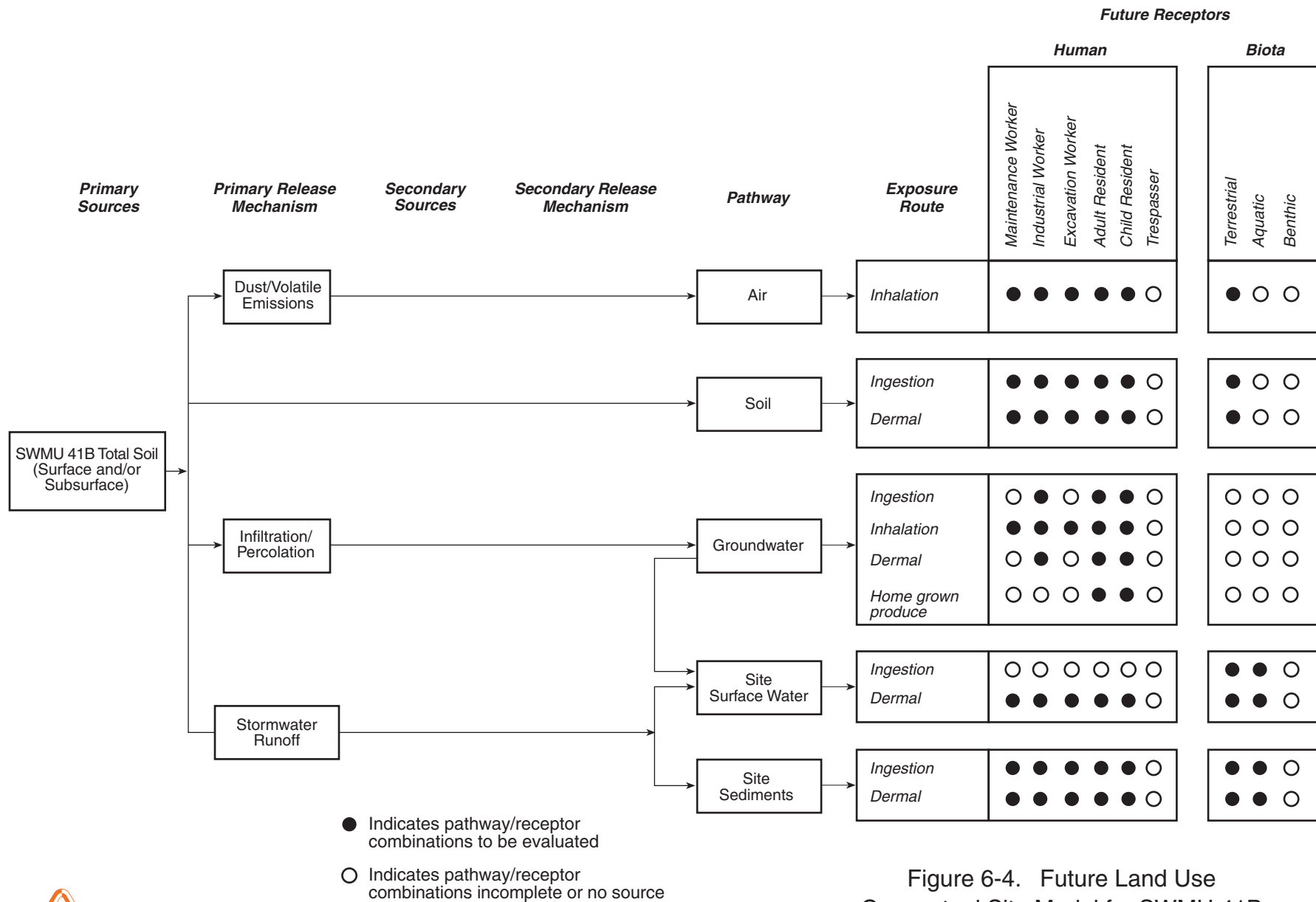


Figure 6-4. Future Land Use
Conceptual Site Model for SWMU 41B
Radford Army Ammunition Plant, Virginia

less rugged areas having been primarily used for agriculture. Residential and recreational areas are located adjacent to the installation (IT, 2001).

The study area for SWMU 41A and SWMU 41B is characterized by gently to steeply sloping ridges and a general downward slope to the north. Area A is located approximately 100 ft west of Stroubles Creek. The ground surface slopes steeply from the edge of Area A toward the north and east toward Stroubles Creek. Area B is approximately 550 ft southwest of Area A and approximately 100 ft west of an unnamed tributary of Stroubles Creek. The ground surface in Area B slopes toward the north, northeast, and northwest. The land east and northwest of Area B slopes steeply toward a drainage ditch and an unnamed tributary of Stroubles Creek, respectively. The only structures in the combined study area are the concrete equalization basins mentioned previously.

SWMU 41A is a former unlined lagoon area, which has been backfilled. It is 0.19 acres in size. Area B is a burial area containing red water ash. Clayey fill has been placed in an approximately 1.08-acre area at Area B.

There are currently no routine activities occurring at SWMU 41. To address occasional exposures due to grounds-keeping activities, such as mowing the grass or maintaining the storage area, it was conservatively assumed that maintenance workers are the most likely receptors at the site. The maintenance worker scenario was based on a worker who visits the site once per week for 50 weeks during the year. Due to installation security, it is unlikely that trespassers could gain access to SWMUs 41A and 41B; 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 well as sediment and surface water, as a result of disturbing soil during construction/excavation activities undertaken as part of development. The industrial/commercial worker represents a composite of the outdoor and indoor worker scenarios, assuming an exposure frequency of 225 days/year for an exposure duration of 25 years. For the construction worker, a construction period of 125 days/year or 6 months was assumed on the basis of five-day work weeks. Given the sizes of SWMUs 41A (0.19 acres) and 41B (1.08 acres), extensive construction would not be expected at the site. The future industrial worker scenario is based on potential exposures to workers during routine outdoor and indoor activities at the site. Therefore, maintenance worker, industrial worker, and excavation worker exposures at SWMUs 41A and 41B were evaluated for total soil, sediment and surface water in the HHRA. Although groundwater from SWMU 41 is not expected to be used for potable purposes, industrial workers were evaluated for hypothetical exposures to groundwater.

RFAAP is likely to remain a military installation; therefore, a residential scenario is considered unlikely. However, the hypothetical residential scenario was evaluated for exposures to on-site total soil, sediment, surface water, and groundwater at both areas to assess clean closeout requirements under RCRA.

Given the potential for migration of COPCs in groundwater off-site in the future, exposures to groundwater were also evaluated for off-site receptors. On-site and off-site groundwater usage and receptors were assumed to be identical.

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 each receptor listing the rationale for the inclusion or exclusion of each pathway at SWMU 41A and SWMU 41B, respectively.

6.2.3 Calculation of EPCs

To calculate intakes, a 95% 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 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 UCLs 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. EPA'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% 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), sediment, and surface water COPCs are presented in **Appendix E-1, Tables E.1-12 through E.1-15** for SWMU 41A and **Appendix E-2, Tables E.2-12 through E.2-15** for SWMU 41B. The output from ProUCL 4.0 is provided in **Appendix E-4** for SWMU 41A and **Appendix E-5** for SWMU 41B. EPCs were not calculated for groundwater; therefore, the MDC for COPCs identified for groundwater were used in the risk assessment. The EPC values for groundwater are shown in **Table E.1-16** for SWMU 41A and **Table E.2-16** for SWMU 41B.

Models were used to estimate concentrations of COPCs in air from soil, concentrations of COPCs in air from groundwater, and concentrations of COPCs in homegrown produce from groundwater. 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 41A are provided in **Appendix E-1, Tables E.1-17 through E.1-29** and **Appendix E-2, Tables E.2-17 through E.2-29** for SWMU 41B.

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.1-30 through E.1-37** and **Appendix E-2, Tables E.2-30 through E.2-37**.

For exposures to surface water and groundwater via dermal contact, the amount of chemical in water absorbed through the skin must be estimated in order to calculate the dose used in the intake formula. The dose absorbed per unit area per event (DA) is a function of chemical concentration in water, the permeability coefficient for that chemical from water through the skin, and exposure time. Following USEPA (2004a) guidance, receptor-specific DA values were calculated for surface water and groundwater using USEPA's worksheet (2001b) and chemical-specific parameters described in **Appendix E-1, Tables E.1-38 and E.1-39** and **Appendix E-2, Tables E.2-38 and E.2-39**.

To evaluate potential inhalation of chloroform from groundwater at SWMU 41A and PCE from groundwater at SWMU 41B, EPCs were calculated for chloroform and PCE in air using the models depicted in the following sections and provided in **Appendix E-1, Tables E.1-40 through E.1-44** and **Appendix E-2, Tables E.2-40 through E.2-44**. For this scenario, the volatilization model outlined in American Society for Testing and Materials (ASTM) Risk-Based Corrective Action (RBCA) Guidance (ASTM, 1995) for volatilization from groundwater to ambient air was used. In this case, chemical intake is a result of inhalation of outdoor vapors that originate from dissolved hydrocarbons in groundwater located somewhere below ground surface. The equations used to calculate the volatilization factor to ambient air for chloroform in SWMU 41A groundwater and PCE in SWMU 41B groundwater are presented in **Appendix E-1, Table E.1-40** and **Appendix E-2, Table E.2-40**, respectively.

The Johnson and Ettinger model (USEPA, 2004b) is used to estimate indoor air concentrations of volatiles migrating from groundwater through the groundwater and into a structure. While there are no buildings or structures currently present at SWMU 41A or SWMU 41B, potential future exposure due to migration of chloroform and PCE from groundwater via vapor intrusion was evaluated. Because land use plans for SWMUs 41A and 41B are not currently known, default values were conservatively used to represent the characteristics of future buildings. In addition, potential future exposure via vapor intrusion into hypothetical buildings downgradient of this site was also addressed. The worksheet for this model was used to estimate air concentrations of chloroform and PCE in hypothetical office buildings and residences for this HHRA (USEPA, 2004c). The worksheets for chloroform at SWMU 41A and PCE at SWMU 41B are found in **Appendix E-6**. The results are given in **Appendix E-1, Table E.1-41** and **Appendix E-2, Table E.2-41**.

In the event that excavation work is performed at SWMUs 41A or 41B, the worker may be exposed to volatile emissions from groundwater below the bottom of the trench. While USEPA does not have a standardized model for estimating concentrations of airborne VOCs in a trench or a pit, the VDEQ provides such a model on their Voluntary Remediation Program (VRP) web

site (VDEQ, 2008). The equation and parameters are given in **Appendix E-1, Table E.1-42** and **Appendix E-2, Table E.2-42**.

The EPCs for chloroform and PCE in air due to volatilization from SWMU 41A groundwater and SWMU 41B groundwater were estimated for a showering scenario, applicable to the adult resident, using the Foster-Chrostowski (1987, 2003) shower room model. The model is described in **Appendix E-1, Table E.1-43** and **Appendix E-2, Table E.2-43**.

Groundwater-to-air EPCs for chloroform and PCE at SWMU 41A and SWMU 41B are summarized in **Appendix E-1, Table E.1-44** and **Appendix E-2, Table E.2-44**, respectively.

The transfer of COPCs in groundwater to vegetables by watering a garden was calculated using two equations based on “exposed produce” developed by Baes et al. (1984), as shown in **Appendix E-2, Table E.2-45**. It is noted that USEPA has determined that sufficient data exists for only arsenic, cadmium, mercury, nickel, selenium, and zinc (USEPA, 1996b). None of these constituents were found to be COPCs in the groundwater associated with SWMU 41A. Arsenic was found to be a COPC in the groundwater associated with SWMU 41B. The exposure for ingestion of COPCs in home grown produce (vegetables and fruit) by residents was then calculated using the equation and the exposure parameters presented in **Appendix E-2, Table E.2-26**.

6.3 Toxicity Assessment

The methodology used for classifying health effects from exposure to chemicals is recommended by USEPA (2008a). 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, 2008a).
- 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, 2009a).
- 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.1-45 through E.1-48** and **Appendix E-2, Tables E.2-46 through E.2-49**.

6.3.1 Calculations for COPCs with Mutagenic Mode of Action

Benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were COPCs in groundwater at SWMU 41. USEPA has determined that these compounds have a mutagenic mode of action (USEPA 2005a, 2009a). The lifetime cancer risks for each of these PAHs was calculated in accordance with USEPA guidance concerning carcinogens that act via a mutagenic mode of action (USEPA, 2005a, 2009a). 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 groundwater at SWMU 41A is calculated for the ingestion pathway:

Age 0-2

$$\frac{2.75E-02 \mu\text{g} / \text{L} \times 1 \text{ L} / \text{day} \times 1.0E-03 \text{ mg} / \mu\text{g} \times 350 \text{ days} / \text{yr} \times 2 \text{ yr}}{365 \text{ days} / \text{yr} \times 70 \text{ yr} \times 15 \text{ kg}} \times \frac{7.3}{\text{mg} / \text{kg} / \text{day}} \times 10 = 3.7E-06$$

Age 2-6

$$\frac{2.75E-02 \mu\text{g} / \text{L} \times 1 \text{ L} / \text{day} \times 1.0E-03 \text{ mg} / \mu\text{g} \times 350 \text{ days} / \text{yr} \times 4 \text{ yr}}{365 \text{ days} / \text{yr} \times 70 \text{ yr} \times 15 \text{ kg}} \times \frac{7.3}{\text{mg} / \text{kg} / \text{day}} \times 3 = 2.2E-06$$

Age 6-16

$$\frac{2.75E-02 \mu\text{g} / \text{L} \times 2 \text{ L} / \text{day} \times 1.0E-03 \text{ mg} / \mu\text{g} \times 350 \text{ days} / \text{yr} \times 10 \text{ yr}}{365 \text{ days} / \text{yr} \times 70 \text{ yr} \times 70 \text{ kg}} \times \frac{7.3}{\text{mg} / \text{kg} / \text{day}} \times 3 = 2.4E-06$$

Age 16-30

$$\frac{2.75E-02 \mu\text{g} / \text{L} \times 2 \text{ L} / \text{day} \times 1.0E-03 \text{ mg} / \mu\text{g} \times 350 \text{ days} / \text{yr} \times 14 \text{ yr}}{365 \text{ days} / \text{yr} \times 70 \text{ yr} \times 70 \text{ kg}} \times \frac{7.3}{\text{mg} / \text{kg} / \text{day}} \times 1 = 1.1E-06$$

Total Ingestion Risk

$$(3.7 \text{ E-}06) + (2.2 \text{ E-}06) + (2.4 \text{ E-}06) + (1.1 \text{ E-}06) = 9.3 \text{ E-}06$$

Therefore, using ADAFs, the cancer risk for benzo(a)pyrene in groundwater at SWMU 41A is (9.3 E-06) for the ingestion pathway. Cancer risks for benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(c,d-1,2,3)pyrene for all pathways were calculated in a similar manner.

6.3.2 Evaluation of Lead

Quantitative oral toxicity criteria are not available for lead. 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 Integrated Exposure Uptake Biokinetic (IEUBK) Lead Model for Windows®, Version 1.0, Build 264 (USEPA, 1994a, 2002c, 2007b). The IEUBK model was designed to provide predictions of the probability of elevated blood lead levels for children. This model addresses three components of environmental risk assessments: the multimedia nature of exposures to lead, lead pharmacokinetics, and significant variability in exposure and risk, through estimation of probability distributions of blood lead levels for children exposed to similar environmental concentrations. The model output includes probability distribution plots, predicted geometric mean blood lead levels, and the percentages of the population potentially experiencing concentrations above 10 µg/dL (below which adverse manifestations are not expected). The lead risks are considered unacceptable if the child-blood lead level for more than 5% of children is

estimated to equal or exceed the Centers for Disease Control and Prevention concern threshold of 10 grams per deciliter (g/dL).

Lead was identified as a COPC in surface water at SWMU 41B. The maximum value of lead (29 µg/L) exceeded the drinking water action level for lead (15 µg/L). When applying the IEUBK model, the input value for the lead concentration is typically based on the arithmetic mean concentration for lead in the medium of interest. Because the arithmetic mean of the lead concentration in surface water at SWMU 41B was 7.58 µg/L (as shown in **Appendix E-2, Table E.2-15**), lead was not evaluated using the IEUBK model).

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 an 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 acceptable 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 are provided in **Appendix E-1, Tables E.1-49 through E.1-70** for SWMU 41A and **Appendix E-2, Tables E.2-50 through E.2-71** for SWMU 41B. The risks and HIs for each receptor are presented in **Appendix E-1, Tables E.1-71 through E.1-81** (SWMU 41A) and **Appendix E-2, Tables E.2-72 through E.2-82** (SWMU 41B). These risks and hazards are summarized in **Table 6-4** (SWMU 41A) and **Table 6-5** (SWMU 41B). 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.1-82 through E.1-92** (SWMU 41A) and **Appendix E-2, Tables E.2-83 through E.2-93** (SWMU 41B) 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).

Table 6-4
Summary of Risks and Hazards
SWMU 41A
Page 1 of 3

Timeframe/Receptor	Risk	HI	Risk Drivers	Target Organ Segregation HI>1^a
Current maintenance worker	2E-05	4E-01	<u>Surface Soil</u> Arsenic <u>Sediment</u> Arsenic <u>Surface Water</u> TCDD TE	N/A
Future maintenance worker	2E-05	4E-01	<u>Surface Soil</u> Arsenic <u>Sediment</u> Arsenic <u>Surface Water</u> TCDD TE	N/A
Future industrial worker	8E-5	2.E+00	<u>Surface Soil</u> Arsenic <u>Sediment</u> Arsenic <u>Surface Water</u> TCDD TE <u>Groundwater</u> Heptachlor	CNS (1.4) - Surface water [TCDD TE -Derm (1.2)]
Future excavation worker	2E-06	2.E+00	<u>Surface Water</u> TCDD TE	CNS (1.2) - Soil [Manganese -Inh (0.28)]; Surface Water [TCDD TE - Derm (0.68)]
Future adult resident	N/A	8.E-01	N/A	N/A

Table 6-4
Summary of Risks and Hazards
SWMU 41A
Page 2 of 3

Timeframe/Receptor	Risk	HI	Risk Drivers	Target Organ Segregation HI>1 ^a
Future child resident	1E-04	5.E+00	<u>Total Soil</u> TCDD TE Arsenic <u>Sediment</u> Arsenic <u>Surface Water</u> TCDD TE <u>Groundwater</u> Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene Heptachlor Indeno(1,2,3-cd)pyrene	CNS (2.2) - Soil [TCDD TE - Ing (0.11); Aluminum - Ing (0.36); Manganese - Ing (0.63), Derm (0.44)] Surface Water [TCDD TE - Derm (0.58)]
Future lifetime resident	7E-04	N/A	<u>Total Soil</u> TCDD TE Arsenic <u>Sediment</u> Arsenic <u>Surface Water</u> TCDD TE <u>Groundwater</u> Benzo(a)pyrene Benzo(b)fluoranthene Chloroform Dibenz(a,h)anthracene Heptachlor Indeno(1,2,3-cd)pyrene	N/A
Future off-site maintenance worker	4E-12	5E-09	None	N/A
Future off-site industrial worker	3E-06	6E-03	<u>Groundwater</u> Heptachlor	N/A

Table 6-4
Summary of Risks and Hazards
SWMU 41A
Page 3 of 3

Timeframe/Receptor	Risk	HI	Risk Drivers	Target Organ Segregation HI>1 ^a
Future off-site excavation worker	3E-09	1.1E-04	None	N/A
Future off-site adult resident	N/A	3.E-02	N/A	N/A
Future off-site child resident	8E-05	5.E-02	Groundwater Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene Heptachlor Indeno(1,2,3-cd)pyrene	N/A
Future off-site lifetime resident	6E-04	N/A	Groundwater Benzo(a)pyrene Benzo(b)fluoranthene Chloroform Dibenz(a,h)anthracene Heptachlor Indeno(1,2,3-cd)pyrene	N/A

NA = Not Applicable

HI = Hazard Index

HQ = Hazard Quotient

Bold = Exceeds USEPA Risk or Hazard Range.

Ing = Ingestion; Inh = Inhalation; Derm = Dermal

GI = Gastrointestinal

CNS = Central Nervous System

TCDD TE = Dioxin Toxicity Equivalent

a) Cumulative HIs and individual HQs are rounded to the nearest tenth. HIs > 1 and HQs > 0.1 are listed.

Table 6-5
Summary of Risks and Hazards
SWMU 41B
Page 1 of 2

Timeframe/Receptor	Risk	HI	Risk Drivers	Target Organ Segregation HI>1 ^a
Current maintenance worker	6E-06	2E-01	<u>Surface Soil</u> Arsenic <u>Sediment</u> Arsenic	N/A
Future maintenance worker	6E-06	2E-01	<u>Total Soil</u> Arsenic <u>Sediment</u> Arsenic	N/A
Future industrial worker	7E-05	2E+00	<u>Total Soil</u> Arsenic <u>Sediment</u> Arsenic <u>Groundwater</u> Tetrachloroethene Arsenic	No individual target organ exceeds 1.0
Future excavation worker	2E-06	2E+00	No individual chemical exceeded the 1E-06 risk.	CNS (1.2) - Soil [Manganese - Inh (0.52)]; Sediment [Manganese -Ing (.19), Derm (0.28)]
Future adult resident ^b	N/A	2E+00	N/A	No individual target organ exceeds 1.0
Future child resident ^b	1E-04	8E+00	<u>Total Soil</u> Arsenic <u>Sediment</u> Arsenic <u>Groundwater</u> Tetrachloroethene Arsenic	CNS (2.1) - Soil [Manganese - Ing (0.78), Derm (0.54)] Sediment [Manganese - Ing (0.17), Derm (0.12)] Skin (2.8) - Soil [Arsenic - Ing (0.92)] Groundwater [Arsenic - Ing (1.7)] Vascular System (2.8) - Soil [Arsenic - Ing (0.92)] Groundwater [Arsenic - Ing (1.7)]
Future lifetime resident	3E-04	N/A	<u>Total Soil</u> Arsenic TCDD TE <u>Sediment</u> Arsenic <u>Groundwater</u> Tetrachloroethene Arsenic	N/A

Table 6-5
Summary of Risks and Hazards
SWMU 41B
Page 2 of 2

Timeframe/Receptor	Risk	HI	Risk Drivers	Target Organ Segregation HI>1 ^a
Future off-site maintenance worker	8E-12	2E-08	None	N/A
Future off-site industrial worker	4E-05	4E-01	<u>Groundwater</u> Tetrachloroethene Arsenic	
Future off-site excavation worker	2E-09	8E-05	None	N/A
Future off-site adult resident	N/A	1E+00	N/A	No individual target organ exceeds 1.0
Future off-site child resident	7E-05	3E+00	<u>Groundwater</u> Tetrachloroethene Arsenic	Skin (1.7) - Groundwater [Arsenic - Ing (1.7)] Vascular System (1.7) - Groundwater [Arsenic - Ing (1.7)]
Future off-site lifetime resident	2E-04	N/A	<u>Groundwater</u> Tetrachloroethene Arsenic	N/A

NA = Not Applicable

HI = Hazard Index

HQ = Hazard Quotient

Bold = Exceeds USEPA Risk or Hazard Range

Ing = Ingestion; Inh = Inhalation; Derm = Dermal

CNS = Central Nervous System

TCDD TE = Dioxin Toxicity Equivalent

a) Cumulative HIs and individual HQs are rounded to the nearest tenth. HIs > 1 and HQs > 0.1 are listed.

b) Although lead was identified as a COPC in surface water, lead was not evaluated with the IEUBK model because the arithmetic mean concentration was less than the drinking water action level for lead.

6.4.1 Iron Margin of Exposure Evaluation

Because iron concentrations in soil resulted in an HQ of 0.5 or higher for the child resident at SWMU 41B, a “margin of exposure evaluation” was conducted. This evaluation consists of a comparison of estimated intake of iron to the RDA and concentrations known to cause adverse health effects in children. The calculated intake of iron via the route of ingestion is compared with amounts that are associated with an RDA of 10 mg/day (0.36 to 1.11 mg/kg-day) for children from 6 months to 10 years of age (USEPA, 1996a).

For SWMU 41A, the calculated intake of iron via ingestion of total soil was 0.53 mg/kg-day. Iron was not a COPC for SWMU 41A groundwater. The intake calculated for total soil at SWMU 41B was within the allowable range (0.36 to 1.11 mg/kg-day).

For SWMU 41B, the calculated intake of iron via ingestion of total soil was 0.55 mg/kg-day. Iron was not a COPC for SWMU 41B groundwater. The intake calculated for total soil at SWMU 41B was within the allowable range (0.36 to 1.11 mg/kg-day).

6.4.2 Background

Statistical evaluations were conducted to compare metals concentrations in soil at SWMUs 41A and 41B 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, Gehans 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. Gehans test was used because it was found to handle data sets with multiple detection limits better than the Wilcoxon Mann Whitney test. There is no background data set for groundwater.

For SWMU 41A, 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 41A that are above background concentrations include aluminum, arsenic, and iron for surface soil and aluminum, arsenic, and manganese for total soil.

For SWMU 41B, 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**. The COPCs identified for SWMU 41B that are greater than background concentrations include aluminum, arsenic, iron, and manganese for surface soil and aluminum, arsenic, iron, and manganese for total soil.

Table 6-6
Background Comparison for Surface Soil at SWMU 41 Area A

Soil COPC	Gehan Test ^{a, b} Site > Background?	Considered to be Background?
Aluminum	Yes	No
Arsenic	Yes	No
Cobalt	No	Yes
Iron	Yes	No
Manganese	No	Yes
Vanadium	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.

Table 6-7
Background Comparison for Total Soil at SWMU 41 Area A

Soil COPC	Gehan Test ^{a, b} Site > Background?	Considered to be Background?
Aluminum	Yes	No
Arsenic	Yes	No
Cobalt	No	Yes
Iron	No	Yes
Manganese	Yes	No
Vanadium ^b	No	Yes

^a Gehan Test, 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.

Table 6-8
Background Comparison for Surface Soil at SWMU 41 Area B

Soil COPC	Gehan Test ^{a, b} Site > Background?	Considered to be Background?
Aluminum	Yes	No
Arsenic	Yes	No
Cobalt	No	Yes
Iron	Yes	No
Manganese	Yes	No

^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.

Table 6-9
Background Comparison for Total Soil at SWMU 41 Area B

Soil COPC	Gehan Test ^{a, b} Site > Background?	Considered to be Background?
Aluminum	Yes	No
Arsenic	Yes	No
Cobalt	No	Yes
Iron	Yes	No
Manganese	Yes	No
Vanadium ^b	No	Yes

^a Gehan Test, 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.

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 41A and SWMU 41B, 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. 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. In addition, it is noted in *Section 2.3* that fill material covers both SWMUs 41 A and 41B. Therefore, it is possible that some soil samples that are collected at SWMU 41 may not be indicative of past disposal practices. However, these samples would be representative of current and potential future exposures at SWMU 41.

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.

As indicated in *Section 6.1.1.4*, SWMU 41A groundwater collected via the direct-push technique in 2007 yielded highly turbid samples with elevated concentrations of metals. To obtain data that would be expected to be more representative of exposures to groundwater at SWMU 41A, a new well was installed and a groundwater sample (and duplicate) were collected in October 2010

for evaluation in this HHRA. Because the assessment of groundwater is based on a single sample location, it is uncertain as to whether risks and hazards could be over- or underestimated.

It is noted that benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were identified as COPCs in SWMU 41A groundwater. These constituents were detected in the primary sample, but not in the duplicate sample. Because PAHs are relatively insoluble in water, the PAHs may have adsorbed to particulate matter in the sample or may be indicative of fluids used during the drilling process. Therefore, it is possible that the risks and hazards for the PAHs are over-estimated. When compared with ARARs, however, the concentrations of benzo(a)pyrene (2.75E-02 µg/L), benzo(b)fluoranthene (3.2E-02 µg/L), dibenzo(a,h)anthracene (3.3E-02 µg/L), and indeno(1,2,3-cd)pyrene (3.4E-02 µg/L) are below the MCL of 2.0E-01 µg/L for benzo(a)pyrene.

6.5.2 Selection of Chemicals for Evaluation

A comparison of maximum detected chemical concentrations to USEPA Regional SLs was conducted for surface soil, total soil, surface water, sediment, and groundwater. 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 are greater than their respective SLs) and the cumulative risk estimates would not be expected to be significantly greater. As presented on the non-detect method detection limit (MDL) screening tables, the maximum MDL was greater than the adjusted SLs for several chemicals in soil, surface water, sediment, and groundwater; therefore, the site-related risks and hazards could be underestimated for the risk assessments due to inadequate detection limits. It is also noted that, per agreement with USEPA Region 3, the groundwater data obtained from the October 2010 sampling event for SWMU 41A were screened using the Regional SLs dated April 2009. Although there have been changes in some Regional SL values since 2009, the 2009 values were used to be consistent with the screening of all other media in this HHRA. The results for the evaluations of non-detects at SWMU 41A and SWMU 41B are discussed in the following sections.

The reporting limits for chemicals that were not detected in surface soil, total soil, surface water, sediment, and groundwater at SWMU 41A were compared with SLs in **Appendix E-1, Tables E.1-3, E.1-5, E.1-7, E.1-9, and E.1-11**, respectively. As shown in **Appendix E-1, Table E.1-3**, reporting limits in surface soil were above SLs for 8 of 139 constituents (6 percent). These constituents include 1,2-dibromo-3-chloropropane, nitroglycerin, MCPA, MCPP, 2,6-DNT, benzo(a)pyrene, dibenz(a,h)anthracene, and n-nitroso-di-n-propylamine. One compound, 2,6-DNT, was selected as a COPC in groundwater at SWMU 41A. The PAHs, benzo(a)pyrene and dibenz(a,h)anthracene, could be associated with past disposal activities. Nitroglycerin has been detected elsewhere on the Installation. If these constituents are actually present, risk and hazard could be underestimated. However, the reporting limits were greater than 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 them would be less. For 15 of 139 constituents (11 percent) in surface soil, there were no SLs for comparison. These constituents include: chlorobromomethane, PETN, dichloroprop, dimethylphthalate, 1,3-dichlorobenzene, 2-nitroaniline, 3-nitroaniline, 2-nitrophenol, 4-nitrophenol, carbazole, di-octylphthalate,

dibenzofuran, 2-hexanone, 4-bromophenyl phenylether, and 4-chlorophenyl phenylether. These chemicals are not known to be associated with past disposal at SWMU 41A.

As shown in **Appendix E-1, Table E.1-5**, reporting limits in total soil were greater than SLs for 24 of 139 constituents (17 percent). These constituents include: 1,2-dibromo-3-chloropropane, benzidine, n-nitrosodimethylamine, nitroglycerin, aldrin, alpha-BHC, heptachlor, MCPA, MCPP, toxaphene, Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1260, 2,6-DNT, 3,3'-dichlorobenzidine, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and n-nitroso-di-n-propylamine. Past disposal of PCBs at SWMU 41A cannot be ruled out because Aroclor 1254 was selected as a COPC in total soil at SWMU 41A. In addition, it is possible that PAHs could have been associated with past disposal activities at SWMU 41A. If these constituents are actually present, risk and hazard could be underestimated. However, the reporting limits are greater than 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 be less. For 14 of 139 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 41A.

As shown in **Appendix E-1, Table E.1-7**, none of the reporting limits for 145 constituents in sediment were found to be above SLs. For 16 of 145 constituents (11 percent) in sediment, there were no SLs for comparison. These constituents include: chlorobromomethane, methylcyclohexane, PETN, dichloroprop, dimethylphthalate, 1,3-dichlorobenzene, 2-nitroaniline, 3-nitroaniline, 2-nitrophenol, 4-nitrophenol, carbazole, dibenzofuran, di-octylphthalate, 2-hexanone, 4-bromophenyl phenylether, and 4-chlorophenyl phenylether. These chemicals are not known to be associated with past disposal at SWMU 41A.

As shown in **Appendix E-1, Table E.1-9**, reporting limits in surface water were greater than SLs for 31 of 179 constituents (17 percent). These constituents include 1,2-dibromo-3-chloropropane, 1,2-dibromoethane, atrazine, nitroglycerin, arsenic, thallium, aldrin, dieldrin, MCPA, MCPP, toxaphene, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260, 1,4-dichlorobenzene, 2,6-DNT, 3,3'-dichlorobenzidine, 4,6-dinitro-o-cresol, benzo(a)pyrene, bis(2-chloroethyl)ether, bis(2-chloroisopropyl)ether, dibenz(a,h)anthracene, hexachlorobenzene, n-nitroso-di-n-propylamine, p-chloroaniline, pentachlorophenol, 1,1,2,2-TCA, and vinyl chloride. Some of these compounds were selected as COPCs in other media at SWMU 41A. Arsenic is a COPC in soil, sediment, and groundwater, Aroclor 1254 is a COPC in total soil and 2,6-DNT was selected as a COPC in groundwater. Vinyl chloride is a breakdown product of PCE, which was detected in groundwater at SWMU 41B. The PAHs, benzo(a)pyrene and dibenz(a,h)anthracene, could be associated with past disposal activities. Nitroglycerin has been detected elsewhere on the Installation. If these constituents are actually present, risk and hazard could be underestimated. However, the reporting limits were greater than 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 them would not go over. For 18 of 179 constituents (10 percent) in surface water, there were no SLs for comparison. These constituents include: chlorobromomethane, methylcyclohexane, PETN, total tetrachlorodibenzo-p-dioxin, dichloroprop, dimethylphthalate, 1,3-dichlorobenzene, 2-nitroaniline, 3-nitroaniline, 2-nitrophenol, 4-nitrophenol, carbazole, di-octylphthalate, dibenzofuran, 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 41A.

As shown in **Appendix E-1, Table E.1-11**, reporting limits in groundwater were greater than SLs for 65 of 165 constituents (39 percent). For 18 of 165 constituents (11 percent) in groundwater, there were no SLs for comparison. Several of these constituents were PCB and dioxin congeners. Aroclor 1254 was identified as a COPC in surface soil and total soil at SWMU 41A. Dioxins/furans expressed as a 2,3,7,8-TCDD toxicity equivalent was selected as a COPC in total soil at SWMU 41B and in surface water at SWMU 41A. Some of these constituents could potentially be site related. Some of these constituents could potentially be site-related. It is assumed, however, groundwater exposures at SWMU 41A involve limited exposure frequency and exposure duration for maintenance and industrial workers. In addition, while a residential scenario has been included for completeness, it is unlikely that SWMU 41A groundwater will be used for residential purposes in the future.

The reporting limits for chemicals that were not detected in surface soil, total soil, surface water, sediment, and groundwater at SWMU 41B were compared with SLs in **Appendix E-2, Tables E.2-3, E.2-5, E.2-7, E.2-9, and E.2-11**, respectively. As shown in **Appendix E-2, Table E.2-3**, reporting limits in surface soil were greater than SLs for 7 of 119 constituents (6 percent). These constituents include: nitroglycerin, MCPA, MCPP, 2,6-DNT, benzo(a)pyrene, dibenz(a,h)anthracene, and n-n-nitroso-di-n-propylamine. One compound, 2,6-DNT, was selected as a COPC in groundwater at SWMU 41A. The PAHs, benzo(a)pyrene and dibenz(a,h)anthracene, could be associated with past disposal activities. Nitroglycerin has been detected elsewhere on the Installation. If these constituents are actually present, risk and hazard could be underestimated. However, the reporting limits are greater than 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 go over. For 13 of 119 constituents (11 percent) in surface soil, there were no SLs for comparison. These constituents include: chlorobromomethane, PETN, dichloroprop, dimethylphthalate, 2-nitroaniline, 3-nitroaniline, 2-nitrophenol, 4-nitrophenol, carbazole, di-octylphthalate, dibenzofuran, 4-bromophenyl phenylether, and 4-chlorophenyl phenylether. These chemicals are not known to be associated with past disposal at SWMU 41B.

As shown in **Appendix E-2, Table E.2-5**, reporting limits in total soil were greater than SLs for 6 of 106 constituents (less than 1 percent). These constituents include: nitroglycerin, MCPA, MCPP, 2,6-DNT, dibenz(a,h)anthracene, and n-nitroso-di-n-propylamine. Of these, 2,6-DNT, was selected as a COPC in groundwater at SWMU 41A. One PAH, dibenz(a,h)anthracene, could be associated with past disposal activities. Nitroglycerin has been detected elsewhere on the Installation. If these constituents are actually present, risk and hazard could be underestimated. However, the reporting limits SLs that are based on a cancer risk of 1E-06 or HQ of 0.1. If the reporting limits for 2,6-DNT and dibenz(a,h)anthracene were compared with SLs based on 1E-05 and HQ of 1, these compounds would not exceed. For 13 of 106 constituents (12 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 41B.

As shown in **Appendix E-2, Table E.2-7**, the reporting limit for only one compound (nitroglycerin) out of 164 constituents in sediment exceeded SLs. Although it was not detected in any other media at SWMU 41A or 41B, nitroglycerin has been detected elsewhere on the

Installation. However, the reporting limit exceeds an SL based on an HQ of 0.1. If the reporting limit for nitroglycerin was compared with an SL based on an HQ of 1, the reporting limit would not exceed. For 19 of 164 constituents (12 percent) in sediment, there were no SLs for comparison. These constituents include: several dioxin congeners, chlorobromomethane, methylcyclohexane, PETN, dichloroprop, dimethylphthalate, 1,3-dichlorobenzene, 2-nitroaniline, 3-nitroaniline, 2-nitrophenol, 4-nitrophenol, carbazole, dibenzofuran, di-octylphthalate, p-chloro-m-cresol, 2-hexanone, 4-bromophenyl phenylether, and 4-chlorophenyl phenylether. Of these, dioxins/furans, expressed as a 2,3,7,8-TCDD toxicity equivalent, and methylcyclohexane were selected as COPCs in soil at SWMU 41B. Dioxins/furans were also selected as COPCs in surface water at SWMU 41A. The remaining chemicals are not known to be associated with past disposal at SWMU 41B.

As shown in **Appendix E-2, Table E.2-9**, reporting limits in surface water exceeded SLs for 17 of 132 constituents (13 percent). These constituents include: 1,2-dibromo-3-chloropropane, 1,2-dibromoethane, atrazine, nitroglycerin, 2,6-DNT, 3,3'-dichlorobenzidine, 4,6-dinitro-o-cresol, benzo(a)pyrene, bis(2-chloroethyl)ether, bis(2-chloroisopropyl)ether, dibenz(a,h)anthracene, hexachlorobenzene, n-nitroso-di-n-propylamine, p-chloroaniline, pentachlorophenol, 1,1,2,2-TCA, and vinyl chloride. Some of these compounds were selected as COPCs in other media at SWMU 41B. 1,2-dibromo-3-chloropropane, is a COPC in soil at SWMU 41B and 2,6-DNT is a COPC in groundwater at SWMU 41A. Vinyl chloride is a breakdown product of PCE, which was detected in groundwater at SWMU 41B. The PAHs, benzo(a)pyrene and dibenz(a,h)anthracene, could be associated with past disposal activities. Nitroglycerin has been detected elsewhere on the Installation. 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 them would not exceed. For 16 of 132 constituents (12 percent) in surface water, there were no SLs for comparison. These constituents include: chlorobromomethane, methylcyclohexane, PETN, dimethylphthalate, 1,3-dichlorobenzene, 2-nitroaniline, 3-nitroaniline, 2-nitrophenol, 4-nitrophenol, carbazole, di-octylphthalate, dibenzofuran, p-chloro-m-cresol, 2-hexanone, 4-bromophenyl phenylether, and 4-chlorophenyl phenylether. Of these, methylcyclohexane was selected as a COPCs in soil at SWMU 41B. The remaining chemicals are not known to be associated with past disposal at SWMU 41B.

As shown in **Appendix E-2, Table E.2-11**, reporting limits in groundwater exceeded SLs for 64 of 187 constituents (34 percent). For 39 of 187 constituents (21 percent) in groundwater, there were no SLs for comparison. Several of these constituents were dioxin congeners. Dioxins/furans expressed as a 2,3,7,8-TCDD toxicity equivalent was selected as a COPC in total soil at SWMU 41B and in surface water at SWMU 41A. Some of these constituents could potentially be site related. It is assumed, however, groundwater exposures at SWMU 41B involve limited exposure frequency and exposure duration for maintenance and industrial workers. In addition, while a residential scenario has been included for completeness, it is unlikely that SWMU 41B groundwater will be used for residential purposes in the future.

In general, these chemicals, if present in surface soil, total soil, surface water, sediment, and groundwater, could contribute additional risk and hazard at SWMU 41A and SWMU 41B. Therefore, risks and hazards associated with the site may be underestimated. Even if the risk and hazard were underestimated for groundwater, however, it is noted that the risk estimate already exceeds 1E-04 and the HI is well above 1.

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 41A and SWMU 41B are consistently higher or lower than background. However, the background data obtained may not fully characterize naturally-occurring metals levels in the material used to backfill SWMU 41A. 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.

For some COPCs without screening levels, the values used for screening were based on surrogate chemicals with similar structures and properties. The surrogates for this HHRA were based on proxy compounds as identified in VDEQ's Risk Assessment Guidance, Risk-Based Screening Levels Proxy Values (VDEQ, 2008). With the exception of the benzo(g,h,i)perylene and phenanthrene, the screening levels based on surrogate chemicals were only used to screen the detection limits for the non-detected constituents. Use of the screening levels of these compounds had no effect on the risks/hazards calculated in this HHRA.

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. However, sodium was identified as a COPC in SWMU 41A and SWMU 41B groundwater. In both cases, this essential nutrient was retained in the HHRA.

6.5.3 Exposure Assessment

The primary areas of uncertainty affecting exposure parameter estimation involve the assumptions regarding exposure pathways, the estimation of EPCs, 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 41A, the PEFs and VFs for the maintenance workers, industrial workers, and construction workers were based on the actual size of the site (0.19 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 volatilization factor values likely underestimate the inhalation risk and hazard for the residents. SWMU 41B is 1.08 acre in size; however, the PEFs and VFs for the workers and residents were based on 0.5 acres because the factors for the Q/C calculations were derived for sites between 0.5 to 500 acres (USEPA, 2002b). As a result, the risks and hazards for the inhalation pathway could be overestimated for SWMU 41B. The potential overestimation would not affect the conclusions for either site.

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 41A and SWMU 41B 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 acceptable risk range and HI. 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. For example, the biodegradation of PCE could result in the formation of vinyl chloride over time. Vinyl chloride is classified as a known human carcinogen. Therefore, the cancer risks associated with future exposures to groundwater may be underestimated.

When calculating EPCs from sample data using ProUCL, non-detect results are coded as “zeroes.” As indicated in the ProUCL output for SWMU 41 (**Appendices E-4 and E-5**), summary statistics, such as the arithmetic mean, are based on detected values only. For 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 ProUCL software typically gives a warning when data sets are too small (sample size < 10), which suggests that the 95% UCL values could be unreliable. If the 95% UCL exceeds the maximum detected value or if fewer than five samples are available, the maximum was conservatively used as a default EPC in this HHRA. Using a value that is based on one sampling location (i.e., the maximum) has associated uncertainty and it adds a great deal of conservatism to the assessment. Using the maximum value, however, is less uncertain than using potentially unreliable results.

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 EPCs for groundwater, however, were based on maximum values, which could result in an overestimation of risk or hazard.

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. For example, the exposure frequency for the industrial worker was assumed to be 225 days/year for 25 years. As stated in *Section 6.2.1*, the potential future industrial worker scenario represents a composite of the outdoor and indoor worker scenarios. This approach is consistent with previous HHRAs at RFAAP.

The EF for the industrial worker used in this HHRA (225 days/year) is different from the default exposure frequency of 250 days/year recommended by USEPA for the indoor worker (USEPA, 2002b). For soil, the difference in the EF is balanced by the difference in soil ingestion rates. For example, the incidental ingestion rate for the outdoor worker is 100 mg/day while the incidental ingestion rate for the indoor worker is 50 mg/day. Exposures to soil via the dermal

absorption and inhalation pathways for the indoor worker are assumed to be negligible. For groundwater, the difference between risks calculated for an exposure frequency of 250 days/year ($3.4\text{E-}06$) were slightly higher than risks calculated for 225 days/year ($3.1\text{E-}06$). The differences between the HIs (0.0056 versus 0.0062) were minimal as well. In either case, there was no change to the conclusions of the HHRA.

In addition, many USEPA (1991b) default exposure parameters are highly conservative and are based on risk management interpretations of limited data. For example, although current USEPA guidance recommends default 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 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.

In the evaluation of SWMU 41B groundwater, the uptake of arsenic in groundwater by homegrown fruits and vegetables was estimated for the residential scenario. To estimate the intake of fruits and vegetables for adults and children, a consumption rate of 18.6 grams/kg-day was obtained from USEPA's *Exposure Factors Handbook* (USEPA, 1997d). This value was based on consumption patterns for adults and has been consistently applied to risk and hazard calculations for both adults and children in previous HHRA's at RFAAP. More recent guidance, USEPA's *Child-Specific Exposure Factors Handbook* (USEPA, 2008c), has provided specific values for fruit and vegetable consumption by children. For example, based on 95th percentile consumption rates for children of 1 to 2 years old and 3 to 5 years old, the average intake value is estimated to be 48.4 grams/kg-day. This value is more conservative for children than the adult consumption rate assumed in this HHRA; therefore, risk and hazard are likely under-estimated for child residents. However, even if this value had been used in the HHRA, the risk and hazard for the intake of homegrown produce by hypothetical child residents at SWMU 41B would have been below the acceptable risk range and an HI of 1. The conclusions of the HHRA would not change.

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 *RAGS: Part E, Supplemental Guidance for Dermal Risk Assessment* (USEPA, 2004a). 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, 2000, 2004, 2006, 2007) indicate that metals such as aluminum, arsenic, cobalt, manganese, 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). Therefore, using the

dermal absorption factors to evaluate dermal absorption exposures to soil may result in an overestimation of risks.

The soil-to-skin adherence factors that were applied at SWMUs 41A and 41B are consistent with factors that are recommended in Exhibit 3-3 (Activity Specific-Surface Area Weighted Soil Adherence Factors) of U.S. EPA's *Risk Assessment Guidance for Superfund Part E, Supplemental Guidance for Dermal Risk Assessment* (USEPA, 2004a). The guidance provides different adherence factors for dry and wet soil conditions. For this HHRA, it was assumed that exposure scenarios involving wading activities would result in direct exposure to sediment. All sediment exposures were treated as "wet soil" to be conservative. An adherence factor of 0.6 mg/cm^2 was applied for the maintenance and excavation workers, as suggested. Although there are no specific adherence factors listed in Exhibit 3-3 (RAGS, Part E) for adult resident exposures to wet soil, an adherence factor of 0.2 mg/cm^2 was used. This value reflected the 95th percentile value for landscaping/rockery. It is also in the same range as the average value of adherence factors for farmers, rugby players, archaeologists, and reed gatherers (based on geometric mean) that are likely to have similar exposures to wet soil. The same value (0.2 mg/cm^2) was also used as the adherence factor (based on the geometric mean) for children playing in wet soil. These factors are also consistent with those applied to sediment exposures in previous HHRA's at RFAAP. These factors are conservative because some of the sediment would wash off during wading rather than adhere to the skin surface. Therefore, dermal exposures to sediment are likely to be over-estimated.

For exposures to COPCs in groundwater via dermal absorption, the USEPA's dermal guidance (USEPA, 2004a) cautions that the procedures for estimating dermal dose from water contact are very new. The dermal permeability estimates are probably the most uncertain of the parameters in the dermal dose equation. The equation used to calculate the term, DA_{event} , is based on a regression model that predicts the water permeability coefficient for organics. Statistical analysis of the regression equation provides the range of octanol/water partition coefficients (K_{ow}) and molecular weights where this regression model could be used to predict permeability coefficients (Effective Prediction Domain or EPD). For chemicals outside the EPD, such as PAHs and dioxins, a model for predicting the fraction absorbed dose (FA) is proposed for chemicals with a high K_{ow} , taking into account the balance between the increased lag time of these chemicals in the stratum corneum and the desquamation of skin during the absorption process. The following FAs in this HHRA were less than 1.0: dibenzo(a,h)anthracene (0.6), heptachlor (0.8), indeno(1,2,3-cd)anthracene (0.6), and 2,3,7,8-TCDD (0.5). The consequence is a net decrease in total systemic absorption. For example, by applying an FA of 0.5 to the calculation of DA_{event} , the risk is 50% lower than it would have been calculated without accounting for the EPD. In addition, the guidance (USEPA, 2004a) notes that particulate-bound chemicals in aqueous medium (e.g., suspended soil particles) would be considered much less bioavailable for dermal absorption due to inefficient adsorption of suspended particles onto the skin surface and a slower rate of absorption into the skin. Because PAHs and dioxins adsorb to soil, the detection of PAHs in SWMU 41A groundwater samples and dioxins in SWMU 41A surface water samples is possibly attributable to the presence of particulates. Therefore, risks due to dermal absorption could potentially be overestimated for the dioxins. Conversely, the permeability coefficients for the halogenated compounds (chloroform and PCE) are likely to be underestimated. Because halogenated chemicals have a lower ratio of molar volume relative to their molecular weight than hydrocarbons (due to the relatively weighty halogen atom), the K_p

correlation based on molecular weight of hydrocarbons will tend to underestimate permeability coefficients for halogenated organic chemicals (USEPA, 2004a).

Several models were used to evaluate exposure scenarios that involve the volatilization of COPCs from groundwater to air. These models include: the ASTM Model for volatilization from groundwater to ambient air, the Johnson & Ettinger Model for migration of VOCs from groundwater into indoor air, the VDEQ Trench Model for volatilization of VOCs from groundwater into a construction/utility trench, and the Foster-Chrostowski Shower Model for volatilization of VOCs from groundwater into shower air. The uncertainties associated with these models are discussed in the following sections.

The volatilization model outlined in ASTM RBCA Guidance (ASTM, 1995) was used to estimate the concentrations of chloroform and PCE in ambient or outdoor air at SWMU 41A and SWMU 41B, respectively, that originates from dissolved hydrocarbons in groundwater located some distance below ground surface (**Appendix E-1, Table E.1-40** and **Appendix E-2, Table E.2-40**). This model calculates a representative concentration in air based on the following assumptions:

- A constant dissolved concentration in groundwater.
- Linear equilibrium partitioning between the dissolved chemicals and groundwater and chemical vapors in the groundwater table.
- Steady-state vapor- and liquid-phase diffusion through the capillary fringe and vadose zones to ground surface.
- No loss of chemical as it diffuses towards the ground surface (i.e., no biodegradation).
- Steady well-mixed atmospheric dispersion for the emanating vapors within the breathing zone as modeled by a “box model” for air dispersion.

A number of uncertainties associated with this model would likely result in an overestimation of risk and hazard in this HHRA. First, the maximum concentrations of chloroform and PCE in groundwater were assumed to be the constant dissolved concentration. Use of the maximum value may over-estimate risk and hazard. Second, it is assumed that there is no loss of chemical due to biodegradation over time. This assumption is especially conservative with respect to exposure for the industrial worker scenario, which is based on an exposure duration of 25 years. Third, it is assumed that vapor concentrations remain constant over the duration of exposures and that all inhaled chemicals are absorbed.

The ASTM model also considers wind speed, mixing height, depth to groundwater, and diffusion coefficients in air and water. Uncertainty based on mechanisms such as partitioning, diffusion, and dispersion would be dependent on chemical-specific and site-specific conditions and could result in either over- or underestimation of chemical concentrations at SWMUs 41A and 41B. The area of SWMU 41A is relatively small (0.19 acre) and the depth to groundwater was based on one data point [32 ft or 975 centimeters (cm)]. The effect of fluctuations in the depth to groundwater on risk and hazard are uncertain. The depth to groundwater assumed for the calculations at SWMU 41B was based on the average depth to groundwater (54 ft or 1,646 cm). The shallowest depth to groundwater measured at SWMU 41B has been measured at 38 ft (or 1,158 cm). The soil type above the water table consists of gray limestone/dolomite bedrock. A layer of clayey gravel was encountered above bedrock. Because groundwater is relatively deep

and found in the bedrock at SWMU 41B, concentrations of PCE migrating from groundwater to the ground surface over time would likely be negligible.

The Johnson and Ettinger model (1991; USEPA, 2004b) was used to estimate indoor air concentrations of volatiles migrating from groundwater through the soil and into potential future on-site and off-site residences and buildings (**Appendix E-1, Table E.1-41** and **Appendix E-2, Table E.2-41**). As acknowledged in the *User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings* (USEPA, 2004b), the Johnson and Ettinger model "...was developed for use as an SL model and consequently is based on a number of simplifying assumptions regarding contaminant distribution and occurrence, subsurface characteristics, transport mechanisms, and building construction." Limitations and assumptions associated with the Johnson and Ettinger model are described in the *User's Guide* (USEPA, 2004b). These include:

Contaminant Distribution and Occurrence

- No contaminant free-liquid/precipitate phase present.
- Contaminant is homogeneously distributed within the zone of contamination.
- No contaminant sources or sinks in the building.
- Equilibrium partitioning at contaminant source.
- Chemical or biological transformations are not significant (i.e., the model will predict more intrusion).

For the SWMU 41A HHRA, the concentration of chloroform from a single sample was used as the input concentration in the model. For the SWMU 41B HHRA, the maximum concentration of PCE in groundwater was conservatively used as the input for the groundwater concentration in the model. Although homogeneous distribution is assumed, the maximum concentration is not likely to be representative of the chemical concentrations across the site. Also, neither sorption nor biodegradation is accounted for in the transport of vapor from the source to the base of the building. Vinyl chloride is a possible byproduct of biodegradation over time. Potential future cancer risks associated with vinyl chloride could result in an underestimation of risk. On balance, however, the risk and hazard associated with inhalation of COPCs in indoor air are likely to be overestimated.

Subsurface Characteristics

- Soil is homogeneous within any horizontal plane.
- All soil properties in any horizontal plane are homogeneous.
- The top of the capillary fringe must be below the bottom of the building floor in contact with the soil.
- The EPA version of the Johnson and Ettinger Model assumes the capillary fringe is uncontaminated.

Currently, the only structures nearby are below-grade concrete equalization basins that receive stormwater runoff, and it is likely that the area will remain industrial in nature. There are no buildings at SWMU 41A or SWMU 41B. Therefore, the location of the capillary fringe at SWMU 41A with respect to a building is hypothetical. Furthermore, the capillary fringe can be considered to be contaminated because volatile COPCs were detected in soil collected between 0

to 10 ft. None of these VOCs were identified as COPCs in groundwater at SWMU 41A. Therefore, the effect on risk and hazard would be expected to be negligible. Because the water level is below the rock layer in SWMU 41B, there is no capillary fringe. Due to the presence of the rock layer, the soil and the soil properties in any horizontal plane are not homogeneous. The *User's Guide* (USEPA, 2004b) acknowledges that "...In theory the limitations are readily conceptualized, but in practice the presence of these limiting conditions may be difficult to verify even when extensive characterization data are available." Although there are a number of limitations associated with the Johnson and Ettinger Model, it is likely that similar limitations are encountered at other RCRA and Superfund sites. The results of the risk assessments at RFAAP as well as others would be more uncertain if a less accepted or documented model was used.

Transport Mechanisms

- Transport is one-dimensional.
- There are two separate flow zones: diffusive and convective.
- Vapor-phase diffusion is the dominant mechanism for transporting contaminant vapors from contaminant sources located away from the foundation to the soil region near the foundation.
- There is a straight-line gradient in the diffusive flow zone.
- Diffusion through soil moisture is insignificant.
- Convective transport is likely to be most significant in the region very close to the basement or the foundation, and vapor velocities decrease rapidly with increasing distance from a structure.
- Vapor flow is described by Darcy's Law (i.e., porous media flow assumption).
- Steady state convection is assumed (i.e., the flow is not affected by barometric pressure or infiltration). Convective flow near the foundation is uniform (i.e., flow rate does not vary by location).
- Convective velocity through cracks or porous medium is uniform.
- Significant convective transport only occurs in the vapor phase.
- All contaminant vapors originating from directly below the basement will enter the basement, unless the floor and walls are perfect barriers. Contaminant vapors enter structures primarily through cracks and openings in the walls and foundation.

Because most of the inputs to the model are not collected during a typical site characterization, conservative inputs were estimated or inferred from available data and other non-site-specific sources of information. In addition, because there are currently no structures at or near SWMU 41A or SWMU 41B, the default values for a typical residential building were used to represent the building characteristics in the model. It was also assumed that the building would be constructed with a basement and would be located in an area with the shallowest depth to groundwater. The shallowest depths to groundwater at SWMU 41A and SWMU 41B are 32 ft and 38 ft, respectively. It is assumed that vapor velocities decrease rapidly with increasing distance from a structure. These assumptions contribute to a conservative estimates of the hypothetical chloroform and PCE concentrations in building air at SWMU 41A and SWMU 41B.

As stated in *Section 6.2.3*, EPA has not developed a standardized model for estimating concentrations of airborne VOCs released from groundwater during construction or excavation activities. Therefore, VDEQ's VRP trench model was used in this HHRA (**Appendix E-1, Table E.1-42** and **Appendix E-2, Table E.2-42**). Due to several conservative assumptions used in VDEQ's trench model, risks and hazards due to potential exposures to groundwater during the hypothetical excavation of a construction/utility trench are likely to be overestimated. The uncertainties associated with this model include:

- The single concentration of chloroform in SWMU 41A groundwater and maximum concentration of PCE in SWMU 41B groundwater were used to estimate exposures to chloroform and PCE in ambient air in a construction/utility trench. The use of the maximum value is likely to overestimate risk and hazard. In addition, the model does not account for the dilution, dissipation, or degradation of chloroform or PCE over time.
- The depth of the trench was set at VDEQ's default value at 8 ft. The depth to groundwater at SWMU 41A was measured at 32 ft and the depth to groundwater at the shallowest point at SWMU 41B is 38 ft. Migration of chloroform and PCE from these depths is unlikely.
- To be consistent with the other excavation/construction exposures in this HHRA, an exposure frequency of 250 days/year and exposure duration of 1 year were assumed for a worker in the trench. The default value for exposure time in the trench model was 4 hours per each day of excavation/construction work. As a practical matter, it is unlikely that the same individual(s) would work in a trench at SWMUs 41A and 41B for 4 hours each day for 1 year.

The Foster-Chrostowski (1987, 2003) shower room model was used to estimate the EPC of chloroform and PCE in air due to volatilization from groundwater during showering and applied to an adult resident (**Appendix E-1, Table E.1-43** and **Appendix E-2, Table E.2-43**). Although chloroform and PCE may volatilize into indoor air from most typical household uses of groundwater, showering likely represents the upper-bound for exposure. The warm water temperature of a shower facilitates volatilization and the receptor is confined in a relatively small space with the released VOCs. The showering scenario and the characteristics of a typical shower room have been studied sufficiently to permit the estimation of shower room air concentrations of VOCs.

There are several factors that contribute to the potential uncertainty of the results of the shower model (Foster-Chrostowski, 2003). These factors include chemical-specific input parameters (e.g., Henry's Law constants), calculation of mass-transfer coefficients, and indoor air compartment flow rates. The calculation of mass transfer coefficients is an important component of modeling volatilization and requires information on chemical-specific properties as well as the interfacial area across which volatilization can occur. Mass transfer can be affected by different water characteristics, such as water flow rate, shower nozzle type, droplet size, distribution, and water temperature. There are also uncertainties associated with the choice of the flow. For example, a plug flow model represents the mass transfer from a flowing water supply, such as a shower. Other model uncertainties include the exclusion of some sources of VOC volatilization into indoor air other than the water droplet in the shower. The Foster-Chrostowski model does not address volatilization from water after it has impacted nearby surfaces or as it drains from the floor of the shower. As a result, risk or hazard could be underestimated.

Finally, although the shower model focuses on indoor air concentrations associated with showering, it does not address other indoor air from uses of water such as bathing, air humidifiers, dish washing machines, clothes washing machines, toilets, and sinks. Therefore, with respect to chloroform and PCE in indoor air from all potential household uses, risk and hazard are likely to be underestimated.

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 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. For some COPCs, however, oral-based toxicity criteria were used to estimate risks from inhalation exposure through route-to-route extrapolation. For example, the inhalation RfC for TCDD TE is based on a dietary study (Cal EPA, 2000). The following uncertainties are 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 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.

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.

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.

For chemicals without IRIS toxicity criteria, provisional toxicity criteria were used where available (**Appendix E-1, Tables E.1-45 through E.1-48** and **Appendix E-2, Tables E.2-46 through E.2-49**). 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, 2,3,7,8-TCDD toxicity equivalents, chloroform, PAHs [benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene], aluminum, cobalt, iron, and vanadium for SWMU 41A and for 1,2-dibromo-3-chloropropane, 2,3,7,8-TCDD toxicity equivalents, PCE, aluminum, cobalt, iron, and vanadium at SWMU 41B. Provisional inhalation toxicity values were used for Aroclor 1254, 2,3,7,8-TCDD toxicity equivalents, chloroform, PAHs [benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene] 2,6-DNT, aluminum, and cobalt for SWMU 41A and 1,2-dibromo-3-chloropropane, 2,3,7,8-TCDD toxicity equivalents, PCE, aluminum, and cobalt for SWMU 41B. 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, 2009a, ATSDR, 2009). Using this oral RfD, the HQs of 1,000 and 2,500 were calculated for adult and child resident exposures to SWMU41A groundwater, respectively. 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). Therefore, the HQs for 2,3,7,8-TCDD are likely to be over-estimated. In addition, it is noted that n-hexane was used as a surrogate for methylcyclohexane. The oral toxicity value for n-hexane was obtained from HEAST. The HEAST document, however, has not been updated since 1997. 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.1-45 through E.1-48** and **Appendix E-2, Tables E.2-46 through E.1-49**). In some cases, chemicals with similar structures and properties served as surrogates. The values for these surrogates were consistent with those shown in VDEQ's Risk Assessment Guidance, Tables 4.1 and 4.2. (VDEQ, 2008). Because no toxicity values were available for p-chloro-m-cresol and methylcyclohexane, values for 3-methylphenol and n-hexane were used, respectively, as surrogates for these compounds in the assessment of total soil for SWMUs 41A and 41B. There are no toxicity values available or surrogates identified for 2-hexanone, which was identified as a COPC in total soil at SWMU 41B.

Maximum concentrations of sodium in groundwater at SWMUs 41A and 41B (90.6 mg/L and 3,030 mg/L, respectively) exceeded USEPA's drinking water advisory for sodium of 20 mg/L (USEPA, 2009b). Furthermore, this advisory is intended for individuals on a 500 mg/day restricted sodium diet. The taste threshold for sodium is 30 to 60 mg/L and is defined as the concentration at which the majority of consumers do not notice an adverse taste in drinking water. In addition to its poor aesthetic quality, groundwater at SWMUs 41A and 41B is unlikely to be used as source of drinking water in the future. 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 HQs for exposures by the construction worker. Although subchronic values for some chemicals are included in USEPA's database of PPRTVs, this web site 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 41A and SWMU 41B, however, hazards associated with individual COPCs for this pathway were below the target HI.

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.1-49 through E.1-70** and **Appendix E-2, Tables E.2-50 through E.2-71** 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.1-71 through E.1-92** and **Appendix E-2, Tables E.2-72 through E.2-93**.

6.6 HHRA Summary and Conclusions

This HHRA was performed to evaluate the potential human health effects associated with previous activities at SWMU 41A and SWMU 41B. 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. Off-site adult and child residents were also evaluated for potential exposures to groundwater in the event that groundwater migrates off site in the future.

6.6.1 SWMU 41A Summary

As presented in *Section 6.4*, the total cancer risk for current maintenance worker exposures to surface soil (2E-06) was within the acceptable 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 sediment (2E-06) was also within the acceptable risk range due to arsenic. The total HI for sediment was less

than 1. The total cancer risk for exposures to surface water (1E-05) was within the acceptable risk range due to dioxins/furans. The total HI for surface water was less than 1. Although there were no ingestion or dermal absorption pathways associated with groundwater for this receptor, one volatile COPC was identified in groundwater. Therefore, inhalation of volatiles from groundwater was evaluated. The total cancer risk was below the acceptable risk range and the total HI was less than 1.

For the future maintenance worker, the total cancer risk for exposures to surface soil (2E-06) was within the acceptable 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 (2E-06) was within the acceptable risk range due to arsenic. The total HI for total soil was less than 1. The total cancer risk for exposures to sediment (2E-06) was within the acceptable risk range due to arsenic. The total HI for sediment was less than 1. The total cancer risk for exposures to surface water (1E-05) was within the acceptable risk range due to dioxins/furans. The total HI for surface water was less than 1. Although there were no ingestion or dermal absorption pathways associated with groundwater for this receptor, one volatile COPC was identified in groundwater. Therefore, inhalation of volatiles from groundwater was evaluated. The total cancer risk was below the acceptable risk range and the total HI was less than 1.

For future industrial worker exposures to surface soil, the total cancer risk for exposures to surface soil (7E-06) was within the acceptable 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 (7E-06) was within the acceptable risk range due to arsenic. The total HI for total soil was less than 1. The total cancer risk for exposures to sediment (1E-05) was within the acceptable risk range due to arsenic. The total HI for sediment was less than 1. The total cancer risk for exposures to surface water (6E-05) was within the acceptable risk range due to dioxins/furans. The total HI for surface water (1E+00) was equal to 1. The total cancer risk associated with groundwater (3E-05) was within the acceptable risk range, primarily due to heptachlor. The total HI for groundwater was less than 1. When recalculated by target organ, only one organ system exceeded 1: central nervous system (CNS) (1.4).

For the future excavation worker, the total cancer risk for exposures to total soil (5E-07) was below the acceptable risk range of 1E-06 to 1E-04. The total HI for total soil was less than 1. The total cancer risk for exposures to sediment (5E-07) was below the acceptable risk range. The total HI for sediment was less than 1. The total cancer risk for exposures to surface water (1E-06) was equal to the lower limit of the acceptable risk range due to dioxins/furans. The total HI for surface water was less than 1. Although there were no ingestion or dermal absorption pathways associated with groundwater for this receptor, one volatile COPC was identified in groundwater. Therefore, inhalation of volatiles from groundwater was evaluated. The total cancer risk was below the acceptable risk range and the total HI was less than 1. When recalculated by target organ, only one organ system exceeded 1: CNS (1.2).

For the future hypothetical lifetime resident, the total cancer risk for exposures to total soil (3E-05) was within the acceptable risk range of 1E-06 to 1E-04 due to dioxins/furans and arsenic. The total HI for total soil was less than 1. The total cancer risk for exposures to sediment (4E-06) was within the acceptable risk range due to arsenic. The total HI for sediment was less than 1. The total cancer risk for exposures to surface water (2E-05) was within the acceptable risk range due to dioxins/furans. The total HI for surface water was less than 1. The total cancer risk associated with groundwater (6E-04) was above the acceptable risk range,

primarily due to benzo(a)pyrene, benzo(b)fluoranthene, chloroform, dibenzo(a,h)anthracene, heptachlor, and indeno(1,2,3-cd)pyrene. As discussed in *Section 6.5.1*, the elevated concentrations of PAHs are based on a single sample collected in October 2010. These PAHs were not reported in the duplicate sample. The concentrations of benzo(a)pyrene ($2.75\text{E-}05$ µg/L), benzo(b)fluoranthene ($3.2\text{E-}05$ µg/L), dibenzo(a,h)anthracene ($3.3\text{E-}05$ µg/L), and indeno(1,2,3-cd)pyrene ($3.4\text{E-}05$ µg/L) are below the MCL of benzo(a)pyrene.

The total HI for groundwater was less than 1. For the hypothetical child resident, the total cancer risk for exposures to total soil ($2\text{E-}05$) was within the acceptable risk range of $1\text{E-}06$ to $1\text{E-}04$ due to dioxins/furans and arsenic. The total HI for total soil ($4\text{E+}00$) was above 1, primarily due to manganese. The total cancer risk for exposures to sediment ($3\text{E-}06$) was within the acceptable risk range due to arsenic. The total HI for sediment was less than 1. The total cancer risk for exposures to surface water ($7\text{E-}06$) was within the acceptable risk range due to dioxins/furans. The total HI for surface water was less than 1. The total cancer risk associated with groundwater ($8\text{E-}05$) was within the acceptable risk range, primarily due to benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, heptachlor, and indeno(1,2,3-cd)pyrene. The total HI for groundwater was less than 1.

Off-site receptors were evaluated to address potential future migration of COPCs in groundwater. For the future maintenance worker, only the pathway for inhalation of volatiles in off-site groundwater was evaluated. The total cancer risk was below the acceptable risk range and the total HI was less than 1.

For future industrial workers, the total cancer risk associated with off-site groundwater ($3\text{E-}05$) was within the acceptable risk range, primarily due to heptachlor. The total HI for groundwater was below 1.

For the future excavation worker, only the pathway for inhalation of volatiles in off-site groundwater was evaluated. The total cancer risk was below the acceptable risk range and the total HI was less than 1.

For the future hypothetical lifetime resident, the total cancer risk associated with off-site groundwater ($6\text{E-}04$) was above the acceptable risk range, primarily due to benzo(a)pyrene, benzo(b)fluoranthene, chloroform, dibenzo(a,h)anthracene, heptachlor, and indeno(1,2,3-cd)pyrene. The total HI for groundwater was less than 1.

For the hypothetical child resident, the total cancer risk associated with off-site groundwater ($8\text{E-}05$) was within the acceptable risk range, primarily due to benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, heptachlor, and indeno(1,2,3-cd)pyrene. The total HI for groundwater was less than 1.

6.6.2 SWMU 41B Summary

As presented in *Section 6.4*, the total cancer risk for current maintenance worker exposures to surface soil ($3\text{E-}06$) was within the acceptable risk range of $1\text{E-}06$ to $1\text{E-}04$ due to arsenic. The total HI for surface soil was less than 1. The total cancer risk for exposures to sediment ($3\text{E-}06$) was within the acceptable risk range due to arsenic. The total HI for sediment was less than 1. The total cancer risk for exposures to surface water ($3\text{E-}08$) was below the acceptable risk range. The total HI for surface water was less than 1. The total cancer risk associated with groundwater ($8\text{E-}12$) was below the acceptable risk range. The total HI for groundwater was below 1.

For the future maintenance worker, the total cancer risk for exposures to surface soil (3E-06) was within the acceptable 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 acceptable risk range due to arsenic. The total HI for total soil was less than 1. The total cancer risk for exposures to sediment (3E-06) was within the acceptable risk range due to arsenic. The total HI for sediment was less than 1. The total cancer risk for exposures to surface water (3E-08) was below the acceptable risk range. The total HI for surface water was less than 1. The total cancer risk associated with groundwater (8E-12) was below the acceptable risk range. The total HI for groundwater was below 1.

For future industrial worker exposures to surface soil, the total cancer risk for exposures to surface soil (1E-05) was within the acceptable 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 (1E-05) was within the acceptable risk range due to arsenic. The total HI for total soil was less than 1. The total cancer risk for exposures to sediment (1E-05) was within the acceptable risk range due to arsenic. The total HI for sediment was less than 1. The total cancer risk for exposures to surface water (1E-07) was below the acceptable risk range. The total HI for surface water was less than 1. The total cancer risk associated with groundwater (4E-05) was within the acceptable risk range due to PCE and arsenic. The total HI for groundwater was below 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 acceptable risk range. The risks for individual COPCs were below the acceptable risk range. The total HI for total soil (1E+00) was equal to 1. The HIs for individual COPCs were below 1. The total cancer risk for exposures to sediment (7E-07) was below the acceptable risk range. The total HI for sediment was less than 1. The total cancer risk for exposures to surface water (3E-09) was below the acceptable risk range. The total HI for surface water was less than 1. The total cancer risk associated with groundwater (2E-9) was below the acceptable risk range. The total HI was below 1.

For the future hypothetical lifetime resident, the total cancer risk for exposures to total soil (6E-05) was within the acceptable risk range of 1E-06 to 1E-04 due to dioxins/furans and arsenic. The total HI for total soil was less than 1. The total cancer risk for exposures to sediment (5E-06) was within the acceptable risk range due to arsenic. The total HI for sediment was less than 1. The total cancer risk for exposures to surface water (5E-08) was below the acceptable risk range. The total HI for surface water was less than 1. The total cancer risk associated with groundwater (2E-04) was above the acceptable risk range, primarily due to PCE and arsenic. The total HI (1E+00) was equal to 1. The HIs for individual COPCs and target organs were below 1.

For the hypothetical child resident, the total cancer risk for exposures to total soil (4E-05) was within the acceptable risk range of 1E-06 to 1E-04 due to arsenic. The total HI for total soil (4E+00) was above 1, primarily due to arsenic and manganese. The total cancer risk for exposures to sediment (3E-06) was within the acceptable risk range due to arsenic. The total HI for sediment was less than 1. The total cancer risk for exposures to surface water (1E-08) was below the acceptable risk range. The total HI for surface water was less than 1. The total cancer risk associated with groundwater (7E-05) was within the acceptable risk range, primarily due to PCE and arsenic. The total HI (3E+00) was above 1, primarily due to arsenic and cobalt. When recalculated by target organ, the following organs exceeded 1: CNS (2.1), skin (2.8), and

vascular system (2.8). The margin-of-exposure evaluation for iron indicated that the iron intake was within the allowable range.

Off-site receptors were evaluated to address potential future migration of COPCs in groundwater. For the future maintenance worker, total cancer risk associated with off-site groundwater ($8\text{E-}12$) was below the acceptable risk range. The total HI was below 1.

For future industrial workers, the total cancer risk for exposures to off-site groundwater ($4\text{E-}05$) was within the acceptable risk range due to PCE and arsenic. The total HI was below 1.

For the future excavation worker, the total cancer risk for exposures to off-site groundwater ($2\text{E-}9$) was below the acceptable risk range. The total HI was below 1.

For the future lifetime resident, the total cancer risk for exposures to off-site groundwater ($2\text{E-}04$) was above the acceptable risk range, primarily due to PCE and arsenic. The total HI ($1\text{E}+00$) was equal to 1. The HIs for individual COPCs and target organs were below 1.

For the child resident, the total cancer risk for exposures to off-site groundwater ($7\text{E-}05$) was within the acceptable risk range, primarily due to PCE and arsenic. The total HI ($3\text{E}+00$) was above 1, primarily due to arsenic and cobalt. When recalculated by target organ, the following organs exceeded 1: skin (1.7), and vascular system (1.7).

7.0 SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

A SLERA was performed at each site to provide an estimate of current and future ecological risk associated with potential hazardous substance releases at SWMU 41 Areas A and/or B. Common methods and procedures are presented in *Section 7.1*, and individual results for SWMU 41 Area A and SWMU 41 Area B 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 SWMU 41 Areas A and B 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 41 Areas A and B. The results of the SLERAs contribute to the overall characterization of the sites and the scientific/management decision point (SMDP) 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 MWP* (URS, 2003), the *RFAAP Site Screening Process* (USEPA, 2001c), 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 (ERAGS): Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997c). 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 41 Area A and SWMU 41 Area B, 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 41 Area A and SWMU 41 Area B.

Concentrations of chemicals were measured in surface soil, sediment, and surface water which were the relevant environmental media at SWMU 41 Areas A and B. Groundwater that may have been collected in association with SWMU 41 is being assessed under MWP Work Plan Addendum 009, "Horseshoe Area Groundwater Study" (IT, 2002b).

Using available concentration data, the SLERAs were performed by following Steps 1 and 2 of USEPA (1997c). Step 1 includes a screening-level problem formulation and ecological effects evaluation, and Step 2 includes a screening level preliminary exposure estimate and risk calculation. The SLERA is organized as follows: General SWMU 41 Site Characterization (*Section 7.1.1*); Methodologies for the Identification of Chemicals of Potential Ecological Concern (COPECs) 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 41 Area A and Area B Site Characterization

This section includes a general discussion of the Installation, vegetative communities, a species inventory, and a discussion on threatened and endangered species. SWMU 41 is located in the southeast section of the MMA at RFAAP (**Figure 1-1**). **Figure 2-1** shows the layout of the site, which consists of two non-contiguous disposal areas (Areas A and B) for red water ash, a byproduct of combustion of TNT production wastewater (i.e., “red water”).

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 SWMU 41 during the Installation-wide biological survey of 1999. Five state-listed rare plants were observed at RFAAP during this survey: *Clematis coactails*, *Cystopteris 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

¹maple, buckeye, beech, tuliptree, oak, linden

²maple, birch, beech, hemlock

A Shaw ecologist performed site reconnaissance activities in 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

Area A is located approximately 100 ft west of Stroubles Creek at an elevation of approximately 1,730 to 1,735 ft msl. The ground surface slopes steeply from the edge of Area A toward the north and east toward Stroubles Creek. The burial area in Area B is approximately 550 ft southwest of Area A and approximately 70 to 100 ft west of an unnamed tributary of Stroubles Creek. The ground surface in Area B slopes toward the north, northeast, and northwest from an elevation of approximately 1,800 ft msl to a minimum elevation of approximately 1,776 ft msl. The land east and northwest of Area B slopes steeply toward a drainage ditch and an unnamed tributary of Stroubles Creek, respectively.

7.1.1.3 Groundwater

As mentioned previously, groundwater is being evaluated separately under the Horseshoe Area Groundwater Study. Surface water and sediment samples were collected in Stroubles Creek and an unnamed tributary to Stroubles Creek in the proximity of SWMU 41. Sediment and surface water from the streams are the likely exposure points for ecological receptors; therefore, groundwater was not evaluated as part of the SLERA.

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 wetlands at SWMU 41 Areas A and B. 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 aerial photograph in **Appendix F-1**. As shown in **Appendix F-1**, the area surrounding SWMU 41 Areas A and B is primarily maintained grass, with some trees located along the edges of the sites. As shown in the site aerial photograph, SWMU 41 Areas A and B are bordered to the east and south by successional forest habitat.

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 SWMU 41 Areas A and B, 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 oligosanthos*, *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 plants 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 that may be within or near 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 7.1.1.1*, no threatened, rare, or endangered species have been documented at SWMU 41 Areas A and B.

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

Common Name	Scientific Name	Federal Status	State Status
Midland sedge	<i>Carex mesochorea</i>	not available	Watchlist
Shaggy false gromwell	<i>Onosmodium hispidissimum</i>	not available	Watchlist
Regal fritillary butterfly	<i>Speyeria idalia</i>	not available	State threatened
Henslow's sparrow	<i>Ammodramus henslowii</i>	not available	State threatened
Loggerhead shrike	<i>Lanius ludovicianus</i>	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 SWMU 41 Areas A and B.

7.1.2 Methodologies for the Identification of COPECs and Concentration Statistics

Using the chemical results from environmental media samples collected at SWMU 41 Areas A and B, 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 7.2.2*). 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 **Tables 7-5 and 7-20** for SWMU 41 Area A and SWMU 41 Area B, 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, as well as sediment and surface water data from Stroubles Creek and an unnamed tributary to Stroubles Creek, have been considered. The 0-2 ft soil 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 SWMU 41 Area A and Area B 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-detected 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 QC 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 B, 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 41 Areas A and B are detailed in *Sections 7.2.2 and 7.3.2*, respectively.

Dioxin-like compounds (PCDDs and PCDFs) were not detected in soil at SWMU 41 Areas A or B, but they were detected in surface water and sediment at Area A and in sediment at Area B. For the SWMU 41 Areas A and B 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 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, 2000c). 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 10 surface soil samples collected at various MMA sites resulted in a soil pH range of 4.00 to 7.57. Since the lowered pH from these soil samples (4.00) is less than a pH of 5.5, it is possible that aluminum is a concern for direct contact exposure. 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, but not for food chain exposure.

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 typically 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.

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 SWMU 41 Areas A and B 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**.

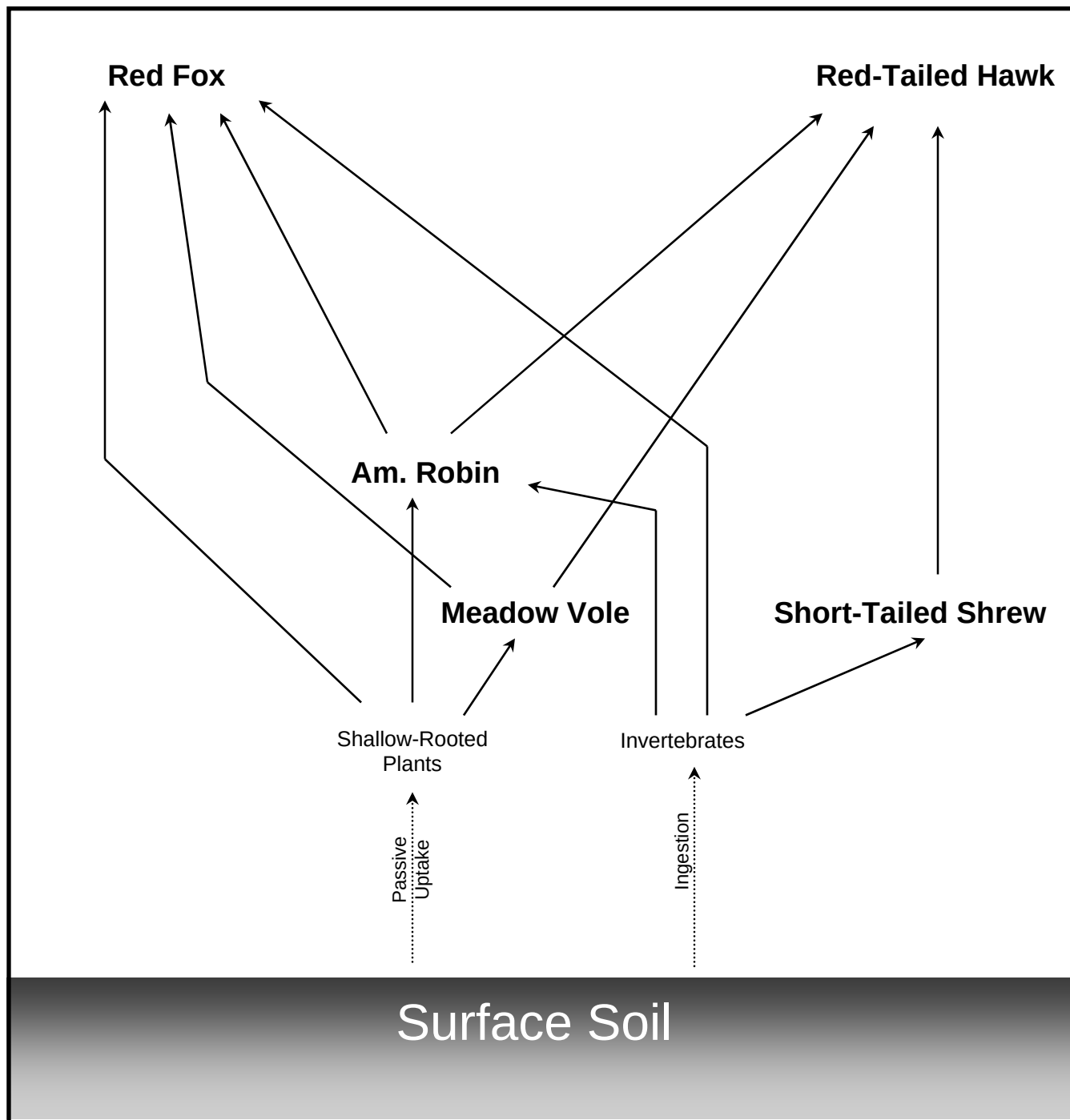
The meadow vole, shrew, and robin represent the prey base for the larger predators of the area (represented by the red-tailed hawk and the red fox). A terrestrial food web is presented in **Figure 7-1**. Many of these species have limited home ranges, particularly the meadow vole, shrew, and American 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

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



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.

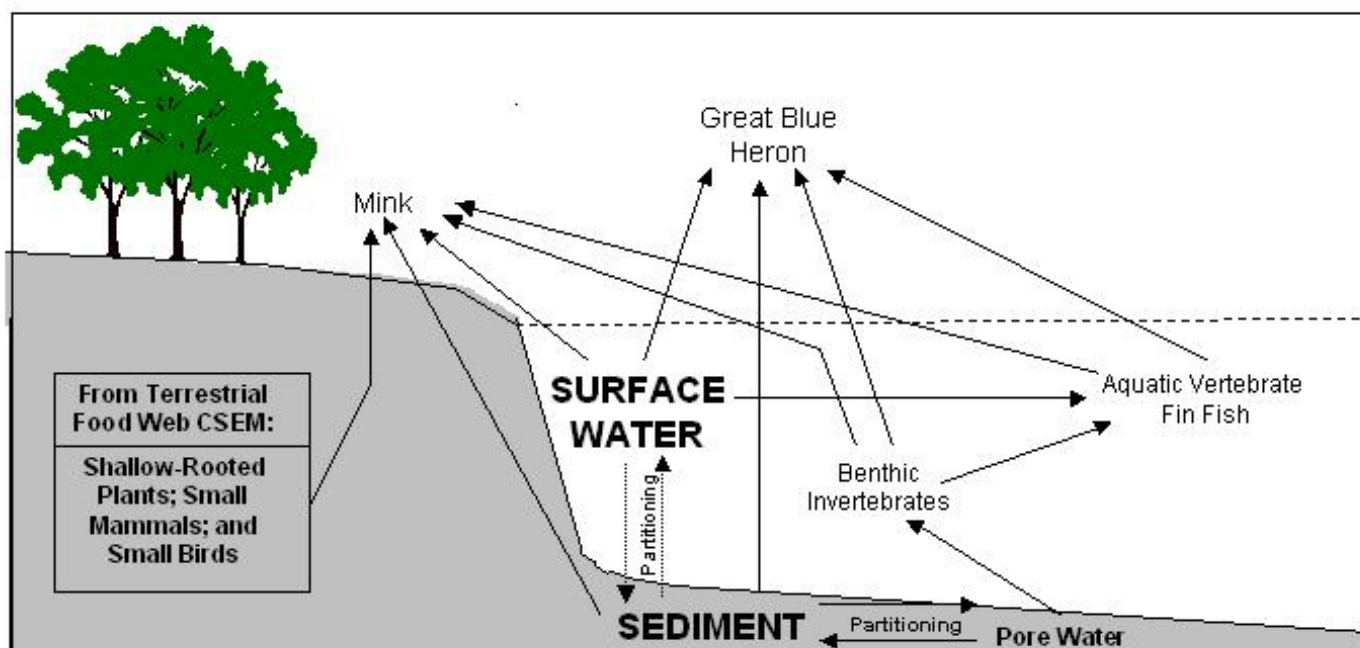
7.1.3.2 Aquatic Receptors

Two representative aquatic receptor species that are expected or possible in the area of the SWMU 41 Areas A and B 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 aquatic plants and other aquatic biota were assessed by comparing measured surface water and sediment COPEC concentrations with available direct-contact criteria. The two animal species selected include the great blue heron (*Ardea herodias*) (medium, piscivorous

bird) and the mink, (small, omnivorous mammal). Data used to model exposure for these species are summarized in **Appendix F-2, Table F-1**.

An aquatic food web is presented on **Figure 7-2**. The selected aquatic receptor species have a potential for high abundance at the sites that have adequate aquatic habitat; also, sufficient toxicological information (with the exception of some COPECs for the bird species) is available in the literature for comparative and interpretive purposes. Both of the species are considered important to the stability of the local ecological food chain and biotic community. Finally, the selected species have readily-available exposure data, as summarized in the *Wildlife Exposure Factors Handbook* (USEPA, 1993).

Figure 7-2
Simplified Aquatic Food Web Conceptual Site Exposure Model (CSEM)



Receptor profiles for these two selected species are presented in the following paragraphs.

Great Blue Heron. The great blue heron is the largest member of its group in North America (99 to 132 centimeters) (Bull and Farrand, 1995), with body weights ranging from 2.2 to 2.58 kg (USEPA, 1993). It ranges from coastal Alaska, and Nova Scotia south to Mexico (Bull and Farrand, 1995). Habitat of this heron includes both fresh and marine waters, including freshwater lakes and rivers, brackish marshes, lagoons, mangroves, and coastal wetlands, particularly where small fish are plentiful (USEPA, 1993). Great blues tend to nest in dense colonies, or heronries. The location of the heronry is generally close to foraging grounds, and tall trees are preferred over shorter trees or bushes for nest sites. Fish are the preferred prey, but the heron will also eat crustaceans, amphibians, reptiles, insects, birds, and mammals. Foraging home range may be as great as 24 kilometers; however, an average home range of 21 acres is used in the current assessment. Population densities along streams and rivers range from 2.3 to 3.6 birds per kilometer (USEPA, 1993). Once a year the female will lay 2 to 7 eggs (Bull and Farrand, 1995), and the first year mortality rate is approximately 64 percent (USEPA, 1993).

Mink. The mink is the most abundant and widespread carnivorous mammal in North America. Mink are distributed throughout North America, except in the extreme north of Canada, Mexico, and arid areas of the southwestern United States. Mink do not undergo hibernation and are active year-round. Mink are particularly sensitive to PCBs and similar chemicals. Mink body size varies greatly throughout its range, with males weighing markedly more than females. Males measure from 33 to 43 cm with an 18 to 23 cm tail, and females measure from 30 to 36 cm, with a 13 to 20 cm tail. An average body weight of 1.02 kg has been used for purposes of the current assessment, and body weights range from 0.55 to 1.73 kg (USEPA, 1993).

Mink are found associated with aquatic habitats of every kind, including waterways such as rivers, streams, lakes, and ditches, as well as swamps, marshes, and backwater areas. Mink prefer irregular shorelines to more open exposed banks. They also tend to use brushy or woody cover adjacent to the water, where cover for prey is abundant and where downfall and debris provide den sites. Mink are predominantly nocturnal hunters. Shorelines and emergent vegetation are the mink's principal hunting areas. Mink are opportunistic feeders, taking whatever is abundant. Mammals can be the mink's most important prey year-round, but mink also hunt aquatic prey such as fish, amphibians, and crustaceans and other terrestrial prey such as birds, reptiles, and insects, depending on the season. In winter, mink often supplement their diet with fish. Based on information presented in the *Wildlife Exposure Factors Handbook* (USEPA, 1993), some vegetation in mink's diet occurs, based on stomach content studies (an estimate of 18 percent vegetation intake by mink is presented in **Appendix F-2, Table F-1**).

The home range of mink encompasses both their foraging areas around waterways and their dens. Home range depends mostly on food abundance, but also on the age and sex of the mink, season, and social stability. In winter, mink spend more time near dens and use a smaller portion of their range than in summer. Adult male home ranges are generally larger than female home ranges, particularly during the mating season when males may range over 1,000 hectares. For the purposes of this assessment an average home range of 35 acres was used (USEPA, 1993).

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 sites, 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).

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, 1997c) 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 SWMU 41 Areas A and B 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_0) 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 adverse 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/sediment dwelling invertebrates.

The food web CSEMs were developed to illustrate how the selected terrestrial and aquatic species are ecologically linked. For terrestrial and aquatic invertebrates, small prey items, fish, 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, 1997c).

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 sites 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 samples collected from the MMA range from about 4.0 to 7.6. 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/or sediment, 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-2, Tables F-2 through F-29**.

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, soil-to-small mammals and birds, sediment-to-aquatic invertebrates, and surface water-to-fish are presented in **Appendix F-2, Tables F-31, F-32, F-33, F-34, and F-35**, 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, 2001c) 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-31**) are based on information from Bechtel Jacobs (1998a), USEPA (2008b), Efroymsen (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:

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

where:

$\text{Log } K_{ow}$ = log octanol-water partition coefficient (see **Appendix F-2, Table F-31**)

In order to estimate Tier 1 and Tier 2 BAF/BCF plant uptake values using the Travis and Arms (1988) regression equation, the log K_{ow} value from the USEPA Estimation Programs Interface (EPI) Suite program (USEPA, 2007c) was used. BAF/BCF values estimated for organics using the Travis and Arms (1988) equation ranged from 0.004 (for TCDD and Aroclor 1254) to 5.2 (nitroglycerin) for the Tier 1 and Tier 2 approaches (**Appendix F-2, Table F-31**).

Soil-to-earthworm BAF/BCF values (**Appendix F-2, Table F-32**) are based on information from USEPA (2008b), 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 Soil Screening Level (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-33**) are based on information from USEPA (2008b) and Sample et al. (1998b). Values are based on regression equations (USEPA, 2008b) 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.

Sediment-to-aquatic invertebrate BAF/BCF values (**Appendix F-2, Table F-34**) are based on information from Bechtel Jacobs (1998b). If no uptake value was available for inorganic COPECs, geometric means of the available inorganic uptake values from Bechtel Jacobs (1998b) were used: the geometric mean of the 90th percentile values (2.1) was used for the Tier 1 BAF/BCF value and the geometric mean of the median values (0.42) was used for the Tier 2 BAF/BCF value. If no uptake value was available for organic COPECs, a soil-to-terrestrial invertebrate BAF/BCF value was used (from **Appendix F-2, Table F-32**).

Water-to-fish BAF/BCF values (**Appendix F-2, Table F-35**) are based on information from IAEA (1994), Bintein and Devillers (1993), USEPA (1999), and USEPA (1989c). The Tier 1 value was the maximum BAF/BCF value available from the literature, while the Tier 2 value used represents a conservative, yet more realistic uptake value.

For surface water organic COPECs that did not have available literature uptake values from IAEA (1994), the following equation from Bintein and Devillers (1993) was used to estimate the BAF/BCF, along with the COPEC-specific K_{ow} :

$$\text{LogBAF/BCF} = 0.910 \times \text{Log}K_{ow} - 1.975 \times \text{Log}(6.8 \times 10^{-7} \times K_{ow} + 1) - 0.786$$

where:

Log K_{ow} = log octanol-water partition coefficient (see Appendix F-2, Table F-35)

Fish BAF/BCF values estimated using the Bintein and Devillers (1993) equation ranged up to 7,680 (for TCDD) (**Appendix F-2, Table F-35**). Both Tier 1 and Tier 2 approaches used the log K_{ow} value from the USEPA EPI Suite program (USEPA, 2007c).

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); EcoSSLs (USEPA, 2008b); Ecorisk Database, Release 2.2 (LANL, 2005); Toxicological Profile for Silver, U.S. Public Health Service (ATSDR, 1990); Toxicological Profile for 1,1,2,2-TCA, U.S. Public Health Service (ATSDR, 1996); PAH Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review (Eisler, 1987); TERRETOX, <http://www.epa.gov/ecotox>; Terrestrial Toxicity Database (USACHPPM, 2002); SLERA Protocol for Hazardous Waste Combustion Facilities (USEPA, 1999); OPP (Office of Pesticide Programs) Environmental Effects Database (USEPA, 2000d); and IRIS (USEPA, 2008a). Some values were extrapolated to chronic no-observed-adverse-effect level (NOAEL) or lowest-observed-adverse-effect level (LOAEL) values using recommended Tri-Service (Wentzel et al., 1996) uncertainty factors (UFs).

7.1.6.2 Development of Toxicity Reference Values

Toxicity reference values (TRVs) were selected from available data for use in the SWMU 41 Areas A and B 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-36 and F-37** 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 LD₅₀ 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-36 and F-37**. 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 UFs 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-38** 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 or via reviewing site photographs. The overall health of the plant community at the sites 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 SWMU 41 Areas A and B are estimated in the SLERAs. The risk estimation has been performed through a series of quantitative HQ calculations that compare receptor-specific exposure doses 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. Whether or not HQ summation was appropriate and scientifically defensible is based on whether the chemicals that have a similar mode of toxicological action (see *Sections 7.2.3.2 and 7.3.3.2*). 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 and aquatic receptors at the SWMU 41 Areas A and B are presented in risk characterization tables, referenced in each site SLERA section, for the seven selected receptor species.

7.1.8 Approach for the Evaluation of Direct Contact Toxicity

For direct contact exposure for soil invertebrates to COPECs in surface soil, sediment, and surface water; measured COPEC concentrations were simply compared with direct contact benchmarks appropriate for these communities. COPEC media concentrations are compared with Biological Technical Assistance Group (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, sediment, and surface water. 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, 2008b), 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 **Tables 7-16** (Area A) and **7-31** (Area B).

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):

- National Oceanic and Atmospheric Administration (NOAA) SQuiRT (Buchman, 1999). Most conservative target value used.
- 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, 2008b).
- ORNL (1997a, ES/ER/TM-85/R3), screening benchmarks for plants.
- ORNL (1997b, ES/ER/TM-126/R2), screening benchmarks for earthworms.

7.1.8.2 Sediment

As there are no promulgated sediment screening criteria for aquatic organisms potentially exposed to COPECs in sediment collected from SWMU 41 Areas A and B, a weight-of-evidence approach was used, where the more sediment benchmarks exceeded by the COPEC concentration, the greater the potential for adverse effects. The results are summarized in **Tables 7-17** (Area A) and **7-32** (Area B). As most sediment-dwelling aquatic biota are relatively non-mobile, maximum detected sediment concentrations are used. In addition, an exposure concentration more representative of potential community-level effects is also used in the evaluation, expressed as the 95% UCL. Sediment benchmarks used to assess direct contact exposure include the following:

- BTAG Screening Values (USEPA, 2006).
- Threshold Effect Concentrations from Assessment and Remediation of Contaminated Sediments (ARCS) program (ORNL, 1997c).
- Probable Effect Concentrations from ARCS program (ORNL, 1997c).
- No Effect Concentrations from ARCS program (ORNL, 1997c).
- Sediment Quality Benchmarks (ORNL, 1997c).
- Canadian Interim Sediment Quality Guidelines (CCME, 2003).
- Canadian Probable Effects Levels (PELs) (CCME, 2003).
- NOAA Effect Range – Low values (ORNL, 1997c).
- NOAA Effect Range – Median (ORNL, 1997c).
- Florida Department of Environmental Protection (FDEP) Threshold Effect Levels (ORNL, 1997c).
- FDEP PEL (ORNL, 1997c).
- Washington State Adverse Effect Thresholds (ORNL, 1997c).

7.1.8.3 Surface Water

For aquatic organisms potentially exposed to COPECs in surface water collected from SWMU 41 Areas A and B, comparison of the EPC to promulgated water quality criteria or a weight-of-evidence approach (for constituents without promulgated criteria) was used. The results are summarized in **Tables 7-18** (Area A) and **7-33** (Area B). It should be noted that because of the nature of various benchmark sources, promulgated water quality criteria [e.g., National Recommended Water Quality Criteria (NRWQC) and Virginia Water Quality Standards] were determined to be more critical during the evaluation than non-promulgated benchmarks. COPEC selection was based on whether or not promulgated criteria were exceeded or when no promulgated criteria were available, whether more than half of the available surface water benchmarks were exceeded. As some aquatic biota are relatively non-mobile, maximum detected surface water concentrations are used, in addition to a more realistic exposure concentration expressed as the 95% UCL. Surface water benchmarks used to assess direct contact exposure include the following:

- USEPA Region III BTAG SLs (July 2006). Values are for freshwater.
- USEPA (2009b) - 4304T. NRWQC.
 - o It should be noted that, for copper, the current version of the NRWQC (USEPA, 2010) recommends the use of the Biotic Ligand Model (BLM) to derive site-specific copper criteria for freshwater environments. However, as the BLM requires ten site-specific water quality parameter inputs, which are not available for SWMU 41 surface water, the copper criteria from USEPA (2009b), based on hardness alone, have been used.
- Virginia Water Quality Standards, 9 VAC 25-260, October 2008.
- ORNL. 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision, ES/ER/TM-96/R2.
- USEPA Region 4 Ecological Benchmark Screening Values for Surface Water (2000e).

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 MDCs less than the background UTL and 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).

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, sediment, and surface water analytical samples. The uncertainty associated with these constituents' detection limits for SWMU 41 Areas A and B, was evaluated by presenting a comparison of the maximum detection limit for each non-detect constituent with a conservative ecological toxicity screening value (see *Sections 7.2.6 and 7.3.6*).

Some of the non-detect constituents had maximum detection limits that exceeded the screening criteria. 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, 1997a).

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 HQ 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 UF 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 HQ 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 41, Area A, Screening Level Ecological Risk Assessment

This section presents the SLERA for SWMU 41 (Red Water Ash Burial Site), Area A. 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

SWMU 41 is located in the southeast section of the MMA at RFAAP (**Figure 1-1**). **Figure 2-1** shows the layout of the site, which consists of two non-contiguous disposal areas (Areas A and B) for red water ash, a byproduct of combustion of TNT production wastewater (i.e., “red water”). Area A is an approximate 0.19-acre (approximately 93 ft by 109 ft) former unlined lagoon area, which has been backfilled with up to 15 ft of fill. This lagoon received rinsate from ash transport vehicle rinsing (USEPA, 1987).

Surface soil, sediment, and surface water 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).

Table 7-5
SWMU 41 Area A Sample Groupings

Surface Soil	Sediment	Surface Water
41SB2A	41SD5	41SW5
41SB3A	41SD6	41SW6
41SB4A	41SD7	41SW7
41SB5A	41SD08	41SW08
41TP2A	41SD09	41SW09
	41SD10	41SW10

7.2.2 Summary of COPEC Selection

Tables 7-6 and 7-7 (surface soil), **7-8 and 7-9** (sediment), and **7-10 and 7-11** (surface water) have been prepared for detected constituents with the following information:

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

Table 7-6
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Direct Contact Exposure at SWMU 41 Area A
Page 1 of 2

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
Surface Soil	120-82-1	1,2,4-Trichlorobenzene	3.40E-03	3.40E-03	mg/kg	41TP2A	1/5	5.00E-03 - 5.00E-03	Yes	DET
	78-93-3	2-Butanone	4.70E-03	3.80E-02	mg/kg	41TP2A	5/5	N/A	Yes	DET
	50-29-3	4,4-DDT	1.20E-03	1.20E-03	mg/kg	41SB2A	1/2	2.00E-02 - 2.00E-02	Yes	DET
	67-64-1	Acetone	2.40E-02	5.50E-02	mg/kg	41SB3A	5/5	N/A	Yes	DET
	5103-71-9	alpha-Chlordane	1.50E-03	1.50E-03	mg/kg	41SB2A	1/2	2.00E-02 - 2.00E-02	Yes	DET
	11097-69-1	Aroclor 1254	1.50E-01	1.50E-01	mg/kg	41SB2A	1/2	3.30E-02 - 3.30E-02	Yes	DET
	71-43-2	Benzene	2.40E-04	5.20E-04	mg/kg	41SB3A	4/5	5.00E-03 - 5.00E-03	Yes	DET
	117-81-7	bis(2-Ethylhexyl) phthalate	1.60E-02	2.00E-01	mg/kg	41SB2A	5/5	N/A	Yes	DET
	75-15-0	Carbon disulfide	1.30E-03	5.00E-03	mg/kg	41TP2A	5/5	N/A	Yes	DET
	156-59-2	cis-1,2-Dichloroethene	1.10E-02	1.10E-02	mg/kg	41TP2A	1/5	5.00E-03 - 5.00E-03	Yes	DET
	60-57-1	Dieldrin	1.40E-03	1.40E-03	mg/kg	41SB2A	1/2	2.00E-02 - 2.00E-02	Yes	DET
	84-74-2	Di-n-butyl phthalate	3.60E-02	2.10E-01	mg/kg	41TP2A	5/5	N/A	Yes	DET
	33213-65-9	Endosulfan II	1.00E-03	1.00E-03	mg/kg	41SB2A	1/2	2.00E-02 - 2.00E-02	Yes	DET
	72-20-8	Endrin	6.40E-03	6.40E-03	mg/kg	41SB2A	1/2	2.00E-02 - 2.00E-02	Yes	DET
	53494-70-5	Endrin ketone	1.70E-03	1.70E-03	mg/kg	41SB2A	1/2	2.00E-02 - 2.00E-02	Yes	DET
	206-44-0	Fluoranthene	6.40E-03	6.40E-03	mg/kg	41SB2A	1/5	2.10E-02 - 2.10E-02	Yes	DET
	5103-74-2	gamma-Chlordane	1.70E-03	1.70E-03	mg/kg	41SB2A	1/2	2.00E-02 - 2.00E-02	Yes	DET
	1024-57-3	Heptachlor epoxide	1.80E-03	1.80E-03	mg/kg	41SB2A	1/2	2.00E-02 - 2.00E-02	Yes	DET
	108-87-2	Methylcyclohexane	2.00E-04	6.60E-04	mg/kg	41SB4A	5/5	N/A	Yes	DET
	75-09-2	Methylene chloride	5.90E-03	5.90E-03	mg/kg	41TP2A	1/5	5.00E-03 - 5.00E-03	Yes	DET
	59-50-7	p-Chloro-m-cresol	8.00E-03	8.00E-03	mg/kg	41SB4A	1/5	1.70E-01 - 1.70E-01	Yes	DET
	129-00-0	Pyrene	3.80E-03	3.80E-03	mg/kg	41SB2A	1/5	2.10E-02 - 2.10E-02	Yes	DET
	127-18-4	Tetrachloroethene	5.10E-03	5.10E-03	mg/kg	41TP2A	1/5	5.00E-03 - 5.00E-03	Yes	DET
	108-88-3	Toluene	1.80E-04	4.90E-04	mg/kg	41SB3A	5/5	N/A	Yes	DET
	79-01-6	Trichloroethene	8.90E-04	8.90E-04	mg/kg	41TP2A	1/5	5.00E-03 - 5.00E-03	Yes	DET
	75-69-4	Trichlorofluoromethane	5.70E-04	5.70E-04	mg/kg	41TP2A	1/5	5.00E-03 - 5.00E-03	Yes	DET
	75-01-4	Vinyl Chloride	1.20E-03	1.20E-03	mg/kg	41TP2A	1/5	5.00E-03 - 5.00E-03	Yes	DET
	1330-20-7	Xylenes (total)	4.10E-04	4.10E-04	mg/kg	41SB3A	1/5	5.00E-03 - 5.00E-03	Yes	DET
	7429-90-5	Aluminum	1.88E+04	3.11E+04	mg/kg	41SB2A	5/5	N/A	Yes	DET
	7440-36-0	Antimony	2.10E-01	1.50E+00	mg/kg	41SB2A	5/5	N/A	Yes	DET
	7440-38-2	Arsenic	6.00E+00	1.20E+01	mg/kg	41SB2A	5/5	N/A	Yes	DET
	7440-39-3	Barium	1.10E+02	5.53E+02	mg/kg	41SB5A	5/5	N/A	Yes	DET

Table 7-6
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Direct Contact Exposure at SWMU 41 Area A
Page 2 of 2

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
Surface Soil	7440-41-7	Beryllium	3.40E-01	1.20E+00	mg/kg	41SB4A	5/5	N/A	Yes	DET
	7440-43-9	Cadmium	2.20E+00	2.90E+00	mg/kg	41TP2A	5/5	N/A	Yes	DET
	7440-70-2	Calcium	3.31E+04	1.56E+05	mg/kg	41SB5A	5/5	N/A	Yes	DET
	7440-47-3	Chromium	1.30E+01	2.50E+01	mg/kg	41TP2A	5/5	N/A	Yes	DET
	7440-48-4	Cobalt	7.80E+00	1.40E+01	mg/kg	41SB4A	5/5	N/A	Yes	DET
	7440-50-8	Copper	2.60E+01	6.90E+01	mg/kg	41SB2A	5/5	N/A	Yes	DET
	7439-89-6	Iron	2.43E+04	4.32E+04	mg/kg	41SB2A	5/5	N/A	Yes	DET
	7439-92-1	Lead	8.90E+01	1.43E+02	mg/kg	41SB3A	5/5	N/A	Yes	DET
	7439-95-4	Magnesium	2.30E+04	8.28E+04	mg/kg	41SB5A	5/5	N/A	Yes	DET
	7439-96-5	Manganese	5.17E+02	9.18E+02	mg/kg	41SB5A	5/5	N/A	Yes	DET
	7439-97-6	Mercury	4.70E-02	8.60E-02	mg/kg	41TP2A	5/5	N/A	Yes	DET
	7440-02-0	Nickel	1.70E+01	2.60E+01	mg/kg	41SB4A	5/5	N/A	Yes	DET
	7440-09-7	Potassium	1.89E+03	2.68E+03	mg/kg	41SB4A	5/5	N/A	Yes	DET
	7782-49-2	Selenium	5.20E-01	8.00E-01	mg/kg	41SB3A	5/5	N/A	Yes	DET
	7440-22-4	Silver	8.60E-02	7.70E-01	mg/kg	41SB3A	5/5	N/A	Yes	DET
	7440-23-5	Sodium	5.00E+01	1.73E+03	mg/kg	41SB2A	5/5	N/A	Yes	DET
	7440-28-0	Thallium	1.50E-01	2.60E-01	mg/kg	41SB4A	5/5	N/A	Yes	DET
	7440-62-2	Vanadium	2.90E+01	5.10E+01	mg/kg	41SB4A	5/5	N/A	Yes	DET
	7440-66-6	Zinc	2.42E+02	1.49E+03	mg/kg	41SB2A	5/5	N/A	Yes	DET
	57-12-5	Total Cyanide	5.00E-02	7.00E-02	mg/kg	41SB3A	5/5	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 41 Area A
Page 1 of 2

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	120-82-1	1,2,4-Trichlorobenzene	3.40E-03	3.40E-03	mg/kg	41TP2A	1/5	5.00E-03 - 5.00E-03	Yes	IBC
	78-93-3	2-Butanone	4.70E-03	3.80E-02	mg/kg	41TP2A	5/5	N/A	No	NIBC
	50-29-3	4,4-DDT	1.20E-03	1.20E-03	mg/kg	41SB2A	1/2	2.00E-02 - 2.00E-02	Yes	IBC
	67-64-1	Acetone	2.40E-02	5.50E-02	mg/kg	41SB3A	5/5	N/A	No	NIBC
	5103-71-9	alpha-Chlordane	1.50E-03	1.50E-03	mg/kg	41SB2A	1/2	2.00E-02 - 2.00E-02	Yes	IBC
	11097-69-1	Aroclor 1254	1.50E-01	1.50E-01	mg/kg	41SB2A	1/2	3.30E-02 - 3.30E-02	Yes	IBC
	71-43-2	Benzene	2.40E-04	5.20E-04	mg/kg	41SB3A	4/5	5.00E-03 - 5.00E-03	No	NIBC
	117-81-7	bis(2-Ethylhexyl) phthalate	1.60E-02	2.00E-01	mg/kg	41SB2A	5/5	N/A	No	NIBC
	75-15-0	Carbon disulfide	1.30E-03	5.00E-03	mg/kg	41TP2A	5/5	N/A	No	NIBC
	156-59-2	cis-1,2-Dichloroethene	1.10E-02	1.10E-02	mg/kg	41TP2A	1/5	5.00E-03 - 5.00E-03	No	NIBC
	60-57-1	Dieldrin	1.40E-03	1.40E-03	mg/kg	41SB2A	1/2	2.00E-02 - 2.00E-02	Yes	IBC
	84-74-2	Di-n-butyl phthalate	3.60E-02	2.10E-01	mg/kg	41TP2A	5/5	N/A	No	NIBC
	33213-65-9	Endosulfan II	1.00E-03	1.00E-03	mg/kg	41SB2A	1/2	2.00E-02 - 2.00E-02	Yes	IBC
	72-20-8	Endrin	6.40E-03	6.40E-03	mg/kg	41SB2A	1/2	2.00E-02 - 2.00E-02	Yes	IBC
	53494-70-5	Endrin ketone	1.70E-03	1.70E-03	mg/kg	41SB2A	1/2	2.00E-02 - 2.00E-02	Yes	IBC
	206-44-0	Fluoranthene	6.40E-03	6.40E-03	mg/kg	41SB2A	1/5	2.10E-02 - 2.10E-02	Yes	IBC
	5103-74-2	gamma-Chlordane	1.70E-03	1.70E-03	mg/kg	41SB2A	1/2	2.00E-02 - 2.00E-02	Yes	IBC
	1024-57-3	Heptachlor epoxide	1.80E-03	1.80E-03	mg/kg	41SB2A	1/2	2.00E-02 - 2.00E-02	Yes	IBC
	108-87-2	Methylcyclohexane	2.00E-04	6.60E-04	mg/kg	41SB4A	5/5	N/A	No	NIBC
	75-09-2	Methylene chloride	5.90E-03	5.90E-03	mg/kg	41TP2A	1/5	5.00E-03 - 5.00E-03	No	NIBC
	59-50-7	p-Chloro-m-cresol	8.00E-03	8.00E-03	mg/kg	41SB4A	1/5	1.70E-01 - 1.70E-01	No	NIBC
	129-00-0	Pyrene	3.80E-03	3.80E-03	mg/kg	41SB2A	1/5	2.10E-02 - 2.10E-02	Yes	IBC
	127-18-4	Tetrachloroethene	5.10E-03	5.10E-03	mg/kg	41TP2A	1/5	5.00E-03 - 5.00E-03	No	NIBC
	108-88-3	Toluene	1.80E-04	4.90E-04	mg/kg	41SB3A	5/5	N/A	No	NIBC
	79-01-6	Trichloroethene	8.90E-04	8.90E-04	mg/kg	41TP2A	1/5	5.00E-03 - 5.00E-03	No	NIBC
	75-69-4	Trichlorofluoromethane	5.70E-04	5.70E-04	mg/kg	41TP2A	1/5	5.00E-03 - 5.00E-03	No	NIBC
	75-01-4	Vinyl Chloride	1.20E-03	1.20E-03	mg/kg	41TP2A	1/5	5.00E-03 - 5.00E-03	No	NIBC
	1330-20-7	Xylenes (total)	4.10E-04	4.10E-04	mg/kg	41SB3A	1/5	5.00E-03 - 5.00E-03	No	NIBC
	7429-90-5	Aluminum	1.88E+04	3.11E+04	mg/kg	41SB2A	5/5	N/A	No	NIBC
	7440-36-0	Antimony	2.10E-01	1.50E+00	mg/kg	41SB2A	5/5	N/A	No	NIBC
	7440-38-2	Arsenic	6.00E+00	1.20E+01	mg/kg	41SB2A	5/5	N/A	Yes	IBC
	7440-39-3	Barium	1.10E+02	5.53E+02	mg/kg	41SB5A	5/5	N/A	No	NIBC
	7440-41-7	Beryllium	3.40E-01	1.20E+00	mg/kg	41SB4A	5/5	N/A	No	NIBC

Table 7-7
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Food Chain Exposure at SWMU 41 Area A
Page 2 of 2

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	7440-43-9	Cadmium	2.20E+00	2.90E+00	mg/kg	41TP2A	5/5	N/A	Yes	IBC
	7440-70-2	Calcium	3.31E+04	1.56E+05	mg/kg	41SB5A	5/5	N/A	No	NIBC
	7440-47-3	Chromium	1.30E+01	2.50E+01	mg/kg	41TP2A	5/5	N/A	Yes	IBC
	7440-48-4	Cobalt	7.80E+00	1.40E+01	mg/kg	41SB4A	5/5	N/A	No	NIBC
	7440-50-8	Copper	2.60E+01	6.90E+01	mg/kg	41SB2A	5/5	N/A	Yes	IBC
	7439-89-6	Iron	2.43E+04	4.32E+04	mg/kg	41SB2A	5/5	N/A	No	NIBC
	7439-92-1	Lead	8.90E+01	1.43E+02	mg/kg	41SB3A	5/5	N/A	Yes	IBC
	7439-95-4	Magnesium	2.30E+04	8.28E+04	mg/kg	41SB5A	5/5	N/A	No	NIBC
	7439-96-5	Manganese	5.17E+02	9.18E+02	mg/kg	41SB5A	5/5	N/A	No	NIBC
	7439-97-6	Mercury	4.70E-02	8.60E-02	mg/kg	41TP2A	5/5	N/A	Yes	IBC
	7440-02-0	Nickel	1.70E+01	2.60E+01	mg/kg	41SB4A	5/5	N/A	Yes	IBC
	7440-09-7	Potassium	1.89E+03	2.68E+03	mg/kg	41SB4A	5/5	N/A	No	NIBC
	7782-49-2	Selenium	5.20E-01	8.00E-01	mg/kg	41SB3A	5/5	N/A	Yes	IBC
	7440-22-4	Silver	8.60E-02	7.70E-01	mg/kg	41SB3A	5/5	N/A	Yes	IBC
	7440-23-5	Sodium	5.00E+01	1.73E+03	mg/kg	41SB2A	5/5	N/A	No	NIBC
	7440-28-0	Thallium	1.50E-01	2.60E-01	mg/kg	41SB4A	5/5	N/A	No	NIBC
	7440-62-2	Vanadium	2.90E+01	5.10E+01	mg/kg	41SB4A	5/5	N/A	No	NIBC
	7440-66-6	Zinc	2.42E+02	1.49E+03	mg/kg	41SB2A	5/5	N/A	Yes	IBC
	57-12-5	Total Cyanide	5.00E-02	7.00E-02	mg/kg	41SB3A	5/5	N/A	No	NIBC

COPEC Selection Rationale Codes

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

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

Table 7-8
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Sediment Direct Contact Exposure at SWMU 41 Area A
Page 1 of 3

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

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
Sediment	N/A	2,3,7,8-TCDD-TE	2.84E-06	6.28E-06	mg/kg	41SD10	3/3	N/A	Yes	DET
	67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	2.22E-05	6.22E-05	mg/kg	41SD08	3/3	N/A	No	TEQ
	35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	2.08E-05	4.67E-05	mg/kg	41SD08	3/3	N/A	No	TEQ
	55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	4.98E-07 J	1.26E-06 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	3.07E-06 J	8.37E-06 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	3.16E-07 J	8.05E-07 J	mg/kg	41SD10	2/3	1.43E-06 - 1.43E-06	No	TEQ
	57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	1.88E-06 J	4.78E-06 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	5.95E-07 J	1.41E-06 J	mg/kg	41SD10	2/3	1.43E-06 - 1.43E-06	No	TEQ
	72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	1.89E-07 J	5.41E-07 J	mg/kg	41SD10	2/3	1.43E-06 - 1.43E-06	No	TEQ
	19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	1.01E-06 J	3.18E-06 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	1.15E-06 J	2.90E-06 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	2.59E-07 J	6.01E-07 J	mg/kg	41SD10	2/3	1.43E-06 - 1.43E-06	No	TEQ
	60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	4.82E-07 J	1.68E-06 J	mg/kg	41SD10	3/3	N/A	No	TEQ
	57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	6.33E-07 J	1.40E-06 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	2.80E-07 J	7.48E-07 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	8.66E-07 J	1.58E-06 J	mg/kg	41SD10	3/3	N/A	No	TEQ
	3268-87-9	Octachlorodibenzodioxin	8.97E-04	2.08E-03	mg/kg	41SD08	3/3	N/A	No	TEQ
	39001-02-0	Octachlorodibenzofuran	2.08E-05	5.39E-05	mg/kg	41SD08	3/3	N/A	No	TEQ
	Shaw 05	Total Heptachlorodibenzofuran	2.72E-05	7.56E-05	mg/kg	41SD08	3/3	N/A	No	TEQ
	Shaw 04	Total Heptachlorodibenzo-p-dioxin	4.44E-05	9.90E-05	mg/kg	41SD08	3/3	N/A	No	TEQ
	Shaw 07	Total Hexachlorodibenzofuran	1.63E-05	4.53E-05 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	Shaw 06	Total Hexachlorodibenzo-p-dioxin	6.76E-06 J	1.44E-05 J	mg/kg	41SD10	3/3	N/A	No	TEQ
	Shaw 09	Total Pentachlorodibenzofuran	1.30E-05 J	3.26E-05 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	Shaw 08	Total Pentachlorodibenzo-p-dioxin	2.15E-06 J	4.57E-06	mg/kg	41SD08	3/3	N/A	No	TEQ
	Shaw 11	Total Tetrachlorodibenzofuran	1.03E-05 J	2.76E-05 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	Shaw 10	Total Tetrachlorodibenzo-p-dioxin	2.80E-07 J	3.52E-06 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	120-82-1	1,2,4-Trichlorobenzene	3.90E-03	4.40E-03	mg/kg	41SD7	2/6	5.00E-03 - 4.50E-01	Yes	DET
	78-93-3	2-Butanone	2.60E-02	4.88E-02 J	mg/kg	41SD08	4/6	2.80E-02 - 3.70E-02	Yes	DET
	50-29-3	4,4'-DDT	1.04E-03	1.98E-03	mg/kg	41SD7	2/6	2.00E-02 - 8.80E-02	Yes	DET
	83-32-9	Acenaphthene	1.70E-02	1.70E-02	mg/kg	41SD5	1/6	1.00E-01 - 7.20E-01	Yes	DET
	67-64-1	Acetone	2.53E-01 J	2.53E-01 J	mg/kg	41SD08	1/6	5.50E-02 - 7.30E-02	Yes	DET

Table 7-8
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Sediment Direct Contact Exposure at SWMU 41 Area A
Page 2 of 3

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

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
Sediment	120-12-7	Anthracene	1.10E-03	1.90E-02	mg/kg	41SD5	3/6	3.20E-01 - 7.20E-01	Yes	DET
	71-43-2	Benzene	2.00E-04	2.80E-04	mg/kg	41SD7	3/6	5.50E-03 - 1.70E-02	Yes	DET
	56-55-3	Benzo(a)anthracene	1.70E-02	6.70E-02	mg/kg	41SD5	6/6	N/A	Yes	DET
	50-32-8	Benzo(a)pyrene	1.70E-02	7.90E-02	mg/kg	41SD5	6/6	N/A	Yes	DET
	205-99-2	Benzo(b)fluoranthene	2.10E-02	1.20E-01 J	mg/kg	41SD08	5/6	2.10E-02 - 2.10E-02	Yes	DET
	191-24-2	Benzo(g,h,i)perylene	2.00E-02 L	1.00E-01	mg/kg	41SD5	6/6	N/A	Yes	DET
	207-08-9	Benzo(k)fluoranthene	8.40E-03	6.69E-02 J	mg/kg	41SD08	6/6	N/A	Yes	DET
	117-81-7	bis(2-Ethylhexyl) phthalate	2.30E-02	4.70E-02	mg/kg	41SD5	3/6	4.00E-01 - 9.00E-01	Yes	DET
	74-83-9	Bromomethane	1.50E-03	1.50E-03	mg/kg	41SD7	1/6	5.00E-03 - 1.70E-02	Yes	DET
	75-15-0	Carbon disulfide	5.50E-03	6.70E-03	mg/kg	41SD5	2/6	5.00E-03 - 1.70E-02	Yes	DET
	67-66-3	Chloroform	5.40E-04	5.40E-04	mg/kg	41SD6	1/6	5.00E-03 - 1.70E-02	Yes	DET
	218-01-9	Chrysene	1.90E-02	9.82E-02 J	mg/kg	41SD08	6/6	N/A	Yes	DET
	84-74-2	Di-n-butyl phthalate	4.80E-02	6.90E-02	mg/kg	41SD5	3/6	4.00E-01 - 9.00E-01	Yes	DET
	7421-93-4	Endrin aldehyde	2.45E-03	2.45E-03	mg/kg	41SD7	1/6	4.00E-03 - 2.00E-02	Yes	DET
	206-44-0	Fluoranthene	3.40E-02	2.00E-01	mg/kg	41SD5	5/6	3.20E-01 - 3.20E-01	Yes	DET
	86-73-7	Fluorene	1.00E-02	1.00E-02	mg/kg	41SD5	1/6	2.10E-02 - 7.20E-01	Yes	DET
	193-39-5	Indeno(1,2,3-cd)pyrene	1.50E-02	6.71E-02 J	mg/kg	41SD08	6/6	N/A	Yes	DET
	79-20-9	Methyl Acetate	7.60E-04	7.60E-04	mg/kg	41SD6	1/3	1.00E-02 - 1.00E-02	Yes	DET
	75-09-2	Methylene chloride	3.80E-03	7.80E-03	mg/kg	41SD6	3/6	1.10E-02 - 3.50E-02	Yes	DET
	55-63-0	Nitroglycerin	5.80E+00	5.80E+00	mg/kg	41SD6	1/6	1.60E+00 - 1.00E+01	Yes	DET
	59-50-7	p-Chloro-m-cresol	1.70E-02	1.70E-02	mg/kg	41SD5	1/6	1.70E-01 - 4.50E-01	Yes	DET
	85-01-8	Phenanthrene	6.30E-03	1.10E-01	mg/kg	41SD5	4/6	3.20E-01 - 7.20E-01	Yes	DET
	129-00-0	Pyrene	2.80E-02	1.50E-01	mg/kg	41SD5	5/6	3.20E-01 - 3.20E-01	Yes	DET
	108-88-3	Toluene	2.60E-04	1.10E-03	mg/kg	41SD5	3/6	5.50E-03 - 1.70E-02	Yes	DET
	7429-90-5	Aluminum	6.17E+03	1.55E+04	mg/kg	41SD7	6/6	N/A	Yes	DET
	7440-36-0	Antimony	1.80E-01	4.50E-01	mg/kg	41SD6	3/4	7.20E-01 - 7.20E-01	Yes	DET
	7440-38-2	Arsenic	3.70E+00	1.80E+01	mg/kg	41SD6	6/6	N/A	Yes	DET
	7440-39-3	Barium	6.30E+01	1.95E+02	mg/kg	41SD6	6/6	N/A	Yes	DET
	7440-41-7	Beryllium	2.30E-01	8.80E-01	mg/kg	41SD08	6/6	N/A	Yes	DET
	7440-43-9	Cadmium	5.60E-01	2.20E+00	mg/kg	41SD6	3/6	6.30E-02 - 5.80E-01	Yes	DET
	7440-70-2	Calcium	5.59E+03	2.56E+04	mg/kg	41SD08	6/6	N/A	Yes	DET

Table 7-8
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Sediment Direct Contact Exposure at SWMU 41 Area A
Page 3 of 3

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

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
Sediment	7440-47-3	Chromium	9.60E+00	3.30E+01	mg/kg	41SD6	6/6	N/A	Yes	DET
	7440-48-4	Cobalt	6.90E+00	2.00E+01	mg/kg	41SD6	6/6	N/A	Yes	DET
	7440-50-8	Copper	1.27E+01	2.60E+01	mg/kg	41SD6	6/6	N/A	Yes	DET
	7439-89-6	Iron	1.25E+04	4.79E+04	mg/kg	41SD6	6/6	N/A	Yes	DET
	7439-92-1	Lead	1.04E+01 K	3.50E+01	mg/kg	41SD7	6/6	N/A	Yes	DET
	7439-95-4	Magnesium	3.68E+03	1.09E+04	mg/kg	41SD6	6/6	N/A	Yes	DET
	7439-96-5	Manganese	2.99E+02	1.64E+03	mg/kg	41SD6	6/6	N/A	Yes	DET
	7439-97-6	Mercury	2.40E-02	3.30E-02	mg/kg	41SD7	3/3	N/A	Yes	DET
	7440-02-0	Nickel	1.00E+01	2.50E+01	mg/kg	41SD6	6/6	N/A	Yes	DET
	7440-09-7	Potassium	9.68E+02	1.82E+03	mg/kg	41SD7	3/3	N/A	Yes	DET
	7782-49-2	Selenium	3.40E-01	7.70E+00 K	mg/kg	41SD09	4/4	N/A	Yes	DET
	7440-22-4	Silver	7.20E-02 J	1.60E-01	mg/kg	41SD5	4/6	5.20E-02 - 1.20E-01	Yes	DET
	7440-23-5	Sodium	3.60E+01	6.60E+01	mg/kg	41SD7	3/3	N/A	Yes	DET
	7440-28-0	Thallium	8.80E-02	1.30E-01	mg/kg	41SD7	2/6	5.00E-01 - 1.20E+00	Yes	DET
	57-12-5	Total Cyanide	8.00E-02	1.30E-01	mg/kg	41SD7	3/3	N/A	Yes	DET
	7440-62-2	Vanadium	1.21E+01	3.60E+01	mg/kg	41SD6	6/6	N/A	Yes	DET
	7440-66-6	Zinc	5.79E+01	1.21E+02	mg/kg	41SD6	6/6	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

K = Estimated Value

L = Estimated Value

mg/kg = milligrams per kilogram

Table 7-9
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Sediment Food Chain Exposure at SWMU 41 Area A
Page 1 of 3

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

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
Sediment	N/A	2,3,7,8-TCDD-TE	2.84E-06	6.28E-06	mg/kg	41SD10	3/3	N/A	Yes	IBC
	67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	2.22E-05	6.22E-05	mg/kg	41SD08	3/3	N/A	No	TEQ
	35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	2.08E-05	4.67E-05	mg/kg	41SD08	3/3	N/A	No	TEQ
	55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	4.98E-07 J	1.26E-06 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	3.07E-06 J	8.37E-06 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	3.16E-07 J	8.05E-07 J	mg/kg	41SD10	2/3	1.43E-06 - 1.43E-06	No	TEQ
	57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	1.88E-06 J	4.78E-06 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	5.95E-07 J	1.41E-06 J	mg/kg	41SD10	2/3	1.43E-06 - 1.43E-06	No	TEQ
	72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	1.89E-07 J	5.41E-07 J	mg/kg	41SD10	2/3	1.43E-06 - 1.43E-06	No	TEQ
	19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	1.01E-06 J	3.18E-06 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	1.15E-06 J	2.90E-06 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	2.59E-07 J	6.01E-07 J	mg/kg	41SD10	2/3	1.43E-06 - 1.43E-06	No	TEQ
	60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	4.82E-07 J	1.68E-06 J	mg/kg	41SD10	3/3	N/A	No	TEQ
	57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	6.33E-07 J	1.40E-06 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	2.80E-07 J	7.48E-07 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	8.66E-07 J	1.58E-06 J	mg/kg	41SD10	3/3	N/A	No	TEQ
	3268-87-9	Octachlorodibenzodioxin	8.97E-04	2.08E-03	mg/kg	41SD08	3/3	N/A	No	TEQ
	39001-02-0	Octachlorodibenzofuran	2.08E-05	5.39E-05	mg/kg	41SD08	3/3	N/A	No	TEQ
	Shaw 05	Total Heptachlorodibenzofuran	2.72E-05	7.56E-05	mg/kg	41SD08	3/3	N/A	No	TEQ
	Shaw 04	Total Heptachlorodibenzo-p-dioxin	4.44E-05	9.90E-05	mg/kg	41SD08	3/3	N/A	No	TEQ
	Shaw 07	Total Hexachlorodibenzofuran	1.63E-05	4.53E-05 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	Shaw 06	Total Hexachlorodibenzo-p-dioxin	6.76E-06 J	1.44E-05 J	mg/kg	41SD10	3/3	N/A	No	TEQ
	Shaw 09	Total Pentachlorodibenzofuran	1.30E-05 J	3.26E-05 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	Shaw 08	Total Pentachlorodibenzo-p-dioxin	2.15E-06 J	4.57E-06	mg/kg	41SD08	3/3	N/A	No	TEQ
	Shaw 11	Total Tetrachlorodibenzofuran	1.03E-05 J	2.76E-05 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	Shaw 10	Total Tetrachlorodibenzo-p-dioxin	2.80E-07 J	3.52E-06 J	mg/kg	41SD08	3/3	N/A	No	TEQ
	120-82-1	1,2,4-Trichlorobenzene	3.90E-03	4.40E-03	mg/kg	41SD7	2/6	5.00E-03 - 4.50E-01	Yes	IBC
	78-93-3	2-Butanone	2.60E-02	4.88E-02 J	mg/kg	41SD08	4/6	2.80E-02 - 3.70E-02	No	NIBC
	50-29-3	4,4'-DDT	1.04E-03	1.98E-03	mg/kg	41SD7	2/6	2.00E-02 - 8.80E-02	Yes	IBC
	83-32-9	Acenaphthene	1.70E-02	1.70E-02	mg/kg	41SD5	1/6	1.00E-01 - 7.20E-01	Yes	IBC
	67-64-1	Acetone	2.53E-01 J	2.53E-01 J	mg/kg	41SD08	1/6	5.50E-02 - 7.30E-02	No	NIBC
	120-12-7	Anthracene	1.10E-03	1.90E-02	mg/kg	41SD5	3/6	3.20E-01 - 7.20E-01	Yes	IBC
	71-43-2	Benzene	2.00E-04	2.80E-04	mg/kg	41SD7	3/6	5.50E-03 - 1.70E-02	No	NIBC

Table 7-9
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Sediment Food Chain Exposure at SWMU 41 Area A
Page 2 of 3

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

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
Sediment	56-55-3	Benzo(a)anthracene	1.70E-02	6.70E-02	mg/kg	41SD5	6/6	N/A	Yes	IBC
	50-32-8	Benzo(a)pyrene	1.70E-02	7.90E-02	mg/kg	41SD5	6/6	N/A	Yes	IBC
	205-99-2	Benzo(b)fluoranthene	2.10E-02	1.20E-01 J	mg/kg	41SD08	5/6	2.10E-02 - 2.10E-02	Yes	IBC
	191-24-2	Benzo(g,h,i)perylene	2.00E-02 L	1.00E-01	mg/kg	41SD5	6/6	N/A	Yes	IBC
	207-08-9	Benzo(k)fluoranthene	8.40E-03	6.69E-02 J	mg/kg	41SD08	6/6	N/A	Yes	IBC
	117-81-7	bis(2-Ethylhexyl) phthalate	2.30E-02	4.70E-02	mg/kg	41SD5	3/6	4.00E-01 - 9.00E-01	No	NIBC
	74-83-9	Bromomethane	1.50E-03	1.50E-03	mg/kg	41SD7	1/6	5.00E-03 - 1.70E-02	No	NIBC
	75-15-0	Carbon disulfide	5.50E-03	6.70E-03	mg/kg	41SD5	2/6	5.00E-03 - 1.70E-02	No	NIBC
	67-66-3	Chloroform	5.40E-04	5.40E-04	mg/kg	41SD6	1/6	5.00E-03 - 1.70E-02	No	NIBC
	218-01-9	Chrysene	1.90E-02	9.82E-02 J	mg/kg	41SD08	6/6	N/A	Yes	IBC
	84-74-2	Di-n-butyl phthalate	4.80E-02	6.90E-02	mg/kg	41SD5	3/6	4.00E-01 - 9.00E-01	No	NIBC
	7421-93-4	Endrin aldehyde	2.45E-03	2.45E-03	mg/kg	41SD7	1/6	4.00E-03 - 2.00E-02	Yes	IBC
	206-44-0	Fluoranthene	3.40E-02	2.00E-01	mg/kg	41SD5	5/6	3.20E-01 - 3.20E-01	Yes	IBC
	86-73-7	Fluorene	1.00E-02	1.00E-02	mg/kg	41SD5	1/6	2.10E-02 - 7.20E-01	Yes	IBC
	193-39-5	Indeno(1,2,3-cd)pyrene	1.50E-02	6.71E-02 J	mg/kg	41SD08	6/6	N/A	Yes	IBC
	79-20-9	Methyl Acetate	7.60E-04	7.60E-04	mg/kg	41SD6	1/3	1.00E-02 - 1.00E-02	No	NIBC
	75-09-2	Methylene chloride	3.80E-03	7.80E-03	mg/kg	41SD6	3/6	1.10E-02 - 3.50E-02	No	NIBC
	55-63-0	Nitroglycerin	5.80E+00	5.80E+00	mg/kg	41SD6	1/6	1.60E+00 - 1.00E+01	Yes	EXP
	59-50-7	p-Chloro-m-cresol	1.70E-02	1.70E-02	mg/kg	41SD5	1/6	1.70E-01 - 4.50E-01	No	NIBC
	85-01-8	Phenanthrene	6.30E-03	1.10E-01	mg/kg	41SD5	4/6	3.20E-01 - 7.20E-01	Yes	IBC
	129-00-0	Pyrene	2.80E-02	1.50E-01	mg/kg	41SD5	5/6	3.20E-01 - 3.20E-01	Yes	IBC
	108-88-3	Toluene	2.60E-04	1.10E-03	mg/kg	41SD5	3/6	5.50E-03 - 1.70E-02	No	NIBC
	7429-90-5	Aluminum	6.17E+03	1.55E+04	mg/kg	41SD7	6/6	N/A	No	NIBC
	7440-36-0	Antimony	1.80E-01	4.50E-01	mg/kg	41SD6	3/4	7.20E-01 - 7.20E-01	No	NIBC
	7440-38-2	Arsenic	3.70E+00	1.80E+01	mg/kg	41SD6	6/6	N/A	Yes	IBC
	7440-39-3	Barium	6.30E+01	1.95E+02	mg/kg	41SD6	6/6	N/A	No	NIBC
	7440-41-7	Beryllium	2.30E-01	8.80E-01	mg/kg	41SD08	6/6	N/A	No	NIBC
	7440-43-9	Cadmium	5.60E-01	2.20E+00	mg/kg	41SD6	3/6	6.30E-02 - 5.80E-01	Yes	IBC
	7440-70-2	Calcium	5.59E+03	2.56E+04	mg/kg	41SD08	6/6	N/A	No	NIBC
	7440-47-3	Chromium	9.60E+00	3.30E+01	mg/kg	41SD6	6/6	N/A	Yes	IBC
	7440-48-4	Cobalt	6.90E+00	2.00E+01	mg/kg	41SD6	6/6	N/A	No	NIBC
	7440-50-8	Copper	1.27E+01	2.60E+01	mg/kg	41SD6	6/6	N/A	Yes	IBC
	7439-89-6	Iron	1.25E+04	4.79E+04	mg/kg	41SD6	6/6	N/A	No	NIBC

Table 7-9
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Sediment Food Chain Exposure at SWMU 41 Area A
Page 3 of 3

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

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
Sediment	7439-92-1	Lead	1.04E+01 K	3.50E+01	mg/kg	41SD7	6/6	N/A	Yes	IBC
	7439-95-4	Magnesium	3.68E+03	1.09E+04	mg/kg	41SD6	6/6	N/A	No	NIBC
	7439-96-5	Manganese	2.99E+02	1.64E+03	mg/kg	41SD6	6/6	N/A	No	NIBC
	7439-97-6	Mercury	2.40E-02	3.30E-02	mg/kg	41SD7	3/3	N/A	Yes	IBC
	7440-02-0	Nickel	1.00E+01	2.50E+01	mg/kg	41SD6	6/6	N/A	Yes	IBC
	7440-09-7	Potassium	9.68E+02	1.82E+03	mg/kg	41SD7	3/3	N/A	No	NIBC
	7782-49-2	Selenium	3.40E-01	7.70E+00 K	mg/kg	41SD09	4/4	N/A	Yes	IBC
	7440-22-4	Silver	7.20E-02 J	1.60E-01	mg/kg	41SD5	4/6	5.20E-02 - 1.20E-01	Yes	IBC
	7440-23-5	Sodium	3.60E+01	6.60E+01	mg/kg	41SD7	3/3	N/A	No	NIBC
	7440-28-0	Thallium	8.80E-02	1.30E-01	mg/kg	41SD7	2/6	5.00E-01 - 1.20E+00	No	NIBC
	57-12-5	Total Cyanide	8.00E-02	1.30E-01	mg/kg	41SD7	3/3	N/A	No	NIBC
	7440-62-2	Vanadium	1.21E+01	3.60E+01	mg/kg	41SD6	6/6	N/A	No	NIBC
	7440-66-6	Zinc	5.79E+01	1.21E+02	mg/kg	41SD6	6/6	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

K = Estimated Value

L = Estimated Value

mg/kg = milligrams per kilogram

Table 7-10
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Water Direct Contact Exposure at SWMU 41 Area A
Page 1 of 2

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

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
Surface Water	N/A	2,3,7,8-TCDD-TE	6.57E-12	1.98E-08	mg/L	41SW09	3/3	N/A	Yes	DET
	35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	5.64E-09 J	5.64E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	5.36E-09 J	5.36E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	55673-89-7	1,2,3,4,7,8-Heptachlorodibenzofuran	4.02E-09 J	4.02E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	4.68E-09 J	4.68E-09 J	mg/L	41SW09	1/3	5.25E-09 - 6.89E-09	No	TEQ
	70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	5.32E-09 J	5.32E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	4.75E-09 J	4.75E-09 J	mg/L	41SW09	1/3	5.25E-09 - 7.02E-09	No	TEQ
	57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	5.09E-09 J	5.09E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	4.95E-09 J	4.95E-09 J	mg/L	41SW09	1/3	5.25E-09 - 7.12E-09	No	TEQ
	72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	5.01E-09 J	5.01E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	6.07E-09 J	6.07E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	6.62E-09 J	6.62E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	1.47E-09 J	1.47E-09 J	mg/L	41SW09	1/3	1.28E-09 - 5.25E-09	No	TEQ
	60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	4.09E-09 J	4.09E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	5.89E-09 J	5.89E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	2.57E-09 J	2.57E-09 J	mg/L	41SW09	1/3	1.64E-09 - 1.79E-09	No	TEQ
	3268-87-9	Octachlorodibenzodioxin	2.19E-08 J	6.18E-08 J	mg/L	41SW10	3/3	N/A	No	TEQ
	39001-02-0	Octachlorodibenzofuran	8.74E-09 J	8.74E-09 J	mg/L	41SW09	1/3	1.05E-08 - 1.08E-08	No	TEQ
	Shaw 04	Total Heptachlorodibenzo-p-dioxin	5.64E-09	5.64E-09	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	Shaw 05	Total Heptachlorodibenzofuran	9.55E-09 J	9.55E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	Shaw 06	Total Hexachlorodibenzo-p-dioxin	1.44E-08	1.44E-08	mg/L	41SW09	1/3	5.25E-09 - 7.12E-09	No	TEQ
	Shaw 07	Total Hexachlorodibenzofuran	1.95E-08	1.95E-08	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	Shaw 08	Total Pentachlorodibenzo-p-dioxin	6.07E-09	6.07E-09	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	Shaw 09	Total Pentachlorodibenzofuran	1.25E-08	1.25E-08	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	Shaw 11	Total Tetrachlorodibenzofuran	1.47E-09	1.47E-09	mg/L	41SW09	1/3	1.28E-09 - 5.25E-09	No	TEQ
	118-96-7	2,4,6-Trinitrotoluene	1.30E-03	1.30E-03	mg/L	41SW10	1/6	2.00E-04 - 6.50E-04	Yes	DET
	35572-78-2	2-amino-4,6-Dinitrotoluene	2.70E-04	1.10E-03	mg/L	41SW10	3/6	1.00E-03 - 1.00E-03	Yes	DET
	19406-51-0	4-amino-2,6-Dinitrotoluene	8.70E-04	2.50E-03	mg/L	41SW10	3/6	1.00E-03 - 1.00E-03	Yes	DET
	84-66-2	Diethyl phthalate	1.80E-04	2.10E-04	mg/L	41SW7	3/6	4.90E-03 - 5.70E-03	Yes	DET

Table 7-10
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Water Direct Contact Exposure at SWMU 41 Area A
Page 2 of 2

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

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
Surface Water	7429-90-5	Aluminum	8.30E-02	2.35E-01 L	mg/L	41SW10	3/5	2.00E-01 - 2.00E-01	Yes	DET
	7440-39-3	Barium	4.80E-02	6.49E-02 J	mg/L	41SW08	6/6	N/A	Yes	DET
	7440-70-2	Calcium	4.00E+01	5.30E+01	mg/L	41SW10	6/6	N/A	Yes	DET
	7440-47-3	Chromium	9.00E-04	9.80E-04	mg/L	41SW7	3/6	6.00E-04 - 6.00E-04	Yes	DET
	7439-89-6	Iron	5.40E-02	2.00E-01	mg/L	41SW6	3/4	1.50E-02 - 1.50E-02	Yes	DET
	7439-92-1	Lead	3.00E-04	3.00E-04	mg/L	41SW6	1/6	1.00E-03 - 3.40E-03	Yes	DET
	7439-95-4	Magnesium	1.80E+01	3.20E+01	mg/L	41SW6	6/6	N/A	Yes	DET
	7439-96-5	Manganese	2.10E-03	6.19E-02	mg/L	41SW08	5/6	1.00E-02 - 1.00E-02	Yes	DET
	7440-09-7	Potassium	1.50E+00	2.10E+00	mg/L	41SW7	3/3	N/A	Yes	DET
	7440-23-5	Sodium	1.10E+01	1.66E+01	mg/L	41SW10	6/6	N/A	Yes	DET
	7440-62-2	Vanadium	1.10E-03 J	1.40E-03 J	mg/L	41SW09	3/6	2.50E-02 - 2.50E-02	Yes	DET
	7440-66-6	Zinc	2.60E-03 J	6.70E-03 J	mg/L	41SW09	3/6	2.00E-02 - 2.00E-02	Yes	DET
	57-12-5	Total Cyanide	2.00E-03	3.00E-03	mg/L	41SW7	3/3	N/A	Yes	DET
	14797-73-0	Perchlorate	1.35E-04 J	1.68E-04 J	mg/L	41SW08	3/6	1.00E-03 - 1.00E-03	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/L = milligrams per liter

Table 7-11
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Water Food Chain Exposure at SWMU 41 Area A
Page 1 of 2

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

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 Water	N/A	2,3,7,8-TCDD-TE	6.57E-12	1.98E-08	mg/L	41SW09	3/3	N/A	Yes	IBC
	35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	5.64E-09 J	5.64E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	5.36E-09 J	5.36E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	4.02E-09 J	4.02E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	4.68E-09 J	4.68E-09 J	mg/L	41SW09	1/3	5.25E-09 - 6.89E-09	No	TEQ
	70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	5.32E-09 J	5.32E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	4.75E-09 J	4.75E-09 J	mg/L	41SW09	1/3	5.25E-09 - 7.02E-09	No	TEQ
	57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	5.09E-09 J	5.09E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	4.95E-09 J	4.95E-09 J	mg/L	41SW09	1/3	5.25E-09 - 7.12E-09	No	TEQ
	72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran	5.01E-09 J	5.01E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin	6.07E-09 J	6.07E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	6.62E-09 J	6.62E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	1.47E-09 J	1.47E-09 J	mg/L	41SW09	1/3	1.28E-09 - 5.25E-09	No	TEQ
	60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	4.09E-09 J	4.09E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	5.89E-09 J	5.89E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin	2.57E-09 J	2.57E-09 J	mg/L	41SW09	1/3	1.64E-09 - 1.79E-09	No	TEQ
	3268-87-9	Octachlorodibenzodioxin	2.19E-08 J	6.18E-08 J	mg/L	41SW10	3/3	N/A	No	TEQ
	39001-02-0	Octachlorodibenzofuran	8.74E-09 J	8.74E-09 J	mg/L	41SW09	1/3	1.05E-08 - 1.08E-08	No	TEQ
	Shaw 04	Total Heptachlorodibenzo-p-dioxin	5.64E-09	5.64E-09	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	Shaw 05	Total Heptachlorodibenzofuran	9.55E-09 J	9.55E-09 J	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	Shaw 06	Total Hexachlorodibenzo-p-dioxin	1.44E-08	1.44E-08	mg/L	41SW09	1/3	5.25E-09 - 7.12E-09	No	TEQ
	Shaw 07	Total Hexachlorodibenzofuran	1.95E-08	1.95E-08	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	Shaw 08	Total Pentachlorodibenzo-p-dioxin	6.07E-09	6.07E-09	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	Shaw 09	Total Pentachlorodibenzofuran	1.25E-08	1.25E-08	mg/L	41SW09	1/3	5.25E-09 - 5.38E-09	No	TEQ
	Shaw 11	Total Tetrachlorodibenzofuran	1.47E-09	1.47E-09	mg/L	41SW09	1/3	1.28E-09 - 5.25E-09	No	TEQ
	118-96-7	2,4,6-Trinitrotoluene	1.30E-03	1.30E-03	mg/L	41SW10	1/6	2.00E-04 - 6.50E-04	Yes	EXP
	35572-78-2	2-amino-4,6-Dinitrotoluene	2.70E-04	1.10E-03	mg/L	41SW10	3/6	1.00E-03 - 1.00E-03	Yes	EXP
	19406-51-0	4-amino-2,6-Dinitrotoluene	8.70E-04	2.50E-03	mg/L	41SW10	3/6	1.00E-03 - 1.00E-03	Yes	EXP
	84-66-2	Diethyl phthalate	1.80E-04	2.10E-04	mg/L	41SW7	3/6	4.90E-03 - 5.70E-03	No	NIBC
	7429-90-5	Aluminum	8.30E-02	2.35E-01 L	mg/L	41SW10	3/5	2.00E-01 - 2.00E-01	No	NIBC

Table 7-11
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Water Food Chain Exposure at SWMU 41 Area A
Page 2 of 2

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

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 Water	7440-39-3	Barium	4.80E-02	6.49E-02 J	mg/L	41SW08	6/6	N/A	No	NIBC
	7440-70-2	Calcium	4.00E+01	5.30E+01	mg/L	41SW10	6/6	N/A	No	NIBC
	7440-47-3	Chromium	9.00E-04	9.80E-04	mg/L	41SW7	3/6	6.00E-04 - 6.00E-04	Yes	IBC
	7439-89-6	Iron	5.40E-02	2.00E-01	mg/L	41SW6	3/4	1.50E-02 - 1.50E-02	No	NIBC
	7439-92-1	Lead	3.00E-04	3.00E-04	mg/L	41SW6	1/6	1.00E-03 - 3.40E-03	Yes	IBC
	7439-95-4	Magnesium	1.80E+01	3.20E+01	mg/L	41SW6	6/6	N/A	No	NIBC
	7439-96-5	Manganese	2.10E-03	6.19E-02	mg/L	41SW08	5/6	1.00E-02 - 1.00E-02	No	NIBC
	7440-09-7	Potassium	1.50E+00	2.10E+00	mg/L	41SW7	3/3	N/A	No	NIBC
	7440-23-5	Sodium	1.10E+01	1.66E+01	mg/L	41SW10	6/6	N/A	No	NIBC
	7440-62-2	Vanadium	1.10E-03 J	1.40E-03 J	mg/L	41SW09	3/6	2.50E-02 - 2.50E-02	No	NIBC
	7440-66-6	Zinc	2.60E-03 J	6.70E-03 J	mg/L	41SW09	3/6	2.00E-02 - 2.00E-02	Yes	IBC
	57-12-5	Total Cyanide	2.00E-03	3.00E-03	mg/L	41SW7	3/3	N/A	No	NIBC
	14797-73-0	Perchlorate	1.35E-04 J	1.68E-04 J	mg/L	41SW08	3/6	1.00E-03 - 1.00E-03	No	NIBC

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/L = milligrams per liter

COPECs were selected as shown in **Tables 7-6 through 7-11**. In general, COPECs were selected as a concern for the direct contact exposure pathway if the constituent was detected in an environmental medium (**Tables 7-6, 7-8, and 7-10**). For food chain exposure pathways, detected COPECs were selected if they were important bioaccumulative constituents (USEPA, 2000c) or explosive compounds (**Tables 7-7, 7-9, and 7-11**).

Fifty-two (52) COPECs (28 organic and 24 inorganic COPECs) have been selected for surface soil direct contact exposure (**Table 7-6**).

Twenty-two (22) COPECs (12 organic and 10 inorganic COPECs) have been selected for surface soil food chain exposure (**Table 7-7**).

Fifty-four (54) COPECs (30 organic and 24 inorganic COPECs) have been selected for sediment direct contact exposure (**Table 7-8**).

Twenty-eight (28) COPECs (18 organic and 10 inorganic COPECs) have been selected for sediment food chain exposure (**Table 7-9**).

Nineteen (19) COPECs (5 organic and 14 inorganic COPECs) have been selected for surface water direct contact exposure (**Table 7-10**).

Seven COPECs (4 organic and 3 inorganic COPECs) have been selected for surface water food chain exposure (**Table 7-11**).

EPCs based on the statistical procedures discussed in *HHRA Section 6.2.3* are presented in **Tables 7-12** (surface soil), **7-13** (sediment), and **7-14** (surface water). 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 review of site photographs, 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 41 Area A, 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 41 Area A 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

Table 7-12
Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area A - Surface Soil
Page 1 of 2

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	1,2,4-Trichlorobenzene	mg/kg	3.40E-03	N/A	N/A	3.40E-03	3.40E-03	mg/kg	Max	Test (7)
	2-Butanone	mg/kg	1.26E-02	N/A	N/A	3.80E-02	3.80E-02	mg/kg	Max	Test (7)
	4,4-DDT	mg/kg	1.20E-03	N/A	N/A	1.20E-03	1.20E-03	mg/kg	Max	Test (7)
	Acetone	mg/kg	3.40E-02	N/A	N/A	5.50E-02	5.50E-02	mg/kg	Max	Test (7)
	alpha-Chlordane	mg/kg	1.50E-03	N/A	N/A	1.50E-03	1.50E-03	mg/kg	Max	Test (7)
	Aroclor 1254	mg/kg	1.50E-01	N/A	N/A	1.50E-01	1.50E-01	mg/kg	Max	Test (7)
	Benzene	mg/kg	3.75E-04	N/A	N/A	5.20E-04	5.20E-04	mg/kg	Max	Test (7)
	bis(2-Ethylhexyl) phthalate	mg/kg	5.90E-02	N/A	N/A	2.00E-01	2.00E-01	mg/kg	Max	Test (7)
	Carbon disulfide	mg/kg	2.76E-03	N/A	N/A	5.00E-03	5.00E-03	mg/kg	Max	Test (7)
	cis-1,2-Dichloroethene	mg/kg	1.10E-02	N/A	N/A	1.10E-02	1.10E-02	mg/kg	Max	Test (7)
	Dieldrin	mg/kg	1.40E-03	N/A	N/A	1.40E-03	1.40E-03	mg/kg	Max	Test (7)
	Di-n-butyl phthalate	mg/kg	7.68E-02	N/A	N/A	2.10E-01	2.10E-01	mg/kg	Max	Test (7)
	Endosulfan II	mg/kg	1.00E-03	N/A	N/A	1.00E-03	1.00E-03	mg/kg	Max	Test (7)
	Endrin	mg/kg	6.40E-03	N/A	N/A	6.40E-03	6.40E-03	mg/kg	Max	Test (7)
	Endrin ketone	mg/kg	1.70E-03	N/A	N/A	1.70E-03	1.70E-03	mg/kg	Max	Test (7)
	Fluoranthene	mg/kg	6.40E-03	N/A	N/A	6.40E-03	6.40E-03	mg/kg	Max	Test (7)
	gamma-Chlordane	mg/kg	1.70E-03	N/A	N/A	1.70E-03	1.70E-03	mg/kg	Max	Test (7)
	Heptachlor epoxide	mg/kg	1.80E-03	N/A	N/A	1.80E-03	1.80E-03	mg/kg	Max	Test (7)
	Methylcyclohexane	mg/kg	3.84E-04	N/A	N/A	6.60E-04	6.60E-04	mg/kg	Max	Test (7)
	Methylene chloride	mg/kg	5.90E-03	N/A	N/A	5.90E-03	5.90E-03	mg/kg	Max	Test (7)
	p-Chloro-m-cresol	mg/kg	8.00E-03	N/A	N/A	8.00E-03	8.00E-03	mg/kg	Max	Test (7)
	Pyrene	mg/kg	3.80E-03	N/A	N/A	3.80E-03	3.80E-03	mg/kg	Max	Test (7)
	Tetrachloroethene	mg/kg	5.10E-03	N/A	N/A	5.10E-03	5.10E-03	mg/kg	Max	Test (7)
	Toluene	mg/kg	3.12E-04	N/A	N/A	4.90E-04	4.90E-04	mg/kg	Max	Test (7)
	Trichloroethene	mg/kg	8.90E-04	N/A	N/A	8.90E-04	8.90E-04	mg/kg	Max	Test (7)
	Trichlorofluoromethane	mg/kg	5.70E-04	N/A	N/A	5.70E-04	5.70E-04	mg/kg	Max	Test (7)
	Vinyl Chloride	mg/kg	1.20E-03	N/A	N/A	1.20E-03	1.20E-03	mg/kg	Max	Test (7)
	Xylenes (total)	mg/kg	4.10E-04	N/A	N/A	4.10E-04	4.10E-04	mg/kg	Max	Test (7)
	Aluminum	mg/kg	2.58E+04	N/A	N/A	3.11E+04	3.11E+04	mg/kg	Max	Test (7)
	Antimony	mg/kg	5.68E-01	N/A	N/A	1.50E+00	1.50E+00	mg/kg	Max	Test (7)
	Arsenic	mg/kg	8.44E+00	N/A	N/A	1.20E+01	1.20E+01	mg/kg	Max	Test (7)
	Barium	mg/kg	2.66E+02	N/A	N/A	5.53E+02	5.53E+02	mg/kg	Max	Test (7)
	Beryllium	mg/kg	6.56E-01	N/A	N/A	1.20E+00	1.20E+00	mg/kg	Max	Test (7)
	Cadmium	mg/kg	2.54E+00	N/A	N/A	2.90E+00	2.90E+00	mg/kg	Max	Test (7)

Table 7-12
Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area A - Surface Soil
Page 2 of 2

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	Calcium	mg/kg	8.35E+04	N/A	N/A	1.56E+05	1.56E+05	mg/kg	Max	Test (7)
	Chromium	mg/kg	2.02E+01	N/A	N/A	2.50E+01	2.50E+01	mg/kg	Max	Test (7)
	Cobalt	mg/kg	1.05E+01	N/A	N/A	1.40E+01	1.40E+01	mg/kg	Max	Test (7)
	Copper	mg/kg	3.94E+01	N/A	N/A	6.90E+01	6.90E+01	mg/kg	Max	Test (7)
	Iron	mg/kg	3.29E+04	N/A	N/A	4.32E+04	4.32E+04	mg/kg	Max	Test (7)
	Lead	mg/kg	1.16E+02	N/A	N/A	1.43E+02	1.43E+02	mg/kg	Max	Test (7)
	Magnesium	mg/kg	4.66E+04	N/A	N/A	8.28E+04	8.28E+04	mg/kg	Max	Test (7)
	Manganese	mg/kg	7.49E+02	N/A	N/A	9.18E+02	9.18E+02	mg/kg	Max	Test (7)
	Mercury	mg/kg	6.26E-02	N/A	N/A	8.60E-02	8.60E-02	mg/kg	Max	Test (7)
	Nickel	mg/kg	2.06E+01	N/A	N/A	2.60E+01	2.60E+01	mg/kg	Max	Test (7)
	Potassium	mg/kg	2.19E+03	N/A	N/A	2.68E+03	2.68E+03	mg/kg	Max	Test (7)
	Selenium	mg/kg	7.08E-01	N/A	N/A	8.00E-01	8.00E-01	mg/kg	Max	Test (7)
	Silver	mg/kg	2.49E-01	N/A	N/A	7.70E-01	7.70E-01	mg/kg	Max	Test (7)
	Sodium	mg/kg	5.18E+02	N/A	N/A	1.73E+03	1.73E+03	mg/kg	Max	Test (7)
	Thallium	mg/kg	2.10E-01	N/A	N/A	2.60E-01	2.60E-01	mg/kg	Max	Test (7)
	Vanadium	mg/kg	4.32E+01	N/A	N/A	5.10E+01	5.10E+01	mg/kg	Max	Test (7)
	Zinc	mg/kg	5.79E+02	N/A	N/A	1.49E+03	1.49E+03	mg/kg	Max	Test (7)
	Total Cyanide	mg/kg	6.00E-02	N/A	N/A	7.00E-02	7.00E-02	mg/kg	Max	Test (7)

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).

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): 95% UCL recommended by statistical software (e.g., ProUCL) exceeds 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.

⁵ Infrequent detection resulted in ProUCL modeling error for this constituent, therefore distribution, average, and UCL determined using non-ProUCL bootstrap method with random numbers for NDs (see text for details).

Table 7-13
Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area A - Sediment
Page 1 of 2

Scenario Timeframe: Current/Future Medium: Sediment Exposure Medium: Sediment										
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
Sediment	2,3,7,8-TCDD-TE	mg/kg	5.08E-06	N/A	N/A	6.28E-06	6.28E-06	mg/kg	Max	Test (7)
	1,2,4-Trichlorobenzene ⁵	mg/kg	4.15E-03	N/A	1.34E-01 (NP)	4.40E-03	4.40E-03	mg/kg	Max	Test (2)
	2-Butanone	mg/kg	3.30E-02	Yes	3.87E-02 (N)	4.88E-02	3.87E-02	mg/kg	95% KM-t	Test (4)
	4,4-DDT ⁵	mg/kg	1.51E-03	N/A	2.83E-02 (NP)	1.98E-03	1.98E-03	mg/kg	Max	Test (2)
	4-Chloro-3-Methylphenol ⁵	mg/kg	1.70E-02	N/A	1.58E-01 (NP)	1.70E-02	1.70E-02	mg/kg	Max	Test (2)
	Acenaphthene ⁵	mg/kg	1.70E-02	N/A	2.24E-01 (NP)	1.70E-02	1.70E-02	mg/kg	Max	Test (2)
	Acetone ⁵	mg/kg	2.53E-01	N/A	1.08E-01 (NP)	2.53E-01	1.08E-01	mg/kg	95% UCL-Bst	Test (8)
	Anthracene	mg/kg	7.33E-03	Yes	1.91E-02 (N)	1.90E-02	1.90E-02	mg/kg	Max	Test (2)
	Benzene	mg/kg	2.53E-04	Yes	3.07E-04 (NP)	2.80E-04	2.80E-04	mg/kg	Max	Test (2)
	Benzo(a)anthracene	mg/kg	3.61E-02	No	5.38E-02 (N)	6.70E-02	5.38E-02	mg/kg	95% Student's-t	Test (4)
	Benzo(a)pyrene	mg/kg	4.64E-02	No	7.04E-02 (N)	7.90E-02	7.04E-02	mg/kg	95% Student's-t	Test (4)
	Benzo(b)fluoranthene	mg/kg	7.44E-02	No	1.03E-01 (N)	1.20E-01	1.03E-01	mg/kg	95% KM-t	Test (4)
	Benzo(g,h,i)perylene	mg/kg	4.99E-02	No	7.38E-02 (N)	1.00E-01	7.38E-02	mg/kg	95% Student's-t	Test (4)
	Benzo(k)fluoranthene	mg/kg	3.67E-01	No	5.85E-02 (N)	6.69E-01	5.85E-02	mg/kg	95% Student's-t	Test (4)
	Bis(2-ethylhexyl) phthalate	mg/kg	3.43E-02	Yes	4.84E-02 (N)	4.70E-02	4.70E-02	mg/kg	Max	Test (2)
	Bromomethane ⁵	mg/kg	1.50E-03	N/A	5.40E-03 (NP)	1.50E-03	1.50E-03	mg/kg	Max	Test (2)
	Carbon disulfide ⁵	mg/kg	6.10E-03	N/A	6.76E-03 (NP)	6.70E-03	6.70E-03	mg/kg	Max	Test (2)
	Chloroform ⁵	mg/kg	5.40E-04	N/A	5.52E-03 (NP)	5.40E-04	5.40E-04	mg/kg	Max	Test (2)
	Chrysene	mg/kg	5.46E-02	No	8.37E-02 (N)	9.82E-02	8.37E-02	mg/kg	95% Student's-t	Test (4)
	Di-n-butyl phthalate	mg/kg	5.53E-02	Yes	6.91E-02 (N)	6.90E-02	6.90E-02	mg/kg	Max	Test (2)
	Endrin aldehyde ⁵	mg/kg	2.45E-03	N/A	8.42E-03 (NP)	2.45E-03	2.45E-03	mg/kg	Max	Test (2)
	Fluoranthene	mg/kg	1.22E-01	No	1.90E-01 (N)	2.00E-01	1.90E-01	mg/kg	95% KM-t	Test (4)
	Fluorene ⁵	mg/kg	1.00E-02	N/A	2.19E-01 (NP)	1.00E-02	1.00E-02	mg/kg	Max	Test (2)
	Indeno(1,2,3-cd)pyrene	mg/kg	3.82E-02	No	5.72E-02 (N)	6.71E-02	5.72E-02	mg/kg	95% Student's-t	Test (4)
	Methyl acetate	mg/kg	7.60E-04	N/A	N/A	7.60E-04	7.60E-04	mg/kg	Max	Test (7)
	Methylene chloride	mg/kg	5.60E-03	Yes	7.96E-03 (N)	7.80E-03	7.80E-03	mg/kg	Max	Test (2)
	Nitroglycerin ⁵	mg/kg	5.80E+00	N/A	4.98E+00 (NP)	5.80E+00	4.98E+00	mg/kg	95% UCL-Bst	Test (8)
	Phenanthrene	mg/kg	5.21E-02	Yes	9.69E-02 (N)	1.10E-01	9.69E-02	mg/kg	95% KM-t	Test (4)
	Pyrene	mg/kg	9.74E-02	No	1.53E-01 (N)	1.50E-01	1.50E-01	mg/kg	Max	Test (2)
	Toluene	mg/kg	6.13E-04	Yes	1.12E-03 (N)	1.10E-03	1.10E-03	mg/kg	Max	Test (2)
	Aluminum	mg/kg	1.12E+04	No	1.44E+04 (N)	1.55E+04	1.44E+04	mg/kg	95% Student's-t	Test (4)
	Antimony	mg/kg	3.37E-01	N/A	N/A	4.50E-01	4.50E-01	mg/kg	Max	Test (7)
	Arsenic	mg/kg	7.47E+00	No	1.32E+01 (G)	1.80E+01	1.32E+01	mg/kg	95% Approx. Gamma	Test (6)
	Barium	mg/kg	1.18E+02	No	1.56E+02 (N)	1.95E+02	1.56E+02	mg/kg	95% Student's-t	Test (4)
	Beryllium	mg/kg	6.55E-01	No	8.67E-01 (N)	8.80E-01	8.67E-01	mg/kg	95% Student's-t	Test (4)
	Cadmium	mg/kg	1.62E+00	Yes	1.85E+00 (N)	2.20E+00	1.85E+00	mg/kg	95% KM-t	Test (4)
	Calcium	mg/kg	1.42E+04	No	2.02E+04 (N)	2.56E+04	2.02E+04	mg/kg	95% Student's-t	Test (4)

Table 7-13
Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area A - Sediment
Page 2 of 2

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

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
Sediment	Chromium	mg/kg	1.76E+01	No	2.47E+01 (N)	3.30E+01	2.47E+01	mg/kg	95% Student's-t	Test (4)
	Cobalt	mg/kg	1.23E+01	No	1.61E+01 (N)	2.00E+01	1.61E+01	mg/kg	95% Student's-t	Test (4)
	Copper	mg/kg	2.01E+01	No	2.50E+01 (N)	2.60E+01	2.50E+01	mg/kg	95% Student's-t	Test (4)
	Cyanide	mg/kg	1.13E-01	N/A	N/A	1.30E-01	1.30E-01	mg/kg	Max	Test (7)
	Iron	mg/kg	2.59E+04	No	3.61E+04 (N)	4.79E+04	3.61E+04	mg/kg	95% Student's-t	Test (4)
	Lead	mg/kg	2.07E+01	No	2.82E+01 (N)	3.50E+01	2.82E+01	mg/kg	95% Student's-t	Test (4)
	Magnesium	mg/kg	6.89E+03	No	9.49E+03 (N)	1.09E+04	9.49E+03	mg/kg	95% Student's-t	Test (4)
	Manganese	mg/kg	7.72E+02	No	1.18E+03 (N)	1.64E+03	1.18E+03	mg/kg	95% Student's-t	Test (4)
	Mercury	mg/kg	2.90E-02	N/A	N/A	3.30E-02	3.30E-02	mg/kg	Max	Test (7)
	Nickel	mg/kg	1.85E+01	No	2.31E+01 (N)	2.50E+01	2.31E+01	mg/kg	95% Student's-t	Test (4)
	Potassium	mg/kg	1.47E+03	N/A	N/A	1.82E+03	1.82E+03	mg/kg	Max	Test (7)
	Selenium	mg/kg	2.20E+00	N/A	N/A	7.70E+00	7.70E+00	mg/kg	Max	Test (7)
	Silver	mg/kg	1.21E-01	Yes	1.40E-01 (N)	1.60E-01	1.40E-01	mg/kg	95% KM-% Btstrp	Test (4)
	Sodium	mg/kg	5.20E+01	N/A	N/A	6.60E+01	6.60E+01	mg/kg	Max	Test (7)
	Thallium ⁵	mg/kg	1.09E-01	N/A	4.13E-01 (NP)	1.30E-01	1.30E-01	mg/kg	Max	Test (2)
	Vanadium	mg/kg	2.15E+01	No	2.94E+01 (N)	3.60E+01	2.94E+01	mg/kg	95% Student's-t	Test (4)
	Zinc	mg/kg	8.37E+01	No	1.03E+02 (N)	1.21E+02	1.03E+02	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).

Table 7-14
Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area A - Surface Water

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

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 Water	2,3,7,8-TCDD-TE	mg/L	6.30E-09	N/A	N/A	1.89E-08	1.89E-08	mg/L	Max	Test (7)
	2,4,6-Trinitrotoluene ⁵	mg/L	1.30E-03	N/A	6.22E-04 (NP)	1.30E-03	6.22E-04	mg/L	95% UCL-Bst	Test (8)
	2-amino-4,6-Dinitrotoluene	mg/L	7.10E-04	No	1.10E-03 (N)	1.10E-03	1.10E-03	mg/L	95% KM-% Btstrp	Test (4)
	4-amino-2,6-Dinitrotoluene	mg/L	1.69E-03	No	2.50E-03 (N)	2.50E-03	2.50E-03	mg/L	95% KM-% Btstrp	Test (4)
	Diethyl phthalate	mg/L	1.90E-04	Yes	2.10E-04 (NP)	2.10E-04	2.10E-04	mg/L	Max	Test (2)
	Aluminum	mg/L	1.75E-01	N/A	N/A	2.35E-01	2.35E-01	mg/L	Max	Test (7)
	Barium	mg/L	5.80E-02	No	6.39E-02 (N)	6.49E-02	6.39E-02	mg/L	95% Student's-t	Test (4)
	Calcium	mg/L	4.83E+01	No	5.43E+01 (G)	5.30E+01	5.30E+01	mg/L	Max	Test (2)
	Chromium	mg/L	9.27E-04	No	9.80E-04 (NP)	9.80E-04	9.80E-04	mg/L	95% KM-% Btstrp	Test (3)
	Iron	mg/L	1.07E-01	N/A	N/A	2.00E-01	2.00E-01	mg/L	Max	Test (7)
	Lead ⁵	mg/L	3.00E-04	N/A	1.77E-03 (NP)	3.00E-04	3.00E-04	mg/L	Max	Test (2)
	Magnesium	mg/L	2.50E+01	No	3.00E+01 (N)	3.20E+01	3.00E+01	mg/L	95% Student's-t	Test (4)
	Manganese	mg/L	2.69E-02	No	4.28E-02 (N)	6.19E-02	4.28E-02	mg/L	95% KM-t	Test (4)
	Potassium	mg/L	1.87E+00	N/A	N/A	2.10E+00	2.10E+00	mg/L	Max	Test (7)
	Sodium	mg/L	1.48E+01	No	1.65E+01 (N)	1.66E+01	1.65E+01	mg/L	95% Student's-t	Test (4)
	Vanadium	mg/L	1.27E-03	No	1.44E-03 (N)	1.40E-03	1.40E-03	mg/L	Max	Test (2)
	Zinc	mg/L	4.93E-03	No	7.39E-03 (N)	6.70E-03	6.70E-03	mg/L	Max	Test (2)
	Total Cyanide	mg/L	2.33E-03	N/A	N/A	3.00E-03	3.00E-03	mg/L	Max	Test (7)
	Perchlorate	mg/L	1.48E-04	No	1.69E-04 (N)	1.68E-04	1.68E-04	mg/L	Max	Test (2)

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).

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. Whether or not HQ summation was appropriate and scientifically defensible is based on whether the 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 408 (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 41 Area A are presented in risk characterization tables (**Appendix F-2, Tables F-2 through F-15**) for the seven selected receptor species. These summed EEQs are presented in **Table 7-15** (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 7-15**, Tier 1 total EEQs ranged from approximately 2 to 518 for the seven receptor species, using TRVs based on either NOAEL or LOAEL values. The mink was predicted to be the most impacted, followed by the short-tailed shrew, the American robin, the meadow vole, the red fox, the red-tailed hawk, and the great blue heron. The inorganic constituents arsenic and zinc; and the organic constituents TCDD and Aroclor 1254 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 fish, 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 0.0009 to 16. 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, red fox, mink, and great blue heron were below one. Tier 2 total EEQs based on LOAEL values were 4.1 for the meadow vole, 3.6 for the short-tailed shrew, and 2.6 for the American robin (**Table 7-15**).

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, red fox, mink, and great blue heron are not discussed because the summed EEQs are below one.

Meadow Vole. The total EEQs for both NOAEL and LOAEL TRVs exceeded one (12 and 4.1, respectively). Four COPECs had individual NOAEL-based EEQs that exceeded one (EEQ in parenthesis): arsenic (5.1), selenium (1.8), copper (1.8), and zinc (1.7). Only copper (1.4) and selenium (1.1) had a LOAEL-based EEQ that exceeded one. 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 7-15
Wildlife EEQ Hazard Summary for Food Chain Exposure at SWMU 41 Area A

Receptor	Tier 1 ^a		Tier 2 ^b	
	NOAEL-Based EEQ	LOAEL-Based EEQ	NOAEL-Based EEQ	LOAEL-Based EEQ
Meadow vole	34	11	12	4.1
Hazard Driver(s) ^c :	<u>As, Se, and Zn</u> - plant ingestion		<u>As, Cu, and Se</u> - plant and soil ingestion	
Short-tailed shrew	277	62	16	3.6
Hazard Driver(s) ^c :	<u>Aroclor 1254</u> - terrestrial invertebrate ingestion		<u>As and Cd</u> - terrestrial invertebrate ingestion	
American robin	212	34	16	2.6
Hazard Driver(s) ^c :	<u>Zn</u> - terrestrial invertebrate ingestion		<u>Zn</u> - terrestrial invertebrate ingestion	
Red-tailed hawk	13	2.3	0.0009	0.0002
Hazard Driver(s) ^c :	<u>Zn and DDT</u> - small mammal ingestion		--	
Red fox	16	5.0	0.001	0.0002
Hazard Driver(s) ^c :	<u>As and Se</u> - small mammal ingestion		--	
Mink	518	62	0.32	0.04
Hazard Driver(s) ^c :	<u>TCDD</u> - fish ingestion		--	
Great blue heron	16	2.2	0.04	0.01
Hazard Driver(s) ^c :	<u>TCDD</u> - fish ingestion		--	

^a Tier 1 = Max EEQ using max EPC, max BAF/BCF (unless regression equation is used), max Intake Rates, min BW, and FHR =1.

^b Tier 2 = EEQ using 95% EPC, non-max BAF/BCF BCF (unless regression equation is used), 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 (16 and 3.6, respectively). Four COPECs had individual NOAEL-based EEQs that exceeded one (EEQ in parenthesis): arsenic (5.0), cadmium (4.6), lead (1.7), and zinc (1.6). No COPECs had individual LOAEL-based EEQs that exceeded one. The primary exposure pathway was the ingestion of terrestrial invertebrates. The results of the short-tailed shrew Tier 2 risk evaluation are presented in **Appendix F-2, Table F-5**.

American Robin. The total EEQs for both NOAEL and LOAEL TRVs exceeded one (16 and 2.6, respectively). Three COPECs had individual NOAEL-based EEQs that exceeded one (EEQ in parenthesis): zinc (10.6), lead (1.7), and cadmium (1.5). Only zinc (1.2) had an individual LOAEL-based EEQ that exceeded one (EEQ in parenthesis). The primary exposure pathway was the ingestion of terrestrial invertebrates. The results of the Tier 2 risk evaluation for American robins are 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, sediment, and surface water were the exposure media at SWMU 41 Area A. Intake is not calculated because potential adverse effects are assessed by evaluating the COPEC concentrations in the specific medium. Detailed procedures are presented in *Section 7.1.8* and the results are summarized in **Tables 7-16** (surface soil), **7-17** (sediment), and **7-18** (surface water).

7.2.4.1 Surface Soil

Based on the results of the first step, 16 COPECs were selected based on an EcoSSL or BTAG exceedance while 14 additional chemicals were evaluated further because of the lack of available EcoSSL or BTAG screening values (**Table 7-16**). In the second step, the MDC of these 30 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-butanone, acetone, bis(2-ethylhexyl)phthalate, calcium, carbon disulfide, endosulfan II, endrin, magnesium, methylcyclohexane, p-chloro-m-cresol, potassium, sodium, and trichlorofluoromethane.
- The barium MDC exceeded all four available barium benchmarks. However, only 20 percent of the samples exceeded three of the barium benchmarks, and only 40 percent of the samples exceeded the fourth benchmark. Due the low frequency of benchmark exceedance, the potential for direct contact toxicity is not likely significant enough to recommend further action at SWMU 41 Area A.
- The cadmium MDC exceeded one of the four available benchmarks for direct contact for cadmium. Therefore, the potential for direct contact toxicity is not likely significant enough to recommend further action at SWMU 41 Area A.
- The cobalt MDC exceeded one of the three available benchmarks for direct contact for cobalt. Therefore, the potential for direct contact toxicity is not likely significant enough to recommend further action at SWMU 41 Area A.

Table 7-16
Direct Toxicity Evaluation for Surface Soil at SWMU 41 Area A

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	NOAA SQuiRT 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
1,2,4-Trichlorobenzene	1/5	3.40E-03	3.40E-03	3.40E-03	NVA	Yes		0.1	0.05	NVA	NVA	20	0/3	No exceedences
2-Butanone	5/5	3.80E-02	3.80E-02	4.70E-03	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
4,4'-DDT	1/2	1.20E-03	1.20E-03	1.20E-03	1.00E-01	No								
Acetone	5/5	5.50E-02	5.50E-02	2.40E-02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
alpha-Chlordane	1/2	1.50E-03	1.50E-03	1.50E-03	1.00E-01	No								
Aroclor 1254	1/2	1.50E-01	1.50E-01	1.50E-01	1.00E-01	Yes	Plant tox (no ref)	0.5	0.5	NVA	40	NVA	0/3	No exceedences
Benzene	4/5	5.20E-04	5.20E-04	2.40E-04	1.00E-01	No								
bis(2-Ethylhexyl) phthalate	5/5	2.00E-01	2.00E-01	1.60E-02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Carbon disulfide	5/5	5.00E-03	5.00E-03	1.30E-03	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
cis-1,2-Dichloroethene	1/5	1.10E-02	1.10E-02	1.10E-02	3.00E-01	No								
Dieldrin	1/2	1.40E-03	1.40E-03	1.40E-03	4.90E-03	No								
Di-n-butyl phthalate	5/5	2.10E-01	2.10E-01	3.60E-02	NVA	Yes		NVA	NVA	NVA	200	NVA	0/1	No exceedences
Endosulfan II	1/2	1.00E-03	1.00E-03	1.00E-03	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Endrin	1/2	6.40E-03	6.40E-03	6.40E-03	NVA	Yes		NVA	NVA	NVA	NVA	NVA	MVA	
Endrin ketone	1/2	1.70E-03	1.70E-03	1.70E-03	1.00E-01	No								
Fluoranthene	1/5	6.40E-03	6.40E-03	6.40E-03	1.1E+00 (HMW)	No								
gamma-Chlordane	1/2	1.70E-03	1.70E-03	1.70E-03	1.00E+02	No								
Heptachlor epoxide	1/2	1.80E-03	1.80E-03	1.80E-03	1.00E-01	No								
Methylcyclohexane	5/5	6.60E-04	6.60E-04	2.00E-04	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Methylene chloride	1/5	5.90E-03	5.90E-03	5.90E-03	3.00E-01	No								
p-Chloro-m-cresol	1/5	8.00E-03	8.00E-03	8.00E-03	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Pyrene	1/5	3.80E-03	3.80E-03	3.80E-03	1.1E+00 (HMW)	No								
Tetrachloroethene	1/5	5.10E-03	5.10E-03	5.10E-03	3.00E-01	No								
Toluene	5/5	4.90E-04	4.90E-04	1.80E-04	1.00E-01	No								
Trichloroethene	1/5	8.90E-04	8.90E-04	8.90E-04	3.00E-01	No								
Trichlorofluoromethane	1/5	5.70E-04	5.70E-04	5.70E-04	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Vinyl Chloride	1/5	1.20E-03	1.20E-03	1.20E-03	3.00E-01	No								
Xylenes (total)	1/5	4.10E-04	4.10E-04	4.10E-04	pH ≥ 5.5	No								
Aluminum	5/5	3.11E+04	3.11E+04	1.88E+04	1.00E+00	Yes	pH < 5.5; Plant tox (OHMTADS)							pH = 5.98
Antimony	5/5	1.50E+00	1.50E+00	2.10E-01	2.70E-01	Yes	Mammal tox	NVA	20	78	5	NVA	0/3	No exceedences
Arsenic	5/5	1.20E+01	1.20E+01	6.00E+00	1.80E+01	No								
Barium	5/5	5.53E+02	5.53E+02	1.10E+02	3.30E+02	Yes	invertebrate tox	440	500	330	500	NVA	4/4	
Beryllium	5/5	1.20E+00	1.20E+00	3.40E-01	2.10E+01	No								
Cadmium	5/5	2.90E+00	2.90E+00	2.20E+00	3.60E-01	Yes	Mammal tox	NVA	1.4	32	4	20	1/4	
Calcium	5/5	1.56E+05	1.56E+05	3.31E+04	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Chromium (Cr III tox)	5/5	2.50E+01	2.50E+01	1.30E+01	2.60E+01	No								
Chromium (Cr VI tox)	5/5	2.50E+01	2.50E+01	1.30E+01	1.30E+02	No								
Cobalt	5/5	1.40E+01	1.40E+01	7.80E+00	1.30E+01	Yes	Plant tox	NVA	40	13	20	NVA	1/3	
Copper	5/5	6.90E+01	6.90E+01	2.60E+01	2.80E+01	Yes	Bird tox	NVA	63	70	100	50	1/4	
Iron	5/5	4.32E+04	4.32E+04	2.43E+04	5 ≤ pH ≤ 8	No								
Lead	5/5	1.43E+02	1.43E+02	8.90E+01	1.10E+01	Yes	Bird tox	16	70	120	50	500	4/5	
Magnesium	5/5	8.28E+04	8.28E+04	2.30E+04	4.40E+03	Yes	No reference	NVA	NVA	NVA	NVA	NVA	NVA	
Manganese	5/5	9.18E+02	9.18E+02	5.17E+02	2.20E+02	Yes	Plant tox	NVA	NVA	220	500	NVA	2/2	Plant tox
Mercury	5/5	8.60E-02	8.60E-02	4.70E-02	5.80E-02	Yes	No reference	0.058	6.6	NVA	0.3	0.1	1/4	No reference for BTAG
Nickel	5/5	2.60E+01	2.60E+01	1.70E+01	3.80E+01	No								
Potassium	5/5	2.68E+03	2.68E+03	1.89E+03	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Selenium	5/5	8.00E-01	8.00E-01	5.20E-01	5.20E-01	Yes	Plant tox	0.26	1	0.52	1	70	2/5	Plant tox
Silver	5/5	7.70E-01	7.70E-01	8.60E-02	4.20E+00	No								
Sodium	5/5	1.73E+03	1.73E+03	5.00E+01	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Thallium	5/5	2.60E-01	2.60E-01	1.50E-01	1.00E-03	Yes	Plant tox (no ref)	NVA	1	NVA	1	NVA	0/2	No exceedences
Vanadium	5/5	5.10E+01	5.10E+01	2.90E+01	7.80E+00	Yes	Bird tox	58	130	NVA	2	NVA	1/3	EcoSSL says data insufficient to derive direct contact SSL
Zinc	5/5	1.49E+03	1.49E+03	2.42E+02	4.60E+01	Yes	Plant tox (OHMTADS)	48	200	120	50	200	5/5	
Total Cyanide	5/5	7.00E-02	7.00E-02	5.00E-02	5.00E-03	Yes	Microbiotic tox	NVA	0.9	NVA	NVA	NVA	0/1	No exceedences

All values presented in mg/kg.
NVA = No Value Available
LMW = Low Molecular Weight PAH
HMW = High Molecular Weight PAH
Surface soil pH of 7.57 based on one geochemical sample (LFSB12A) collected at FLFA.

- (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) NOAA SQuiRT (Buckman, 1999). Most conservative target value used.
(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).

Table 7-17
Direct Contact Toxicity Evaluation for Sediment at SWMU 41 Area A
Page 1 of 2

COPEC	MDC (mg/kg)	EPC (mg/kg)	USEPA Region 3 BTAG (mg/kg) ^A	ARCS ^B			SQB (mg/kg) ^{B,C}	Canadian ISQG (mg/kg) ^D	Canadian PEL (mg/kg) ^D	NOAA ^B		FDEP ^B		Weight of Evidence Exceedence	
				TEC (mg/kg)	PEC (mg/kg)	NEC (mg/kg)				ER-L (mg/kg)	ER-M (mg/kg)	TEL (mg/kg)	PEL (mg/kg)	Using MDC	Using EPC
2,3,7,8-TCDD-TE	6.28E-06	6.28E-06	8.50E-07	---	---	---	---	8.50E-07	2.15E-05	---	---	---	---	2 / 3	2 / 3
1,2,4-Trichlorobenzene	4.40E-03	4.40E-03	2.10E+00	---	---	---	9.60E+00	---	---	---	---	---	---	0 / 2	0 / 2
2-Butanone	4.88E-02	3.87E-02	---	---	---	---	2.70E-01	---	---	---	---	---	---	0 / 1	0 / 1
4,4'-DDT	1.98E-03	1.98E-03	4.16E-03	---	---	---	3.40E-01	1.19E-03	4.77E-03	1.00E-03	7.00E-03	1.19E-03	4.77E-03	3 / 8	3 / 8
4-Chloro-3-Methylphenol	1.70E-02	1.70E-02	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Acenaphthene	1.70E-02	1.70E-02	6.70E-03	---	---	---	1.30E+00	6.71E-03	8.89E-02	1.60E-02	5.00E-01	6.71E-03	8.89E-02	4 / 8	4 / 8
Acetone	2.53E-01	1.08E-01	---	---	---	---	8.70E-03	---	---	---	---	---	---	1 / 1	1 / 1
Anthracene	1.90E-02	1.90E-02	5.72E-02	3.16E-02	5.48E-01	1.70E+00	2.70E-02	4.69E-02	2.45E-01	8.53E-02	1.10E+00	4.69E-02	2.45E-01	0 / 11	0 / 11
Benzene	2.80E-04	2.80E-04	---	---	---	---	1.60E-01	---	---	---	---	---	---	0 / 1	0 / 1
Benzo(a)anthracene	6.70E-02	5.38E-02	1.08E-01	2.60E-01	4.20E+00	3.50E+00	1.10E-01	3.17E-02	3.85E-01	2.61E-01	1.60E+00	7.48E-02	6.93E-01	1 / 11	1 / 11
Benzo(a)pyrene	7.90E-02	7.04E-02	1.50E-01	3.50E-01	3.94E-01	4.40E-01	1.40E-01	3.19E-02	7.82E-01	4.30E-01	1.60E+00	8.88E-02	7.63E-01	1 / 11	1 / 11
Benzo(b)fluoranthene	1.20E-01	1.03E-01	2.72E-02	2.72E-02	---	4.00E+00	---	---	---	---	---	---	---	2 / 3	2 / 3
Benzo(g,h,i)perylene	1.00E-01	7.38E-02	1.70E-01	2.90E-01	6.30E+00	3.80E+00	---	---	---	---	---	---	---	0 / 4	0 / 4
Benzo(k)fluoranthene	6.69E-01	5.85E-02	2.40E-01	---	---	---	---	---	---	---	---	---	---	1 / 1	0 / 1
Bis(2-ethylhexyl) phthalate	4.70E-02	4.70E-02	1.80E-01	---	---	---	8.90E+02	---	---	---	---	1.82E-01	2.65E+00	0 / 4	0 / 4
Bromomethane	1.50E-03	1.50E-03	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Carbon disulfide	6.70E-03	6.70E-03	8.51E-04	---	---	---	8.50E-04	---	---	---	---	---	---	2 / 2	2 / 2
Chloroform	5.40E-04	5.40E-04	---	---	---	---	2.20E-02	---	---	---	---	---	---	0 / 1	0 / 1
Chrysene	9.82E-02	8.37E-02	1.66E-01	5.00E-01	5.20E+00	4.00E+00	---	5.71E-02	8.62E-01	3.84E-01	2.80E+00	1.08E-01	8.46E-01	1 / 10	1 / 10
Di-n-butyl phthalate	6.90E-02	6.90E-02	6.47E+00	---	---	---	1.10E+01	---	---	---	---	---	---	0 / 2	0 / 2
Endrin aldehyde	2.45E-03	2.45E-03	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Fluoranthene	2.00E-01	1.90E-01	4.23E-01	6.42E-02	8.34E-01	7.50E+00	6.20E+00	1.11E-01	2.36E+00	6.00E-01	5.10E+00	1.13E-01	1.49E+00	3 / 11	3 / 11
Fluorene	1.00E-02	1.00E-02	7.74E-02	3.46E-02	6.52E-01	1.80E+00	5.40E-01	2.12E-02	1.44E-01	1.90E-02	5.40E-01	2.12E-02	1.44E-01	0 / 11	0 / 11
Indeno(1,2,3-cd)pyrene	6.71E-02	5.72E-02	1.90E-01	7.80E-02	8.37E-01	3.80E+00	---	---	---	---	---	---	---	0 / 4	0 / 4
Methyl acetate	7.60E-04	7.60E-04	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Methylene chloride	7.80E-03	7.80E-03	---	---	---	---	3.70E-01	---	---	---	---	---	---	0 / 1	0 / 1
Nitroglycerine	5.80E+00	4.98E+00	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Phenanthrene	1.10E-01	9.69E-02	2.04E-01	---	---	---	1.80E+00	4.19E-02	5.15E-01	2.40E-01	1.50E+00	8.67E-02	5.44E-01	2 / 8	2 / 8
Pyrene	1.50E-01	1.50E-01	1.95E-01	5.70E-01	3.23E+00	6.10E+00	---	5.30E-02	8.75E-01	6.65E-01	2.60E+00	1.53E-01	1.40E+00	1 / 10	1 / 10
Toluene	1.10E-03	1.10E-03	---	---	---	---	5.00E-02	---	---	---	---	---	---	0 / 1	0 / 1
Aluminum	1.55E+04	1.44E+04	---	---	5.80E+04	7.32E+04	---	---	---	---	---	---	---	0 / 2	0 / 2
Antimony	4.50E-01	4.50E-01	2.00E+00	---	---	---	---	---	---	2.00E+00	2.50E+01	---	---	0 / 3	0 / 3
Arsenic	1.80E+01	1.32E+01	9.80E+00	1.21E+01	5.70E+01	9.29E+01	---	5.90E+00	1.70E+01	8.20E+00	7.00E+01	7.24E+00	4.16E+01	6 / 10	5 / 10
Barium	1.95E+02	1.56E+02	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Beryllium	8.80E-01	8.67E-01	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Cadmium	2.20E+00	1.85E+00	9.90E-01	5.92E-01	1.17E+01	4.11E+01	---	6.00E-01	3.50E+00	1.20E+00	9.60E+00	6.80E-01	4.21E+00	5 / 10	5 / 10
Calcium	2.56E+04	2.02E+04	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Chromium	3.30E+01	2.47E+01	4.34E+01	5.60E+01	1.59E+02	3.12E+02	---	3.73E+01	9.00E+01	8.10E+01	3.70E+02	5.23E+01	1.60E+02	0 / 10	0 / 10
Cobalt	2.00E+01	1.61E+01	5.00E+01	---	---	---	---	---	---	---	---	---	---	0 / 1	0 / 1
Copper	2.60E+01	2.50E+01	3.16E+01	2.80E+01	7.77E+01	5.48E+01	---	3.57E+01	1.97E+02	3.40E+01	2.70E+02	1.87E+01	1.08E+02	1 / 10	1 / 10

Table 7-17
Direct Contact Toxicity Evaluation for Sediment at SWMU 41 Area A
Page 2 of 2

COPEC	MDC (mg/kg)	EPC (mg/kg)	USEPA Region 3 BTAG (mg/kg) ^A	ARCS ^B			SQB (mg/kg) ^{B,C}	Canadian ISQG (mg/kg) ^D	Canadian PEL (mg/kg) ^D	NOAA ^B		FDEP ^B		Weight of Evidence Exceedence	
				TEC (mg/kg)	PEC (mg/kg)	NEC (mg/kg)				ER-L (mg/kg)	ER-M (mg/kg)	TEL (mg/kg)	PEL (mg/kg)	Using MDC	Using EPC
Cyanide	1.30E-01	1.30E-01	1.00E-01	---	---	---	---	---	---	---	---	---	---	1 / 1	1 / 1
Iron	4.79E+04	3.61E+04	2.00E+04	---	---	---	---	---	---	---	---	---	---	1 / 1	1 / 1
Lead	3.50E+01	2.82E+01	3.58E+01	3.42E+01	3.96E+02	6.87E+01	---	3.50E+01	9.13E+01	4.67E+01	2.18E+02	3.02E+01	1.12E+02	2 / 10	0 / 10
Magnesium	1.09E+04	9.49E+03	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Manganese	1.64E+03	1.18E+03	4.60E+02	1.67E+03	1.08E+03	8.19E+02	---	---	---	---	---	---	---	3 / 4	3 / 4
Mercury	3.30E-02	3.30E-02	1.80E-01	---	---	---	---	1.70E-01	4.86E-01	1.50E-01	7.10E-01	1.30E-01	7.00E-01	0 / 7	0 / 7
Nickel	2.50E+01	2.31E+01	2.27E+01	3.96E+01	3.85E+01	3.79E+01	---	---	---	2.09E+01	5.16E+01	1.59E+01	4.28E+01	3 / 8	3 / 8
Potassium	1.82E+03	1.82E+03	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Selenium	7.70E+00	7.70E+00	2.00E+00	---	---	---	---	---	---	---	---	---	---	1 / 1	1 / 1
Silver	1.60E-01	1.40E-01	1.00E+00	---	---	---	---	---	---	1.00E+00	3.70E+00	7.30E-01	1.77E+00	0 / 5	0 / 5
Sodium	6.60E+01	6.60E+01	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Thallium	1.30E-01	1.30E-01	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Vanadium	3.60E+01	2.94E+01	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Zinc	1.21E+02	1.03E+02	1.21E+02	1.59E+02	1.53E+03	5.41E+02	---	1.23E+02	3.15E+02	1.50E+02	4.10E+02	1.24E+02	2.71E+02	0 / 10	0 / 10

--- No Value Available

ARCS = Assessment and Remediation of Contaminated Sediment

COPEC = Chemical of Potential Ecological Concern.

EPC = Exposure Point Concentration. The 95% upper confidence limit concentration was selected as the EPC unless it exceeded the maximum detected concentration, in which case the MDC was chosen as the EPC.

ER-L = Effect Range-Low

ER-M = Effect Range Median

FDEP = Florida Department of Environmental Protection

ISQG = Interim Sediment Quality Guideline

MDC = Maximum detected concentration.

NEC = High No Effect Concentration

NOAA = National Oceanic and Atmospheric Administration

PEC = Probable Effect Concentration

PEL = Probably Effect Level

SQB = Sediment Quality Benchmark

TEC = Threshold Effect Concentration

TEL = Threshold Effect Level

ARCS, SQB, and Canadian values for freshwater environments.

NOAA and FDEP values for estuarine and marine environments, but may be used for screening purposes.

^A Screening toxicity values from USEPA Region 3 BTAG, August 2006.

^B Values from Jones, D.S and Suter, G.W. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. ES/ER/TM-95/R4.

^C The lowest of the Eq P-derived sediment quality benchmarks presented in Jones, D.S and Suter, G.W. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. ES/ER/TM-95/R4. is presented here (assumed TOC of 1%).

^D Values from Canadian Council of Ministers of the Environment (CCME). 2002. Canadian Environmental Quality Guidelines. Summary Table Update 2002.

^E Washington state sediment quality standards as presented in Jones, D.S and Suter, G.W. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. ES/ER/TM-95/R4.

Table 7-18
Surface Water Direct Contact Assessment for Aquatic Life at SWMU 41 Area A

COPEC	MDC (ug/L)	EPC (ug/L)	USEPA Region 3 BTAG (ug/L) ^A	NAWQC (ug/L) ^B		Virginia Criteria (ug/L) ^C		Tier II Secondary Values (ug/L) ^D		Lowest Chronic Values (ug/L) ^D				USEPA Region 4 Benchmark Screening Values (ug/L) ^E	Weight of Evidence Exceedence	
				Acute	Chronic	Acute	Chronic	Acute	Chronic	Fish	Daphnids	Non- Daphnids	Aquatic Plants		Using MDC	Using EPC
2,3,7,8-TCDD-TE	1.89E-05	1.89E-05	3.10E-09	---	---	---	---	---	---	---	---	---	---	1.00E-05	2 / 2	2 / 2
2,4,6-Trinitrotoluene	1.30E+00	6.22E-01	100	---	---	---	---	---	---	---	---	---	---	90	0 / 2	0 / 2
2-amino-4,6-Dinitrotoluene	1.10E+00	1.10E+00	1480	---	---	---	---	---	---	---	---	---	---	20	0 / 2	0 / 2
4-amino-2,6-Dinitrotoluene	2.50E+00	2.50E+00	1480 ^F	---	---	---	---	---	---	---	---	---	---	20 ^F	0 / 2	0 / 2
Diethyl phthalate	2.10E-01	2.10E-01	210	---	---	---	---	1800	210	---	---	---	85600	521	0 / 5	0 / 5
Aluminum	2.35E+02	2.35E+02	87	750	87	---	---	---	---	3288	1900	---	460	87	3 / 7	3 / 7
Barium	6.49E+01	6.39E+01	4	---	---	---	---	110	4	---	---	---	---	3.9	3 / 4	3 / 4
Calcium	5.30E+04	5.30E+04	116000	---	---	---	---	---	---	---	116000	---	---	116000	0 / 3	0 / 3
Chromium (III)	9.80E-01	9.80E-01	74	570	74	570	74	---	---	68.63	<44	---	397	117.32	0 / 9	0 / 9
Chromium (VI)	9.80E-01	9.80E-01	11	16	11	16	11	---	---	73.18	6.132	---	2	11	0 / 9	0 / 9
Iron	2.00E+02	2.00E+02	300	---	1000	---	---	---	---	1300	158	---	---	1000	1 / 5	1 / 5
Lead	3.00E-01	3.00E-01	2.5	65	2.5	120	14	---	---	18.88	12.26	25.46	500	1.32	0 / 10	0 / 10
Magnesium	3.20E+04	3.00E+04	82000	---	---	---	---	---	---	---	82000	---	---	82000	0 / 3	0 / 3
Manganese	6.19E+01	4.28E+01	120	---	---	---	---	2300	120	1780	<1,100	---	---	80	0 / 6	0 / 6
Potassium	2.10E+03	2.10E+03	53000	---	---	---	---	---	---	---	53000	---	---	53000	0 / 3	0 / 3
Sodium	1.66E+04	1.65E+04	680000	---	---	---	---	---	---	---	680000	---	---	680000	0 / 3	0 / 3
Vanadium	1.40E+00	1.40E+00	20	---	---	---	---	280	20	80	1900	---	---	19	0 / 6	0 / 6
Zinc	6.70E+00	6.70E+00	120	120	120	120	120	---	---	36.41	46.73	>5,243	30	58.9	0 / 10	0 / 10
Total Cyanide	3.00E+00	3.00E+00	5	22	5.2	22	5.2	---	---	7.8	---	18.33	30	5.2	0 / 9	0 / 9
Perchlorate	1.68E-01	1.68E-01	---	---	---	---	---	---	---	---	---	---	---	---	NVA	NVA

Bold value indicates an exceedance of the NAWQC and/or Virginia WQS.

--- No Value Available

COPEC = Chemical of potential ecological concern

EPC = Exposure Point Concentration. The 95% UCL was selected as the EPC unless it exceeded the maximum detected concentration, in which case the MDC was chosen as the EPC.

MDC = Maximum Detected Concentration

NAWQC = National Ambient Water Quality Criteria

95% UCL = 95% upper confidence limit concentration

^A Values from USEPA Region 3 BTAG Screening Levels (July 2006). Values are for freshwater.

^B Unless otherwise noted, values from USEPA (2009) - 4304T. National Recommended Water Quality Criteria.

^C Values from Virginia Water Quality Standards, 9 VAC 25-260, October 2008.

^D Unless otherwise noted, values from Suter, G.W., and Tsao, C.L. 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision, ES/ER/TM-96/R2.

^E Values from USEPA Region 4 Ecological Benchmark Screening Values for Surface Water (2000).

^F Value for 2-amino-4,6-dinitrotoluene used as a surrogate.

- The copper MDC exceeded one of the four available benchmarks for direct contact for copper. Therefore, the potential for direct contact toxicity is not likely significant enough to recommend further action at SWMU 41 Area A.
- The lead MDC exceeded four of the five available benchmarks for direct contact. Therefore, there is potential for direct contact toxicity for lead at SWMU 41 Area A. This may or may not result in the reduction of terrestrial invertebrates as a food source at SWMU 41 Area A.
- 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 41 Area A.
- The mercury MDC exceeded one of the four available benchmarks for direct contact for mercury. Therefore, the potential for direct contact toxicity is not likely significant enough to recommend further action at SWMU 41 Area A.
- The selenium MDC exceeded two of the five available benchmarks for direct contact for selenium. Therefore, the potential for direct contact toxicity is not likely significant enough to recommend further action at SWMU 41 Area A.
- The vanadium MDC exceeded one (for plant toxicity) of the three available benchmarks; however, the EcoSSL guidance (USEPA, 2008b) 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 41 Area A.
- The zinc MDC exceeded all five available benchmarks for direct contact. Therefore, there is potential for direct contact toxicity for zinc at SWMU 41 Area A. This may or may not result in the reduction of terrestrial invertebrates as a food source at SWMU 41 Area A.
- None of the other COPECs selected in the first screening step had any benchmark exceedance.

These results suggest that direct contact toxicity for COPECs in soil may be a concern for lead, and zinc. 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.

7.2.4.2 Sediment

Using the sediment benchmarks discussed in *Section 7.1.8*, direct contact exposure to aquatic biota was assessed. As shown in **Table 7-17**, up to 11 benchmarks were potentially available for comparison purposes for sediment COPECs. Using a weight-of-evidence approach, based on the MDC, 32 sediment COPECs did not exceed any of the available sediment benchmarks or did not have a benchmark available. Based on the 95% EPC, 34 sediment COPECs did not exceed any of the available sediment benchmarks or did not have a benchmark available. Based on the weight-of-evidence, the following COPECs did not exceed more than 50 percent of their respective sediment benchmarks when compared to both the MDC and 95% EPC, and the potential for direct contact toxicity is not significant enough to recommend further action at

SWMU 41 Area A: 4,4'-DDT, acenaphthene, benzo(a)anthracene, benzo(a)pyrene, cadmium, chrysene, copper, fluoranthene, lead, nickel, phenanthrene, and pyrene.

TCDD, acetone, arsenic, benzo(b)fluoranthene, benzo(k)fluoranthene, cadmium, carbon disulfide, cyanide, iron, manganese, selenium each exceeded more than 50 percent of their respective sediment benchmarks when compared to both the MDC and/or 95% EPC. The results of the screening are as follows:

- The TCDD MDC and EPC exceeded two of the three available benchmarks for TCDD. Therefore, there is potential for direct contact toxicity for TCDD at SWMU 41 Area A. Based on this finding, it is possible that organisms inhabiting the stream sediment near SWMU 41 Area A may be adversely impacted by levels of TCDD.
- The acetone MDC and EPC exceeded the only available benchmark for acetone. Therefore, there is potential for direct contact toxicity for acetone at SWMU 41 Area A. Based on this finding, it is possible that organisms inhabiting the stream sediment near SWMU 41 Area A may be adversely impacted by levels of acetone.
- The arsenic MDC exceeded six of the ten available benchmarks for arsenic. However, the arsenic 95% EPC only exceeded five out of the ten sediment benchmarks. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 41 Area A.
- The benzo(b)fluoranthene MDC and EPC exceeded two of the three available benchmarks for benzo(b)fluoranthene. Therefore, there is potential for direct contact toxicity for benzo(b)fluoranthene at SWMU 41 Area A. Based on this finding, it is possible that organisms inhabiting the stream sediment near SWMU 41 Area A may be adversely impacted by levels of benzo(b)fluoranthene.
- The benzo(k)fluoranthene MDC exceeded the only available benchmark for benzo(k)fluoranthene. However, the benzo(k)fluoranthene 95% EPC did not exceed the sediment benchmark. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 41 Area A.
- The carbon disulfide MDC and EPC exceeded both available benchmarks for carbon disulfide. Therefore, there is potential for direct contact toxicity for carbon disulfide at SWMU 41 Area A. Based on this finding, it is possible that organisms inhabiting the stream sediment near SWMU 41 Area A may be adversely impacted by levels of carbon disulfide.
- The cyanide MDC and EPC exceeded the only available benchmark for cyanide. Therefore, there is potential for direct contact toxicity for cyanide at SWMU 41 Area A. Based on this finding, it is possible that organisms inhabiting the stream sediment near SWMU 41 Area A may be adversely impacted by levels of cyanide.
- The iron MDC and EPC exceeded the only available benchmark for iron. Therefore, there is potential for direct contact toxicity for iron at SWMU 41 Area A. Based on this finding, it is possible that organisms inhabiting the stream sediment near SWMU 41 Area A may be adversely impacted by levels of iron.
- The manganese MDC and EPC exceeded three of the four available benchmarks for manganese. Therefore, there is potential for direct contact toxicity for manganese at

SWMU 41 Area A. Based on this finding, it is possible that organisms inhabiting the stream sediment near SWMU 41 Area A may be adversely impacted by levels of manganese.

- The selenium MDC and EPC exceeded the only available benchmark for selenium. However, only 25% of the samples exceeded the benchmark. Due to the low frequency of benchmark exceedance, the potential for direct contact toxicity is not likely significant enough to recommend further action at SWMU 41 Area A.

These results suggest that direct contact toxicity for COPECs in sediment at SWMU 41 Area A may be a concern for TCDD, acetone, benzo(b)fluoranthene, carbon disulfide, cyanide, iron, and manganese.

7.2.4.3 Surface Water

Using the surface water benchmarks discussed in *Section 7.1.8*, direct contact exposure to aquatic biota was assessed. As shown in **Table 7-18**, up to 12 benchmarks were potentially available for comparison purposes for surface water COPECs. Using a weight-of-evidence approach, based on the MDC and the 95% EPC concentration for each COPEC, 15 of the surface water COPECs had concentrations that did not exceed any of the available surface water benchmarks. TCDD, aluminum, barium, and iron each had at least one exceedance of their respective surface water benchmarks. The results of the screening are as follows:

- The TCDD MDC and EPC exceeded both available benchmarks for TCDD. Therefore, there is potential for direct contact toxicity for TCDD at SWMU 41 Area A. Based on this finding, it is possible that organisms inhabiting the streams near SWMU 41 Area A may be adversely impacted by levels of TCDD.
- The aluminum MDC and EPC only exceeded three of the seven available benchmarks for aluminum. However, aluminum exceeded the NRWQC for chronic exposure. Based on this finding, it is possible that organisms inhabiting the streams near SWMU 41 Area A may be adversely impacted by levels of aluminum.
- The barium MDC and EPC exceeded three of the four available benchmarks for barium. Therefore, there is potential for direct contact toxicity for barium at SWMU 41 Area A. Based on this finding, it is possible that organisms inhabiting the streams near SWMU 41 Area A may be adversely impacted by levels of barium.
- The iron MDC and EPC only exceeded one of the five available benchmarks for iron. It also did not exceed the NRWQC for iron. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 41 Area A.

These results suggest that direct contact toxicity for COPECs in surface water at SWMU 41 Area A may be a concern for TCDD, aluminum, and barium.

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, there were three inorganic COPEC drivers (copper, selenium, and zinc) with EEQs greater than 1 for the food chain assessment. COPEC hazard drivers for the direct contact assessment were: barium, lead, and zinc. 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 7-19**, copper, lead, selenium, and zinc are the direct contact and/or food chain COPECs in Area A surface soil considered to be potentially site related and not attributed to background. Details of the background evaluation are presented in *Section 6.0, Tables 6-6 through 6-9 and Appendices E-7 and E-8*.

Table 7-19
Background Comparison for Surface Soil at SWMU 41 Area A

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

^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.

7.2.6 Uncertainty Analysis

There were 139, 145, and 179 chemical constituents not detected in surface soil, sediment, and surface water analytical samples, respectively. **Appendix F-2, Tables F-39** (surface soil), **F-40** (sediment), and **F-41** (surface water) evaluate the uncertainty associated with these constituents' detection limits by presenting a comparison of the maximum detection limit for each non-detect constituent with a conservative ecological toxicity screening value. USEPA Region III BTAG soil SLs are antiquated (last published in 1995) relative to USEPA Region III BTAG surface water and sediment values (updated in 2006); therefore, non-detect soil values were compared to BTAG soil levels as well as additional soil screening values presented in **Appendix F-2**,

Table F-42. USEPA Region III BTAG sediment and surface water screening values were used for the sediment and surface water comparison.

Thirty-one (31) of the non-detect surface soil, 50 of the non-detect sediment, and 52 of the non-detect surface water constituents had maximum detection limits that exceeded the screening criteria, respectively. These findings are not unexpected, given the conservative and numerically low screening values.

The size of the data set was less than ten for all media; therefore, there is some uncertainty in using EPCs derived from statistical calculations. However, as the number of soil samples was less than or equal to five, the MDC was used in the SLERA; therefore, EPCs were not potentially underestimated for soil. For COPECs in surface water and sediment, direct contact assessments used both MDCs and EPCs, and weight-of-evidence findings did not differ between the two approaches for surface water, and differed only slightly for sediment (e.g., arsenic).

There is some uncertainty in the SLERA due to the fact that sediment-to-fish BAFs/BCFs were not used to quantify the potential uptake of COPECs from sediment to fish, potentially resulting in an underestimation of hazards to fish-eating wildlife. It should be noted, however, that sediment-to-fish BAFs/BCFs are very uncertain, and such factors are not presented in the Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities (USEPA, 1999). While biota-sediment accumulation factors (BSAFs) are presented in the *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (USEPA, 2005b; and online HHRAP database), BSAFs are only presented for the lipophilic compounds dioxin/furans (BSAFs range from 0.0001 to 0.09) and PCBs (value of 2.0 presented for Aroclor 1016 and 1254). In addition, these BSAFs are for the consumption of larger game fish fillets by humans, not the ingestion of fish by wildlife which likely include smaller and younger fish that have not bioaccumulated COPECs comparable to larger (and older) game fish. Additional BSAFs are available in *The Incidence and Severity of Sediment Contamination in Surface Waters of the United States* (USEPA, 1997e); however, these factors are only recommended as guidelines for hazard comparisons among chemicals and do not take into account site-specific conditions, and are based on two memos, assumed not to have been peer-reviewed or published, submitted from Cook (1995) and Hansen (1995) to C. Fox of EPA's Office of Water. As USEPA (2005b) does not use or cite these USEPA (1997e) BSAFs, it is assumed they were deemed by USEPA to be unreliable for quantitative risk assessment purposes.

Dioxin/furans were detected in surface water at SWMU 41 Area A, and 2,3,7,8-TCDD-TE fish tissue concentrations were estimated using the water-to-fish tissue BAF/BCF values from **Table 7-28**, resulting in estimated fish tissue concentrations of 4.0E-4 mg/kg and 1.5E-4 mg/kg, for Tier 1 and Tier 2, respectively (**Appendix F-2**). If a BSAF of 0.09 for 2,3,7,8-TCDD had been used to estimate a fish tissue concentration from sediment, it would have been 5.7E-7 mg/kg (6.28E-6 mg/kg in sediment $\times$ 0.09), which is approximately 700-fold lower than the estimated fish tissue concentration from surface water uptake. This finding shows that exclusion of the sediment-to-fish transport pathway in the SLERA did not result in an underestimation of hazards for fish-eating wildlife for dioxin/furans.

PCBs were not detected in surface water or sediment at SWMU 41 Area A; therefore, the sediment-to-fish transport pathway could not be assessed for the other COPEC listed in the USEPA (2005b) database with a BSAF value. However, PCBs were detected at SWMU 41 Area B, so this pathway is discussed in *Section 7.3.6*.

Based on this discussion, the potential underestimation of hazards to fish-eating wildlife is deemed minor at Area A.

7.2.7 SLERA Results and Conclusions

The data, results, and conclusions of the SLERA evaluated risks to ecological populations inhabiting SWMU 41 Area A. 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 7-15**, and direct contact exposure results, which may serve as a food source for wildlife, are summarized in **Tables 7-16** (surface soil), **7-17** (sediment), and **7-18** (surface water) and discussed in *Section 7.2.4*.

The food chain assessment suggests potential adverse impacts to terrestrial wildlife, especially shrews, robins, and voles for modeled contact with the hazard drivers (arsenic, copper, selenium, and zinc) in surface soil. However, based on the Tier 2 LOAEL-based approach no individual EEQs (when rounded to one significant figure) exceeded 1. The direct contact assessment results suggest a potential reduction in wildlife food supply due to lead and zinc in surface soil; TCDD, acetone, benzo(b)fluoranthene, carbon disulfide, cyanide, iron, and manganese in sediment; and TCDD, aluminum, and barium in surface water. However, due to the small size of the site (0.19 acres) this potential reduction in food is not considered biologically significant. In addition, although seven COPECs in sediment and three COPECs in surface water had concentrations that exceeded more than 50 percent of the available screening benchmarks (or for surface water, exceeded a promulgated criterion), the small size of the site and the associated small size of the sampled aquatic habitat suggests further ecological assessment is not warranted.

Based on no Tier 2 LOAEL EEQs exceeding 1 (when rounded to one significant figure), the fact that no wildlife rare, threatened, or endangered (RTE) species have been confirmed at the study area, and the relatively small size of the SWMU, 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.

The assessment results may serve as the foci 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 41, Area B, Screening Level Ecological Risk Assessment

This section presents the SLERA for SWMU 41 (Red Water Ash Burial Site), Area B. 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

SWMU 41 is located in the southeast section of the MMA at RFAAP (**Figure 1-1**). **Figure 2-1** shows the layout of the site, which consists of two non-contiguous disposal areas (Areas A and B) for red water ash, a byproduct of combustion of TNT production wastewater (i.e., “red water”). Area B is a natural clay-lined landfill, approximately 225 ft by 70 ft, containing red water ash. Clayey fill has been placed in an approximately 1.08-acre area at Area B. Prior to the construction of the red water treatment plant, red water was concentrated by evaporation and burned in four rotary kilns located in the TNT manufacturing area.

Surface soil, sediment, and surface water samples collected from the site and utilized in the SLERA are listed in **Table 7-20**; note that subsurface soil samples were not used in the SLERA (see *Section 7.1.2.1* for discussion).

Table 7-20
SWMU 41 Area B Sample Groupings

Surface Soil	Sediment	Surface Water
41SB7A	41SD2	41SW2
41SB7A_D1 (duplicate)	41SD3	41SW3
41SB11A	41SD3_D4 (duplicate)	41SW4
41SB6A	41SD4	41SP2
41SB8A	41SD11	
41SB9A		
41SB10A		
41SC20A		
41SP2soil		

7.3.2 Summary of COPEC Selection

Tables 7-21 and 7-22 (surface soil), **7-23 and 7-24** (sediment), and **7-25 and 7-26** (surface water) have been prepared for detected constituents with the following information:

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

Table 7-21
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Direct Contact Exposure at SWMU 41 Area B

Page1 of 2

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
Surface Soil	79-34-5	1,1,2,2-Tetrachloroethane	5.80E-03	5.80E-03	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	DET
	87-61-6	1,2,3-Trichlorobenzene	4.00E-04	3.80E-03	mg/kg	41SB8A	5/8	5.00E-03 - 5.00E-03	Yes	DET
	120-82-1	1,2,4-Trichlorobenzene	3.00E-04	4.40E-03	mg/kg	41SP2soil	4/8	5.00E-03 - 5.00E-03	Yes	DET
	96-12-8	1,2-Dibromo-3-chloropropane	9.40E-03	9.40E-03	mg/kg	41SB6A	1/8	1.00E-02 - 1.00E-02	Yes	DET
	106-93-4	1,2-Dibromoethane	9.60E-04	9.60E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	DET
	95-50-1	1,2-Dichlorobenzene	7.00E-04	7.00E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	DET
	107-06-2	1,2-Dichloroethane	5.70E-04	5.70E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	DET
	541-73-1	1,3-Dichlorobenzene	5.20E-03	5.20E-03	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	DET
	106-46-7	1,4-Dichlorobenzene	7.40E-04	7.40E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	DET
	78-93-3	2-Butanone	4.00E-03	4.00E-02	mg/kg	41SC20A	8/8	N/A	Yes	DET
	591-78-6	2-Hexanone	1.00E-02	1.00E-02	mg/kg	41SB6A	1/8	1.00E-02 - 1.00E-02	Yes	DET
	108-10-1	4-Methyl-2-pentanone	7.70E-03	7.70E-03	mg/kg	41SB6A	1/8	1.00E-02 - 1.00E-02	Yes	DET
	67-64-1	Acetone	2.80E-02	7.30E-02	mg/kg	41SP2soil	6/8	6.00E-02 - 6.00E-02	Yes	DET
	5103-71-9	alpha-Chlordane	3.80E-03	3.80E-03	mg/kg	41SB10A	1/3	2.00E-02 - 2.00E-02	Yes	DET
	11097-69-1	Aroclor 1254	4.10E-02	4.10E-02	mg/kg	41SB10A	1/3	3.30E-02 - 3.30E-02	Yes	DET
	71-43-2	Benzene	2.60E-04	2.80E-03	mg/kg	41SP2soil	8/8	N/A	Yes	DET
	117-81-7	bis(2-Ethylhexyl) phthalate	1.60E-02	2.40E-01	mg/kg	41SB10A	8/8	N/A	Yes	DET
	74-83-9	Bromomethane	1.70E-03	1.90E-03	mg/kg	41SB8A	4/8	5.00E-03 - 5.00E-03	Yes	DET
	75-15-0	Carbon disulfide	1.00E-03	6.00E-03	mg/kg	41SP2soil	7/8	5.00E-03 - 5.00E-03	Yes	DET
	108-90-7	Chlorobenzene	2.80E-04	2.80E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	DET
	156-59-2	cis-1,2-Dichloroethene	7.80E-04	7.80E-04	mg/kg	41SC20A	1/8	5.00E-03 - 5.00E-03	Yes	DET
	10061-01-5	cis-1,3-Dichloropropene	3.20E-04	3.20E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	DET
	110-82-7	Cyclohexane	6.50E-04	3.20E-03	mg/kg	41SB7A	4/8	1.00E-02 - 1.00E-02	Yes	DET
	124-48-1	Dibromochloromethane	5.50E-04	5.50E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	DET
	84-66-2	Diethyl phthalate	1.40E-02	2.30E-02	mg/kg	41SB9A	2/8	1.70E-01 - 1.70E-01	Yes	DET
	84-74-2	Di-n-butyl phthalate	2.40E-02	4.00E-01	mg/kg	41SB6A	8/8	N/A	Yes	DET
	33213-65-9	Endosulfan II	4.20E-04	4.40E-04	mg/kg	41SP2soil	2/3	2.00E-02 - 2.00E-02	Yes	DET
	7421-93-4	Endrin aldehyde	6.00E-04	6.90E-04	mg/kg	41SP2soil	2/3	2.00E-02 - 2.00E-02	Yes	DET
	53494-70-5	Endrin ketone	8.60E-04	8.60E-04	mg/kg	41SP2soil	1/3	2.00E-02 - 2.00E-02	Yes	DET
	100-41-4	Ethylbenzene	2.00E-04	2.00E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	DET
	206-44-0	Fluoranthene	5.00E-03	5.00E-03	mg/kg	41SB10A	1/8	2.10E-02 - 2.10E-02	Yes	DET
	5103-74-2	gamma-Chlordane	8.75E-04	2.10E-03	mg/kg	41SB10A	2/3	2.00E-02 - 2.00E-02	Yes	DET
	76-44-8	Heptachlor	5.26E-03	5.26E-03	mg/kg	41SB7A	1/3	2.00E-02 - 2.00E-02	Yes	DET
	98-82-8	Isopropylbenzene	2.30E-04	2.30E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	DET
	72-43-5	Methoxychlor	1.10E-03	1.10E-03	mg/kg	41SB10A	1/3	2.00E-02 - 2.00E-02	Yes	DET
	79-20-9	Methyl acetate	5.00E-03	5.00E-03	mg/kg	41SB6A	1/8	1.00E-02 - 1.00E-02	Yes	DET
	1634-04-4	Methyl tert-butyl ether	5.80E-04	5.80E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	DET
	108-87-2	Methylcyclohexane	4.20E-04	3.20E-03	mg/kg	41SP2soil	7/8	1.00E-02 - 1.00E-02	Yes	DET
	75-09-2	Methylene chloride	2.80E-03	4.70E-03	mg/kg	41SP2soil	3/8	5.00E-03 - 5.00E-03	Yes	DET
	59-50-7	p-Chloro-m-cresol	2.00E-02	2.00E-02	mg/kg	41SB9A	1/8	1.70E-01 - 1.70E-01	Yes	DET
	85-01-8	Phenanthrene	1.70E-03	1.70E-03	mg/kg	41SB10A	1/8	2.10E-02 - 2.10E-02	Yes	DET
	129-00-0	Pyrene	3.80E-03	3.80E-03	mg/kg	41SB10A	1/8	2.10E-02 - 2.10E-02	Yes	DET

Table 7-21
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Direct Contact Exposure at SWMU 41 Area B
Page2 of 2

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
Surface Soil	100-42-5	Styrene	2.70E-03	2.70E-03	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	DET
	108-88-3	Toluene	2.30E-04	3.30E-03	mg/kg	41SP2soil	8/8	N/A	Yes	DET
	10061-02-6	trans-1,3-Dichloropropene	4.60E-04	4.60E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	DET
	75-25-2	Tribromomethane	1.20E-03	1.20E-03	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	DET
	75-69-4	Trichlorofluoromethane	1.70E-04	5.20E-04	mg/kg	41SC20A	3/8	5.00E-03 - 5.00E-03	Yes	DET
	1330-20-7	Xylenes (total)	5.40E-04	1.90E-03	mg/kg	41SP2soil	7/8	5.00E-03 - 5.00E-03	Yes	DET
	7429-90-5	Aluminum	1.44E+04	2.72E+04	mg/kg	41SB7A	8/8	N/A	Yes	DET
	7440-36-0	Antimony	4.70E-01	7.00E-01	mg/kg	41SB8A	8/8	N/A	Yes	DET
	7440-38-2	Arsenic	1.40E+01	2.30E+01	mg/kg	41SB11A	8/8	N/A	Yes	DET
	7440-39-3	Barium	5.80E+01	2.81E+02	mg/kg	41SP2soil	8/8	N/A	Yes	DET
	7440-41-7	Beryllium	9.70E-02	9.70E-01	mg/kg	41SB9A	8/8	N/A	Yes	DET
	7440-43-9	Cadmium	1.60E+00	3.50E+00	mg/kg	41SP2soil	8/8	N/A	Yes	DET
	7440-70-2	Calcium	2.84E+04	1.54E+05	mg/kg	41SB11A	8/8	N/A	Yes	DET
	7440-47-3	Chromium	1.20E+01	2.30E+01	mg/kg	41SB7A	8/8	N/A	Yes	DET
	7440-48-4	Cobalt	7.20E+00	1.20E+01	mg/kg	41SP2soil	8/8	N/A	Yes	DET
	7440-50-8	Copper	3.10E+01	5.70E+01	mg/kg	41SB9A	8/8	N/A	Yes	DET
	7439-89-6	Iron	2.95E+04	4.75E+04	mg/kg	41SB7A	8/8	N/A	Yes	DET
	7439-92-1	Lead	3.30E+01	7.50E+01	mg/kg	41SP2soil	8/8	N/A	Yes	DET
	7439-95-4	Magnesium	2.09E+04	5.80E+04	mg/kg	41SB11A	8/8	N/A	Yes	DET
	7439-96-5	Manganese	9.12E+02	2.34E+03	mg/kg	41SP2soil	8/8	N/A	Yes	DET
	7439-97-6	Mercury	3.60E-02	2.40E-01	mg/kg	41SB6A	8/8	N/A	Yes	DET
	7440-02-0	Nickel	1.60E+01	2.60E+01	mg/kg	41SB7A	8/8	N/A	Yes	DET
	7440-09-7	Potassium	5.46E+02	1.44E+03	mg/kg	41SP2soil	8/8	N/A	Yes	DET
	7782-49-2	Selenium	5.00E-01	9.20E-01	mg/kg	41SB7A	8/8	N/A	Yes	DET
	7440-22-4	Silver	6.40E-02	2.20E-01	mg/kg	41SC20A	8/8	N/A	Yes	DET
	7440-23-5	Sodium	8.60E+01	3.73E+03	mg/kg	41SP2soil	8/8	N/A	Yes	DET
	7440-28-0	Thallium	9.20E-02	2.70E-01	mg/kg	41SB6A	6/8	5.00E-01 - 5.00E-01	Yes	DET
	7440-62-2	Vanadium	2.60E+01	4.70E+01	mg/kg	41SB6A	8/8	N/A	Yes	DET
	7440-66-6	Zinc	1.10E+02	2.34E+02	mg/kg	41SP2soil	8/8	N/A	Yes	DET
	57-12-5	Total Cyanide	4.00E-02	3.70E-01	mg/kg	41SP2soil	8/8	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 7-22
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Food Chain Exposure at SWMU 41 Area B
Page 1 of 2

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	79-34-5	1,1,2,2-Tetrachloroethane	5.80E-03	5.80E-03	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	IBC
	87-61-6	1,2,3-Trichlorobenzene	4.00E-04	3.80E-03	mg/kg	41SB8A	5/8	5.00E-03 - 5.00E-03	Yes	IBC
	120-82-1	1,2,4-Trichlorobenzene	3.00E-04	4.40E-03	mg/kg	41SP2soil	4/8	5.00E-03 - 5.00E-03	Yes	IBC
	96-12-8	1,2-Dibromo-3-chloropropane	9.40E-03	9.40E-03	mg/kg	41SB6A	1/8	1.00E-02 - 1.00E-02	No	NIBC
	106-93-4	1,2-Dibromoethane	9.60E-04	9.60E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	No	NIBC
	95-50-1	1,2-Dichlorobenzene	7.00E-04	7.00E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	IBC
	107-06-2	1,2-Dichloroethane	5.70E-04	5.70E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	No	NIBC
	541-73-1	1,3-Dichlorobenzene	5.20E-03	5.20E-03	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	IBC
	106-46-7	1,4-Dichlorobenzene	7.40E-04	7.40E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	Yes	IBC
	78-93-3	2-Butanone	4.00E-03	4.00E-02	mg/kg	41SC20A	8/8	N/A	No	NIBC
	591-78-6	2-Hexanone	1.00E-02	1.00E-02	mg/kg	41SB6A	1/8	1.00E-02 - 1.00E-02	No	NIBC
	108-10-1	4-Methyl-2-pentanone	7.70E-03	7.70E-03	mg/kg	41SB6A	1/8	1.00E-02 - 1.00E-02	No	NIBC
	67-64-1	Acetone	2.80E-02	7.30E-02	mg/kg	41SP2soil	6/8	6.00E-02 - 6.00E-02	No	NIBC
	5103-71-9	alpha-Chlordane	3.80E-03	3.80E-03	mg/kg	41SB10A	1/3	2.00E-02 - 2.00E-02	Yes	IBC
	11097-69-1	Aroclor 1254	4.10E-02	4.10E-02	mg/kg	41SB10A	1/3	3.30E-02 - 3.30E-02	Yes	IBC
	71-43-2	Benzene	2.60E-04	2.80E-03	mg/kg	41SP2soil	8/8	N/A	No	NIBC
	117-81-7	bis(2-Ethylhexyl) phthalate	1.60E-02	2.40E-01	mg/kg	41SB10A	8/8	N/A	No	NIBC
	74-83-9	Bromomethane	1.70E-03	1.90E-03	mg/kg	41SB8A	4/8	5.00E-03 - 5.00E-03	No	NIBC
	75-15-0	Carbon disulfide	1.00E-03	6.00E-03	mg/kg	41SP2soil	7/8	5.00E-03 - 5.00E-03	No	NIBC
	108-90-7	Chlorobenzene	2.80E-04	2.80E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	No	NIBC
	156-59-2	cis-1,2-Dichloroethene	7.80E-04	7.80E-04	mg/kg	41SC20A	1/8	5.00E-03 - 5.00E-03	No	NIBC
	10061-01-5	cis-1,3-Dichloropropene	3.20E-04	3.20E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	No	NIBC
	110-82-7	Cyclohexane	6.50E-04	3.20E-03	mg/kg	41SB7A	4/8	1.00E-02 - 1.00E-02	No	NIBC
	124-48-1	Dibromochloromethane	5.50E-04	5.50E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	No	NIBC
	84-66-2	Diethyl phthalate	1.40E-02	2.30E-02	mg/kg	41SB9A	2/8	1.70E-01 - 1.70E-01	No	NIBC
	84-74-2	Di-n-butyl phthalate	2.40E-02	4.00E-01	mg/kg	41SB6A	8/8	N/A	No	NIBC
	33213-65-9	Endosulfan II	4.20E-04	4.40E-04	mg/kg	41SP2soil	2/3	2.00E-02 - 2.00E-02	Yes	IBC
	7421-93-4	Endrin aldehyde	6.00E-04	6.90E-04	mg/kg	41SP2soil	2/3	2.00E-02 - 2.00E-02	Yes	IBC
	53494-70-5	Endrin ketone	8.60E-04	8.60E-04	mg/kg	41SP2soil	1/3	2.00E-02 - 2.00E-02	Yes	IBC
	100-41-4	Ethylbenzene	2.00E-04	2.00E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	No	NIBC
	206-44-0	Fluoranthene	5.00E-03	5.00E-03	mg/kg	41SB10A	1/8	2.10E-02 - 2.10E-02	Yes	IBC
	5103-74-2	gamma-Chlordane	8.75E-04	2.10E-03	mg/kg	41SB10A	2/3	2.00E-02 - 2.00E-02	Yes	IBC
	76-44-8	Heptachlor	5.26E-03	5.26E-03	mg/kg	41SB7A	1/3	2.00E-02 - 2.00E-02	Yes	IBC
	98-82-8	Isopropylbenzene	2.30E-04	2.30E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	No	NIBC
	72-43-5	Methoxychlor	1.10E-03	1.10E-03	mg/kg	41SB10A	1/3	2.00E-02 - 2.00E-02	Yes	IBC
	79-20-9	Methyl acetate	5.00E-03	5.00E-03	mg/kg	41SB6A	1/8	1.00E-02 - 1.00E-02	No	NIBC
	1634-04-4	Methyl tert-butyl ether	5.80E-04	5.80E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	No	NIBC
	108-87-2	Methylcyclohexane	4.20E-04	3.20E-03	mg/kg	41SP2soil	7/8	1.00E-02 - 1.00E-02	No	NIBC
	75-09-2	Methylene chloride	2.80E-03	4.70E-03	mg/kg	41SP2soil	3/8	5.00E-03 - 5.00E-03	No	NIBC
	59-50-7	p-Chloro-m-cresol	2.00E-02	2.00E-02	mg/kg	41SB9A	1/8	1.70E-01 - 1.70E-01	No	NIBC
	85-01-8	Phenanthrene	1.70E-03	1.70E-03	mg/kg	41SB10A	1/8	2.10E-02 - 2.10E-02	Yes	IBC
	129-00-0	Pyrene	3.80E-03	3.80E-03	mg/kg	41SB10A	1/8	2.10E-02 - 2.10E-02	Yes	IBC

Table 7-22
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Soil Food Chain Exposure at SWMU 41 Area B
Page 2 of 2

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	100-42-5	Styrene	2.70E-03	2.70E-03	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	No	NIBC
	108-88-3	Toluene	2.30E-04	3.30E-03	mg/kg	41SP2soil	8/8	N/A	No	NIBC
	10061-02-6	trans-1,3-Dichloropropene	4.60E-04	4.60E-04	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	No	NIBC
	75-25-2	Tribromomethane	1.20E-03	1.20E-03	mg/kg	41SB6A	1/8	5.00E-03 - 5.00E-03	No	NIBC
	75-69-4	Trichlorofluoromethane	1.70E-04	5.20E-04	mg/kg	41SC20A	3/8	5.00E-03 - 5.00E-03	No	NIBC
	1330-20-7	Xylenes (total)	5.40E-04	1.90E-03	mg/kg	41SP2soil	7/8	5.00E-03 - 5.00E-03	No	NIBC
	7429-90-5	Aluminum	1.44E+04	2.72E+04	mg/kg	41SB7A	8/8	N/A	No	NIBC
	7440-36-0	Antimony	4.70E-01	7.00E-01	mg/kg	41SB8A	8/8	N/A	No	NIBC
	7440-38-2	Arsenic	1.40E+01	2.30E+01	mg/kg	41SB11A	8/8	N/A	Yes	IBC
	7440-39-3	Barium	5.80E+01	2.81E+02	mg/kg	41SP2soil	8/8	N/A	No	NIBC
	7440-41-7	Beryllium	9.70E-02	9.70E-01	mg/kg	41SB9A	8/8	N/A	No	NIBC
	7440-43-9	Cadmium	1.60E+00	3.50E+00	mg/kg	41SP2soil	8/8	N/A	Yes	IBC
	7440-70-2	Calcium	2.84E+04	1.54E+05	mg/kg	41SB11A	8/8	N/A	No	NIBC
	7440-47-3	Chromium	1.20E+01	2.30E+01	mg/kg	41SB7A	8/8	N/A	Yes	IBC
	7440-48-4	Cobalt	7.20E+00	1.20E+01	mg/kg	41SP2soil	8/8	N/A	No	NIBC
	7440-50-8	Copper	3.10E+01	5.70E+01	mg/kg	41SB9A	8/8	N/A	Yes	IBC
	7439-89-6	Iron	2.95E+04	4.75E+04	mg/kg	41SB7A	8/8	N/A	No	NIBC
	7439-92-1	Lead	3.30E+01	7.50E+01	mg/kg	41SP2soil	8/8	N/A	Yes	IBC
	7439-95-4	Magnesium	2.09E+04	5.80E+04	mg/kg	41SB11A	8/8	N/A	No	NIBC
	7439-96-5	Manganese	9.12E+02	2.34E+03	mg/kg	41SP2soil	8/8	N/A	No	NIBC
	7439-97-6	Mercury	3.60E-02	2.40E-01	mg/kg	41SB6A	8/8	N/A	Yes	IBC
	7440-02-0	Nickel	1.60E+01	2.60E+01	mg/kg	41SB7A	8/8	N/A	Yes	IBC
	7440-09-7	Potassium	5.46E+02	1.44E+03	mg/kg	41SP2soil	8/8	N/A	No	NIBC
	7782-49-2	Selenium	5.00E-01	9.20E-01	mg/kg	41SB7A	8/8	N/A	Yes	IBC
	7440-22-4	Silver	6.40E-02	2.20E-01	mg/kg	41SC20A	8/8	N/A	Yes	IBC
	7440-23-5	Sodium	8.60E+01	3.73E+03	mg/kg	41SP2soil	8/8	N/A	No	NIBC
	7440-28-0	Thallium	9.20E-02	2.70E-01	mg/kg	41SB6A	6/8	5.00E-01 - 5.00E-01	No	NIBC
	7440-62-2	Vanadium	2.60E+01	4.70E+01	mg/kg	41SB6A	8/8	N/A	No	NIBC
	7440-66-6	Zinc	1.10E+02	2.34E+02	mg/kg	41SP2soil	8/8	N/A	Yes	IBC
	57-12-5	Total Cyanide	4.00E-02	3.70E-01	mg/kg	41SP2soil	8/8	N/A	No	NIBC

COPEC Selection Rationale Codes

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

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

Table 7-23
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Sediment Direct Contact Exposure at SWMU 41 Area B
Page 1 of 2

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

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
Sediment	N/A	2,3,7,8-TCDD-TE	1.18E-06	1.18E-06	mg/kg	41SD11	1/1	N/A	Yes	DET
	67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	4.20E-06 B	4.20E-06 B	mg/kg	41SD11	1/1	N/A	No	TEQ
	35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	2.79E-05	2.79E-05	mg/kg	41SD11	1/1	N/A	No	TEQ
	55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	3.61E-07 J	3.61E-07 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	8.01E-07 B	8.01E-07 B	mg/kg	41SD11	1/1	N/A	No	TEQ
	39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	2.14E-07 J	2.14E-07 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	2.97E-07 J	2.97E-07 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	5.37E-07 J	5.37E-07 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	1.27E-06 J	1.27E-06 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	2.35E-07 J	2.35E-07 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	3.42E-07 J	3.42E-07 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	3.56E-07 J	3.56E-07 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	4.92E-07 B	4.92E-07 B	mg/kg	41SD11	1/1	N/A	No	TEQ
	3268-87-9	Octachlorodibenzodioxin	1.71E-03	1.71E-03	mg/kg	41SD11	1/1	N/A	No	TEQ
	39001-02-0	Octachlorodibenzofuran	1.12E-05 B	1.12E-05 B	mg/kg	41SD11	1/1	N/A	No	TEQ
	N/A	Total Heptachlorodibenzofuran	1.05E-05	1.05E-05	mg/kg	41SD11	1/1	N/A	No	TEQ
	N/A	Total Heptachlorodibenzo-p-dioxin	6.59E-05	6.59E-05	mg/kg	41SD11	1/1	N/A	No	TEQ
	N/A	Total Hexachlorodibenzofuran	5.08E-06 J	5.08E-06 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	N/A	Total Hexachlorodibenzo-p-dioxin	8.65E-06	8.65E-06	mg/kg	41SD11	1/1	N/A	No	TEQ
	N/A	Total Pentachlorodibenzofuran	3.10E-06 J	3.10E-06 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	N/A	Total Pentachlorodibenzo-p-dioxin	2.68E-07	2.68E-07	mg/kg	41SD11	1/1	N/A	No	TEQ
	N/A	Total Tetrachlorodibenzofuran	2.55E-06 J	2.55E-06 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	78-93-3	2-Butanone	1.10E-02	2.70E-02	mg/kg	41SD4	3/4	2.80E-02 - 2.80E-02	Yes	DET
	50-29-3	4,4'-DDT	6.62E-03	6.62E-03	mg/kg	41SD3	1/4	2.00E-02 - 3.90E-02	Yes	DET
	11097-69-1	Aroclor 1254	1.75E-02	9.02E-02	mg/kg	41SD11	2/4	6.60E-02 - 6.60E-02	Yes	DET
	71-43-2	Benzene	2.00E-04	2.45E-04	mg/kg	41SD3	2/4	5.00E-03 - 5.60E-03	Yes	DET
	117-81-7	bis(2-Ethylhexyl) phthalate	2.20E-02	4.65E-02	mg/kg	41SD3	3/4	3.80E-01 - 3.80E-01	Yes	DET
	85-68-7	Butyl benzyl phthalate	4.95E-02	4.95E-02	mg/kg	41SD3	1/4	1.70E-01 - 3.80E-01	Yes	DET
	75-15-0	Carbon disulfide	5.65E-03	5.65E-03	mg/kg	41SD3	1/4	5.00E-03 - 5.60E-03	Yes	DET
	67-66-3	Chloroform	1.80E-03 J	1.80E-03 J	mg/kg	41SD3	2/4	5.00E-03 - 5.60E-03	Yes	DET
	84-74-2	Di-n-butyl phthalate	4.40E-02	1.43E-01	mg/kg	41SD3	3/4	3.80E-01 - 3.80E-01	Yes	DET
	7421-93-4	Endrin aldehyde	1.74E-03	6.10E-03	mg/kg	41SD3	2/4	1.90E-02 - 2.00E-02	Yes	DET
	75-09-2	Methylene chloride	4.20E-03	5.75E-03	mg/kg	41SD3	3/4	1.10E-02 - 1.10E-02	Yes	DET
	85-01-8	Phenanthrene	1.60E-03	1.60E-03	mg/kg	41SD4	1/4	2.10E-02 - 3.10E-01	Yes	DET
	108-88-3	Toluene	6.16E-03	6.16E-03	mg/kg	41SD3	1/4	5.00E-03 - 5.60E-03	Yes	DET
	79-01-6	Trichloroethene	1.66E-03 J	1.66E-03 J	mg/kg	41SD3	1/4	5.00E-03 - 5.60E-03	Yes	DET
	7429-90-5	Aluminum	1.43E+04	1.59E+04	mg/kg	41SD2	4/4	N/A	Yes	DET
	7440-36-0	Antimony	2.30E-01	3.60E-01	mg/kg	41SD2	3/3	N/A	Yes	DET

Table 7-23
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Sediment Direct Contact Exposure at SWMU 41 Area B
Page 2 of 2

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

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
Sediment	7440-38-2	Arsenic	1.30E+01	1.66E+01	mg/kg	41SD11	4/4	N/A	Yes	DET
	7440-39-3	Barium	1.46E+02	2.19E+02	mg/kg	41SD11	4/4	N/A	Yes	DET
	7440-41-7	Beryllium	6.40E-01	1.00E+00	mg/kg	41SD11	4/4	N/A	Yes	DET
	7440-43-9	Cadmium	1.70E+00	2.50E+00	mg/kg	41SD4	3/4	5.60E-02 - 5.60E-02	Yes	DET
	7440-70-2	Calcium	9.33E+03	3.52E+04	mg/kg	41SD4	4/4	N/A	Yes	DET
	7440-47-3	Chromium	2.04E+01	3.50E+01	mg/kg	41SD3	4/4	N/A	Yes	DET
	7440-48-4	Cobalt	1.34E+01	2.00E+01	mg/kg	41SD2	4/4	N/A	Yes	DET
	7440-50-8	Copper	2.80E+01	3.84E+01	mg/kg	41SD11	4/4	N/A	Yes	DET
	7439-89-6	Iron	2.59E+04	4.28E+04	mg/kg	41SD4	4/4	N/A	Yes	DET
	7439-92-1	Lead	2.60E+01	5.93E+01	mg/kg	41SD11	4/4	N/A	Yes	DET
	7439-95-4	Magnesium	6.84E+03	1.90E+04	mg/kg	41SD4	4/4	N/A	Yes	DET
	7439-96-5	Manganese	1.57E+03	2.80E+03	mg/kg	41SD11	4/4	N/A	Yes	DET
	7439-97-6	Mercury	3.25E-02	3.70E-02	mg/kg	41SD2	3/3	N/A	Yes	DET
	7440-02-0	Nickel	1.34E+01	2.20E+01	mg/kg	41SD3	4/4	N/A	Yes	DET
	7440-09-7	Potassium	1.66E+03	1.88E+03	mg/kg	41SD2	3/3	N/A	Yes	DET
	7782-49-2	Selenium	4.85E-01	5.40E+00 K	mg/kg	41SD11	4/4	N/A	Yes	DET
	7440-22-4	Silver	1.00E-01	1.10E-01	mg/kg	41SD2	3/4	5.10E-02 - 5.10E-02	Yes	DET
	7440-23-5	Sodium	5.10E+01	2.15E+03	mg/kg	41SD11	4/4	N/A	Yes	DET
	7440-28-0	Thallium	1.10E-01	1.30E-01	mg/kg	41SD4	3/3	N/A	Yes	DET
	7440-62-2	Vanadium	2.90E+01	3.90E+01	mg/kg	41SD4	4/4	N/A	Yes	DET
	7440-66-6	Zinc	9.60E+01	1.55E+02	mg/kg	41SD4	4/4	N/A	Yes	DET
	57-12-5	Total Cyanide	8.50E-02	2.00E+00	mg/kg	41SD2	3/3	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

B = Blank related constituent; however, were analyzed by the 2,3,7,8-TCDD TE.

J = Estimated Value

K = Estimated Value

L = Estimated Value

mg/kg = milligrams per kilogram

Table 7-24
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Sediment Food Chain Exposure at SWMU 41 Area B
Page 1 of 2

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

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
Sediment	N/A	2,3,7,8-TCDD-TE	1.18E-06	1.18E-06	mg/kg	41SD11	1/1	N/A	Yes	IBC
	67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran	4.20E-06 B	4.20E-06 B	mg/kg	41SD11	1/1	N/A	No	TEQ
	35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	2.79E-05	2.79E-05	mg/kg	41SD11	1/1	N/A	No	TEQ
	55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran	3.61E-07 J	3.61E-07 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran	8.01E-07 B	8.01E-07 B	mg/kg	41SD11	1/1	N/A	No	TEQ
	39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	2.14E-07 J	2.14E-07 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran	2.97E-07 J	2.97E-07 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	5.37E-07 J	5.37E-07 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	1.27E-06 J	1.27E-06 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran	2.35E-07 J	2.35E-07 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran	3.42E-07 J	3.42E-07 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran	3.56E-07 J	3.56E-07 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	51207-31-9	2,3,7,8-Tetrachlorodibenzofuran	4.92E-07 B	4.92E-07 B	mg/kg	41SD11	1/1	N/A	No	TEQ
	3268-87-9	Octachlorodibenzodioxin	1.71E-03	1.71E-03	mg/kg	41SD11	1/1	N/A	No	TEQ
	39001-02-0	Octachlorodibenzofuran	1.12E-05 B	1.12E-05 B	mg/kg	41SD11	1/1	N/A	No	TEQ
	N/A	Total Heptachlorodibenzofuran	1.05E-05	1.05E-05	mg/kg	41SD11	1/1	N/A	No	TEQ
	N/A	Total Heptachlorodibenzo-p-dioxin	6.59E-05	6.59E-05	mg/kg	41SD11	1/1	N/A	No	TEQ
	N/A	Total Hexachlorodibenzofuran	5.08E-06 J	5.08E-06 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	N/A	Total Hexachlorodibenzo-p-dioxin	8.65E-06	8.65E-06	mg/kg	41SD11	1/1	N/A	No	TEQ
	N/A	Total Pentachlorodibenzofuran	3.10E-06 J	3.10E-06 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	N/A	Total Pentachlorodibenzo-p-dioxin	2.68E-07	2.68E-07	mg/kg	41SD11	1/1	N/A	No	TEQ
	N/A	Total Tetrachlorodibenzofuran	2.55E-06 J	2.55E-06 J	mg/kg	41SD11	1/1	N/A	No	TEQ
	78-93-3	2-Butanone	1.10E-02	2.70E-02	mg/kg	41SD4	3/4	2.80E-02 - 2.80E-02	No	NIBC
	50-29-3	4,4'-DDT	6.62E-03	6.62E-03	mg/kg	41SD3	1/4	2.00E-02 - 3.90E-02	Yes	IBC
	11097-69-1	Aroclor 1254	1.75E-02	9.02E-02	mg/kg	41SD11	2/4	6.60E-02 - 6.60E-02	Yes	IBC
	71-43-2	Benzene	2.00E-04	2.45E-04	mg/kg	41SD3	2/4	5.00E-03 - 5.60E-03	No	NIBC
	117-81-7	bis(2-Ethylhexyl) phthalate	2.20E-02	4.65E-02	mg/kg	41SD3	3/4	3.80E-01 - 3.80E-01	No	NIBC
	85-68-7	Butyl benzyl phthalate	4.95E-02	4.95E-02	mg/kg	41SD3	1/4	1.70E-01 - 3.80E-01	No	NIBC
	75-15-0	Carbon disulfide	5.65E-03	5.65E-03	mg/kg	41SD3	1/4	5.00E-03 - 5.60E-03	No	NIBC
	67-66-3	Chloroform	1.80E-03 J	1.80E-03 J	mg/kg	41SD3	2/4	5.00E-03 - 5.60E-03	No	NIBC
	84-74-2	Di-n-butyl phthalate	4.40E-02	1.43E-01	mg/kg	41SD3	3/4	3.80E-01 - 3.80E-01	No	NIBC
	7421-93-4	Endrin aldehyde	1.74E-03	6.10E-03	mg/kg	41SD3	2/4	1.90E-02 - 2.00E-02	Yes	IBC
	75-09-2	Methylene chloride	4.20E-03	5.75E-03	mg/kg	41SD3	3/4	1.10E-02 - 1.10E-02	No	NIBC
	85-01-8	Phenanthrene	1.60E-03	1.60E-03	mg/kg	41SD4	1/4	2.10E-02 - 3.10E-01	Yes	IBC
	108-88-3	Toluene	6.16E-03	6.16E-03	mg/kg	41SD3	1/4	5.00E-03 - 5.60E-03	No	NIBC
	79-01-6	Trichloroethene	1.66E-03 J	1.66E-03 J	mg/kg	41SD3	1/4	5.00E-03 - 5.60E-03	No	NIBC
	7429-90-5	Aluminum	1.43E+04	1.59E+04	mg/kg	41SD2	4/4	N/A	No	NIBC
	7440-36-0	Antimony	2.30E-01	3.60E-01	mg/kg	41SD2	3/3	N/A	No	NIBC

Table 7-24
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Sediment Food Chain Exposure at SWMU 41 Area B
Page 2 of 2

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

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
Sediment	7440-38-2	Arsenic	1.30E+01	1.66E+01	mg/kg	41SD11	4/4	N/A	Yes	IBC
	7440-39-3	Barium	1.46E+02	2.19E+02	mg/kg	41SD11	4/4	N/A	No	NIBC
	7440-41-7	Beryllium	6.40E-01	1.00E+00	mg/kg	41SD11	4/4	N/A	No	NIBC
	7440-43-9	Cadmium	1.70E+00	2.50E+00	mg/kg	41SD4	3/4	5.60E-02 - 5.60E-02	Yes	IBC
	7440-70-2	Calcium	9.33E+03	3.52E+04	mg/kg	41SD4	4/4	N/A	No	NIBC
	7440-47-3	Chromium	2.04E+01	3.50E+01	mg/kg	41SD3	4/4	N/A	Yes	IBC
	7440-48-4	Cobalt	1.34E+01	2.00E+01	mg/kg	41SD2	4/4	N/A	No	NIBC
	7440-50-8	Copper	2.80E+01	3.84E+01	mg/kg	41SD11	4/4	N/A	Yes	IBC
	7439-89-6	Iron	2.59E+04	4.28E+04	mg/kg	41SD4	4/4	N/A	No	NIBC
	7439-92-1	Lead	2.60E+01	5.93E+01	mg/kg	41SD11	4/4	N/A	Yes	IBC
	7439-95-4	Magnesium	6.84E+03	1.90E+04	mg/kg	41SD4	4/4	N/A	No	NIBC
	7439-96-5	Manganese	1.57E+03	2.80E+03	mg/kg	41SD11	4/4	N/A	No	NIBC
	7439-97-6	Mercury	3.25E-02	3.70E-02	mg/kg	41SD2	3/3	N/A	Yes	IBC
	7440-02-0	Nickel	1.34E+01	2.20E+01	mg/kg	41SD3	4/4	N/A	Yes	IBC
	7440-09-7	Potassium	1.66E+03	1.88E+03	mg/kg	41SD2	3/3	N/A	No	NIBC
	7782-49-2	Selenium	4.85E-01	5.40E+00 K	mg/kg	41SD11	4/4	N/A	Yes	IBC
	7440-22-4	Silver	1.00E-01	1.10E-01	mg/kg	41SD2	3/4	5.10E-02 - 5.10E-02	Yes	IBC
	7440-23-5	Sodium	5.10E+01	2.15E+03	mg/kg	41SD11	4/4	N/A	No	NIBC
	7440-28-0	Thallium	1.10E-01	1.30E-01	mg/kg	41SD4	3/3	N/A	No	NIBC
	7440-62-2	Vanadium	2.90E+01	3.90E+01	mg/kg	41SD4	4/4	N/A	No	NIBC
	7440-66-6	Zinc	9.60E+01	1.55E+02	mg/kg	41SD4	4/4	N/A	Yes	IBC
	57-12-5	Total Cyanide	8.50E-02	2.00E+00	mg/kg	41SD2	3/3	N/A	No	NIBC

COPEC Selection Rationale Codes

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

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

B = Blank related constituent; however, were analyzed by the 2,3,7,8-TCDD TE.

J = Estimated Value

K = Estimated Value

L = Estimated Value

mg/kg = milligrams per kilogram

Table 7-25
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Water Direct Contact Exposure at SWMU 41 Area B

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

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
Surface Water	84-66-2	Diethyl phthalate	2.10E-04	3.20E-04	mg/l	41SW2	3/4	5.00E-03 - 5.00E-03	Yes	DET
	67-66-3	Trichloromethane	3.00E-04	5.90E-04	mg/l	41SW2	3/4	1.00E-03 - 1.00E-03	Yes	DET
	7429-90-5	Aluminum	1.10E-01	9.27E+00	mg/l	41SP2	4/4	N/A	Yes	DET
	7440-38-2	Arsenic	2.20E-04	7.10E-03	mg/l	41SP2	3/4	1.00E-03 - 1.00E-03	Yes	DET
	7440-39-3	Barium	6.00E-02	2.30E-01	mg/l	41SP2	4/4	N/A	Yes	DET
	7440-41-7	Beryllium	6.00E-04	6.00E-04	mg/l	41SP2	1/4	4.00E-03 - 4.00E-03	Yes	DET
	7440-43-9	Cadmium	3.00E-04	3.00E-04	mg/l	41SP2	1/4	5.00E-04 - 5.00E-04	Yes	DET
	7440-70-2	Calcium	4.90E+01	8.90E+01	mg/l	41SP2	4/4	N/A	Yes	DET
	7440-47-3	Chromium	7.00E-04	9.40E-03	mg/l	41SP2	4/4	N/A	Yes	DET
	7440-50-8	Copper	1.90E-02	1.90E-02	mg/l	41SP2	1/4	2.00E-02 - 2.00E-02	Yes	DET
	7439-89-6	Iron	2.30E-01	1.04E+01	mg/l	41SP2	4/4	N/A	Yes	DET
	7439-92-1	Lead	3.00E-04	2.90E-02	mg/l	41SP2	4/4	N/A	Yes	DET
	7439-95-4	Magnesium	3.00E+01	3.20E+01	mg/l	41SP2	4/4	N/A	Yes	DET
	7439-96-5	Manganese	2.00E-02	4.10E-01	mg/l	41SP2	4/4	N/A	Yes	DET
	7440-02-0	Nickel	1.00E-02	1.00E-02	mg/l	41SP2	1/4	1.00E-03 - 1.00E-03	Yes	DET
	7440-09-7	Potassium	1.10E+00	1.60E+00	mg/l	41SW3	4/4	N/A	Yes	DET
	7782-49-2	Selenium	4.00E-04	4.00E-04	mg/l	41SP2	1/4	2.00E-03 - 2.00E-03	Yes	DET
	7440-23-5	Sodium	4.30E+00	1.30E+01	mg/l	41SP2	4/4	N/A	Yes	DET
	7440-28-0	Thallium	9.00E-05	9.00E-05	mg/l	41SP2	1/4	1.00E-03 - 1.00E-03	Yes	DET
	7440-62-2	Vanadium	1.70E-02	1.70E-02	mg/l	41SP2	1/4	2.50E-02 - 2.50E-02	Yes	DET
	7440-66-6	Zinc	7.50E-02	7.50E-02	mg/l	41SP2	1/4	2.00E-02 - 2.00E-02	Yes	DET
	57-12-5	Total Cyanide	2.00E-03	2.00E-03	mg/l	41SW4	4/4	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/l = milligrams per liter

Table 7-26
Occurrence, Distribution, and Selection of Chemicals of Potential Ecological Concern
for Surface Water Food Chain Exposure at SWMU 41 Area B

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

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 Water	84-66-2	Diethyl phthalate	2.10E-04	3.20E-04	mg/l	41SW2	3/4	5.00E-03 - 5.00E-03	No	NIBC
	67-66-3	Trichloromethane	3.00E-04	5.90E-04	mg/l	41SW2	3/4	1.00E-03 - 1.00E-03	No	NIBC
	7429-90-5	Aluminum	1.10E-01	9.27E+00	mg/l	41SP2	4/4	N/A	No	NIBC
	7440-38-2	Arsenic	2.20E-04	7.10E-03	mg/l	41SP2	3/4	1.00E-03 - 1.00E-03	Yes	IBC
	7440-39-3	Barium	6.00E-02	2.30E-01	mg/l	41SP2	4/4	N/A	No	NIBC
	7440-41-7	Beryllium	6.00E-04	6.00E-04	mg/l	41SP2	1/4	4.00E-03 - 4.00E-03	No	NIBC
	7440-43-9	Cadmium	3.00E-04	3.00E-04	mg/l	41SP2	1/4	5.00E-04 - 5.00E-04	Yes	IBC
	7440-70-2	Calcium	4.90E+01	8.90E+01	mg/l	41SP2	4/4	N/A	No	NIBC
	7440-47-3	Chromium	7.00E-04	9.40E-03	mg/l	41SP2	4/4	N/A	Yes	IBC
	7440-50-8	Copper	1.90E-02	1.90E-02	mg/l	41SP2	1/4	2.00E-02 - 2.00E-02	Yes	IBC
	7439-89-6	Iron	2.30E-01	1.04E+01	mg/l	41SP2	4/4	N/A	No	NIBC
	7439-92-1	Lead	3.00E-04	2.90E-02	mg/l	41SP2	4/4	N/A	Yes	IBC
	7439-95-4	Magnesium	3.00E+01	3.20E+01	mg/l	41SP2	4/4	N/A	No	NIBC
	7439-96-5	Manganese	2.00E-02	4.10E-01	mg/l	41SP2	4/4	N/A	No	NIBC
	7440-02-0	Nickel	1.00E-02	1.00E-02	mg/l	41SP2	1/4	1.00E-03 - 1.00E-03	Yes	IBC
	7440-09-7	Potassium	1.10E+00	1.60E+00	mg/l	41SW3	4/4	N/A	No	NIBC
	7782-49-2	Selenium	4.00E-04	4.00E-04	mg/l	41SP2	1/4	2.00E-03 - 2.00E-03	Yes	IBC
	7440-23-5	Sodium	4.30E+00	1.30E+01	mg/l	41SP2	4/4	N/A	No	NIBC
	7440-28-0	Thallium	9.00E-05	9.00E-05	mg/l	41SP2	1/4	1.00E-03 - 1.00E-03	No	NIBC
	7440-62-2	Vanadium	1.70E-02	1.70E-02	mg/l	41SP2	1/4	2.50E-02 - 2.50E-02	No	NIBC
	7440-66-6	Zinc	7.50E-02	7.50E-02	mg/l	41SP2	1/4	2.00E-02 - 2.00E-02	Yes	IBC
	57-12-5	Total Cyanide	2.00E-03	2.00E-03	mg/l	41SW4	4/4	N/A	No	NIBC

COPEC Selection Rationale Codes

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

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/l = milligrams per liter

- 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 7-21 through 7-26**. In general, COPECs were selected as a concern for the direct contact exposure pathway if the constituent was detected in an environmental medium (**Tables 7-21, 7-23, and 7-25**). For food chain exposure pathways, detected COPECs were selected if they were important bioaccumulative constituents (USEPA, 2000c) or explosive compounds (**Tables 7-22, 7-24, and 7-26**).

Seventy-two (72) COPECs (48 organic and 24 inorganic COPECs) have been selected for surface soil direct contact exposure (**Table 7-21**).

Twenty-seven (27) COPECs (17 organic and 10 inorganic COPECs) have been selected for surface soil food chain exposure (**Table 7-22**).

Thirty-nine (39) COPECs (15 organic and 24 inorganic COPECs) have been selected for sediment direct contact exposure (**Table 7-23**).

Fifteen (15) COPECs (5 organic and 10 inorganic COPECs) have been selected for sediment food chain exposure (**Table 7-24**).

Twenty-two (22) COPECs (2 organic and 20 inorganic COPECs) have been selected for surface water direct contact exposure (**Table 7-25**).

Eight COPECs (all inorganic) have been selected for surface water food chain exposure (**Table 7-26**).

EPCs based on the statistical procedures discussed in *HHRA Section 6.2.3* are presented in **Tables 7-27** (surface soil), **7-28** (sediment), and **7-29** (surface water). 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 review of the site photographs 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 41 Area B, 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.

Table 7-27
Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area B - Surface Soil
Page 1 of 3

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	1,1,2,2-Tetrachloroethane ⁵	mg/kg	5.80E-03	N/A	3.70E-03 (NP)	5.80E-03	3.70E-03	mg/kg	95% UCL-Bst	Test (8)
	1,2,3-Trichlorobenzene	mg/kg	2.62E-03	No	3.90E-03 (N)	3.80E-03	3.80E-03	mg/kg	Max	Test (2)
	1,2,4-Trichlorobenzene	mg/kg	3.15E-03	No	4.98E-03 (N)	4.40E-03	4.40E-03	mg/kg	Max	Test (2)
	1,2-Dibromo-3-chloropropane ⁵	mg/kg	9.40E-03	N/A	7.10E-03 (NP)	9.40E-03	7.10E-03	mg/kg	95% UCL-Bst	Test (8)
	1,2-Dibromoethane ⁵	mg/kg	9.60E-04	N/A	3.27E-03 (NP)	9.60E-04	9.60E-04	mg/kg	Max	Test (2)
	1,2-Dichlorobenzene ⁵	mg/kg	7.00E-04	N/A	3.25E-03 (NP)	7.00E-04	7.00E-04	mg/kg	Max	Test (2)
	1,2-Dichloroethane ⁵	mg/kg	5.70E-04	N/A	3.19E-03 (NP)	5.70E-04	5.70E-04	mg/kg	Max	Test (2)
	1,3-Dichlorobenzene ⁵	mg/kg	5.20E-03	N/A	3.57E-03 (NP)	5.20E-03	3.57E-03	mg/kg	95% UCL-Bst	Test (8)
	1,4-Dichlorobenzene ⁵	mg/kg	7.40E-04	N/A	3.20E-03 (NP)	7.40E-04	7.40E-04	mg/kg	Max	Test (2)
	2-Butanone	mg/kg	1.67E-02	No	3.21E-02 (G)	4.00E-02	3.21E-02	mg/kg	95% Approx. Gamma	Test (6)
	2-Hexanone ⁵	mg/kg	1.00E-02	N/A	7.63E-03 (NP)	1.00E-02	7.63E-03	mg/kg	95% UCL-Bst	Test (8)
	4-Methyl-2-pentanone ⁵	mg/kg	7.70E-03	N/A	6.84E-03 (NP)	7.70E-03	6.84E-03	mg/kg	95% UCL-Bst	Test (8)
	Acetone	mg/kg	4.18E-02	No	5.11E-02 (N)	7.30E-02	5.11E-02	mg/kg	95% KM-t	Test (4)
	alpha-Chlordane	mg/kg	3.80E-03	N/A	N/A	3.80E-03	3.80E-03	mg/kg	Max	Test (7)
	Aroclor 1254	mg/kg	4.10E-02	N/A	N/A	4.10E-02	4.10E-02	mg/kg	Max	Test (7)
	Benzene	mg/kg	1.22E-03	No	1.73E-03 (N)	2.80E-03	1.73E-03	mg/kg	95% Student's-t	Test (4)
	bis(2-Ethylhexyl) phthalate	mg/kg	4.93E-02	No	1.69E-01 (NP)	2.40E-01	1.69E-01	mg/kg	95% Cheby, Mean, Sd	Test (3)
	Bromomethane	mg/kg	1.78E-03	No	1.87E-03 (N)	1.90E-03	1.87E-03	mg/kg	95% KM-t	Test (4)
	Carbon disulfide	mg/kg	2.47E-03	No	3.55E-03 (G)	6.00E-03	3.55E-03	mg/kg	95% KM-BCA	Test (6)
	Chlorobenzene ⁵	mg/kg	2.80E-04	N/A	3.23E-03 (NP)	2.80E-04	2.80E-04	mg/kg	Max	Test (2)
	cis-1,2-Dichloroethene ⁵	mg/kg	7.80E-04	N/A	3.23E-03 (NP)	7.80E-04	7.80E-04	mg/kg	Max	Test (2)
	cis-1,3-Dichloropropene ⁵	mg/kg	3.20E-04	N/A	3.25E-03 (NP)	3.20E-04	3.20E-04	mg/kg	Max	Test (2)
	Cyclohexane	mg/kg	1.66E-03	No	2.74E-03 (N)	3.20E-03	2.74E-03	mg/kg	95% KM-t	Test (4)
	Dibromochloromethane ⁵	mg/kg	5.50E-04	N/A	3.22E-03 (NP)	5.50E-04	5.50E-04	mg/kg	Max	Test (2)
	Diethyl phthalate ⁵	mg/kg	1.85E-02	N/A	1.01E-01 (NP)	2.30E-02	2.30E-02	mg/kg	Max	Test (2)
	Di-n-butyl phthalate	mg/kg	8.44E-02	No	2.82E-01 (NP)	4.00E-01	2.82E-01	mg/kg	95% Cheby, Mean, Sd	Test (3)
	Endosulfan II	mg/kg	4.30E-04	N/A	N/A	4.40E-04	4.40E-04	mg/kg	Max	Test (7)
	Endrin aldehyde	mg/kg	6.45E-04	N/A	N/A	6.90E-04	6.90E-04	mg/kg	Max	Test (7)
	Endrin ketone	mg/kg	8.60E-04	N/A	N/A	8.60E-04	8.60E-04	mg/kg	Max	Test (7)
	Ethylbenzene ⁵	mg/kg	2.00E-04	N/A	3.25E-03 (NP)	2.00E-04	2.00E-04	mg/kg	Max	Test (2)

Table 7-27
Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area B - Surface Soil
Page 2 of 3

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	Fluoranthene ⁵	mg/kg	5.00E-03	N/A	1.37E-02 (NP)	5.00E-03	5.00E-03	mg/kg	Max	Test (2)
	gamma-Chlordane	mg/kg	1.49E-03	N/A	N/A	2.10E-03	2.10E-03	mg/kg	Max	Test (7)
	Heptachlor	mg/kg	5.26E-03	N/A	N/A	5.26E-03	5.26E-03	mg/kg	Max	Test (7)
	Isopropylbenzene ⁵	mg/kg	2.30E-04	N/A	3.19E-03 (NP)	2.30E-04	2.30E-04	mg/kg	Max	Test (2)
	Methoxychlor	mg/kg	1.10E-03	N/A	N/A	1.10E-03	1.10E-03	mg/kg	Max	Test (7)
	Methyl acetate ⁵	mg/kg	5.00E-03	N/A	6.58E-03 (NP)	5.00E-03	5.00E-03	mg/kg	Max	Test (2)
	Methyl tert-butyl ether ⁵	mg/kg	5.80E-04	N/A	3.29E-03 (NP)	5.80E-04	5.80E-04	mg/kg	Max	Test (2)
	Methylcyclohexane	mg/kg	1.60E-03	No	2.38E-03 (N)	3.20E-03	2.38E-03	mg/kg	95% KM-t	Test (4)
	Methylene chloride	mg/kg	3.97E-03	No	5.08E-03 (N)	4.70E-03	4.70E-03	mg/kg	Max	Test (2)
	p-Chloro-m-cresol ⁵	mg/kg	2.00E-02	N/A	1.10E-01 (NP)	2.00E-02	2.00E-02	mg/kg	Max	Test (2)
	Phenanthrene ⁵	mg/kg	1.70E-03	N/A	1.36E-02 (NP)	1.70E-03	1.70E-03	mg/kg	Max	Test (2)
	Pyrene ⁵	mg/kg	3.80E-03	N/A	1.37E-02 (NP)	3.80E-03	3.80E-03	mg/kg	Max	Test (2)
	Styrene ⁵	mg/kg	2.70E-03	N/A	3.33E-03 (NP)	2.70E-03	2.70E-03	mg/kg	Max	Test (2)
	Toluene	mg/kg	1.27E-03	No	1.91E-03 (N)	3.30E-03	1.91E-03	mg/kg	95% Student's-t	Test (4)
	trans-1,3-Dichloropropene ⁵	mg/kg	4.60E-04	N/A	3.18E-03 (NP)	4.60E-04	4.60E-04	mg/kg	Max	Test (2)
	Tribromomethane ⁵	mg/kg	1.20E-03	N/A	3.24E-03 (NP)	1.20E-03	1.20E-03	mg/kg	Max	Test (2)
	Trichlorofluoromethane	mg/kg	3.77E-04	No	5.77E-04 (N)	5.20E-04	5.20E-04	mg/kg	Max	Test (2)
	Xylenes (total)	mg/kg	9.36E-04	No	1.27E-03 (G)	1.90E-03	1.27E-03	mg/kg	95% KM-BCA	Test (6)
	Aluminum	mg/kg	2.04E+04	No	2.34E+04 (N)	2.72E+04	2.34E+04	mg/kg	95% Student's-t	Test (4)
	Antimony	mg/kg	5.66E-01	No	6.18E-01 (N)	7.00E-01	6.18E-01	mg/kg	95% Student's-t	Test (4)
	Arsenic	mg/kg	1.94E+01	No	2.18E+01 (N)	2.30E+01	2.18E+01	mg/kg	95% Student's-t	Test (4)
	Barium	mg/kg	1.09E+02	No	2.23E+02 (NP)	2.81E+02	2.23E+02	mg/kg	95% Cheby, Mean, Sd	Test (3)
	Beryllium	mg/kg	5.98E-01	No	8.22E-01 (N)	9.70E-01	8.22E-01	mg/kg	95% Student's-t	Test (4)
	Cadmium	mg/kg	2.65E+00	No	3.13E+00 (N)	3.50E+00	3.13E+00	mg/kg	95% Student's-t	Test (4)
	Calcium	mg/kg	9.76E+04	No	1.27E+05 (N)	1.54E+05	1.27E+05	mg/kg	95% Student's-t	Test (4)
	Chromium	mg/kg	1.81E+01	No	2.10E+01 (N)	2.30E+01	2.10E+01	mg/kg	95% Student's-t	Test (4)
	Cobalt	mg/kg	9.53E+00	No	1.12E+01 (G)	1.20E+01	1.12E+01	mg/kg	95% Approx. Gamma	Test (6)
	Copper	mg/kg	4.35E+01	No	4.98E+01 (N)	5.70E+01	4.98E+01	mg/kg	95% Student's-t	Test (4)
	Iron	mg/kg	3.68E+04	No	4.06E+04 (N)	4.75E+04	4.06E+04	mg/kg	95% Student's-t	Test (4)
	Lead	mg/kg	4.36E+01	No	5.31E+01 (NP)	7.50E+01	5.31E+01	mg/kg	95% Modified-t	Test (3)

Table 7-27
Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area B - Surface Soil
Page 3 of 3

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	Magnesium	mg/kg	3.97E+04	No	4.87E+04 (N)	5.80E+04	4.87E+04	mg/kg	95% Student's-t	Test (4)
	Manganese	mg/kg	1.36E+03	No	1.67E+03 (N)	2.34E+03	1.67E+03	mg/kg	95% Student's-t	Test (4)
	Mercury (Inorganic)	mg/kg	8.91E-02	No	1.39E-01 (G)	2.40E-01	1.39E-01	mg/kg	95% Approx. Gamma	Test (6)
	Nickel	mg/kg	1.91E+01	No	2.15E+01 (N)	2.60E+01	2.15E+01	mg/kg	95% Student's-t	Test (4)
	Potassium	mg/kg	9.99E+02	No	1.23E+03 (N)	1.44E+03	1.23E+03	mg/kg	95% Student's-t	Test (4)
	Selenium	mg/kg	6.40E-01	No	7.32E-01 (N)	9.20E-01	7.32E-01	mg/kg	95% Student's-t	Test (4)
	Silver	mg/kg	1.01E-01	No	1.44E-01 (L)	2.20E-01	1.44E-01	mg/kg	95% H-UCL	Test (5)
	Sodium	mg/kg	6.28E+02	No	5.09E+03 (NP)	3.73E+03	3.73E+03	mg/kg	Max	Test (2)
	Thallium	mg/kg	1.58E-01	No	2.10E-01 (N)	2.70E-01	2.10E-01	mg/kg	95% KM-t	Test (4)
	Vanadium	mg/kg	3.67E+01	No	4.23E+01 (N)	4.70E+01	4.23E+01	mg/kg	95% Student's-t	Test (4)
	Zinc	mg/kg	1.71E+02	No	1.98E+02 (N)	2.34E+02	1.98E+02	mg/kg	95% Student's-t	Test (4)
	Total Cyanide	mg/kg	1.33E-01	No	2.35E-01 (G)	3.70E-01	2.35E-01	mg/kg	95% Approx. Gamma	Test (6)

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): 95% UCL exceeds 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).

Table 7-28
Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area B - Sediment
Page 1 of 2

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

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
Sediment	2,3,7,8-TCDD-TE	mg/kg	1.44E-06	N/A	N/A	1.44E-06	1.44E-06	mg/kg	Max	Test (7)
	2-Butanone	mg/kg	1.73E-02	N/A	N/A	2.70E-02	2.70E-02	mg/kg	Max	Test (7)
	4,4'-DDT	mg/kg	6.62E-03	N/A	N/A	6.62E-03	6.62E-03	mg/kg	Max	Test (7)
	Aroclor 1254	mg/kg	5.39E-02	N/A	N/A	9.02E-02	9.02E-02	mg/kg	Max	Test (7)
	Benzene	mg/kg	2.23E-04	N/A	N/A	2.45E-04	2.45E-04	mg/kg	Max	Test (7)
	bis(2-Ethylhexyl) phthalate	mg/kg	3.28E-02	N/A	N/A	4.65E-02	4.65E-02	mg/kg	Max	Test (7)
	Butyl benzyl phthalate	mg/kg	4.95E-02	N/A	N/A	4.95E-02	4.95E-02	mg/kg	Max	Test (7)
	Carbon disulfide	mg/kg	5.65E-03	N/A	N/A	5.65E-03	5.65E-03	mg/kg	Max	Test (7)
	Chloroform	mg/kg	1.80E-03	N/A	N/A	1.80E-03	1.80E-03	mg/kg	Max	Test (7)
	Di-n-butyl phthalate	mg/kg	8.13E-02	N/A	N/A	1.43E-01	1.43E-01	mg/kg	Max	Test (7)
	Endrin aldehyde	mg/kg	3.92E-03	N/A	N/A	6.10E-03	6.10E-03	mg/kg	Max	Test (7)
	Methylene chloride	mg/kg	4.82E-03	N/A	N/A	5.75E-03	5.75E-03	mg/kg	Max	Test (7)
	Phenanthrene	mg/kg	1.60E-03	N/A	N/A	1.60E-03	1.60E-03	mg/kg	Max	Test (7)
	Toluene	mg/kg	6.16E-03	N/A	N/A	6.16E-03	6.16E-03	mg/kg	Max	Test (7)
	Total Cyanide	mg/kg	7.52E-01	N/A	N/A	2.00E+00	2.00E+00	mg/kg	Max	Test (7)
	Trichloroethene	mg/kg	1.66E-03	N/A	N/A	1.66E-03	1.66E-03	mg/kg	Max	Test (7)
	Aluminum	mg/kg	1.51E+04	N/A	N/A	1.59E+04	1.59E+04	mg/kg	Max	Test (7)
	Antimony	mg/kg	2.98E-01	N/A	N/A	3.60E-01	3.60E-01	mg/kg	Max	Test (7)
	Arsenic	mg/kg	1.50E+01	N/A	N/A	1.66E+01	1.66E+01	mg/kg	Max	Test (7)
	Barium	mg/kg	1.76E+02	N/A	N/A	2.19E+02	2.19E+02	mg/kg	Max	Test (7)
	Beryllium	mg/kg	7.58E-01	N/A	N/A	1.00E+00	1.00E+00	mg/kg	Max	Test (7)
	Cadmium	mg/kg	2.08E+00	N/A	N/A	2.50E+00	2.50E+00	mg/kg	Max	Test (7)
	Calcium	mg/kg	2.26E+04	N/A	N/A	3.52E+04	3.52E+04	mg/kg	Max	Test (7)
	Chromium	mg/kg	2.99E+01	N/A	N/A	3.50E+01	3.50E+01	mg/kg	Max	Test (7)
	Cobalt	mg/kg	1.67E+01	N/A	N/A	2.00E+01	2.00E+01	mg/kg	Max	Test (7)
	Copper	mg/kg	3.16E+01	N/A	N/A	3.84E+01	3.84E+01	mg/kg	Max	Test (7)
	Iron	mg/kg	3.68E+04	N/A	N/A	4.28E+04	4.28E+04	mg/kg	Max	Test (7)
	Lead	mg/kg	4.10E+01	N/A	N/A	5.93E+01	5.93E+01	mg/kg	Max	Test (7)

Table 7-28
Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area B - Sediment
Page 2 of 2

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

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
Sediment	Magnesium	mg/kg	1.37E+04	N/A	N/A	1.90E+04	1.90E+04	mg/kg	Max	Test (7)
	Manganese	mg/kg	2.14E+03	N/A	N/A	2.80E+03	2.80E+03	mg/kg	Max	Test (7)
	Mercury	mg/kg	3.55E-02	N/A	N/A	3.70E-02	3.70E-02	mg/kg	Max	Test (7)
	Nickel	mg/kg	1.84E+01	N/A	N/A	2.20E+01	2.20E+01	mg/kg	Max	Test (7)
	Potassium	mg/kg	1.81E+03	N/A	N/A	1.88E+03	1.88E+03	mg/kg	Max	Test (7)
	Selenium	mg/kg	1.78E+00	N/A	N/A	5.40E+00	5.40E+00	mg/kg	Max	Test (7)
	Silver	mg/kg	1.07E-01	N/A	N/A	1.10E-01	1.10E-01	mg/kg	Max	Test (7)
	Sodium	mg/kg	5.88E+02	N/A	N/A	2.15E+03	2.15E+03	mg/kg	Max	Test (7)
	Thallium	mg/kg	1.23E-01	N/A	N/A	1.30E-01	1.30E-01	mg/kg	Max	Test (7)
	Vanadium	mg/kg	3.35E+01	N/A	N/A	3.90E+01	3.90E+01	mg/kg	Max	Test (7)
	Zinc	mg/kg	1.16E+02	N/A	N/A	1.55E+02	1.55E+02	mg/kg	Max	Test (7)

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).

Table 7-29
Medium-Specific Exposure Point Concentration Summary for SWMU 41 Area B - Surface Water

Scenario Timeframe: Current/Future Medium: Water Exposure Medium: Surface Water										
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 Water	Diethyl phthalate	mg/L	2.53E-04	N/A	N/A	3.20E-04	3.20E-04	mg/L	Max	Test (7)
	Trichloromethane	mg/L	4.13E-04	N/A	N/A	5.90E-04	5.90E-04	mg/L	Max	Test (7)
	Aluminum	mg/L	2.42E+00	N/A	N/A	9.27E+00	9.27E+00	mg/L	Max	Test (7)
	Arsenic	mg/L	2.52E-03	N/A	N/A	7.10E-03	7.10E-03	mg/L	Max	Test (7)
	Barium	mg/L	1.04E-01	N/A	N/A	2.30E-01	2.30E-01	mg/L	Max	Test (7)
	Beryllium	mg/L	6.00E-04	N/A	N/A	6.00E-04	6.00E-04	mg/L	Max	Test (7)
	Cadmium	mg/L	3.00E-04	N/A	N/A	3.00E-04	3.00E-04	mg/L	Max	Test (7)
	Calcium	mg/L	6.03E+01	N/A	N/A	8.90E+01	8.90E+01	mg/L	Max	Test (7)
	Chromium	mg/L	3.08E-03	N/A	N/A	9.40E-03	9.40E-03	mg/L	Max	Test (7)
	Copper	mg/L	1.90E-02	N/A	N/A	1.90E-02	1.90E-02	mg/L	Max	Test (7)
	Iron	mg/L	2.82E+00	N/A	N/A	1.04E+01	1.04E+01	mg/L	Max	Test (7)
	Lead	mg/L	7.58E-03	N/A	N/A	2.90E-02	2.90E-02	mg/L	Max	Test (7)
	Magnesium	mg/L	3.10E+01	N/A	N/A	3.20E+01	3.20E+01	mg/L	Max	Test (7)
	Manganese	mg/L	1.21E-01	N/A	N/A	4.10E-01	4.10E-01	mg/L	Max	Test (7)
	Nickel	mg/L	1.00E-02	N/A	N/A	1.00E-02	1.00E-02	mg/L	Max	Test (7)
	Potassium	mg/L	1.45E+00	N/A	N/A	1.60E+00	1.60E+00	mg/L	Max	Test (7)
	Selenium	mg/L	4.00E-04	N/A	N/A	4.00E-04	4.00E-04	mg/L	Max	Test (7)
	Sodium	mg/L	8.53E+00	N/A	N/A	1.30E+01	1.30E+01	mg/L	Max	Test (7)
	Thallium	mg/L	9.00E-05	N/A	N/A	9.00E-05	9.00E-05	mg/L	Max	Test (7)
	Vanadium	mg/L	1.70E-02	N/A	N/A	1.70E-02	1.70E-02	mg/L	Max	Test (7)
	Zinc	mg/L	7.50E-02	N/A	N/A	7.50E-02	7.50E-02	mg/L	Max	Test (7)
	Cyanide	mg/L	2.00E-03	N/A	N/A	2.00E-03	2.00E-03	mg/L	Max	Test (7)

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-% Bstpr); 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).

7.3.3.2 Predictive Risk Estimation for Terrestrial Wildlife

The potential wildlife risks associated with SWMU 41 Area B 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. Whether or not HQ summation was appropriate and scientifically defensible is based on whether the 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 207 (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 41 Area B are presented in risk characterization tables (**Appendix F-2, Tables F-16 through F-29**) for the seven selected receptor species. These summed EEQs are presented in **Table 7-30** (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 7-30**, Tier 1 total EEQs ranged from approximately 2 to 207 for the seven 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 mink, the American robin, the red fox, the meadow vole, the great blue heron, and the red-tailed hawk. The inorganic constituents arsenic, chromium, mercury, selenium, and zinc; and the organic constituents TCDD and Aroclor 1254 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 fish, 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 0.0006 to 84. 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, red fox, mink, and great blue heron were below one. Tier 2 total EEQs based on LOAEL values were 15 for the short-tailed shrew, 8.5 for the American robin, and 3.6 for the meadow vole (**Table 7-30**).

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, red fox, mink, and great blue heron are not discussed because the summed EEQs are below one.

Meadow Vole. The total EEQs for both NOAEL and LOAEL TRVs exceeded one (15 and 3.6, respectively). Four COPECs had individual NOAEL-based EEQs that exceeded one (EEQ in

Table 7-30
Wildlife EEQ Hazard Summary for Food Chain Exposure at SWMU 41 Area B

Receptor	Tier 1 ^a		Tier 2 ^b	
	NOAEL-Based EEQ	LOAEL-Based EEQ	NOAEL-Based EEQ	LOAEL-Based EEQ
Meadow vole	44	11	15	3.6
Hazard Driver(s) ^c :	<u>As</u> and <u>Se</u> - plant ingestion		<u>As</u> - plant ingestion	
Short-tailed shrew	207	41	84	15
Hazard Driver(s) ^c :	<u>Aroclor 1254</u> and <u>As</u> - terrestrial invertebrate ingestion		<u>As</u> and <u>Cd</u> - terrestrial invertebrate and soil ingestion	
American robin	116	27	45	8.5
Hazard Driver(s) ^c :	<u>Hg</u> and <u>Zn</u> - terrestrial invertebrate ingestion		<u>Zn</u> - terrestrial invertebrate ingestion	
Red-tailed hawk	7.1	1.8	0.003	0.0006
Hazard Driver(s) ^c :	<u>Cr</u> and <u>Zn</u> - small mammal ingestion		--	
Red fox	16	4.5	0.003	0.0009
Hazard Driver(s) ^c :	<u>As</u> and <u>Se</u> - small mammal ingestion		--	
Mink	172	28	0.56	0.09
Hazard Driver(s) ^c :	<u>As</u> and <u>Se</u> - fish ingestion		--	
Great blue heron	30	5.8	0.19	0.04
Hazard Driver(s) ^c :	<u>Zn</u> - fish ingestion		--	

^a Tier 1 = Max EEQ using max EPC, max BAF/BCF (unless regression equation is used), max Intake Rates, min BW, and FHR =1.

^b Tier 2 = EEQ using 95% EPC, non-max BAF/BCF BCF (unless regression equation is used), 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

parenthesis): arsenic (9.2), selenium (1.6), copper (1.5), and cadmium (1.1). Only copper (1.2) had a LOAEL-based EEQ that exceeded one (EEQ in parenthesis). 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-17**.

Short-tailed Shrew. The total EEQs for both NOAEL and LOAEL TRVs exceeded one (84 and 15, respectively). Six COPECs had individual NOAEL-based EEQs that exceeded one (EEQ in parenthesis): arsenic (41), cadmium (24), selenium (4.8), lead (3.7), zinc (3.7), and copper (3.1). Five COPECs had individual LOAEL-based EEQs that exceeded one (EEQ in parenthesis): arsenic (4.1), selenium (2.9), cadmium (2.4), copper (2.4), and zinc (1.9). The primary exposure pathway was the ingestion of terrestrial invertebrates and soil. The results of the short-tailed shrew Tier 2 risk evaluation are presented in **Appendix F-2, Table F-19**.

American Robin. The total EEQs for both NOAEL and LOAEL TRVs exceeded one (45 and 8.5, respectively). Five COPECs had individual NOAEL-based EEQs that exceeded one (EEQ in parenthesis): zinc (25.5), cadmium (8.9), lead (4.3), chromium (2.1) and selenium (1.6). Only zinc (2.8) and chromium (2.1) COPECs had individual LOAEL-based EEQs that exceeded one (EEQs in parenthesis). The primary exposure pathway was the ingestion of terrestrial invertebrates. The results of the Tier 2 risk evaluation for American robins are presented in **Appendix F-2, Table F-20**.

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, sediment, and surface water were the exposure media at SWMU 41 Area B. Intake is not calculated because potential adverse effects are assessed by evaluating the COPEC concentrations in the specific medium. Detailed procedures are presented in *Section 7.1.8* and the results are summarized in **Tables 7-31** (surface soil), **7-32** (sediment), and **7-33** (surface water).

7.3.4.1 Surface Soil

Based on the results of the first step, 13 COPECs were selected based on an EcoSSL or BTAG exceedance while 26 additional chemicals were evaluated further because of the lack of available EcoSSL or BTAG screening values (**Table 7-31**). In the second step, the MDC of these 39 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 1,2-dibromo-3-chloropropane, 1,2-dibromoethane, 2-butanone, 2-hexanone, acetone, bis(2-ethylhexyl)phthalate, bromomethane, carbon disulfide, cyclohexane, dibromochloromethane, endosulfan II, endrin, aldehyde, heptachlor, isopropylbenzene, methyl acetate, methyl tert-butyl ether, methylcyclohexane, p-chloro-m-cresol, trichlorofluoromethane, calcium, magnesium, potassium, and sodium.

- The arsenic MDC exceeded three of four available arsenic benchmarks. Therefore, there is potential for direct contact toxicity for barium at SWMU 41 Area B. This may or may not result in the reduction of terrestrial invertebrates as a food source at SWMU 41 Area B.

Table 7-31
Direct Toxicity Evaluation for Surface Soil at SWMU 41 Area B
Page 1 of 2

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	NOAA SQuiRT 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
1,1,2,2-Tetrachloroethane	1/8	5.80E-03	3.70E-03	5.80E-03	3.00E-01	No								
1,2,3-Trichlorobenzene	5/8	3.80E-03	3.80E-03	4.00E-04	1.00E-01	No								
1,2,4-Trichlorobenzene	4/8	4.40E-03	4.40E-03	3.00E-04	NVA	Yes		0.1	0.05	NVA	NVA	20	0/3	No exceedances
1,2-Dibromo-3-chloropropane	1/8	9.40E-03	7.10E-03	9.40E-03	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
1,2-Dibromoethane	1/8	9.60E-04	9.60E-04	9.60E-04	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
1,2-Dichlorobenzene	1/8	7.00E-04	7.00E-04	7.00E-04	1.00E-01	No								
1,2-Dichloroethane	1/8	5.70E-04	5.70E-04	5.70E-04	8.70E+02	No								
1,3-Dichlorobenzene	1/8	5.20E-03	3.57E-03	5.20E-03	NVA	Yes		1	0.1	NVA	NVA	20 (1,4-dcb)	0/3	No exceedances
1,4-Dichlorobenzene	1/8	7.40E-04	7.40E-04	7.40E-04	1.00E-01	No								
2-Butanone	8/8	4.00E-02	3.21E-02	4.00E-03	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
2-Hexanone	1/8	1.00E-02	7.63E-03	1.00E-02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
4-Methyl-2-pentanone	1/8	7.70E-03	6.84E-03	7.70E-03	1.00E+02	No								
Acetone	6/8	7.30E-02	5.11E-02	2.80E-02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
alpha-Chlordane	1/3	3.80E-03	3.80E-03	3.80E-03	1.00E-01	No								
Aroclor 1254	1/3	4.10E-02	4.10E-02	4.10E-02	1.00E-01	No								
Benzene	8/8	2.80E-03	1.73E-03	2.60E-04	1.00E-01	No								
bis(2-Ethylhexyl) phthalate	8/8	2.40E-01	1.69E-01	1.60E-02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Bromomethane	4/8	1.90E-03	1.87E-03	1.70E-03	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Carbon disulfide	7/8	6.00E-03	3.55E-03	1.00E-03	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Chlorobenzene	1/8	2.80E-04	2.80E-04	2.80E-04	1.00E-01	No								
cis-1,2-Dichloroethene	1/8	7.80E-04	7.80E-04	7.80E-04	3.00E-01	No								
cis-1,3-Dichloropropene	1/8	3.20E-04	3.20E-04	3.20E-04	3.00E-01	No								
Cyclohexane	4/8	3.20E-03	2.74E-03	6.50E-04	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Dibromochloromethane	1/8	5.50E-04	5.50E-04	5.50E-04	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Diethyl phthalate	2/8	2.30E-02	2.30E-02	1.40E-02	NVA	Yes		NVA	NVA	NVA	100	NVA	0/1	No exceedances
Di-n-butyl phthalate	8/8	4.00E-01	2.82E-01	2.40E-02	NVA	Yes		NVA	NVA	NVA	200	NVA	0/1	No exceedances
Endosulfan II	2/3	4.40E-04	4.40E-04	4.20E-04	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Endrin aldehyde	2/3	6.90E-04	6.90E-04	6.00E-04	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Endrin ketone	1/3	8.60E-04	8.60E-04	8.60E-04	1.00E-01	No								
Ethylbenzene	1/8	2.00E-04	2.00E-04	2.00E-04	1.00E-01	No								
Fluoranthene	1/8	5.00E-03	5.00E-03	5.00E-03	1.1E+00 (HMW)	No								
gamma-Chlordane	2/3	2.10E-03	2.10E-03	8.75E-04	1.00E+02	No								
Heptachlor	1/3	5.26E-03	5.26E-03	5.26E-03	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Isopropylbenzene	1/8	2.30E-04	2.30E-04	2.30E-04	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Methoxychlor	1/3	1.10E-03	1.10E-03	1.10E-03	1.00E-01	No								
Methyl acetate	1/8	5.00E-03	5.00E-03	5.00E-03	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Methyl tert-butyl ether	1/8	5.80E-04	5.80E-04	5.80E-04	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Methylcyclohexane	7/8	3.20E-03	2.38E-03	4.20E-04	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Methylene chloride	3/8	4.70E-03	4.70E-03	2.80E-03	3.00E-01	No								
p-Chloro-m-cresol	1/8	2.00E-02	2.00E-02	2.00E-02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Phenanthrene	1/8	1.70E-03	1.70E-03	1.70E-03	2.9E+01 (LMW)	No								
Pyrene	1/8	3.80E-03	3.80E-03	3.80E-03	1.1E+00 (HMW)	No								
Styrene	1/8	2.70E-03	2.70E-03	2.70E-03	1.00E-01	No								
Toluene	8/8	3.30E-03	1.91E-03	2.30E-04	1.00E-01	No								
trans-1,3-Dichloropropene	1/8	4.60E-04	4.60E-04	4.60E-04	3.00E-01	No								
Tribromomethane	1/8	1.20E-03	1.20E-03	1.20E-03	1.47E+03	No								
Trichlorofluoromethane	3/8	5.20E-04	5.20E-04	1.70E-04	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Xylenes (total)	7/8	1.90E-03	1.27E-03	5.40E-04	1.00E-01	No								

Table 7-31
Direct Toxicity Evaluation for Surface Soil at SWMU 41 Area B
Page 2 of 2

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	NOAA SQuiRT 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	8/8	2.72E+04	2.34E+04	1.44E+04	pH dependant	No	pH < 5.5; Plant tox (OHMTADS)							pH = 5.98
Antimony	8/8	7.00E-01	6.18E-01	4.70E-01	2.70E-01	Yes	Mammal tox	NVA	20	78	5	NVA	0/3	No exceedances
Arsenic	8/8	2.30E+01	2.18E+01	1.40E+01	1.80E+01	Yes	Plant tox	NVA	12	18	10	60	3/4	
Barium	8/8	2.81E+02	2.23E+02	5.80E+01	3.30E+02	No								
Beryllium	8/8	9.70E-01	8.22E-01	9.70E-02	2.10E+01	No								
Cadmium	8/8	3.50E+00	3.13E+00	1.60E+00	3.60E-01	Yes	Mammal tox	NVA	1.4	32	4	20	1/4	
Calcium	8/8	1.54E+05	1.27E+05	2.84E+04	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Chromium (Cr III tox)	8/8	2.30E+01	2.10E+01	1.20E+01	2.60E+01	No								
Chromium (Cr VI tox)	8/8	2.30E+01	2.10E+01	1.20E+01	1.30E+02	No								
Cobalt	8/8	1.20E+01	1.12E+01	7.20E+00	1.30E+01	No								
Copper	8/8	5.70E+01	4.98E+01	3.10E+01	2.80E+01	Yes	Bird tox	NVA	63	70	100	50	1/4	
Iron	8/8	4.75E+04	4.06E+04	2.95E+04	5 ≤ pH ≤ 8	No								
Lead	8/8	7.50E+01	5.31E+01	3.30E+01	1.10E+01	Yes	Bird tox	16	70	120	50	500	3/5	
Magnesium	8/8	5.80E+04	4.87E+04	2.09E+04	4.40E+03	Yes	No reference	NVA	NVA	NVA	NVA	NVA	NVA	
Manganese	8/8	2.34E+03	1.67E+03	9.12E+02	2.20E+02	Yes	Plant tox	NVA	NVA	220	500	NVA	2/2	Plant tox
Mercury	8/8	2.40E-01	1.39E-01	3.60E-02	5.80E-02	Yes	No reference	0.058	6.6	NVA	0.3	0.1	2/4	No reference for BTAG
Nickel	8/8	2.60E+01	2.15E+01	1.60E+01	3.80E+01	No								
Potassium	8/8	1.44E+03	1.23E+03	5.46E+02	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Selenium	8/8	9.20E-01	7.32E-01	5.00E-01	5.20E-01	Yes	Plant tox	0.26	1	0.52	1	70	2/5	Plant tox
Silver	8/8	2.20E-01	1.44E-01	6.40E-02	4.20E+00	No								
Sodium	8/8	3.73E+03	3.73E+03	8.60E+01	NVA	Yes		NVA	NVA	NVA	NVA	NVA	NVA	
Thallium	6/8	2.70E-01	2.10E-01	9.20E-02	1.00E-03	Yes	Plant tox (no ref)	NVA	1	NVA	1	NVA	0/2	No exceedances
Vanadium	8/8	4.70E+01	4.23E+01	2.60E+01	7.80E+00	Yes	Bird tox	58	130	NVA	2	NVA	1/3	EcoSSL says data insufficient to derive direct contact SSL
Zinc	8/8	2.34E+02	1.98E+02	1.10E+02	4.60E+01	Yes	Plant tox (OHMTADS)	48	200	120	50	200	5/5	
Total Cyanide	8/8	3.70E-01	2.35E-01	4.00E-02	5.00E-03	Yes	Microbiotic tox	NVA	0.9	NVA	NVA	NVA	0/1	No exceedances

All values presented in mg/kg.
NVA = No Value Available
LMW = Low Molecular Weight PAH
HMW = High Molecular Weight PAH
Surface soil pH of 7.57 based on one geochemical sample (LFSB12A) collected at FLFA.

- (1) COPECs from Table 7-21.
(2) Screening toxicity values from BTAG (1995) or EcoSSL (USEPA, 2007). EcoSSLs given highest priority as they are more definitive.
(3) NOAA SQuiRT (Buckman, 1999). Most conservative target value used.
(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).

Table 7-32
Direct Contact Toxicity Evaluation for Sediment at SWMU 41 Area B

COPEC	MDC (mg/kg)	EPC (mg/kg)	USEPA Region III BTAG (mg/kg) ^A	ARCS ^B			SQB (mg/kg) ^{B,C}	Canadian ISQG (mg/kg) ^D	Canadian PEL (mg/kg) ^D	NOAA ^E		FDEP ^E		Weight of Evidence Exceedence	
				TEC (mg/kg)	PEC (mg/kg)	NEC (mg/kg)				ER-L (mg/kg)	ER-M (mg/kg)	TEL (mg/kg)	PEL (mg/kg)	Using MDC	Using EPC
2,3,7,8-TCDD-TE	1.18E-06	1.18E-06	8.50E-07	---	---	---	---	8.50E-07	2.15E-05	---	---	---	---	2 / 3	2 / 3
2-Butanone	2.70E-02	2.70E-02	---	---	---	---	2.70E-01	---	---	---	---	---	---	0 / 1	0 / 1
4,4'-DDT	6.62E-03	6.62E-03	4.16E-03	---	---	---	3.40E-01	1.19E-03	4.77E-03	1.00E-03	7.00E-03	1.19E-03	4.77E-03	6 / 8	6 / 8
Aroclor 1254	9.02E-02	9.02E-02	5.98E-02	---	---	---	8.10E-01	---	---	2.27E-02	1.80E-01	2.16E-02	1.89E-01	3 / 6	3 / 6
Benzene	2.45E-04	2.45E-04	---	---	---	---	1.60E-01	---	---	---	---	---	---	0 / 1	0 / 1
Bis(2-ethylhexyl) phthalate	4.65E-02	4.65E-02	1.80E-01	---	---	---	8.90E+02	---	---	---	---	1.82E-01	2.65E+00	0 / 4	0 / 4
Butyl benzyl phthalate	4.95E-02	4.95E-02	1.09E+01	---	---	---	1.10E+01	---	---	---	---	---	---	0 / 2	0 / 2
Carbon disulfide	5.65E-03	5.65E-03	8.51E-04	---	---	---	8.50E-04	---	---	---	---	---	---	2 / 2	2 / 2
Chloroform	1.80E-03	1.80E-03	---	---	---	---	2.20E-02	---	---	---	---	---	---	0 / 1	0 / 1
Di-n-butyl phthalate	1.43E-01	1.43E-01	6.47E+00	---	---	---	1.10E+01	---	---	---	---	---	---	0 / 2	0 / 2
Endrin aldehyde	6.10E-03	6.10E-03	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Methylene chloride	5.75E-03	5.75E-03	---	---	---	---	3.70E-01	---	---	---	---	---	---	0 / 1	0 / 1
Phenanthrene	1.60E-03	1.60E-03	2.04E-01	---	---	---	1.80E+00	4.19E-02	5.15E-01	2.40E-01	1.50E+00	8.67E-02	5.44E-01	0 / 8	0 / 8
Toluene	6.16E-03	6.16E-03	---	---	---	---	5.00E-02	---	---	---	---	---	---	0 / 1	0 / 1
Trichloroethene	1.66E-03	1.66E-03	9.69E-02	---	---	---	2.20E-01	---	---	---	---	---	---	0 / 2	0 / 2
Aluminum	1.59E+04	1.59E+04	---	---	5.80E+04	7.32E+04	---	---	---	---	---	---	---	0 / 2	0 / 2
Antimony	3.60E-01	3.60E-01	2.00E+00	---	---	---	---	---	---	2.00E+00	2.50E+01	---	---	0 / 3	0 / 3
Arsenic	1.66E+01	1.66E+01	9.80E+00	1.21E+01	5.70E+01	9.29E+01	---	5.90E+00	1.70E+01	8.20E+00	7.00E+01	7.24E+00	4.16E+01	5 / 10	5 / 10
Barium	2.19E+02	2.19E+02	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Beryllium	1.00E+00	1.00E+00	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Cadmium	2.50E+00	2.50E+00	9.90E-01	5.92E-01	1.17E+01	4.11E+01	---	6.00E-01	3.50E+00	1.20E+00	9.60E+00	6.80E-01	4.21E+00	5 / 10	5 / 10
Calcium	3.52E+04	3.52E+04	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Chromium	3.50E+01	3.50E+01	4.34E+01	5.60E+01	1.59E+02	3.12E+02	---	3.73E+01	9.00E+01	8.10E+01	3.70E+02	5.23E+01	1.60E+02	0 / 10	0 / 10
Cobalt	2.00E+01	2.00E+01	5.00E+01	---	---	---	---	---	---	---	---	---	---	0 / 1	0 / 1
Copper	3.84E+01	3.84E+01	3.16E+01	2.80E+01	7.77E+01	5.48E+01	---	3.57E+01	1.97E+02	3.40E+01	2.70E+02	1.87E+01	1.08E+02	5 / 10	5 / 10
Total Cyanide	2.00E+00	2.00E+00	1.00E-01	---	---	---	---	---	---	---	---	---	---	1 / 1	1 / 1
Iron	4.28E+04	4.28E+04	2.00E+04	---	---	---	---	---	---	---	---	---	---	1 / 1	1 / 1
Lead	5.93E+01	5.93E+01	3.58E+01	3.42E+01	3.96E+02	6.87E+01	---	3.50E+01	9.13E+01	4.67E+01	2.18E+02	3.02E+01	1.12E+02	5 / 10	5 / 10
Magnesium	1.90E+04	1.90E+04	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Manganese	2.80E+03	2.80E+03	4.60E+02	1.67E+03	1.08E+03	8.19E+02	---	---	---	---	---	---	---	4 / 4	4 / 4
Mercury	3.70E-02	3.70E-02	1.80E-01	---	---	---	---	1.70E-01	4.86E-01	1.50E-01	7.10E-01	1.30E-01	7.00E-01	0 / 7	0 / 7
Nickel	2.20E+01	2.20E+01	2.27E+01	3.96E+01	3.85E+01	3.79E+01	---	---	---	2.09E+01	5.16E+01	1.59E+01	4.28E+01	2 / 8	2 / 8
Potassium	1.88E+03	1.88E+03	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Selenium	5.40E+00	5.40E+00	2.00E+00	---	---	---	---	---	---	---	---	---	---	1 / 1	1 / 1
Silver	1.10E-01	1.10E-01	1.00E+00	---	---	---	---	---	---	1.00E+00	3.70E+00	7.30E-01	1.77E+00	0 / 5	0 / 5
Sodium	2.15E+03	2.15E+03	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Thallium	1.30E-01	1.30E-01	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Vanadium	3.90E+01	3.90E+01	---	---	---	---	---	---	---	---	---	---	---	0 / 0	0 / 0
Zinc	1.55E+02	1.55E+02	1.21E+02	1.59E+02	1.53E+03	5.41E+02	---	1.23E+02	3.15E+02	1.50E+02	4.10E+02	1.24E+02	2.71E+02	4 / 10	4 / 10

--- No Value Available

ARCS = Assessment and Remediation of Contaminated Sediment

COPEC = Chemical of Potential Ecological Concern.

EPC = Exposure Point Concentration. The 95% upper confidence limit concentration was selected as the EPC unless it exceeded the maximum detected concentration, in which case the MDC was chosen as the EPC.

ER-L = Effect Range-Low

ER-M = Effect Range Median

FDEP = Florida Department of Environmental Protection

ISQG = Interim Sediment Quality Guideline

ARCS, SQB, and Canadian values for freshwater environments.

NOAA and FDEP values for estuarine and marine environments, but may be used for screening purposes.

MDC = Maximum detected concentration.

NEC = High No Effect Concentration

NOAA = National Oceanic and Atmospheric Administration

PEC = Probable Effect Concentration

PEL = Probably Effect Level

SQB = Sediment Quality Benchmark

TEC = Threshold Effect Concentration

TEL = Threshold Effect Level

^A Screening toxicity values from USEPA Region 3 BTAG, August 2006.

^B Values from Jones, D.S and Suter, G.W. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. ES/ER/TM-95/R4.

^C The lowest of the Eq P-derived sediment quality benchmarks presented in Jones, D.S and Suter, G.W. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. ES/ER/TM-95/R4. is presented here (assumed TOC of 1%).

^D Values from Canadian Council of Ministers of the Environment (CCME), 2002. Canadian Environmental Quality Guidelines. Summary Table Update 2002.

^E Washington state sediment quality standards as presented in Jones, D.S and Suter, G.W. 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision. ES/ER/TM-95/R4.

Table 7-33
Surface Water Direct Contact Assessment for Aquatic Life at SWMU 41 Area B

COPEC	MDC (ug/L)	EPC (ug/L)	USEPA Region III BTAG (ug/L) ^A	NAWQC (ug/L) ^B		Virginia Criteria (ug/L) ^C		Tier II Secondary Values (ug/L) ^D		Lowest Chronic Values (ug/L) ^D				USEPA Region 4 Benchmark Screening Values (ug/L) ^E	Weight of Evidence Exceedence	
				Acute	Chronic	Acute	Chronic	Acute	Chronic	Fish	Daphnids	Non-Daphnids	Aquatic Plants		Using MDC	Using EPC
Diethyl phthalate	3.20E-01	3.20E-01	210	---	---	---	---	1800	210	---	---	---	85600	521	0 / 5	0 / 5
Trichloromethane	5.90E-01	5.90E-01	1.8	---	---	---	---	490	28	1240	4483	---	---	289	0 / 6	0 / 6
Aluminum	9.27E+03	9.27E+03	87	750	87	---	---	---	---	3288	1900	---	460	87	7 / 7	7 / 7
Arsenic	7.10E+00	7.10E+00	5	340	150	340	150	---	---	2962	914.1	---	2320	190	1 / 9	1 / 9
Barium	2.30E+02	2.30E+02	4	---	---	---	---	110	4	---	---	---	---	3.9	4 / 4	4 / 4
Beryllium	6.00E-01	6.00E-01	0.66	---	---	---	---	35	0.66	57	5.3	---	100000	53	0 / 7	0 / 7
Cadmium	3.00E-01	3.00E-01	0.25	2	0.25	3.9	1.1	---	---	1.7	0.15	---	2	66	3 / 9	3 / 9
Calcium	8.90E+04	8.90E+04	116000	---	---	---	---	---	---	---	116000	---	---	116000	0 / 3	0 / 3
Chromium (III)	9.40E+00	9.40E+00	74	570	74	570	74	---	---	68.63	<44	---	397	117.32	0 / 9	0 / 9
Chromium (VI)	9.40E+00	9.40E+00	11	16	11	16	11	---	---	73.18	6.132	---	2	11	0 / 9	0 / 9
Copper	1.90E+01	1.90E+01	9	13	9	13	9	---	---	3.8	0.23	6.066	1	6.54	10 / 10	10 / 10
Iron	1.04E+04	1.04E+04	300	---	1000	---	---	---	---	1300	158	---	---	1000	5 / 5	5 / 5
Lead	2.90E+01	2.90E+01	2.5	65	2.5	120	14	---	---	18.88	12.26	25.46	500	1.32	7 / 10	7 / 10
Magnesium	3.20E+04	3.20E+04	82000	---	---	---	---	---	---	---	82000	---	---	82000	0 / 3	0 / 3
Manganese	4.10E+02	4.10E+02	120	---	---	---	---	2300	120	1780	<1,100	---	---	80	3 / 6	3 / 6
Nickel	1.00E+01	1.00E+01	52	470	52	180	20	---	---	<35	<5	128.4	5	87.7	2 / 10	2 / 10
Potassium	1.60E+03	1.60E+03	53000	---	---	---	---	---	---	---	53000	---	---	53000	0 / 3	0 / 3
Selenium	4.00E-01	4.00E-01	1	---	5	20	5	---	---	88.32	91.65	---	100	5	0 / 8	0 / 8
Sodium	1.30E+04	1.30E+04	680000	---	---	---	---	---	---	---	680000	---	---	680000	0 / 3	0 / 3
Thallium	9.00E-02	9.00E-02	0.8	---	---	---	---	110	12	57	130	---	100	4	0 / 7	0 / 7
Vanadium	1.70E+01	1.70E+01	20	---	---	---	---	280	20	80	1900	---	---	19	0 / 6	0 / 6
Zinc	7.50E+01	7.50E+01	120	120	120	120	120	---	---	36.41	46.73	>5,243	30	58.9	4 / 10	4 / 10
Total Cyanide	2.00E+00	2.00E+00	5	22	5.2	22	5.2	---	---	7.8	---	18.33	30	5.2	0 / 9	0 / 9

Bold value indicates an exceedance of the NAWQC and/or Virginia WQS.

--- No Value Available

COPEC = Chemical of Potential Ecological Concern

EPC = Exposure Point Concentration. The 95% UCL was selected as the EPC unless it exceeded the maximum detected concentration, in which case the MDC was chosen as the EPC.

MDC = Maximum Detected Concentration

NAWQC = National Ambient Water Quality Criteria

95% UCL = 95% upper confidence limit concentration

^A Values from USEPA Region 3 BTAG Screening Levels (July 2006). Values are for freshwater.

^B Unless otherwise noted, values from USEPA (2009) - 4304T: National Recommended Water Quality Criteria.

^C Values from Virginia Water Quality Standards, 9 VAC 25-260, October 2008.

^D Unless otherwise noted, values from Suter, G.W., and Tsao, C.L. 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision, ES/ER/TM-96/R2.

^E Values from USEPA Region 4 Ecological Benchmark Screening Values for Surface Water (2000).

- The cadmium MDC exceeded one of the four available benchmarks for direct contact for cadmium. Therefore, the potential for direct contact toxicity is not likely significant enough to recommend further action at SWMU 41 Area B.
- The copper MDC exceeded one of the four available benchmarks for direct contact for copper. Therefore, the potential for direct contact toxicity is not likely significant enough to recommend further action at SWMU 41 Area B.
- 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 41 Area B. This may or may not result in the reduction of terrestrial invertebrates as a food source at SWMU 41 Area B.
- 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 41 Area B.
- The mercury MDC exceeded two of the four available benchmarks for direct contact for mercury. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 41 Area B.
- The selenium MDC exceeded two of the five available benchmarks for direct contact for selenium. Therefore, the potential for direct contact toxicity is not likely significant enough to recommend further action at SWMU 41 Area B.
- The vanadium MDC exceeded one (for plant toxicity) of the three available benchmarks; however, the EcoSSL guidance (USEPA, 2008b) 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 41 Area B.
- The zinc MDC exceeded all five available benchmarks for direct contact. Therefore, there is potential for direct contact toxicity for zinc at SWMU 41 Area B. This may or may not result in the reduction of terrestrial invertebrates as a food source at SWMU 41 Area B.
- None of the other COPECs selected in the first screening step had any benchmark exceedance.

These results suggest that direct contact toxicity for COPECs in soil may be a concern for arsenic, lead, and zinc. 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.

7.3.4.2 Sediment

Using the sediment benchmarks discussed in *Section 7.1.8*, direct contact exposure to aquatic biota was assessed. As shown in **Table 7-32**, up to 11 benchmarks were potentially available for comparison purposes for sediment COPECs. Using a weight-of-evidence approach, based on the MDC and the 95% EPC, 25 sediment COPECs did not exceed any of the available sediment benchmarks or did not have a benchmark available. Based on the weight-of-evidence, the following COPECs did not exceed more than 50 percent of their respective sediment benchmarks

when compared to both the MDC and 95% EPC, and the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 41 Area B: Aroclor 1254, arsenic, cadmium, copper, lead, nickel, and zinc.

TCDD, 4,4'-DDT, carbon disulfide, iron, manganese, selenium, and total cyanide each exceeded more than 50 percent of their respective sediment benchmarks when compared to both the MDC and 95% EPC. The results of the screening are as follows:

- The TCDD MDC and EPC exceeded two of the three available benchmarks for TCDD. Therefore, there is potential for direct contact toxicity for TCDD at SWMU 41 Area B. Based on this finding, it is possible that organisms inhabiting the stream sediment near SWMU 41 Area B may be adversely impacted by levels of TCDD.
- The 4,4'-DDT MDC and EPC exceeded six of the eight available benchmarks for 4,4'-DDT. Therefore, there is potential for direct contact toxicity for 4,4'-DDT at SWMU 41 Area B. Based on this finding, it is possible that organisms inhabiting the stream sediment near SWMU 41 Area B may be adversely impacted by levels of 4,4'-DDT.
- The carbon disulfide MDC and EPC exceeded both available benchmarks for carbon disulfide. Therefore, there is potential for direct contact toxicity for carbon disulfide at SWMU 41 Area B. Based on this finding, it is possible that organisms inhabiting the stream sediment near SWMU 41 Area B may be adversely impacted by levels of carbon disulfide.
- The iron MDC and EPC exceeded the only available benchmark for iron. Therefore, there is potential for direct contact toxicity for iron at SWMU 41 Area B. Based on this finding, it is possible that organisms inhabiting the stream sediment near SWMU 41 Area B may be adversely impacted by levels of iron.
- The manganese MDC and EPC exceeded all four available benchmarks for manganese. Therefore, there is potential for direct contact toxicity for manganese at SWMU 41 Area B. Based on this finding, it is possible that organisms inhabiting the stream sediment near SWMU 41 Area B may be adversely impacted by levels of manganese.
- The selenium MDC and EPC exceeded the only available benchmark for selenium. However, only 25% of the samples exceeded the benchmark. Due the low frequency of benchmark exceedance, the potential for direct contact toxicity is not likely significant enough to recommend further action at SWMU 41 Area B.
- The cyanide MDC and EPC exceeded the only available benchmark for cyanide. Therefore, there is potential for direct contact toxicity for cyanide at SWMU 41 Area B. Based on this finding, it is possible that organisms inhabiting the stream sediment near SWMU 41 Area B may be adversely impacted by levels of cyanide.

These results suggest that direct contact toxicity for COPECs in sediment at SWMU 41 Area B may be a concern for TCDD, 4,4'-DDT, carbon disulfide, iron, manganese, and total cyanide.

7.3.4.3 Surface Water

Using the surface water benchmarks discussed in *Section 7.1.8*, direct contact exposure to aquatic biota was assessed. As shown in **Table 7-33**, up to 12 benchmarks were potentially available for comparison purposes for surface water COPECs. Using a weight-of-evidence

approach, based on the MDC and the 95% EPC concentration for each COPEC, 13 of the surface water COPECs had concentrations that did not exceed any of the available surface water benchmarks. Aluminum, arsenic, barium, cadmium, copper, iron, lead, manganese, nickel, and zinc each had at least one exceedance of their respective surface water benchmarks. The results of the screening are as follows:

- The aluminum MDC and EPC exceeded all seven available benchmarks for aluminum, including the NRWQC for acute and chronic exposure. Therefore, there is potential for direct contact toxicity for barium at SWMU 41 Area B. Based on this finding, it is possible that organisms inhabiting the streams near SWMU 41 Area B may be adversely impacted by levels of aluminum.
- The arsenic MDC and EPC only exceeded one of the nine available benchmarks for arsenic. It also did not exceed the NRWQC or the Virginia Water Quality Standards (WQS) for arsenic. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 41 Area B.
- The barium MDC and EPC exceeded all four available benchmarks for barium. Therefore, there is potential for direct contact toxicity for barium at SWMU 41 Area B. Based on this finding, it is possible that organisms inhabiting the streams near SWMU 41 Area B may be adversely impacted by levels of barium.
- The cadmium MDC and EPC only exceeded three of the nine available benchmarks for cadmium including the NRWQC for chronic exposure. However, only 25 percent of the samples were detected. Due to the low frequency of detects, the potential for direct contact toxicity is not likely significant enough to recommend further action at SWMU 41 Area B.
- The copper MDC and EPC exceeded all ten available benchmarks for copper, including the NRWQC or the Virginia WQS for acute and chronic exposure. However, only 25 percent of the samples were detected. Due to the low frequency of detects, the potential for direct contact toxicity is not likely significant enough to recommend further action at SWMU 41 Area B.
- The iron MDC and EPC exceeded all five available benchmarks for iron, including the NRWQC or the Virginia WQS for chronic exposure. Therefore, there is potential for direct contact toxicity for iron at SWMU 41 Area B. Based on this finding, it is possible that organisms inhabiting the streams near SWMU 41 Area B may be adversely impacted by levels of iron.
- The manganese MDC and EPC exceeded three of the six available benchmarks for manganese but no promulgated criteria. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 41 Area B.
- The nickel MDC and EPC only exceeded two of the ten available benchmarks for nickel. It also did not exceed the NRWQC or the Virginia WQS for nickel. Therefore, the potential for direct contact toxicity is not significant enough to recommend further action at SWMU 41 Area B.
- The zinc MDC and EPC only exceeded four of the ten available benchmarks for zinc. It also did not exceed the NRWQC or the Virginia WQS for zinc. Therefore, the potential

for direct contact toxicity is not significant enough to recommend further action at SWMU 41 Area B.

These results suggest that direct contact toxicity for COPECs in surface water at SWMU 41 Area B may be a concern for aluminum, barium, and iron.

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, there were six inorganic COPEC drivers (arsenic, cadmium, copper, chromium, selenium, and zinc) with EEQs greater than 1 for the food chain assessment. COPEC hazard drivers for the direct contact assessment were: arsenic, lead, and zinc. 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 7-34**, arsenic, cadmium, copper, lead, selenium, and zinc are direct contact and/or COPECs in SWMU 41 Area B surface soil considered to be potentially site related and not attributed to background.

Table 7-34
Background Comparison for Surface Soil at SWMU 41 Area B

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

^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.

7.3.6 Uncertainty Analysis

There were 119, 164, and 132 chemical constituents not detected in surface soil, sediment, and surface water analytical samples, respectively. **Appendix F-2, Tables F-43** (surface soil), **F-44** (sediment), and **F-45** (surface water) evaluate the uncertainty associated with these constituents' detection limits by presenting a comparison of the maximum detection limit for each non-detect constituent with a conservative ecological toxicity screening value. Region III BTAG soil SLs are antiquated (last published in 1995) relative to Region III BTAG surface water and sediment values (updated in 2006); therefore, non-detect soil values were compared to BTAG soil levels as well as additional soil screening values presented in **Appendix F-2, Table F-42**. Region III BTAG sediment and surface water screening values were used for the sediment and surface water comparison.

Twenty-nine (29) of the non-detect surface soil, 47 of the non-detect sediment, and 23 of the non-detect surface water constituents had maximum detection limits that exceeded the screening criteria, respectively. These findings are not unexpected, given the conservative and numerically low screening values.

Six inorganics (arsenic, cadmium, chromium, copper, selenium, and zinc) had Tier 2 LOAEL-based EEQs that exceeded 1 when round to one significant figure. Given the uncertainties associated with the SLERA process, the key parameters associated with these slightly elevated EEQs were examined in more detail in the following sections.

Arsenic. For arsenic, the slightly elevated short-tailed shrew EEQ of 4.1 was primarily from the soil ingestion (52 percent) and earthworm ingestion (48 percent) pathways. The LOAEL of 1.26 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-19**). The use of this UF is quite conservative, and the use of an alternative UF of approximately 2 would result in the arsenic EEQ of 4.1 dropping to 1 when rounded to one significant figure.

Cadmium. For cadmium, the slightly elevated short-tailed shrew EEQ of 2.4 was primarily from the earthworm ingestion pathway (99 percent). The LOAEL of 10 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-19**). The use of this UF is quite conservative, and the use of an alternative UF of approximately 4 would result in the arsenic EEQ of 2.4 dropping to 1 when rounded to one significant figure.

Chromium. For chromium, the slightly elevated American robin EEQ of 2.1 was primarily from the earthworm ingestion pathway (64 percent), with 22 percent being from soil ingestion. The LOAEL TRV of 2.78 mg/kg-day that was used was based on laboratory studies on the black duck, as cited in USEPA (2008b). This chromium LOAEL was the lowest available value from USEPA (2008b) for birds, for the critical endpoints of reproduction, growth, or survival. However, the black duck LOAEL cited in USEPA (2008b) was based on an unpublished study by Haseltine et al., and therefore, the validity of this LOAEL could not be verified. The next highest LOAEL in USEPA (2008b) was 9.91 mg/kg-day, based on chicken study by Montozono et al. (1998). Use of this alternative LOAEL of 9.91 mg/kg-day would decrease the American robin EEQ by approximately 3.5-fold, from 2.1 to less than 1.

A UF of 8 was used for extrapolation from a black duck chromium toxicity study to the selected wildlife receptor (the American robin) (**Appendix F-2, Table F-21**). The use of this UF is quite

conservative, and the use of an alternative UF of approximately 4 would result in the chromium EEQ of 2.1 dropping to 1 when rounded to one significant figure.

Based on this evaluation for chromium, the use of alternative factors (e.g., an alternative LOAEL TRV and/or alternative UF for TRV species extrapolation), would reduce the estimated American robin LOAEL-based EEQ to 1 (rounded to one significant figure) or less.

Copper. For copper, the slightly elevated short-tailed shrew EEQ of 2.4 was primarily from the earthworm ingestion pathway (83 percent). The LOAEL of 15.4 mg/kg-day that was used was based on a mink study from Sample et al. (1996) and the use of a toxicity extrapolation UF of 8 (**Appendix F-2, Table F-19**). The use of this UF is quite conservative, and the use of an alternative UF of approximately 4 would result in the copper EEQ of 2.4 dropping to 1 when rounded to one significant figure.

Selenium. For selenium, the slightly elevated short-tailed shrew EEQ of 2.9 was primarily from the earthworm ingestion pathway (90 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-19**). The use of this UF is conservative, and the use of an alternative UF of approximately 4 would result in the selenium EEQ of 2.9 dropping to 1 when rounded to one significant figure.

Zinc. For zinc, the EEQs were slightly elevated for the short-tailed shrew (EEQ of 1.9) and the American robin (EEQ of 2.8). The short-tailed shrew EEQ of 1.9 was primarily from the earthworm ingestion pathway (96 percent). The LOAEL of 320 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-19**). The use of this UF is conservative, and the use of an alternative UF of approximately 4 or even 6 would result in the zinc EEQ of 1.9 dropping to 1 when rounded to one significant figure. The American robin EEQ of 2.8 was primarily from the earthworm ingestion pathway (74 percent). The LOAEL of 131 mg/kg-day that was used was based on a laboratory chicken study from Sample et al. (1996) and the use of a toxicity extrapolation UF of 8 (**Appendix F-2, Table F-21**). The use of this UF is conservative, and the use of an alternative UF of approximately 4 would result in the zinc EEQ of 2.8 dropping to 1 when rounded to one significant figure.

Based on this evaluation for LOAEL-based risk drivers (EEQs >1), arsenic, cadmium, chromium, copper, selenium and zinc, the use of alternative factors (e.g., an alternative UF for TRV species extrapolation), would reduce the estimated LOAEL-based EEQs to 1 (when rounded to one significant figure) for all receptors.

The size of the data set was less than ten for all media; therefore, there is some uncertainty in using EPCs derived from statistical calculations. As the number of surface soil samples was generally eight, an EPC was calculated and used in the SLERA. A comparison of the MDCs with the estimated EPCs for the six soil hazard drivers (i.e., arsenic, cadmium, chromium, copper, selenium, and zinc) identified in the SLERA shows that if the MDCs had been conservatively used to estimate EEQs, the estimated hazards would increase by approximately 1.06-fold, 1.12-fold, 1.10-fold, 1.14-fold, 1.26-fold, and 1.18-fold, respectively (**Table 7-27**). Based on this finding, although there is some uncertainty associated with using EPCs based on a sample size less than ten samples, the potential degree of EEQ underestimation is low. In addition, as the 95% UCL EPCs for these six hazard drivers were all based on the USEPA ProUCL-recommended robust Student's-t statistic, less robust bootstrapping statistics associated

with small sample sizes were not used; therefore, uncertainties in the EPCs are deemed very low. For COPECs in surface water and sediment, direct contact assessments used both MDCs and EPCs, and weight-of-evidence findings did not differ between the two approaches for surface water and sediment.

As discussed in *Section 7.2.6*, there is some uncertainty in the SLERA due to the fact that sediment-to-fish BAFs/BCFs were not used to quantify the potential uptake of COPECs from sediment to fish, potentially resulting in an underestimation of hazards to fish-eating wildlife. However, BSAFs are only presented in USEPA (2005b) for the lipophilic compounds dioxin/furans (BSAFs range from 0.0001 to 0.09) and PCBs (value of 2.0 presented for Aroclor 1016 and 1254).

Dioxin/furans were not detected in surface water at SWMU 41 Area B, but were detected in sediment, with an EPC of 1.44E-6 mg/kg (**Table 7-28**), which was less than the sediment EPC at Area A (6.28E-6 mg/kg; **Table 7-13**). If this Area B sediment concentration was multiplied by the BSAF of 0.09 from USEPA (2005b), the estimated fish tissue concentration would be approximately 1.3E-7 mg/kg ($1.44\text{E-}6 \times 0.09$). This estimated concentration is considerably lower than the fish tissue concentration estimated for Area A via uptake from surface water (4.04E-4 mg/kg; *Section 7.2.6*) which did not result in either a mink or heron hazard above 1 (**Appendix F-2**). Therefore, the sediment-to-fish uptake of dioxin/furans is not a concern at Area B for fish-eating wildlife.

PCBs were not detected in surface water at SWMU 41 Area B, but were detected in sediment, at a concentration of 0.0902 mg/kg (**Table 7-28**). If this sediment concentration was multiplied by the BSAF of 2 from USEPA (2005b), the estimated fish tissue concentration would be approximately 0.18 mg/kg (0.0902×2). This would result in Tier 2 fish ingestion doses of approximately 3.8E-4 mg/kg-day and 2.5E-4 mg/kg-day for the great blue heron and mink, respectively, as shown below, using receptor-specific fish ingestion rates, body weights, and fraction of home ranges (FHR):

- Heron Dose= $[0.18 \text{ mg/kg} \times 0.096 \text{ kg/day fish ingestion} / (2.34 \text{ kg body weight})] \times \text{FHR of } 0.051$
- Mink Dose= $[0.18 \text{ mg/kg} \times 0.046 \text{ kg/day fish ingestion} / (1.02 \text{ kg body weight})] \times \text{FHR of } 0.031$

These PCB (Aroclor-1254) estimated fish ingestion doses to the great blue heron and mink (from fish uptake from sediment) are considerably less than the bird and mammal LOAEL-based TRVs of 0.225 mg/kg-day and 0.68 mg/kg-day, respectively (**Appendix F-2**), resulting in EEQs orders of magnitude below 1.0 ($3.8\text{E-}4/0.225 = \text{EEQ of } 0.002$; $2.5\text{E-}4/0.68 = \text{EEQ of } 0.0004$). Use of NOAEL-based TRVs would result in similarly low EEQs ($3.8\text{E-}4/0.0225 = \text{EEQ of } 0.02$; $2.5\text{E-}4/0.14 = \text{EEQ of } 0.002$).

Based on this discussion, the potential underestimation of hazards to fish-eating wildlife, from uptake of important COPECs from sediment to fish, is deemed minor at Area B.

7.3.7 SLERA Results and Conclusions

The data, results, and conclusions of the SLERA evaluated risks to ecological populations inhabiting SWMU 41 Area B. 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 7-30** and direct contact exposure, which may serve as a food source for wildlife, are summarized in **Tables 7-21** (surface soil), **7-23** (sediment), **7-25** (surface water) and discussed in *Section 7.3.4*.

The food chain assessment suggests potential adverse impacts to terrestrial wildlife, especially shrews, voles and American robins for modeled contact with arsenic, cadmium, chromium, copper, selenium, and zinc in surface soil. Use of alternative SLERA parameters would reduce the estimated Tier 2 LOAEL-based EEQs to essentially 1. The direct contact assessment results suggest a potential reduction in wildlife food supply due to arsenic, lead, and zinc in surface soil; TCDD, 4,4'-DDT, carbon disulfide, iron, manganese, and total cyanide in sediment; and aluminum, barium, and iron in surface water. However, given the relatively small size of the site (1.08 acres), it is unlikely that the potential loss of prey would be biologically significant. In addition, although six COPECs in sediment and three COPECs in surface water had concentrations that were greater than more than 50 percent of the available screening benchmarks (or for surface water, was greater than a promulgated criterion), the small size of the site and the associated small size of the sampled aquatic habitat suggests further ecological assessment is not warranted.

Based on uncertainties of toxicity, the finding that chromium concentrations in soil are background related, the fact that no wildlife RTE species have been confirmed at the study area, and the relatively small size of the site, 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.

The assessment results may serve as the foci 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

SWMU 41 consists of two non-contiguous disposal areas (Areas A and B). Area A is a former unlined lagoon area, which has been backfilled with up to 15 ft of clay fill. This lagoon received rinsate from ash-transport vehicle rinsing. Area B is a natural clay-lined landfill containing red water ash. Four to nine feet of low permeability clay caps an estimated 509 cubic yards of buried red water ash material at Area B within two adjacent burial areas comprising approximately 7,168 ft² (0.16 acre).

Data from previous investigations was combined with data from the current (2007 and 2010) 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

Area A. As shown in the Area A summary table below, the contamination assessment indicated that with the exception of 2,4,6-TNT, benzo(a)pyrene, and 2,3,7,8-TCDD TE, there were only single detections of eight organics and five metals above SLs in all site media. In soil samples, the calculated concentration of 2,3,7,8-TCDD TE, PCB-1254, aluminum, arsenic, and iron were above r-SLs; however, only arsenic and iron were present at concentrations above i-SLs in one subsurface soil sample. In surface water samples, 2,4,6-TNT, 2,3,7,8-TCDD, and the calculated 2,3,7,8-TCDD TE were present at concentrations above tw-SLs. None of these analytes or dissolved metals in filtered samples was present above MCLs. In sediment samples, benzo(a)pyrene, nitroglycerin, and arsenic were detected at concentrations greater than r-SLs. However, none of these constituents (with the exception of arsenic in one sample) were present at concentrations above i-SLs in any samples. In Area A 2007 direct-push groundwater samples, the calculated concentration of 2,3,7,8-TCDD TE, 2,4,6-TNT, chloroform, cobalt, and manganese were detected at concentrations above tw-SLs. However, only manganese and 2,3,7,8-TCDD TE were present at concentrations above the MCL (both in one direct-push sample). In the 2010 Area A groundwater well sample, the chemicals detected above tw-SLs were chloroform, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and heptachlor. The metals detected above MCL in that sample were aluminum and iron. However, the duplicate sample for that well (41TM4) did not detect any of the PAHs [benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene], making it seem as though the PAHs may have come from a soil particulate in the one sample.

Area A Screening Level Exceedances

Analyte	Soil	Surface Water	Sediment	Groundwater
Organics				
2,3,7,8-TCDD		1		
2,3,7,8-TCDD TE	1	1		2
2,4,6-Trinitrotoluene		2		1
Benzo(a)pyrene			6	1
Benzo(b)fluoranthene				1
Chloroform				1
Dibenz(a,h)anthracene				1
Heptachlor				1
Indeno(1,2,3-cd)pyrene				1

Analyte	Soil	Surface Water	Sediment	Groundwater
Nitroglycerin			1	
PCB-1254	1			
Metals				
Aluminum	1			1
Arsenic	1		1	
Cobalt				1*
Iron	1			1
Manganese				1*

* Filtered metals

Since Area A was a former lagoon that received rinsate from ash-transport vehicle rinsing, dioxins/furans and explosives are the only constituents detected above SLs that are attributable to past practices at the site. 2,3,7,8-TCDD and the calculated 2,3,7,8-TCDD TE was only reported above the tw-SL (but below the MCL) in one surface water sample collected directly downgradient of Area A and in two direct-push groundwater samples. These groundwater samples were collected without a sandpack, which increases the amount of sediment in the sample. It is very likely that the high concentrations of dioxins/furans in these samples were due to the sediment entrained in the samples. Dioxins/furans were not detected in any of the existing well samples from the site. Dioxin/furans are highly hydrophobic and based upon the high percentage of clay contained in the fill material, the thickness of the clay fill (up to 15 ft), and the low permeability, it is unlikely that these concentrations migrated downward and impacted groundwater. Because of this, the highly turbid samples (41GW1, 41GW2, and 41GW3) were removed from the HHRA and replaced with a sample from the newly-installed Area A well (41MW4) that better represents groundwater in that area. In addition, it is likely that the PAHs detected in the 2010 groundwater sample can be attributed to a sediment particle in the sample since the duplicate sample did not have any PAH detections.

Based on the Nature and Extent Assessment of Area A, it does not appear as though site media has been significantly impacted as a result of former site activities.

Area B. As shown in the Area B summary table below, the contamination assessment indicated that four organics and seven metals were detected at concentrations above SLs in site media. In soil samples, the calculated concentration of 2,3,7,8-TCDD TE, PCB-1254, aluminum, arsenic, copper, iron, manganese, and mercury were present at concentrations above r-SLs; however, only arsenic and manganese concentrations were above i-SLs. In surface water samples, the only analyte present at concentrations above tw-SLs (but below MCLs) was chloroform. Total metals were detected at concentrations greater than MCLs in surface water samples; however, none of the dissolved metals concentrations were present above tw-SLs or MCLs in the filtered samples. In sediment samples, PCB-1254, arsenic, and manganese were present at concentrations above r-SLs. Arsenic and manganese were both detected in the same sample above i-SLs. In groundwater samples from the existing wells, PCE, arsenic, and cobalt were detected at concentrations greater than tw-SLs. However, none of the concentrations detected in the existing wells were present above MCLs.

Area B Screening Level Exceedances

Analyte	Soil	Surface Water	Sediment	Groundwater
Organics				
2,3,7,8-TCDD TE	1			
Chloroform		3		
PCB-1254	1		2	
Tetrachloroethene				3
Metals				
Aluminum	1			
Arsenic	15		1	1
Cobalt				1
Copper	2			
Iron	2			
Manganese	2		1	
Mercury	1			

* Filtered metals

Area B was used as a red water ash disposal area. Natural clay exists beneath the disposal area and clayey fill was placed above it. Clayey fill was placed in an approximately 1.08-acre area at Area B. The clay fill emplaced at the site acts as a soil cap at Area B, preventing downward migration of the constituents present in soil as a result of former disposal activities. Sampling results from the soil investigations at Area B indicate that the subsurface soil has been minimally impacted at one location by dioxins/furans. Based upon the high percentage of clay contained in the clay cap, the thickness of the clay fill (4-9 ft), the low permeability cap, and groundwater results from the existing wells at Area B, dioxins/furans are not migrating from soil and negatively impacting groundwater. Sample results from ash collected at Area B indicated that all detected TCLP concentrations were below regulatory limits and that explosives were not detected in any of the ash samples.

Based on the Nature and Extent Assessment of Area B, it does not appear as though site media has been significantly impacted as a result of former site activities.

Human Health Risk Assessment

An HHRA (*Section 6.0*) was conducted at SWMU 41 to evaluate the potential human health risks associated with previous activities at SWMU 41A and SWMU 41B. The risks associated with five exposure scenarios were calculated at the site: current/hypothetical future maintenance workers, hypothetical future industrial workers, hypothetical future excavation workers, hypothetical future adult residents, and hypothetical future child residents. Exposure scenarios for off-site adult and child residents were also evaluated for potential exposures to groundwater in the event that groundwater migrates off site in the future.

At SWMU 41A, the total cancer risks for current maintenance worker exposures to surface soil, sediment, and surface water were within the acceptable risk range of 1E-06 to 1E-04 due to arsenic (for surface soil and sediment) and dioxins/furans (for surface water). Exposures to groundwater were below the acceptable risk range of 1E-06 to 1E-04. The total HIs for surface soil, sediment, surface water, and groundwater were all less than 1.

For the hypothetical future maintenance worker, the total cancer risks for exposures to surface soil, total soil, sediment, and surface water were within the acceptable risk range due to arsenic and dioxins/furans (for surface water). Exposures to groundwater were below the acceptable risk range of $1\text{E-}06$ to $1\text{E-}04$. The total HIs for surface soil, total soil, sediment, surface water, and groundwater were less than 1.

For the hypothetical future industrial worker, the total cancer risks for exposures to surface soil, total soil, sediment, surface water, and groundwater were within the acceptable risk range due to arsenic and dioxins/furans (for surface water) and heptachlor (groundwater). The total HIs for surface soil, total soil, sediment, and groundwater were less than 1. The total HI for surface water was equal to 1. When recalculated by target organ, the HI for the CNS slightly exceeded 1.

For the hypothetical future excavation worker, the total cancer risks for exposures to total soil, sediment, and groundwater were below the acceptable risk range. The total HIs for total soil, sediment, surface water, and groundwater were less than 1. The total cancer risk for exposures to surface water was equal to the lower limit of the acceptable risk range due to dioxins/furans. The total cancer risk was below the acceptable risk range and the total HI was less than 1. When recalculated by target organ, the HI for CNS slightly exceeded 1.

For the hypothetical future lifetime resident, the total cancer risks for exposures to total soil, sediment, and surface water were within the acceptable risk range due to dioxins/furans (for total soil and surface water) and arsenic (for total soil and sediment). The total HIs for total soil, sediment, and surface water were less than 1. The total cancer risk associated with groundwater was above the acceptable risk range, primarily due to benzo(a)pyrene, benzo(b)fluoranthene, chloroform, dibenzo(a,h)anthracene, heptachlor, and indeno(1,2,3-cd)pyrene. The total HI for groundwater was less than 1.

For the hypothetical child resident, the total cancer risks for exposures to total soil, sediment, and surface water were within the acceptable risk range due to dioxins/furans (total soil and surface water) and arsenic. The total HI for total soil was above 1, primarily due to manganese. The total HIs for sediment and surface water were less than 1. The total cancer risk associated with groundwater was within the acceptable risk range, primarily due to benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, heptachlor, and indeno(1,2,3-cd)pyrene. The total HI for groundwater was less than 1.

Off-site receptors were evaluated to address potential future migration of COPCs in groundwater. For the hypothetical future maintenance worker, exposures to groundwater were below the acceptable risk range of $1\text{E-}06$ to $1\text{E-}04$. The total HI for groundwater was less than 1.

For hypothetical future industrial workers, the total cancer risk for exposures to off-site groundwater was above the acceptable risk range, primarily due to dioxins/furans, 2,6-DNT, and arsenic. The total HI for groundwater was above 1, primarily due to dioxins/furans, cobalt, iron, and manganese. When recalculated by target organ, several organs also exceeded 1. The maximum detected concentration (MDC) of lead in groundwater exceeded the MCL for lead. The total cancer risk associated with groundwater was within the acceptable risk range, primarily due to heptachlor. The total HI for groundwater was less than 1.

For the hypothetical future excavation worker, the total cancer risk was below the acceptable risk range. The total HI was less than 1.

For the hypothetical future lifetime resident, the total cancer risk for exposures to off-site groundwater was above the acceptable risk range, primarily due to benzo(a)pyrene, benzo(b)fluoranthene, chloroform, dibenzo(a,h)anthracene, heptachlor, and indeno(1,2,3-cd)pyrene. The total HI for groundwater was less than 1.

For the hypothetical child resident, the total cancer risk for exposures to off-site groundwater was above the acceptable risk range, primarily due to benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, heptachlor, and indeno(1,2,3-cd)pyrene. The total HI for groundwater was less than 1.

At SWMU 41B, the total cancer risk for current maintenance worker exposures to surface soil and sediment was within the acceptable risk range due to arsenic. The total HIs for surface soil, sediment, surface water, and groundwater were less than 1. The total cancer risk for exposures to surface water and groundwater were both below the acceptable risk range.

For the hypothetical future maintenance worker, the total cancer risk for exposures to surface soil, total soil, and sediment was within the acceptable risk range due to arsenic. The total HIs for surface soil, total soil, sediment, surface water, and groundwater were less than 1. The total cancer risks for exposures to surface water and groundwater were both below the acceptable risk range.

For the hypothetical future industrial worker, the total cancer risk for exposures to surface soil, total soil, and sediment, and groundwater was within the acceptable risk range due to arsenic and PCE (groundwater only). The total cancer risk for exposures to surface water was below the acceptable risk range. The total HIs for surface soil, total soil, sediment, surface water, and groundwater were less than 1.

For the hypothetical future excavation worker, the total cancer risk for exposures to total soil was equal to the lower limit of the acceptable risk range. The risks for individual total soil COPCs were below the acceptable risk range. The total HI for total soil was equal to 1. The HIs for individual total soil COPCs were below 1. The total cancer risks for exposures to sediment, surface water, and groundwater were below the acceptable risk range. The total HIs for sediment, surface water, and groundwater were less than 1.

For the hypothetical future lifetime resident, the total cancer risks for exposures to total soil and sediment were within the acceptable risk range due to dioxins/furans (total soil only) and arsenic. The total HIs for total soil, sediment, and surface water were less than 1. The total cancer risk for exposures to surface water was below the acceptable risk range. The total cancer risk associated with groundwater was above the acceptable risk range, primarily due to PCE and arsenic. The total HI was equal to 1. The HIs for individual COPCs and target organs were below 1.

For the hypothetical child resident, the total cancer risks for exposures to total soil, sediment, and groundwater were within the acceptable risk range due to arsenic and PCE (groundwater only). The total HIs for total soil and groundwater were both above 1, primarily due to arsenic, manganese (total soil only), and cobalt (groundwater only). The total HIs for sediment and surface water were both less than 1. The total cancer risk for exposures to surface water was below the acceptable risk range. When recalculating groundwater exposure risk by target organ, several organs also exceeded 1. The margin-of-exposure evaluation for iron indicated that the iron intake was within the allowable range.

Off-site receptors were evaluated to address potential future migration of COPCs in groundwater. For the hypothetical future maintenance worker and hypothetical future excavation worker, total cancer risk associated with off-site groundwater was below the acceptable risk range. The total HIs for both were below 1.

For hypothetical future industrial workers and child residents, the total cancer risk for exposures to off-site groundwater was within the acceptable risk range due to PCE and arsenic. The total HI for hypothetical future industrial workers was below 1. For the child resident, the total HI was above 1, primarily due to arsenic and cobalt. When recalculated by target organ, the skin and the vascular system exceeded 1.

For the hypothetical future lifetime resident, the total cancer risk for exposures to off-site groundwater was above the acceptable risk range, primarily due to PCE and arsenic. The total HI was equal to 1. The HIs for individual COPCs and target organs were below 1.

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 41 Area A and Area B.

At Area A, the food chain assessment results suggest potential adverse impacts to terrestrial wildlife, especially shrews, robins, and voles for modeled contact with the hazard drivers (arsenic, copper, selenium, and zinc) in surface soil. However, based on the Tier 2 LOAEL-based approach no individual EEQs (when rounded to one significant figure) were above one. The direct contact assessment results suggest a potential reduction in wildlife food supply due to lead and zinc in surface soil; TCDD, acetone, benzo(b)fluoranthene, carbon disulfide, cyanide, iron, and manganese in sediment; and TCDD, aluminum, and barium in surface water. However, due to the small size of the site (0.19 acres), this potential reduction in food is not considered biologically significant. Based on the fact that no Tier 2 LOAEL EEQs were above 1, the fact that no wildlife RTE species have been confirmed in the study area, and the relatively small size of the site, remedial measures solely to address ecological concerns are not warranted for soil.

At Area B, the food chain assessment suggests potential adverse impacts to terrestrial wildlife, especially shrews, voles and American robins for modeled contact with arsenic, cadmium, chromium, copper, selenium, and zinc in surface soil. Use of alternative SLERA parameters would reduce the estimated Tier 2 LOAEL-based EEQs to essentially 1. The direct contact assessment results suggest a potential reduction in wildlife food supply due to arsenic, lead, and zinc in surface soil; TCDD, 4,4'-DDT, carbon disulfide, iron, manganese, and total cyanide in sediment; and aluminum, barium, and iron in surface water. However, given the relatively small size of the site (1.08 acres), it is unlikely that the potential loss of prey would be biologically significant. In addition, although six COPECs in sediment and three COPECs in surface water had concentrations greater than more than 50 percent of the available screening benchmarks (or for surface water, were greater than a promulgated criterion), the small size of the site and the associated small size of the sampled aquatic habitat suggests further ecological assessment is not warranted.

Based on uncertainties of toxicity, the finding that chromium concentrations in soil are background-related, the fact that no wildlife RTE species have been confirmed at the SWMU study area, and the relatively small size of the site, remedial measures solely to address

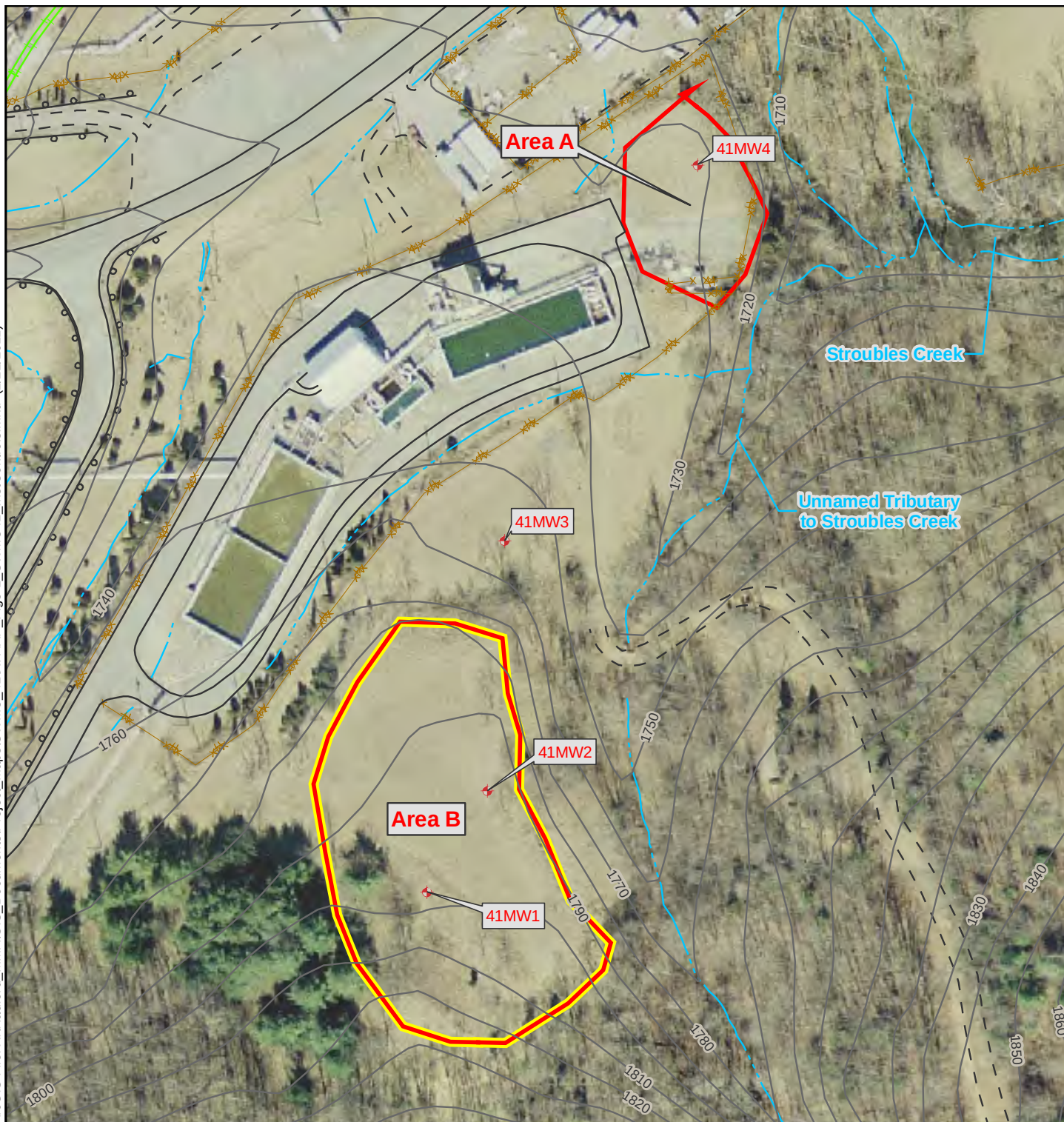
ecological concerns are not warranted for soil. The SMDP reached for this SLERA is that the information collected and presented indicates that a more thorough assessment is not warranted.

Conclusions and Recommendations

Overall, there appears to be minimal risk associated with current and expected future land use at this site. Unacceptable risks were calculated for hypothetical future child and lifetime residents. The SLERA concluded that there may be potential adverse impacts to terrestrial wildlife from site media. However, because no RTE wildlife species have been confirmed at the site and because of the relatively small size of the site, remedial measures to address ecological concerns are not warranted. The results of the investigations to date and the results of the risk assessment indicate that there is little risk associated with the expected future land use at this site.

Based on the results of the Nature and Extent of Contamination Assessment, as well as the results of Human Health and Ecological Risk Assessments, both of which show limited risk to theoretical receptors, Institutional Controls (ICs) are recommended for Area B. No further action is recommended for Area A due to the extremely limited risk to hypothetical receptors and the small size of the site (0.19 acres). This recommendation of Response Complete, with Institutional Controls for Area B, is in support of the current Industrial/Commercial use of the property, and would prevent any residential development from occurring at the site. The implementation of ICs is described below.

Institutional Controls. ICs are being implemented at the site within the boundary of Area B, as depicted on **Figure 8-1**. The objective of the ICs is to maintain Area B in its current industrial/commercial state as a closed SWMU and to prevent any future residential use. Specifically, Area B of this site has been incorporated into plant management manual to ensure long-term protection of human health and the environment. The management manual provides for advance notice, assessment and approval of intrusive work that may occur within the plant with a general digging prohibition at sites such as this. In the event the property is transferred or leased, equivalent ICs will be put into terms and conditions of the deed or lease, which are no less restrictive than the IC objectives described above. Furthermore, the transferee or lessee will be responsible for ensuring IC compliance by any future users. However, the Army acknowledges the responsibility for all original liability under CERCLA and its right and responsibility to enforce ICs unless otherwise transferred to the new property recipient.

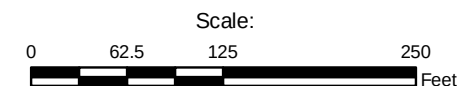


LEGEND

-  Monitoring Well
-  - - - Dirt Road
-  — Paved Road
-  + + + Railroad
-  — Water Feature
-  x x x Fence
-  — 10 ft Contour Line
-  SWMU 41 Boundary
-  Institutional Control Boundary

Notes:

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



U.S. Army Corps of Engineers



Shaw Environmental, Inc.

FIGURE 8-1
Institutional Controls at SWMU 41
 Radford Army Ammunition Plant,
 Radford, VA

9.0 REFERENCES

- Adamcik, R.S., A.W. Todd, and L.B. Keith, 1979. *Demographic and Dietary Responses of Red-Tailed Hawks During a Snowshoe Hare Fluctuation*, Canadian Field Naturalist, Vol. 93, pp. 16-27.
- Agency for Toxic Substances and Disease Registry (ATSDR), 1990. *Toxicological Profile for Silver*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.
- Agency for Toxic Substances and Disease Registry (ATSDR), 1992. *Toxicological Profile for Vanadium*. Agency for Toxic Substances Disease Registry, Atlanta, GA. July.
- Agency for Toxic Substances and Disease Registry (ATSDR), 1996. *Toxicological Profile for 1,1,2,2-Tetrachloroethane*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.
- Agency for Toxic Substances and Disease Registry (ATSDR), 1997. *Toxicological Profile for Chloroform*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.
- Agency for Toxic Substances and Disease Registry (ATSDR), 1998. *Toxicological Profile for Dioxins and Dioxin-like Compounds*. U.S. Department of Health and Human Services, Public Health Service, Atlanta, GA.
- Agency for Toxic Substances and Disease Registry (ATSDR), 2000. *Toxicological Profile for Manganese*. Agency for Toxic Substances Disease Registry, Atlanta, GA. September.
- Agency for Toxic Substances and Disease Registry (ATSDR), 2004. *Toxicological Profile for Cobalt*. Agency for Toxic Substances Disease Registry, Atlanta, GA. April.
- Agency for Toxic Substances and Disease Registry (ATSDR), 2006. *Toxicological Profile for Aluminum*. Agency for Toxic Substances Disease Registry, Atlanta, GA. July.
- Agency for Toxic Substances and Disease Registry (ATSDR), 2007. *Toxicological Profile for Arsenic*. Agency for Toxic Substances Disease Registry, Atlanta, GA. August.
- Agency for Toxic Substances and Disease Registry (ATSDR), 2009. *Minimal Risk Levels for Hazardous Substances*. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. <http://www.atsdr.cdc.gov/mrls>
- Allard, P., R. Hill, G. Mann, C. Mackintosh, R. Hull, L. Kapustka, B. McDonald, B. Hope, B. Sample, A. Fairbrother, and M. Johnson, 2007. *Using Dose-response Relationships for Wildlife TRVs*, SETAC North America 28th Annual Meeting, Milwaukee, Wisconsin, November 11-15.
- Alliant TechSystems, Inc. (ATK), 2003. Responses to URS Group SWMU 41 questions.
- American Society for Testing and Materials (ASTM), 1995. *Standard Guide for Risk-Based Corrective Action at Petroleum Release Sites*. ASTM Committee E-50 on Environmental Assessment. Report No. E1739-95. West Conshohocken, Pennsylvania.

- Baes, C.F., R.D. Sharp, A.L. Sjoreen, and R.W. Shor, 1984. *A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture*, prepared for the U.S. Department of Energy under Contract No. DE-AC05-84OR21400.
- Barceloux, D.G., 1999. *Cobalt*. Clin Toxicol 37(2):201-216.
- Bartell, S.M., 1996. *Ecological/Environmental Risk Assessment Principles and Practice*, in Kolluru, R., S. Bartell, R. Pitblado et al. (eds), Risk Assessment Management Handbook, McGraw Hill, New York, pp. 4.27-4.28, 10.29-10.33.
- Bechtel Jacobs Company LLC, 1998a. *Empirical Models for the Uptake of Inorganic Chemicals from Soil by Plants*. Oak Ridge, Tennessee. BJC/OR-133.
- Bechtel Jacobs Company LLC, 1998b. *Biota Sediment Accumulation Factors for Invertebrates: Review and Recommendations for the Oak Ridge Reservation*. Oak Ridge, Tennessee. BJC/OR-112.
- Bintein, S., J. Devillers, and W. Karcher, 1993. *Nonlinear dependence of fish bioconcentration on n-octanol/water partition coefficient*. SAR QSAR Environ Res.
- Brown, L. and D. Amadon, 1968. *Eagles, Hawks, and Falcons of the World*, Vol. 1, McGraw-Hill Book Company, New York.
- Buchman, M.F., 1999. NOAA Screening Quick Reference Tables (SQuiRT), NOAA HAZMAT Report 99-1, Seattle, WA, Coastal Protection and Restoration Division.
- Bull, J.L. and J. Farrand, 1995. *The National Audubon Society Field Guide to North American Birds, Eastern Region*. National Audubon Society.
- Burt, W.H. and R.P. Grossenheider, 1980. *A Field Guide to Mammals*, Peterson Field Guide Series, Houghton Mifflin Co., Boston.
- Calabrese, E.T., E.J. Stanek, C.E. Gilbert, and R.M. Barnes, 1990. *Preliminary Adult Soil Ingestion Estimates: Results of a Pilot Study*. Reg. Tox. and Pharma. 12:88-95.
- California Environmental Protection Agency (Cal EPA), 2000. *Air Toxics Hot Spots Program Risk Assessment Guideline. Part III, Technical Support Document for the Determination of Noncancer Chronic Reference Levels*. Air Toxicology and Epidemiology Section, Office of Environmental Health Hazard Assessment. February.
- Canadian Council of Ministers of the Environment (CCME), 2003. Canadian Environmental Quality Guidelines, available at <<http://www.ec.gc.ca/ceqg-rcqe/English/download/default.cfm>>.
- Cook, P.M., 1995. Memorandum to C. Fox, EPA Office of Water, March 29, as cited in USEPA 1997e.
- Dames and Moore, 1992. *Final Draft VI Report for the Radford Army Ammunition Plant, Virginia*. Prepared for the U.S. Army Toxic and Hazardous Materials Agency.
- Department of the Army, 1987. Technical Manual TM 5-814-8, *Evaluation Criteria Guide for Water Pollution Prevention, Control, and Abatement Programs*.

- DeRosa, C.T., Brown, D., Dhara, R., Garrett, W., Hansen, H., Holler, J., Jones, D., Jordan-Izaguirre, D., O'Connor, R., Pohl, H., and Xintaras, C., 1997. *Dioxin and Dioxin-Like Compounds in Soil, Part 1: ATSDR Interim Policy Guideline*. Toxicology and Industrial Health, Vol. 13, No. 6, pages 759-768. <http://www.atsdr.cdc.gov/dioxininidt.html>
- DMR, 2000 – See Virginia Department of Mines, Minerals, and Energy.
- Efron, B., 1982. The Jackknife, the Bootstrap, and Other Resampling Plans, Philadelphia, SIAM.
- Efroymson, R.A., 2001. *Uptake of Inorganic Chemicals from Soil by Plant Leaves: Regression of Field Data*, Environ. Toxicol. Chem., 20:2561-2571.
- Ehrlich, P.R., D.S. Dobkin, and D. Wheye, 1988. *The Birders Handbook: A Field Guide to the Natural History of North American Birds*, Simon and Shuster, Inc., New York.
- Eisler, R., 1987. *Polycyclic Aromatic Hydrocarbon Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*. U.S. Fish Wildlife Service Biological Report 85 (1.11).
- Environment Canada, 1997. *Toxic Chemicals in Atlantic Canada - Polynuclear Aromatic Hydrocarbons (PAHs)*. <http://www.ns.ec.gc.ca/epb/envfacts.pah.html>.
- Ford, K.L., F.M. Applehans, and R. Ober, 1992. *Development of Toxicity Reference Values for Terrestrial Wildlife*, in HMCL/Superfund, 92 Conference & Exhibition Proceedings, Hazardous Materials Control Resources Institute, Greenbelt, Maryland.
- Foster, S.A. and P.C. Chrostowski, 1987. *Inhalation Exposures to Volatile Organic Contaminants in the Shower*. In the proceedings of the 80th Annual Meeting of the Air Pollution Control Association (APCA), June 21-26, New York. Air Pollution Control Association.
- Foster, S.A. and P.C. Chrostowski, 2003. *Integrated Human Exposure Model, Version 2 (IHEM2) for Volatile Organic Compounds*. Prepared for Syracuse Research Corporation, Syracuse, New York under EPA Grant No. CR-83109201-0. Prepared by CPF Associates, Inc., Takoma Park, Maryland. December 26.
- Hansen, D.J., 1995. Memorandum to C. Fox, EPA Office of Water, February 28, as cited in USEPA 1997e.
- Hazardous Substances Databank (HSDB), 2007. Profile for Heptachlor Epoxide. <http://toxnet.nlm.nih.go>
- Hull, R.N., P. Allard, A. Fairbrother, B. Hope, M.S. Johnson, L.A. Kapustka, B. McDonald, and B.E. Sample, 2007. *Summary of Recommendations for Wildlife TRV Development and Use*, SETAC North America 28th Annual Meeting, Milwaukee, Wisconsin. November 11-15.
- International Atomic Energy Agency, 1994. *Handbook of Parameter Values for the Protection of Radionuclide Transfer in Temperate Environments*, Technical Reports Series No. 364, Vienna, Austria.
- IT Corporation (IT), 1998. *Ecological Risk Assessment Approach, Main Manufacturing Plant, New River Unit, Radford Army Ammunition Plant*, Delivery Order No. 0013, Environmental Services Program Support, DACA31-94-D-0064, October.

- IT Corporation (IT), 1999. *Screening Ecological Risk Assessment, Radford Army Ammunition Plant*, Delivery Order No. 0013, Environmental Services Program Support, DACA31-94-D-0064. September.
- IT Corporation (IT), 2001. *Facility-Wide Background Study Report*. Radford Army Ammunition Plant, Virginia. Final Report. December 2001. Delivery Order No. 0013, Contract No. DACA31-94-D-0064.
- IT Corporation (IT), 2002a. *Radford Army Ammunition Plant, Master Work Plan Addendum 012*. Draft Final document. February 2002. Delivery Order No. 0013, Contract No. DACA31-94-D-0064.
- IT Corporation (IT), 2002b. *Radford Army Ammunition Plant, Master Work Plan Addendum 009*. Draft Final document. February 2002. Delivery Order No. 008, Contract No. DACA31-94-D-0064.
- Janes, S.W., 1984. *Influences of Territory Composition and Interspecific Competition on Red-Tailed Hawk Reproductive Success*, Ecology, 65:862-870.
- Johnson, P.C. and R.A. Ettinger, 1991. *Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors into Buildings*. Environmental Science & Technology. 25:1445-1452.
- Klaasen, C.D., 1986. *Principles of Toxicology*. In Casarett and Doull's Toxicology, The Basic Science of Poisons. 3rd Edition. C.D. Klaasen, M.O. Amdur, and J. Doull, editors. Macmillen Publishing Company, New York. Page 13.
- Knox, R.C., D.A. Sabatini, and L.W. Canter, 1993. *Subsurface Transport and Fate Processes*. Lewis Publishers.
- Lantzy, R.J. and F.T. Mackenzie, 1979. Atmospheric trace metals: Global cycles and assessment of man's impact. Geochim. Cosmochim. Acta.
- Los Alamos National Laboratory (LANL), 2005. *Los Alamos National Laboratory Ecorisk Database, Release 2.2*.
- Lyman, Warren J. et al., 1990. *Handbook of Chemical Property Estimation Methods*. Washington, D.C.: American Chemical Society.
- Montozono, Y., K. Hatano, N. Sugawara, and T. Ishibashi, 1998. Effects of dietary chromium picolinate on growth, carcass quality and serum lipids of female broilers. Anim. Sci. Tec., 69: 659-665.
- Nagy, K.A., 1987. *Field Metabolic Rate and Food Requirement Scaling in Mammals and Birds*, Ecological Monographs, Vol. 57, pp.111-128.
- Nriagu, J.O., 1989. *A Global Assessment of Natural Sources of Atmospheric Trace Metals*. Nature 338:47-49.
- Oak Ridge National Laboratory (ORNL), 1996. *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota on Oak Ridge Reservation: 1996 Revision*, prepared by G.W. Suter II and C.L. Tsao, ES/ER/TM-96/R2.

- Oak Ridge National Laboratory (ORNL), 1997a. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision*, prepared by R.A. Efroymson, M.E. Will, G.W. Suter, and A.C. Wooten, ES/ER/TM-86/R3.
- Oak Ridge National Laboratory (ORNL), 1997b. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision*, prepared by R.A. Efroymson, M.E. Will, and G.W. Suter, ES/ER/TM-126/R2, November.
- Oak Ridge National Laboratory (ORNL), 1997c. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision*, prepared by D.S. Jones, G.W. Suter II, and R.N. Hull, ES/ER/TM-95/R4.
- Omernik, J.M., 1986. *Ecoregions of the United States*, Corvallis Environmental Research Laboratory, USEPA.
- Rosenblatt, D.H., T.A. Miller, J.C. Dacree, I. Muul, and D.R. Cogley, 1975. *Problem Definition Studies on Potential Environmental Pollutants - II. Physical, Chemical, Toxicological, and Biological Properties of 16 Substances*: U.S. Army Medical Bioengineering Research and Development Laboratory Technical Report 750-9, Fort Detrick, Frederick, Maryland, 289 p.
- Sample, B.E., D.M. Opresko, and G.W. Suter, 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision*, prepared for the U.S. Department of Energy by Health Sciences Research Division, Oak Ridge National Laboratory.
- Sample, B.E., J.J. Beauchamp, R.A. Efroymson, G.W. Suter, and T.L. Ashwood, 1998a. *Development and Validation of Bioaccumulation Models for Earthworms*, Oak Ridge National Laboratory, Oak Ridge, Tennessee, ER/ES/TM-220.
- Sample, B.E., J.J. Beauchamp, R.A. Efroymson, and G.W. Suter, 1998b. *Development and Validation of Bioaccumulation Models for Small Mammals*, Oak Ridge National Laboratory, Oak Ridge, Tennessee, ER/ES/TM-219.
- Sample, B.E., G.W. Suter, J.J. Beauchamp, and R.A. Efroymson, 1999. *Literature-Derived Bioaccumulation Models for Earthworms: Development and Validation*, Environ. Toxicol. Chem., Vol. 18, No. 9, 2110-2120.
- Shaw Environmental, Inc. (Shaw), 2007. *Radford Army Ammunition Plant. Master Work Plan Addendum 019*. Final. July.
- Smith, I.C. and B.L. Carson, 1981. *Trace Metals in the Environment*. Ann Arbor, MI: Ann Arbor Science Publishers.
- Spectrum, 2003. *Chemical Fact Sheet for Cobalt*.
- Suter, G.W., 1993. *Ecological Risk Assessment*, Lewis Publishers, Boca Raton, Florida.
- Tannenbaum, L., 2001. *Journal of Human and Ecological Risk Assessment*, Volume 7, No. 1, CRC Press, Boca Raton, Florida, pp. 217-219.

- Travis, C.C. and A.D. Arms, 1988. Bioconcentration of organics in beef, milk, and vegetation. Health and Safety Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, 3783 1-61 09.
- U.S. Army, 2010. Draft Notes from the Radford Army Ammunition Plant (RFAAP) EPA/VDEQ Partnering Meeting. July 21, 2010.
- U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), 2002. U.S. Army Center for Health Promotion and Preventive Medicine Terrestrial Toxicity Database (TTD). <http://usachppm.amedd.army.mil/tox/herp.aspx>.
- U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), 1976. *Installation Assessment of Radford Army Ammunition Plant*. Records Evaluation Report No. 103.
- U.S. Environmental Protection Agency (USEPA), 1986. *Guidelines for Carcinogen Risk Assessment*. Fed. Reg. 51:33992-34003.
- U.S. Environmental Protection Agency (USEPA), 1987. *RCRA Facility Assessment Radford Army Ammunition Plant, Radford, Virginia*, VAD-21-002-0730.
- U.S. Environmental Protection Agency (USEPA), 1989a. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)*. Interim Final. Office of Emergency and Remedial Response, Washington, D.C., EPA/540/1-89/002.
- U.S. Environmental Protection Agency (USEPA), 1989b. *Update to the Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and Dibenzofurans (CDDs and CDFs)*, Part II. U.S. Environmental Protection Agency. Risk Assessment Forum, Washington, D.C. March 1989.
- U.S. Environmental Protection Agency (USEPA), 1989c. *Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish*, EPA503-8-89-002.
- U.S. Environmental Protection Agency (USEPA), 1991a. *Role of Baseline Risk Assessment in Superfund Remedy Selection Decisions*. OSWER Directive 9355.0-30 Memo from Don R. Clay. April 22, 1991.
- U.S. Environmental Protection Agency (USEPA), 1991b. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Supplemental Guidance*. Standard Default Exposure Factors. Interim Final. Washington, D.C. OSWER Directive 9285.6-03.
- U.S. Environmental Protection Agency (USEPA), 1992. *Installation Assessment: Radford Army Ammunition Plant, Radford, Virginia*. U.S. Environmental Protection Agency, Office of Research and Development. TS-PIC-92372. June 1992.
- U.S. Environmental Protection Agency (USEPA), 1993. *Wildlife Exposure Factors Handbook*, Vols. I and II, Office of Research and Development, Washington, DC, EPA/600/R-93/187a.
- U.S. Environmental Protection Agency (USEPA), 1994a. *Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children*. Office of Emergency and Remedial Response, Washington, D.C. USEPA/540/R-93/081. February 1994.

- U.S. Environmental Protection Agency (USEPA), 1994b. *Estimating Exposure to Dioxin-Like Compounds*. External Review Draft. U.S. Environmental Protection Agency, Office of Research and Development. EPA/600/6-88/005Ca. June 1994.
- U.S. Environmental Protection Agency (USEPA), 1995a. *Innovative Approaches for Validation of Organic and Inorganic Data – Standard Operating Procedures*. Analytical Services and Quality Assurance Branch. Region III, Philadelphia, PA. June 1995.
- U.S. Environmental Protection Agency (USEPA), 1995b. *USEPA Region III Biological Technical Assistance Group (BTAG) Screening Levels*, Philadelphia, PA, 27 pgs, August 9.
- U.S. Environmental Protection Agency (USEPA), 1996a. *Risk Assessment Issue Paper for Derivation of a Provisional RfD for Iron*. National Center for Environmental Assessment. Office of Research and Development. Washington, D.C. July 23.
- U.S. Environmental Protection Agency (USEPA), 1996b. *Soil Screening Guidance: User's Guide*. Office of Solid Waste and Emergency Response. EPA/540/R-96/018. April 1996.
- U.S. Environmental Protection Agency, (USEPA), 1997a. *The Lognormal Distribution in Environmental Applications*, A.K. Singh, A. Singh, and M. Engelhardt, EPA Technology Support Center Issue, Office of Research and Development, Office of Solid Waste and Emergency Response, EPA/600/R-97/006, December.
- U.S. Environmental Protection Agency (USEPA), 1997b. *Human Health Effects Assessment Summary Tables (HEAST)*. Office of Health and Environmental Assessment, Environmental Assessment and Criteria Office, Cincinnati, Ohio. Prepared for Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response, Washington, D.C.
- U.S. Environmental Protection Agency (USEPA), 1997c. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*, EPA/540-R-97-006.
- U.S. Environmental Protection Agency (USEPA), 1997d. *Exposure Factors Handbook*. Office of Research and Development, National Center for Environmental Assessment. EPA/600/P-95/002Fa. August.
- U.S. Environmental Protection Agency (USEPA), 1997e. *The Incidence and Severity of Sediment Contamination in Surface Waters of the United States*, Office of Science and Technology, EPA 823-R-97-006. September.
- U.S. Environmental Protection Agency (USEPA), 1999. *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities*, Appendix C – Media-to-Receptor Bioconcentration Factors, USEPA Office of Solid Waste and Emergency Response, EPA 530-D-99-001A. August.
- U.S. Environmental Protection Agency (USEPA), 2000a. *Radford Army Ammunition Plant Permit for Corrective Action and Waste Minimization*. Permit No. VA1210020730. October 31, 2000.

- U.S. Environmental Protection Agency (USEPA), 2000b. *Memorandum Regarding Use of B-Qualified Data from Monica D. Jones (USEPA, Region III, Quality Assurance Team, 3ES20) to Lynn Flowers (USEPA, Region III, Technical Support Section, 3HS42)*, dated September 27, 2000.
- U.S. Environmental Protection Agency (USEPA), 2000c. *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment – Status and Needs*, Office of Water, Office of Solid Waste, EPA-823-R-00-001. February.
- U.S. Environmental Protection Agency (USEPA), 2000d. *Environmental Effects Database*, Environmental Fate and Effects Division, USEPA, Washington, D.C., Office of Pesticide Programs.
- U.S. Environmental Protection Agency (USEPA), 2000e. *USEPA Region 4 Ecological Benchmark Screening Values for Surface Water*.
- U.S. Environmental Protection Agency (USEPA), 2001a. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments)*. Final. Office of Emergency and Remedial Response. Washington, D.C. 9285.7-47. December 2001.
- U.S. Environmental Protection Agency (USEPA), 2001b. Worksheets to Calculate Dermal Absorption of Organic Chemicals from Aqueous Media. On-line: www.epa.gov/oswer/riskassessment/ragse/pdf/org04_01.xls. Latest version: April 2001.
- U.S. Environmental Protection Agency (USEPA), 2001c. *Radford Army Ammunition Plant Site Screening Process*, October 26.
- U.S. Environmental Protection Agency (USEPA), 2002a. *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*. Office of Emergency and Remedial Response. OSWER 9285.6-10. Washington, D.C. December.
- U.S. Environmental Protection Agency (USEPA), 2002b. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*. OSWER 9355.4-24, December.
- U.S. Environmental Protection Agency (USEPA), 2002c. *User's Guide for the Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children Windows® Version*. EPA 9285.7-42. May.
- U.S. Environmental Protection Agency (USEPA), 2002d. *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites*. Office of Emergency and Remedial Response. EPA 540-R-01-003, OSWER 9285.7-41. September.
- U.S. Environmental Protection Agency (USEPA), 2003a. *Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposure to Lead in Soil*. Office of Solid Waste and Emergency Response. OSWER 9285.7-54. January.
- U.S. Environmental Protection Agency (USEPA), 2003b. *Human Health Toxicity Values in Superfund Risk Assessments*. OSWER Directive 9285.7-53. Memo from Michael B. Cook. December 5, 2003.

- U.S. Environmental Protection Agency (USEPA), 2004a. *Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual* (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/R/99/005. July.
- U.S. Environmental Protection Agency (USEPA), 2004b. *User's Guide for the Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion Into Buildings*. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. June.
- U.S. Environmental Protection Agency (USEPA), 2004c. Johnson and Ettinger Model for Subsurface Vapor Intrusion into Buildings, 3-Phase System Models and Soil-Gas Models. Worksheet: GW-SCREEN-Feb04.xls. Version 3.1. On-line: http://www.epa.gov/swerrims/riskassessment/airmodel/johnson_ettinger.htm. Latest version: February 2004.
- U.S. Environmental Protection Agency (USEPA), 2005a. *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens*. Risk Assessment Forum, Washington, D.C. EPA/630/R-03/003F. March.
- U.S. Environmental Protection Agency (USEPA), 2005b. *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* EPA Document No. EPA530-R-05-006, Office of Solid Waste. September.
- U.S. Environmental Protection Agency (USEPA), 2006. *USEPA Region III Biological Technical Assistance Group (BTAG) Screening Levels*, Philadelphia, PA.
- U.S. Environmental Protection Agency (USEPA), 2007a. *ProUCL Version 4.0 Technical Guide*, EPA/600/R-07/041. April.
- U.S. Environmental Protection Agency (USEPA), 2007b. *Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children Windows® Version*, (IEUBKwin v1.0 build 264). March.
- U.S. Environmental Protection Agency (USEPA), 2007c. *Estimation Programs Interface Suite for Microsoft Windows*, v 3.0. U.S. Environmental Protection Agency, Washington, D.C.
- U.S. Environmental Protection Agency (USEPA), 2008a. Integrated Risk Information System (IRIS). <http://cfpub.epa.gov/ncea/iris/index.cfm>
- U.S. Environmental Protection Agency (USEPA), 2008b. *Ecological Soil Screening Level Guidance* – Office of Solid Waste and Emergency Response, Washington, D.C., April, OSWER Directive No. 9285.7-55, on-line website: <http://www.epa.gov/ecotox/ecossl/>.
- U.S. Environmental Protection Agency (USEPA), 2008c. *Child-Specific Exposure Factors Handbook*. EPA/600/R-06/096F. September.
- U.S. Environmental Protection Agency (USEPA), 2009a. Regional Screening Levels (SL) Table. Developed by Oak Ridge National Laboratory under Interagency Agreement with USEPA. Dated April 2009. On-line: http://www.epa.gov/reg3hwmd/risk/human/rbconcentration_table/Generic_Tables/index.htm
- U.S. Environmental Protection Agency (USEPA), 2009b. National Recommended Water Quality Criteria, Office of Water, Office of Science and Technology, 4304T.

- U.S. Environmental Protection Agency (USEPA), 2010. National Recommended Water Quality Criteria, October 12,
<http://water.epa.gov/scitech/swguidance/waterquality/standards/current/index.cfm>
- URS Corporation (URS), 2003. *Radford Army Ammunition Plant, Final Master Work Plan*. August 2003. Delivery Order No. 0027, Contract No. DACA31-00-D-0011.
- URS Corporation (URS), 2005. *Radford Army Ammunition Plant - RCRA Facility Investigation Report for Solid Waste Management Unit 41*. Prepared for U.S. Army Corps of Engineers Baltimore District. September 2005.
- Van den Berg, M., L.S. Birnbaum, M. Denison, M. DeVito, W. Farland, M. Feeley, H. Fiedler, H. Hakansson, A. Hanberg, L. Haws, M. Rose, S. Safe, D. Schrenk, C. Tohyama, A. Tritscher, J. Tuomisto, M. Tysklind, N. Walker, R.E. Peterson, 2006. *The 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds*. Toxicol Sci. 93(2):223-41.
- Virginia Department of Environmental Quality (VDEQ), 2008. Voluntary Remediation Program Risk Assessment Guidance, Voluntary Remediation Program, Virginia Department of Environmental Quality. On-line: <http://www.deq.state.va.us/vrprisk/raguide.html>. Last updated: August 1, 2008.
- Virginia Department of Game and Inland Fisheries, 1999. *Biological Survey of the Radford Army Ammunition Plant*; including Threatened, Endangered, and Species of Concern. Prepared for Radford Ammunition Plant, May.
- Virginia Department of Mines, Minerals, and Energy, Division of Mineral Resources (DMR), (2000). *Draft Geologic Map of Radford, North, Virginia Quadrangle*. M.J. Bartholamew and A. Schultz.
- Wentsel, R.S., T.W. LaPoint, M. Simini, R.T. Checkai, D. Ludwig, and L.W. Brewer, 1996. *Tri-Service Procedural Guidelines for Ecological Risk Assessments*, U.S. Army Edgewood Research, Development, and Engineering Center, Aberdeen Proving Ground, Maryland.
- Whitaker, Jr., J.O., 1995. *The Audubon Society Field Guide to North American Mammals*, Alfred A. Knopf, Inc., New York.
- World Health Organization (WHO), 1998. *WHO Toxic Equivalency Factors (TEFs) for Dioxin-Like Compounds for Humans and Wildlife*. Summary of WHO Meeting Held in Stockholm, Sweden on June 15-18. World Health Organization, International Programme on Chemical Safety.