RAAP050506\05012

RADFORD ARMY AMMUNITION PLANT, VIRGINIA

Building 4343
RCRA Facility Investigation/
Corrective Measures Study 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
Contract No. DACA31-01-F-0085

Final Document

February 2004

DEPARTMENT OF THE ARMY
RADFORD ARMY AMMUNITION PLANT
P.O. BOX 2
RADFORD VA 24143-0002

REPLY TO
ATTENTION OF

SJMRF-OP

17 August 2004

MEMORANDUM FOR Cmdr, US Army Environmental Center, Attn: SFIM-AEC-CDN (Tony Perry), 5179 Hoadley Road, Aberdeen Proving Ground, MD 21010-5401

SUBJECT: Notification of Radford Army Ammunition Plant Decision Document Building 4343- Excavation of Soil for Clean Close Out, Off Site Disposal, Removal of Source Area (Sumps and Building 4343)

1. Reference Memorandum from Assistant Chief of Staff For Installation Management, 9 Sep 03, Subj: Policies for Staffing and Approving Decision Documents.

2. A copy of the subject decision document (enclosed) is submitted IAW reference. As the cost of the action in the subject decision document is under $2 million, approval authority is with the Installation Commander.

3. Point of contact is Mr. James J. McKenna, 540 639 8641 COM, 931 8641 DSN.

Encl

ROBERT N. DAVIE
Chief Operations Team

Cc

Ms. Deborah Richert
Installation Management Agency
Northeast Region
Attn: SFIM-NE-PW-ER
5 North Gate Road
Fort Monroe, VA 23651-1048

RADFORD ARMY AMMUNITION PLANT, VIRGINIA

Decision Document

Building 4343 - Excavation of Soil for Clean Close Out, Off-Site Disposal, Removal of Source Area (Sumps and Building 4343)

Final

August 2004

1.0 PURPOSE

This Decision Document (DD) is prepared in accordance with the Assistant Chief of Staff for Installation Management (ACSIM) memorandum (ACSIM, 2003) detailing policies for staffing and approving DDs and Defense Environmental Restoration Program (DERP) management guidance (DERP, 2001). This document describes the selected action (Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Removal of Building 4343) for cadmium-contaminated soil at Building 4343 – Former Cadmium Plating Facility at Radford Army Ammunition Plant (RFAAP). This alternative was selected in accordance with the Resource Conservation and Recovery Act of 1976 (RCRA), the Hazardous and Solid Waste Amendments of 1984 (HSWA), the RFAAP Resource Conservation and Recovery Act (RCRA) Permit requirements (USEPA, 2000) (EPA ID No. VA1210020730), and the Final RCRA Corrective Action Plan (USEPA, 1994), as applicable as well as the Building 4343 RCRA Facility Investigation/Corrective Measures Study Report, Final Document February 2004.

The Building 4343 parcel is located in the west central portion of the Horseshoe Area and was established in 1956. Cadmium plating activities were conducted at Building 4343 in support of the NIKE missile program. Treated process water was discharged to an unlined ditch north of the site. The RFAAP RCRA Corrective Action Permit, signed in September 2000, identified Building 4343 as an Area of Concern (AOC) that had the potential to pose a threat, or potential threat, to human health and the environment. The Permit required that a sampling strategy be developed to complete the delineation and characterization of the site. RCRA Facility Investigation (RFI) field efforts were conducted in 1999 and 2002. Data indicated that metals (mainly cadmium) had contaminated soil around Building 4343 and in the process water discharge ditch and alluvial fan. The contamination was mostly confined to the top two feet of soil. Two sumps, related to Building 4343, were identified as having elevated concentrations of metals. Since one of these sumps was located inside Building 4343 there is the potential for contaminated soil underneath the building. Human Health and Screening Level Ecological risk assessments (*Section 2.0*) indicated there was elevated risk at the site and remedial measures were necessary to ensure the protection of human health and the environment.

Based on the findings of the Building 4343 RFI, a Corrective Measures Study (CMS) was conducted. The CMS evaluated remedial alternatives (*Section 8.0*) to address the cadmium contamination at the site. The selected remedy was Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Removal of Building 4343. This alternative was selected as the final alternative for Building 4343 because it is implementable and provides protection to human health and the environment. In addition, this alternative facilitates clean close out and is cost effective. By achieving clean close out, these corrective measures accomplish the Army's Installation Restoration Program (IRP) goal by cleaning up the site and restoring it for beneficial use. Therefore, the alternative - Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Removal of Building 4343 - has been selected by the U.S. Army with concurrence from the U.S. Environmental Protection Agency (USEPA) Region III, Virginia Department of Environmental Quality (VDEQ) and the US Army Center for Health Promotion and Preventive Medicine (USACHPPM). Documents supporting this decision are located in the RFAAP information repository.

2.0 SITE RISK

A human health risk assessment (HHRA) and screening level ecological risk assessment (SLERA) was conducted as part of the Building 4343 RFI/CMS.

The HHRA was performed to evaluate the potential human health effects associated with chemical contamination from past activities at Building 4343. Soil data collected in 1999 and 2002 was evaluated and chemicals of potential concern (COPCs) were selected for quantitative evaluation in the HHRA. The HHRA concluded that the total hazard index (HI) for the current maintenance worker's exposure to surface soil is greater than 1, due to cadmium. Additionally, for the child resident, the total HI was greater than 1, primarily due to cadmium.

The SLERA was performed to provide an estimate of current and future ecological risk associated with potential hazardous substance releases at Building 4343. Tier 2 HIs (rounded to two significant figures), were 280 for the American robin, 800 for the short-tailed shrew, 66 for the meadow vole, 1.4 for the red fox, and less than 1 for the red-tailed hawk. Cadmium was the chemical of potential ecological concern (COPEC) contributing the most to the summed environmental effects quotient (EEQ) for each of the five wildlife receptors. Exposure pathways of most concern, based on the results of the food-chain modeling, were earthworm ingestion and plant ingestion. Incidental soil ingestion was also a significant contributor to the total estimated hazard for the meadow vole. A potential reduction in wildlife food supply was evaluated using a direct contact toxicity evaluation for soil invertebrates (such as earthworms) exposed to COPECs in surface soil. Maximum detected concentrations were used to estimate a Tier 1 EEQ, and exposure point concentrations (EPCs) more appropriate for invertebrate populations [e.g., the 95% upper confidence limit (UCL) concentration] were used to estimate a Tier 2 EEQ. Based on the Tier 2 EEQ results, cadmium, chromium, and zinc are the direct contact COPECs in soil that are estimated to adversely impact the terrestrial invertebrate community, and therefore potentially reduce the food supply for higher trophic level wildlife such as the American robin, and short-tailed shrew.

3.0 REMEDIAL ALTERNATIVES

Four corrective measures alternatives were evaluated to address cadmium in soil at Building 4343:

1. No Further Action;
2. Excavation of Soil with Waste in Place, Off-site Disposal, Removal of Sumps, Removal of Building 4343, and Land Use Controls;
3. Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Removal of Building 4343; and,
4. Stabilization, Removal of Sumps, Removal of Building 4343, and Land Use Controls.

These four alternatives were evaluated using the selection criteria: effectiveness, implementability, and cost. The corrective measures objective (CMO) for the RFI/CMS was to reduce contaminant concentrations in soil to mitigate the human health risk and to allow clean close out of the site. To fully address this objective, a remedy that addressed the potential for future groundwater impact received preferential consideration. RFAAP is underlain by karst

geology. The preferential remedial alternative in this type of geological setting is source removal. Allowing waste to remain in place above actionable regulatory levels represents a risk to RFAAP.

Alternative Three was selected as the final alternative for Building 4343 because it is implementable and provides a greater level of protection to human health and the environment not provided by Alternatives Two and Four. Alternative Three facilitates clean close out, is cost effective, and is protective of groundwater. By achieving clean close out, these corrective measures accomplish the Army's IRP goal by cleaning up the site and restoring it for beneficial use. This corrective measure can be implemented in approximately one year, however, this should be considered an estimate. The actual time to complete the corrective measures could be impacted by site-specific conditions, funding delays, and/or regulatory review. The total estimated cost for this alternative is $656,470.

This alternative includes the following:

- Delineation of soil containing cadmium above the Residential Remedial Goal (RG);
- Excavation of the delineated area such that the remaining soil is below the Residential RG;
- Removal of the sumps (2) inside Building 4343 where elevated metals have been identified;
- Removal of Building 4343 as a source area;
- Transporation and off-site disposal of soil, sump material, and building debris; and,
- Site restoration activities.

Implementation of this alternative will reduce the concentrations of cadmium to below the Residential RG and facilitate clean close out. In addition, the proposed human health RG for residential land use is expected to result in reduction of ecological risks associated with analytes in soil to levels that are protective of the environment. Therefore, implementation of this alternative meets the corrective action objective and is protective of human health and the environment.

4.0 PUBLIC/COMMUNITY INVOLVEMENT

RFAAP has a Restoration Advisory Board (RAB) which has been actively involved throughout the environmental investigation activities conducted during the RFI/CMS. The RAB includes representatives from USEPA and VDEQ, as well as members of the local community.

Comments on the RFI/CMS were solicited from the USEPA and VDEQ. Comments were received and considered by the U.S. Army prior to selection of the Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Removal of Building 4343 alternative for Building 4343.

5.0 DECLARATION

The selected remedy is protective of human health and the environment, attains Federal and State requirements that are applicable or relevant and appropriate to this corrective measures action, and is cost effective. This remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable for this site. However, because treatment of the principal threats of the site was not found to be practicable, this remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. Treatment of cadmium-contaminated soil was determined to not be implementable and cost effective for the volume of contaminated soil at Building 4343. The selected remedy will result in no hazardous substances remaining on-site above levels that would restrict future use, therefore, the five-year review process will not apply to this action.

6.0 APPROVAL AND SIGNATURE

In summary, the Army will implement the Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Removal of Building 4343 alternative for Building 4343 at RFAAP. The total cost for this action is below $2 million; therefore, the appropriate approval authority is the Installation Commander for RFAAP.

Approved By:

Anthony R. Skinner
LTC, CM, Commanding
Radford AAP

17 August 2004
Date

7.0 REFERENCES

Assistant Chief of Staff for Installation Management (ACSIM), 2003. *Memorandum from Major General Larry J. Lust: Policies for Staffing and Approving Decision Documents (DDs)*, dated 09 September 2003.

Defense Environmental Restoration Program (DERP), 2001. *Memorandum for Assistant Secretary of the Army: Management Guidance for the Defense Environmental Restoration Program*, dated 28 September 2001.

U.S. Environmental Protection Agency (USEPA), 1994. *Final RCRA Corrective Action Plan*, Office of Solid Waste and Emergency Response. EPA/520/R/94/004.

U.S. Environmental Protection Agency (USEPA), 2000. *Radford Army Ammunition Plant Permit for Corrective Action and Waste Minimization*. Permit No. VA1210020730. 31 October 2000.

U.S. Army Radford Army Ammunition Plant (RFAAP), 2004. *Building 4343 RCRA Facility Investigation/Corrective Measures Study Report*, Final Document February 2004

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

15.

Date: August 16, 2004

In reply
Refer to 3HS13

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

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

C.A. Jake
Environmental Manager
Alliant Techsystems, Inc.
Radford Army Ammunition Plant
P.O. Box 1
Radford, VA 24141-0100

Re: Radford Army Ammunition Plant
Building 4343
Draft *RFI/CMS*
Document submittal and review

Dear Mr. McKenna and Ms. Jake:

The U.S. Environmental Protection Agency (EPA) has reviewed the Army's July 26, 2004 response to EPA's June 25, 2004 letter pertaining to the review of the Army's February 2004 draft *RCRA Facility Investigation Report/Corrective Measures Study (RFI/CMS)* for Building 4343, located at the Radford Army Ammunition Plant (RFAAP). Based upon our review, the *RFI/CMS* for the investigation of Building 4343 is approved, provided that the Army's July 26, 2004 response recommendations are incorporated into the final *RFI/CMS* document. In accordance with Part II. (E)(5) of RFAAP's Corrective Action Permit, the *RFI/CMS* for Building 4343 is now considered final. Please forward two copies of the final *RFI/CMS* to EPA for our files.

Based upon the approval of the *CMS* for Building 4343, the Army shall follow the procedures for the implementation of the corrective measure as described in Part II. (D)(11-21), Interim Measures, of RFAAP's Corrective Action Permit. The next step in

the process for implementation of the CMS is outlined in Part II. (D)(15) of RFAAP's Corrective Action Permit.

If you have any questions, please call me at 215-814-3357.

Sincerely,

Robert Thomson

Robert Thomson, PE
Federal Facilities

cc: Russell Fish, EPA
Leslie Romanchik, VDEQ-RCRA
Durwood Willis, VDEQ-CERCLA

Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, VA 24141
USA

July 26, 2004

Mr. Robert Thomson
U. S. Environmental Protection Agency
Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Subject: Building 4343 RCRA Facility Investigation/Corrective Measures Study Report, Final February 2004
Radford Army Ammunition Plant
EPA ID# VA1 210020730

Dear Mr. Thomson:

Attached are our responses to the comments contained in your June 25, 2004 letter on the subject report and on Radford AAP response letter of March 4, 2004 to your letter of January 14, 2004. Per your June 28, 2004 conversation with Jim McKenna, ACO staff it is our understanding that risk assessment process changes discussed in these comments will be applied to future reports and the Building 4343 report will not need to be revised. Please advise how many additional copies of the subject report you will need for your files.

To assist the VDEQ in transitioning to a new manager, note their office approved this document on December 1, 2003. Please coordinate with and provide any questions or comments to myself at (540) 639-8266, Jerry Redder of my staff (540) 639-7536 or Jim McKenna, ACO Staff (540) 639-8641.

Sincerely,

C. A. Jake, Environmental Manager
Alliant Ammunition and Powder Company LLC

Enclosure

w/o enclosure

c: Russell Fish, P.E., EPA Region III

Durwood Willis (2 copies)
Virginia Department of Environmental Quality
P. O. Box 10009
Richmond, VA 23240-0009

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

Tony Perry
U.S. Army Environmental Center
5179 Hoadley Road, Attn: SFIM-AEC-ERP
Aberdeen Proving Ground, MD 21010-5401

04-815-110
JMcKenna/JJRedder

9

Katie Watson
Engineering & Environment, Inc.
7927 Camberley Drive
Powell, TN 37849

Dennis Druck
U.S. Army Center for Health Promotion and Preventive Medicine
5158 Blackhawk Road, Attn: MCHB-TS-HER
Aberdeen Proving Ground, MD 21010-5403

John Tesner
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
C. A. Jake
J. J. Redder
Env. File

Coordination: J. McKenna

04-815-110
JMcKenna/JJRedder

Response to USEPA Comments dated 25 June 2004
for
Final Building 4343 RFI/CMS Report
Dated February 2004

General Comments

1. EPA Comment 1
The EPA BTAG believes that remediating the site to residential levels, as proposed in this report, should be sufficient to protect ecological receptors at the site. However, several EPA comments were not sufficiently addressed, and comments are provided below in the specific comment section.

RFAAP Response
Comment noted. Responses for specific comments are provided in the specific comment section.

Specific Comments

2. EPA Comment 2, 01/14/2004
RFAAP should note that the latest Background guidance (previously referenced) does not recommend elimination of chemicals of concern (COCs) present at background levels at the COPCs screening phase of the risk assessment. While this procedure is contained in the Site Screening Process, it is not appropriate for use in the RFI phase of the investigation. It is recommended that the background analysis be performed at the risk characterization phase of the risk assessment for COCs. As recommended in the guidance, elimination of COCs should be done only by the risk managers after the risk assessment is completed.

RFAAP Response
Please reference the conference call of 22 October 2003, between USEPA and RFAAP. Per that discussion, it was agreed that RFI reports based on work plans prior to Work Plan Addendum 17 would be allowed to continue screening chemical results against background levels at the beginning of the risk assessment process.

Per June 28, 2004 discussion with USEPA clarified that the 4343 RFI/CMS would be allowed to proceed without revision to the risk assessment to address this issue. In turn, RFAAP has agreed to revise in-process risk assessments prior to WPA 17 to comply with the latest Background guidance as referenced in the comment.

3. EPA Comment 3, 01/14/2004
RFAAP can use their own spreadsheets to calculate the UCLs. However, they should consider using the latest UCL guidance as previously noted.

RFAAP Response
Comment noted.

4. EPA Comment 4, 01/14/2004
RFAAP should note that the SSL guidance recommends the use of 0.5 acre for residential areas. Since the site is not currently residential (i.e., there are no homes currently onsite), the conservative assumption is to assume the future residential plot is 0.5 acre.

RFAAP Response
Comment noted. The default value will be used in future RFI reports. Since the selected remedy is to remove soil to below residential RBCs, RFAAP does not believe that this report needs to be revised to address this issue.

5. EPA Comment 11, 01/14/2004
Comment 11 states that the use of a "pre-screen" in which maximum concentrations in soil were compared to screening values to determine what chemicals should be evaluated in the screening ecological risk assessment (ERA) is inconsistent with current EPA BTAG guidance for the performance of the RFI. The response states that the use of this "pre-screen" is consistent with the Master Work Plan. Again, please note that this approach, for the RFI phase, is still inconsistent with current EPA BTAG guidance and the approach should be revised. It is not appropriate to assume that the procedures outlined for the Site Screening Process also apply to the RFI process. Future ecological risk assessments should use EPA BTAG screening values to assess direct toxicity to plants and invertebrates and conservative food chain modeling to assess risk to upper food chain receptors.

RFAAP Response
As agreed to with USEPA and VDEQ (reference response to Comment 2), background screening for future HHRA and SLERA efforts will occur at the end of the risk assessment rather than in the beginning of the process as had been presented in the SSP and MWP.

RFAAP had previously agreed as part of the response-to-comments cycle for this report that future SLERAs will use EPA BTAG screening values to assess direct toxicity to plants and invertebrates and conservative food chain modeling to assess risk to upper food chain receptors.

Also, please note that in accordance with previous discussions (22 October 2003 teleconference and previous response-to-comments) that these changes will be reflected in future HHRA's and SLERA's, but would not affect the Building 4343 RFI report.

6. EPA Comment 12, 01/14/2004
Comment 12 stated that the Tier 2 comparison (to means) should not be used alone to develop a list of COPECs since this can overlook hotspots. For example, lead has a maximum concentration of 1410 mg/kg with a screening value of 500 mg/kg, which represents a potential hot spot where ecological risk could be present. The response states that focusing on the Tier 2 EEQ allows a more realistic evaluation as terrestrial wildlife foraging on invertebrates proximate to Building 4343 would not be expected to feed solely at hotspot areas. This may not be the case for wildlife with very small home ranges (i.e., shrew). In addition, these hot spots can have significant effects on local invertebrate populations, which provide the primary food source for smaller ranging birds and

mammals. Therefore, comparison to means should not be used alone to eliminate chemicals from further consideration, without considering the effects of hot spots on receptors. In this case, lead was retained as a COPEC because it exceeded background.

RFAAP Response
The report uses both Tier 1 and Tier 2 calculations to present the results. Although the entire site is an acre, identified hot spots were not large enough to significantly affect home ranges of even small mammals. RFAAP continues to believe that using Tier 2 results provides a conservative yet realistic method to make reasonable risk management decisions.

7. EPA Comment 16, 01/14/2004
Comment 16 stated that no information is presented to support that a remedial goal of 140.4 mg/kg, based on industrial use for cadmium, would be protective of invertebrate and small mammal populations. The response states that the value is likely to be protective of small mammal populations given the limitations with the hazard quotient approach and the conservativeness of the screening ERA. The response only states that there is a high level of uncertainty in the screening ERA. BTAG agrees that uncertainty is high. However, a high level of uncertainty in the screening ERA is still insufficient information to support that cleaning up to industrial levels would be protective. Uncertainty is best addressed through the use of a baseline ERA, which the Army felt was unnecessary. In addition, the response does not address potential risk to invertebrate populations. As long as the Army agrees to cleanup to residential levels, this issue is not relevant at this site.

RFAAP Response
Comment noted. RFAAP restates their intention to cleanup soil at AOC 4343 to residential RBC levels.

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

June 25, 2004

In reply
Refer to 3HS13

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

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

C.A. Jake
Environmental Manager
Alliant Techsystems, Inc.
Radford Army Ammunition Plant
P.O. Box 1
Radford, VA 24141-0100

Re: Radford Army Ammunition Plant
Building 4343
Army draft revised *RFI/CMS*
Review of the Army's 3/4/04 Response to EPA's 1/14/04 review letter

Dear Mr. McKenna and Ms. Jake:

The U.S. Environmental Protection Agency (EPA) has reviewed the U.S. Army's (Army's) February 2004 draft revised *RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) Report* for the investigation of Building 4343, located at the Radford Army Ammunition Plant (RFAAP), as well as the Army's March 4, 2004 response to EPA's January 14, 2004 review letter pertaining to the draft *RFI/CMS*. Outlined below, please find EPA's comments based upon that review:

GENERAL COMMENT

1. The EPA BTAG believes that remediating the site to residential levels, as proposed in this report, should be sufficient to protect ecological receptors at the site. However, several EPA comments were not sufficiently addressed, and comments are provided below in the specific comment section.

SPEICIFIC COMMENTS

2. Comment 2 RFAAP should note that the latest Background guidance (previously referenced) does not recommend elimination of chemicals of concern (COCs) present at background levels at the COPCs screening phase of the risk assessment. While this procedure is contained in the Site Screening Process, it is not appropriate for use in the RFI phase of the investigation. It is recommended that the background analysis be performed at the risk characterization phase of the risk assessment for COCs. As recommended in the guidance, elimination of COCs should be done only by the risk managers after the risk assessment is completed.

3. Comment 3 RFAAP can use their own spreadsheets to calculate the UCLs. However, they should consider using the latest UCL guidance as previously noted.

4. Comment 4 RFAAP should note that the SSL guidance recommends the use of 0.5 acre for residential areas. Since the site is not currently residential (i.e., there are no homes currently onsite), the conservative assumption is to assume the future residential plot is 0.5 acre.

5. Comment 11 states that the use of a "pre-screen" in which maximum concentrations in soil were compared to screening values to determine what chemicals should be evaluated in the screening ecological risk assessment (ERA) is inconsistent with current EPA BTAG guidance for the performance of the RFI. The response states that the use of this "pre-screen" is consistent with the Master Work Plan. Again, please note that this approach, for the RFI phase, is still inconsistent with current EPA BTAG guidance and the approach should be revised. It is not appropriate to assume that the procedures outlined for the Site Screening Process also apply to the RFI process. Future ecological risk assessments should use EPA BTAG screening values to assess direct toxicity to plants and invertebrates and conservative food chain modeling to assess risk to upper food chain receptors.

6. Comment 12 stated that the Tier 2 comparison (to means) should not be used alone to develop a list of COPECs since this can overlook hotspots. For example, lead has a maximum concentration of 1410 mg/kg with a screening value of 500 mg/kg, which represents a potential hot spot where ecological risk could be present. The response states that focusing on the Tier 2 EEQ allows a more realistic evaluation as terrestrial wildlife foraging on invertebrates proximate to Building 4343 would not be expected to feed solely at hotspot areas. This may not be the case for wildlife with very small home ranges (i.e., shrew). In addition, these hot spots can have significant effects on local invertebrate populations, which provide the primary food source for smaller ranging birds and mammals. Therefore, comparison to means should not be used alone to eliminate chemicals from further consideration, without considering the effects of hot spots on receptors. In this case, lead was retained as a COPEC because it exceeded background.

7. Comment 16 stated that no information is presented to support that a remedial goal of 140.4 mg/kg, based on industrial use for cadmium, would be protective of invertebrate and small mammal populations. The response states that the value is likely

to be protective of small mammal populations given the limitations with the hazard quotient approach and the conservativeness of the screening ERA. The response only states that there is a high level of uncertainty in the screening ERA. BTAG agrees that uncertainty is high. However, a high level of uncertainty in the screening ERA is still insufficient information to support that cleaning up to industrial levels would be protective. Uncertainty is best addressed through the use of a baseline ERA, which the Army felt was unnecessary. In addition, the response does not address potential risk to invertebrate populations. As long as the Army agrees to cleanup to residential levels, this issue is not relevant at this site.

This concludes EPA's review of the Army's February 2004 draft revised *RFI/CMS Report* for the investigation of Building 4343, located at the RFAAP, as well as the Army's March 4, 2004 response to EPA's January 14, 2004 review letter pertaining to the draft *RFI/CMS*. The referenced draft revised *RFI/CMS* is disapproved by EPA in its current form, and must be revised to reflect the comments above. Per Part II, Section E.4.e. of the EPA RCRA Corrective Action Permit, the Army is required to revise the draft document and submit a revised draft copy to EPA for review within 60 days of the receipt of EPA comments on the draft document. Part II, Section E.4.f. of the Permit allows for an additional 20 days for issuing the revised draft document to EPA, provided that timely notice is given, i.e. within 10 days. Additional time extensions can be requested under Part II, Section F. of the permit.

If you have any questions, please call me at 215-814-3357.

Sincerely,

Robert Thomson

Robert Thomson, PE
Federal Facilities Branch

cc: Russell Fish, EPA
Leslie Romanchik, VDEQ-RCRA
Durwood Willis, VDEQ-CERCLA

REQUEST FOR APPROVAL OF DISPOSAL OF BUILDINGS AND IMPROVEMENTS For use of this form, see AR 405-90; the proponent agency is Office of the Chief of Engineers.		DATE December 16, 1994
NAME OF INSTALLATION RADFORD ARMY AMMUNITION PLANT RADFORD, VIRGINIA 24141	LOCATION MONTGOMERY COUNTY, VIRGINIA	ACCOUNTABLE OFFICER IRIS L. WILLIAMS PROPERTY ADMINISTRATOR

POST NO.	DESIGNATION AND DESCRIPTION (Include information on installed property to be removed prior to disposal)	TYPE OF CONSTRUCTION*	ORIGINAL COST & YEAR BUILT (Estimate if not known)
51565	**INSTALLATION** **BUILDING NUMBER:** 4343 **RPI BUILDING NUMBER:** 04343 **CATEGORY:** 22680 **BUILDING DESIGNATION:** Cadmium Plating House **COMPLETE DESCRIPTION OF BUILDING:** Foundation - 8" Conc. Wall on 1'4" Conc. Footer; Structure - Conc. Block; Floor - 6" Conc. Slab; Walls - 8" Conc. Block; Roof - Corr. Alum. on 1" T&G Sheathing on 2x8 Rafters **SIZE OF THE BUILDING:** 34'4" x 16'4" x 8'4"H 561 Sq. Ft. **INSTALLED BUILDING EQUIPMENT:** Installed equipment will be removed and disposed of prior to demolition. **ITEM(S) AND COST(S) THAT WILL REMAIN WITH BUILDING:** See above **EQUIPMENT IN PLACE (IPE; OPE):** See above	P	$ 6,830 1943
	TOTAL COST		

CONTINUE ON ADDITIONAL SHEETS IF NECESSARY

* P - Permanent S - Semi-permanent T - Temporary (See AR 420-70)

DA FORM 1 MAY 88 337 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE.

REMARKS (Include conditions prompting disposal, and indicate whether land on which property is located is leased or government-owned)

CONDITIONS PROMPTING DISPOSAL: This facility has deteriorated to such a degree that it cannot be rehabilitated at a reasonable cost, has served the purpose for which it was constructed and cannot be adapted economically or practically to other beneficial use.

CONTAMINATION STATUS: This facility is contaminated.

TYPE OF CONTAMINATION: Cadmium

DEGREE: 100%

DATE OF THE APPROVED SAFETY SOP FOR DEMOLITION: GOP4-A-14 dtd. 30Jul87

ENVIRONMENTAL CONSIDERATION: See attachments

MOBILIZATION REQUIREMENTS: The facility is not part of a current mobilization plan.

NATIONAL HISTORIC PROPERTY: This disposal conforms to the stipulations of the Programmatic Agreement (PA) for Modified Caretaker Activities. SHPO letter approving disposal dated September 22, 1994.

METHOD OF DISPOSAL: The facility is to be disposed of by demolition by Hercules subcontractor.

INTEREST HELD BY THE UNITED STATES IN THE LAND ON WHICH THE BUILDING IS LOCATED:

This facility is located on U.S. Government-owned land.

NET SALVAGE VALUE: None

STEWART B. MCKINNEY HOMELESS ASSISTANT ACT: Per the McKinney Homeless Assistance Act check lists were forwarded to Headquarters DA December 1989.

THE ESTIMATED TOTAL SALE VALUE OF THE PROPERTY IS IS NOT IN EXCESS OF $50,000.	SIGNATURE OF ESTIMATOR RANDOLPH EVANS OPERATIONS REVIEW
TYPED NAME, GRADE, AND ORGANIZATION OF FINAL APPROVING AUTHORITY STANLEY H. FRIED, GM-15, CHIEF, AMCEN-R	SIGNATURE

FINAL DISPOSITION OF PROPERTY

U. S. GOVERNMENT PRINTING OFFICE; 1969 O - 364-556

25.

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

March 04, 2004

Mr. Robert Thomson
U. S. Environmental Protection Agency
Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Subject: Bldg 4343 RCRA Facility Investigation/Corrective Measures Study Report, Final February 2004 Radford Army Ammunition Plant EPA ID# VA1 210020730

Dear Mr. Thomson:

Enclosed is one certified copy of the Bldg 4343 RCRA Facility Investigation/Corrective Measures Study Report, Final February 2004 Radford Army Ammunition Plant for your review and comment or approval. Your additional three copies will be sent under separate cover as well as additional copies to the Virginia Department of Environmental Quality (VDEQ), U.S. Army Environmental Center, U.S. Army Center for Health Promotion and Preventive Medicine. Attached are responses to the comments in your January 14, 2004 letter.

Note per US Army Environmental Restoration guidance concurrence on the clean up recommendation in this report is being coordinated separately with the U.S. Army Environmental Center and the U.S. Army Center for Health Promotion and Preventive Medicine.

Please coordinate with and provide any questions or comments to Jerry Redder of my staff (540) 639-7536 or Jim McKenna, ACO Staff (540) 639-8641.

Sincerely,

for E. A. Jake, Environmental Manager
Alliant Ammunition and Powder Company LLC

Enclosure

w/o enclosure

c: Russell Fish, P.E., EPA Region III

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Richmond, VA 23240-0009

Mark Leeper
Virginia Department of Environmental Quality
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04-815-36
JMcKenna/JJRedder

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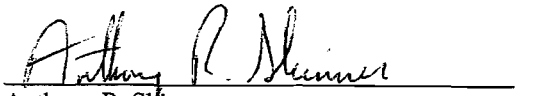
bc: Administrative File
J. McKenna, ACO Staff
Rob Davie-ACO Staff
C. A. Jake
J. J. Redder
Env. File

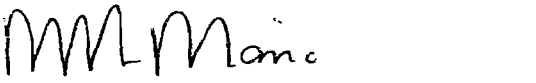
04-815-36
JMcKenna/JJRedder

Concerning the following:

Bldg 4343 RCRA Facility Investigation/Corrective Measures Study Report, Final Febrary 2004
Radford Army Ammunition Plant

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: Anthony R. Skinner
TITLE: LTC, CM, Commanding
Radford AAP

SIGNATURE: 
PRINTED NAME: Anthony Miano
TITLE: Vice President Operations
Alliant Ammunition and Powder Company LLC

04-815-36
JMcKenna/JJRedder

Response to USEPA Comments dated 14 January 2004
for
Draft Building 4343 RFI/CMS Report
Dated December 2003

General Comments

EPA Comment
In reviewing Appendix G-1 (Underground Storage Tank Closure Report) of the draft *RFI/CMS Report*, it was stated that an underground storage tank associated with Building 4343 was removed in 1998, and the analytical results of soil samples indicated a clean closure. The VADEQ issued a No Further Action required letter for the UST site. There were no groundwater samples collected at the UST site. However, on page 4-31, it indicated that the ground water is at least 60 feet below ground surface based on the drilling records of two soil borings, with depth up to 60 feet. EPA agrees with the statement that fate and transport analysis of subsurface soil sample results and the empirical data for the site indicates that vertical migration of cadmium is limited and it is unlikely that groundwater would be impacted due to the release at the site. However, an evaluation of soil contaminant concentrations to SSLs should be clearly documented in the final report.

RFAAP Response
An evaluation of constituents found to exceed soil screening levels (SSL) is presented in Section 4.2.2.1 "Soil Screening Level Comparison."

Specific Comments

EPA Comment 1
Section 2.4, Facility Wide Background Study, on page 2-16 relates the UTL of the background values to residential and industrial screening levels but does not compare them to ecological screening levels. There are many other sections in the report where comparisons are made to human health criteria (e.g. page 4-28, all of Section 5, Fate and Transport, etc.) with no consideration of how they relate to ecological screening levels. In the future, a more balanced discussion should be provided.

RFAAP Response
Section 2.4 is a summary of a previously submitted and USEPA approved report (2001). Section 5.0 is a discussion of chemical reactions and physical/chemical transport mechanisms. Because of the importance of ecological concerns, there is a section (Section 7.0) devoted to ecological concerns and ecological risks. Section 7.0 is the second largest section of the report. The Human Health Risk Assessment (HHRA) (Section 6.0) is the largest section.

EPA Comment 2
Page 6-8. Background Comparison: The background comparison should typically be done after the risk assessment is calculated and only for the risk drivers, not at the screening phase of the risk assessment. Future documents should follow this protocol. Note that at the RI phase, EPA recommends using statistical comparison of the means as the basis for excluding COPCs, not UTLs. Also, UTLs are not recommended for use as comparison to cleanup levels.

RFAAP Response
In responses to comments dated 09 June 2003, RFAAP responded to a similar comment regarding background comparisons. In these responses, RFAAP indicated that means comparisons would be conducted by hypothesis testing. Such hypothesis testing would include tests for similarities in shape and location between the site and background data sets. Depending on these initial tests, other tests (e.g., t-test, Mann-Whitney U, or Kolmogarov-Smirnov) would be used to assess whether there is a difference between the means. Likewise, statistical procedures would also be used for assessing outliers.

With respect to the use of background comparisons in the HHRA, the Army also stated that the purpose of undertaking a Facility-Wide Background Study at RFAAP was to establish a background data set for use in risk assessment. Based on discussions with USEPA early in the RFI process, it was RFAAP's understanding that the development of a background data set would allow for the elimination of chemicals from further consideration based on comparisons of site concentrations to background data. USEPA's *Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual* (RAGS; USEPA, 1989), Section 5.7, permits the use of background data as a selection criterion for chemicals of potential concern (COPCs).

To be consistent with these responses, the following approach is described in Section 6.1.2.3 of the HHRA for Building 4343. Inorganic chemicals detected at concentrations exceeding risk-based concentration (RBCs) and allowable daily intake (ADIs) were compared to background data contained in the *Facility-Wide Background Study Report* (FWBSR) (IT, 2001) to assess whether these chemicals were present at concentrations below naturally occurring levels. For the HHRA, the evaluation of site concentrations to background concentrations was achieved using two methods of comparison. First, the maximum detected concentration for each inorganic constituent was compared to the background upper tolerance limit (UTL), as established in the FWBSR. The second method involved the statistical comparison of site concentrations to background concentrations to evaluate whether the populations were similar (i.e., means comparison). This approach paralleled the methodology applied to population comparisons for the FWBSR. Based on these evaluations, chemicals were eliminated from further quantitative evaluation only if they met both of the following conditions:

- The maximum detected concentration was below the UTL, and
- Based on statistical comparisons, site concentrations are within or below background concentrations.

RFAAP requests that future reports be allowed to continue using the above methodology.

EPA Comment 3
Page 6-17: Please consider for future use the new UCL guidance and the PROUCL software for calculating the UCLs. See-http://www.epa.gov/superfund/programs/risk/ragsa/ucl.pdf.

RFAAP Response
At the outset of the project, the new upper confidence limit (UCL) guidance and PROUCL software were reviewed. Although an early version of the software was obtained, it did not function properly. As described in Section 6.2.2 of the RFI/CMS, however, the approach

that is used for generating statistics for HHRAs at RFAAP parallels the approach described in the UCL guidance. In particular, the "bootstrap method" was used to calculate UCLs for data sets with non-parametric distributions.

Although an improved version of the PROUCL software is now available on USEPA's website, RFAAP requests concurrence from EPA regarding the continued use of calculation spreadsheets that were specifically developed for the RFAAP project. The following rationale is offered:

- Use of our existing spreadsheets would maintain consistency in UCL calculations throughout the project.
- Spreadsheets for the UCL calculations are linked with other RAGS, Part D spreadsheets. The use of a separate software package would be less efficient.

EPA Comment 4
Page 6-19: The site-specific PEF for the resident should be based on 0.5 acre, not 1 acre.

RFAAP Response
The site-specific particulate emission factor (PEF) is based on the approximate area of soil samples collected at the site. Because the samples collected at Building 4343 represent the entire area of the site, the PEF was calculated on the basis of the approximate size of the site (1 acre) rather than using the default value (0.5 acre) for a residential property. RFAAP proposes to leave the site specific PEF value unchanged.

EPA Comment 5
Page 6-20: Note that the new dermal guidance recommends a soil dermal absorption factor of 0.14 for PCBs and 0.001 for cadmium.

RFAAP Response
The original source of dermal absorption factors was USEPA Region III's technical guidance, *Assessing Dermal Exposure for Soil* (dated December 1995). Although USEPA Headquarters issued revised guidance (*Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment*, dated 2001), it was RFAAP's understanding that USEPA Region III's guidance remained in effect until their *Updated Dermal Exposure Assessment Guidance* was issued in June 2003. This updated guidance document describes USEPA Region III's specific implementation of RAGS, Part E.

RFAAP proposes to follow the region-specific guidance. For this HHRA, the changes to dermal absorption factors for PCBs and cadmium will be incorporated. Both documents (USEPA, 2001 and USEPA Region III, 2003) will be referenced.

EPA Comment 6
Page 6-24: Note that the inhalation rate for the outdoor child should be based on light playing as the most likely activity. The recommended inhalation rate for light playing is 1 m3/hr (see Exposure Factor Handbook, page 5-24.)

RFAAP Response
The source of information for the inhalation rate for the child resident was the USEPA Region III technical guidance for the *Risk-Based Concentration Table* (October 2003). The inhalation rate of 12 m^3/day was adjusted to 0.5 m^3/hour, based on a 24-hour period. However, it is noted that the value from the *Exposure Factors Handbook* (USEPA 1997) more specifically addresses activities that would occur outdoors. Therefore, the inhalation rate for the child resident will be revised to 1 m^3/hour, as suggested.

EPA Comment 7
Page 6-24: Note that there is currently a new guidance that explains the new hierarchy for human health toxicity values used for risk assessment that should be considered in future reports. See- http://www.epa.gov/oerrpage/superfund/programs/risk/hhmemo.pdf.

RFAAP Response
The primary purpose of the directive was to formally revise the hierarchy of the human health toxicity values (recommended for use in human health risk assessments) that was originally presented in RAGS, Part A (1989). The revised hierarchy is presented as three tiers of information sources:

Tier 1 - Integrated Risk Information System (IRIS)
Tier 2 - EPA's Provisional Peer-Reviewed Toxicity Values (PPRTVs)
Tier 3 - Other Toxicity Values (including EPA's Health Effects Summary Tables or HEAST)

The major difference between this hierarchy and the original version is that HEAST was previously ranked second as a source and the PPRTVs were ranked third as a source. In the new guidance, the PPRTVs now take precedence over HEAST values.

Given this understanding of the new guidance, RFAAP is willing to incorporate this change in this risk assessment as well as subsequent reports.

EPA Comment 8
Page 6-36: Uncertainty Section- Please indicate in the uncertainty section that while total risks for the future maintenance worker for total soil are acceptable, there are cadmium hot spots in the mixture (i.e., in surface soil) that may have been diluted by combining the surface and subsurface soil data.

RFAAP Response
Text will be added to the Uncertainty Section, as requested.

EPA Comment 9
Section 7.0, Ecological Risk Assessment, on page 7-1 states that "groundwater data are irrelevant for this site as groundwater does not discharge to the surface in the vicinity of the Building 4343 and there is no potential exposure for ecological receptors to groundwater." This statement is not completely accurate for several reasons, including that given in the next sentence it states that "groundwater does ultimately discharge to the New River." At issue is whether or not the individual site presents a risk to groundwater, i.e. through comparison to SSLs, plus a discussion of how groundwater will ultimately be addressed. It is important to determine whether there is a risk of a release from the Building 4343 site to groundwater.

RFAAP Response

SSLs for soil chemical migration to groundwater are calculated based on human health considerations, not ecological receptors. Regardless, a SSL comparison is included in Section 4.2.2.1 (see response to comment 1). Groundwater (and its discharge to the New River) will ultimately be addressed under Master Work Plan (MWP) Work Plan Addendum 009 (Horseshoe Area Groundwater Study) and subsequent groundwater studies. There is essentially no ecological risk for ecological receptors in the immediate vicinity of Building 4343 because groundwater does not discharge to surface water in the immediate vicinity of the site. Additional information regarding releases to groundwater are contained in Section 4.2.2.1 "Soil Screening Level Comparison," 4.2.2.2 "Nature and Extent Conclusions," and Section 5.0 "Contaminant Fate and Transport."

EPA Comment 10

Section 7.1.1, General Installation Background, on page 7-4 states that the area surrounding the building is mowed grass. Section 7.1.4 further states that the area is primarily maintained grass. However, the photos provided in Appendix F show tall grass in the vicinity of the site. The statement on page 7-5 is more accurate that the site is mowed on an infrequent basis to eliminate woody plants. A more accurate description of the site should be provided that is consistent with the photos in Appendix F.

RFAAP Response

The text will be revised to state that the site is mowed on an infrequent basis to eliminate woody plants.

EPA Comment 11

Section 7.2.5, Comparison to Risk-Based Screening Ecotoxicity Values, on page 7-14 states that maximum concentrations in soil were compared to screening values to determine what chemicals should be evaluated in the screening ecological risk assessment (ERA). The screening values used were based on direct contact exposure and food chain exposure. The use of a "pre-screen" prior to the screening ERA is inconsistent with current EPA guidance and with the approach that was agreed to in the Master Work Plan. All detected chemicals should be evaluated in the screening ERA, which consists of a direct toxicity screen and conservative food chain modeling.

RFAAP Response

The Master Work Plan states, in Section 7.1.2, that COPCs identified in the [screening comparison] step will be carried through to the risk characterization step of the screening level RA. Therefore, the use of a prescreen is consistent with the Master Work Plan. In addition, conservative food chain modeling was recommended by BTAG for only those constituents considered to be Important Bioaccumulative Constituents, per Table 4.2 in *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment – Status and Needs* (USEPA, 2000). As shown in the selection of food-chain chemicals of potential ecological concern (COPEC) for Building 4343, additional constituents were selected that are not considered Important Bioaccumulative Constituents. This is considered a more conservative approach then recommended by BTAG.

EPA Comment 12

Section 7.5.3.2, Predictive Risk Estimation for Terrestrial Wildlife, on page 7-29 states that based on the Tier 2 environmental effects quotient (EEQ) results, cadmium, chromium, and zinc are the COPECs in soil that are estimated to adversely impact the terrestrial invertebrate community. Mercury and copper should also be included in the list of COPECs since their Tier 2 EEQs are one. In addition, the Tier 2 comparison should not be used alone to develop a list of COPECs since this can overlook hotspots. For example, lead was eliminated from further consideration since the 95% upper confidence limit (UCL) did not exceed the screening level even though the maximum concentration of 1410 mg/kg was much greater than the screening value of 500 mg/kg. Lead and other chemicals that may exhibit areas of hotspot contamination should also be included as COPECs.

RFAAP Response

By definition, an EEQ of one represents an ecological dose or exposure that is equal to the toxicity reference value. As most toxicity reference values (TRV) are based on no observed adverse effect levels (NOAELs), an EEQ of one would not represent an unacceptable hazard in this case. In the Final Master Work Plan, Section 7.1.5, the text states "In general, USEPA Region III Guidance concludes that an EEQ ratio *greater than* 1 but less than 10 demonstrates a potential risk. Exposures that *exceed* a selected toxicity value suggest that adverse effects to ecological resources are possible." Therefore, mercury and copper should not be included as COPECs.

Both Tier 1 and Tier 2 EEQ results are presented in the report. Focusing on the Tier 2 EEQ results allows a more realistic evaluation of screening level ecological risk assessment (SLERA) findings, as terrestrial wildlife foraging on invertebrates proximate to Building 4343 would not be expected to feed solely at hotspot areas. In the Final Master Work Plan, text in Section 7.1.5 states that a second phase (Tier 2) SLERA approach with 95% UCLs should be used for a conservative yet more realistic approach.

EPA Comment 13

Section 7.5.3.3, Background Metals Considerations, on page 7-29 states that based on statistical evaluation, lead is considered to be at background concentrations, and is not considered a risk driver. No specific information is provided stating what types of statistical analysis was performed to reach this conclusion. However, the maximum lead concentration at the site (1410 mg/kg) is much higher than the maximum background concentration (256 mg/kg). The 95% UCL at the site (133 mg/kg) is also much higher than the 95% UCL of the background concentration (26.8 mg/kg). Based on this comparison, the fact that the maximum concentration exceeds the screening value, and because lead is site related, lead should be retained as a COPEC.

RFAAP Response

Background UTLs were calculated as discussed in Section 2.4 and population statistics were performed as discussed in Section 6.1.2.3, and as stated in Section 7.2.4. For comparison to UTLs, the UTL values are shown in Tables E-1a and E-2a (Occurrence, Distribution, and Selection of Chemicals of Potential Concern) in the column labeled "Background Values." The UTL is compared to the maximum value for each inorganic as listed in the column labeled "Concentration Used for Screening." For the statistical comparisons of the means between the on-site and background data sets, the results of the analyses are provided in Appendix E-1, Attachment 1. Based on the statistical tests performed, lead is not considered to be background related and will be retained as a COPEC; however, arsenic, barium,

beryllium, cobalt, magnesium, and nickel are considered to be background related. Retaining lead as a COPEC does not modify the conclusions of the report.

EPA Comment 14

Section 7.7, Results and Conclusions, on page 7-35 states that based on uncertainties of toxicity, the fact that no rare, threatened or endangered species have been confirmed at the site, and the small size of the site, remedial measures for soil designed to address ecological concerns may not be warranted at this time. This statement is not supported given the high concentrations of metals found at this site. The certainty of effects, particularly for invertebrates is relatively high, given these high concentrations of metals in soil. The magnitude of the soil concentrations should be considered when discussing the uncertainty, and the need for remedial action. The uncertainty of toxicity could also be reduced by continuing the ERA process

RFAAP Response

The statement that "remedial measures for soil designed to address ecological concerns may not be warranted at this time," is supported by the findings of the SLERA. Section 7.7 goes on to state: "The scientific/management decision point (SMDP) reached for this SLERA, however, in conjunction with the findings of the HHRA, is that the information collected and presented indicates that a more thorough assessment is warranted, in this case in the form of a CMS. As human health risks and/or hazards are unacceptable and chemical-specific human health preliminary remediation goals (PRGs) have been developed for the site (Section 8.0), these PRGs are evaluated to (1) decide if they are also protective of the environment; and/or (2) decide if they will reduce the estimated ecological hazards by a significant amount."

Reducing the uncertainty of ecological toxicity by continuing the ERA process was not recommended, as funds were deemed to be more efficiently expended by remediating the site to achieve human health PRGs, which were found to reduce the estimated ecological hazards by a significant amount.

EPA Comment 15

Table 8-2 on page 8-3 presents the ecological implications of human health soil remedial goals on ecological receptors. The table lists the expected residual concentration if the human health remedial goals were applied. The footnote states that the residual concentration was estimated by removing the soil samples from the ecological data base that are within the proposed excavation footprint and recalculating the exposure point concentration. The footnote should state what this value represents (maximum, mean or 95% UCL).

RFAAP Response

The footnote will be revised to state that 95% UCL values were used.

EPA Comment 16

Section 8.2.1, Residual Ecological Hazards, on page 8-4 states that the proposed human health remedial goals for either industrial or residential land use are expected to result in residual COPEC soil concentrations in surface soil that are protective of the environment. The information presented in Table 8-2 and the text do **not** support this statement for the industrial cleanup scenario. No information is presented to support that a remedial goal of 140.4 mg/kg for cadmium would be protective of invertebrate and small mammal populations. The EPA BTAG generally supports this

statement for the residential scenario since the residual metal concentrations either have an EEQ less than one (cadmium, lead, zinc) or are at background concentrations (chromium, mercury).

RFAAP Response
A value of 140.4 mg/kg for cadmium is likely to be protective of the small mammal populations given the limitations with the hazard quotient (HQ) approach itself, and conservatisms used in the SLERA, such as:

- The estimated ecological hazards in Table 8-2 incorporate additional safety factors, such as the use of an 8-fold modifying factor to account for species-to-species extrapolation, and
- HQs are not measures of the probability that a wildlife receptor will develop a toxicological endpoint of concern, such as mortality or reproductive impairment. Additionally, EEQs in excess of 1 do not necessarily indicate that even a single individual of a species will demonstrate the associated effect endpoint. Thus, EEQs of 1 or lower are not necessarily a requirement to demonstrate acceptable ecological impacts.

EPA Comment 17
Section 8.2.1, Residual Ecological Hazards, on page 8-4 states that no additional ecological remedial goals are needed because there is limited ecological habitat at the site and the habitat is of low quality. No information is presented in this report to support this statement. In fact, the photos provided in Appendix F show that there is high quality grassland habitat at the site that could support a diverse ecological community.

RFAAP Response
Grass adjacent to the site was relatively overgrown at the time the photograph was taken and is meant to show that mowing is performed on an infrequent basis (see Comment Response No. 11). However, random mowing would also disrupt the available habitat. The following text will be added to the report to support the statement that the habitat is not of high quality and would not be expected to support a diverse ecological community:

"The habitat is of low quality for wildlife because mowing of the grass and routine maintenance of the area limits the development of a diverse grassland/forbs community. Grasses at the site are predominantly limited to a few species, and the community lacks the variety of species that would develop in a natural undisturbed habitat that might include tall grasses, mid grasses, short grasses, and forbs such as composites and legumes. Grassy areas comprised of only a few species would not be expected to support a diverse wildlife community."

EPA Comment 18
Section 11.0, Ranking of Corrective Measures Alternatives, on page 11-1 states that based on the evaluation, Alternative three (Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Demolition of Building 4343), is the selected corrective measure alternative for this site. Because this alternative includes removal of surface soil to residential human health levels, and these levels appear to also be protective of ecological receptors for the reasons stated in an earlier comment, EPA BTAG supports the selection of this alternative. However, if another alternative is selected that only uses industrial human health levels, EPA BTAG would not support the conclusion that ecological receptors would also be protected based on the information provided in this report.

RFAAP Response
Comment noted.

Table Comments

EPA Comment 19
Table E-1a: Note that the "medium," "exposure medium" and "exposure point" is surface soil, not soil.

RFAAP Response
The table will be revised as requested.

EPA Comment 20
Table E-9: The oral-to-dermal efficiency for aluminum is 27% (see NCEA).

RFAAP Response
The source of guidance for oral-to-dermal efficiency values was *Risk Assessment for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)*. As recommended in the guidance (Page 4-4), an absorption value of 100% was used because there was no chemical-specific value listed for aluminum in the guidance. Given that an oral-to-dermal efficiency value has been provided in these comments, however, the risk/hazard calculations for this HHRA will be revised using the national center for environmental assessment (NCEA) value.

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

January 14, 2004

In reply
Refer to 3HS13

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Commander,
Radford Army Ammunition Plant
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P.O. Box 2
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C.A. Jake
Environmental Manager
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Radford, VA 24141-0100

Re: Radford Army Ammunition Plant
Building 4343 *RFI/CMS Report*
Document submittal and review

Dear Mr. McKenna and Ms. Jake:

The U.S. Environmental Protection Agency (EPA) has reviewed the Army's draft *RFI/CMS Report* for Building 4343, located at the Radford Army Ammunition Plant (RFAAP). Outlined below, please find EPA's comments based upon that review:

General Comment

1. In reviewing Appendix G-1 (Underground Storage Tank Closure Report) of the draft *RFI/CMS Report*, it was stated that an underground storage tank associated with Building 4343 was removed in 1998, and the analytical results of soil samples indicated a clean closure. The VADEQ issued a No Further Action required letter for the UST site. There were no groundwater samples collected at the UST site. However, on page 4-31, it indicated that the ground water is at

least 60 feet below ground surface based on the drilling records of two soil borings, with depth up to 60 feet. EPA agrees with the statement that fate and transport analysis of subsurface soil sample results and the empirical data for the site indicates that vertical migration of cadmium is limited and it is unlikely that groundwater would be impacted due to the release at the site. However, an evaluation of soil contaminant concentrations to SSLs should be clearly documented in the final report.

Specific Comments

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2. Page 6-8. Background Comparison- The background comparison should typically be done after the risk assessment is calculated and only for the risk drivers, not at the screening phase of the risk assessment. Future documents should follow this protocol. Note that at the RI phase, EPA recommends using statistical comparison of the means as the basis for excluding COPCs, not UTLs. Also, UTLs are not recommended for use as comparison to cleanup levels.

3. Page 6-17. Please consider for future use the new UCL guidance and the PROUCL software for calculating the UCLs. See-http://www.epa.gov/superfund/programs/risk/ragsa/ucl.pdf.

4. Page 6-19. The site-specific PEF for the resident should be based on 0.5 acre, not 1 acre.

5. Page 6-20. Note that the new dermal guidance recommends a soil dermal absorption factor of 0.14 for PCBs and 0.001 for cadmium.

6. Page 6-24. Note that the inhalation rate for the outdoor child should be based on light playing as the most likely activity. The recommended inhalation rate for light playing is 1 m3/hr (see Exposure Factor Handbook, page 5-24.)

7. Page 6-24. Note that there is currently a new guidance that explains the new hierarchy for human health toxicity values used for risk assessment that should be considered in future reports. See-http://www.epa.gov/oerrpage/superfund/programs/risk/hhmemo.pdf.

8. Page 6-36. Uncertainty Section- Please indicate in the uncertainty section that while total risks for the future maintenance worker for total soil are acceptable, there are cadmium hot spots in the mixture (i.e., in surface soil) that may have been diluted by combining the surface and subsurface soil data.

Section 7.0, Ecological Risk Assessment, on page 7-1 states that "groundwater data are irrelevant for this site as groundwater does not discharge to the surface in the vicinity of the Building 4343 and there is no potential exposure for ecological receptors to groundwater." This statement is not completely accurate for several reasons, including that given in the next sentence it states that "groundwater does ultimately discharge to the New River." At issue is whether or not the individual site presents a risk to groundwater, i.e. through comparison to SSLs, plus a discussion of how groundwater will ultimately be addressed. It is important to determine whether there is a risk of a release from the Building 4343 site to groundwater.

10. Section 7.1.1, General Installation Background, on page 7-4 states that the area surrounding the building is mowed grass. Section 7.1.4 further states that the area is primarily maintained grass. However, the photos provided in Appendix F show tall grass in the vicinity of the site. The statement on page 7-5 is more accurate that the site is mowed on an infrequent basis to eliminate woody plants. A more accurate description of the site should be provided that is consistent with the photos in Appendix F.

11. Section 7.2.5, Comparison to Risk-Based Screening Ecotoxicity Values, on page 7-14 states that maximum concentrations in soil were compared to screening values to determine what chemicals should be evaluated in the screening ecological risk assessment (ERA). The screening values used were based on direct contact exposure and food chain exposure. The use of a "pre-screen" prior to the screening ERA is inconsistent with current EPA guidance and with the approach that was agreed to in the Master Work Plan. All detected chemicals should be evaluated in the screening ERA, which consists of a direct toxicity screen and conservative food chain modeling.

12. Section 7.5.3.2, Predictive Risk Estimation for Terrestrial Wildlife, on page 7-29 states that based on the Tier 2 environmental effects quotient (EEQ) results, cadmium, chromium, and zinc are the COPECs in soil that are estimated to adversely impact the terrestrial invertebrate community. Mercury and copper should also be included in the list of COPECs since their Tier 2 EEQs are one. In addition, the Tier 2 comparison should not be used alone to develop a list of COPECs since this can overlook hotspots. For example, lead was eliminated from further consideration since the 95% upper confidence limit (UCL) did not exceed the screening level even though the maximum concentration of 1410 mg/kg was much greater than the screening value of 500 mg/kg. Lead and other chemicals that may exhibit areas of hotspot contamination should also be included as COPECs.

13. Section 7.5.3.3, Background Metals Considerations, on page 7-29 states that based on statistical evaluation, lead is considered to be at background concentrations, and is not considered a risk driver. No specific information is provided stating what types of statistical analysis was performed to reach this conclusion. However, the maximum lead concentration at the site (1410 mg/kg) is much higher than the maximum background concentration (256 mg/kg). The 95% UCL at the site (133 mg/kg) is also much higher than the 95% UCL of the background concentration (26.8 mg/kg). Based on this comparison, the fact that the maximum concentration exceeds the screening value, and because lead is site related, lead should be retained as a COPEC.

Section 7.7, Results and Conclusions, on page 7-35 states that based on uncertainties of toxicity, the fact that no rare, threatened or endangered species have been confirmed at the site, and the small size of the site, remedial measures for soil designed to address ecological concerns may not be warranted at this time. This statement is not supported given the high concentrations of metals found at this site. The certainty of effects, particularly for invertebrates is relatively high, given these high concentrations of metals in soil. The magnitude of the soil concentrations should be considered when discussing the uncertainty, and the need for remedial action. The uncertainty of toxicity could also be reduced by continuing the ERA process.

15. Table 8-2 on page 8-3 presents the ecological implications of human health soil remedial goals on ecological receptors. The table lists the expected residual concentration if the human health remedial goals were applied. The footnote states that the residual concentration was estimated by removing the soil samples from the ecological data base that are within the proposed excavation footprint and recalculating the exposure point concentration. The footnote should state what this value represents (maximum, mean or 95% UCL).

16. Section 8.2.1, Residual Ecological Hazards, on page 8-4 states that the proposed human health remedial goals for either industrial or residential land use are expected to result in residual COPEC soil concentrations in surface soil that are protective of the environment. The information presented in Table 8-2 and the text do **not** support this statement for the industrial cleanup scenario. No information is presented to support that a remedial goal of 140.4 mg/kg for cadmium would be protective of invertebrate and small mammal populations. The EPA BTAG generally supports this statement for the residential scenario since the residual metal concentrations either have an EEQ less than one (cadmium, lead, zinc) or are at background concentrations (chromium, mercury).

17. Section 8.2.1, Residual Ecological Hazards, on page 8-4 states that no additional ecological remedial goals are needed because there is limited ecological habitat at the site and the habitat is of low quality. No information is presented in this report to support this statement. In fact, the photos provided in Appendix F show that there is high quality grassland habitat at the site that could support a diverse ecological community.

18. Section 11.0, Ranking of Corrective Measures Alternatives, on page 11-1 states that based on the evaluation, Alternative three (Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Demolition of Building 4343), is the selected corrective measure alternative for this site. Because this alternative includes removal of surface soil to residential human health levels, and these levels appear to also be protective of ecological receptors for the reasons stated in an earlier comment, EPA BTAG supports the selection of this alternative. However, if another alternative is selected that only uses industrial human health levels, EPA BTAG would not support the conclusion that ecological receptors would also be protected based on the information provided in this report.

Tables Comments:

Table E-1a. Note that the "medium," "exposure medium" and "exposure point" is surface soil, not soil.

Table E-9. The oral-to-dermal efficiency for aluminum is 27% (see NCEA).

This concludes EPA's review of the Army's draft *RFI/CMS Report* for Building 4343, located at the RFAAP. The referenced draft *RFI/CMS Report* is disapproved by EPA in its current form, and must be revised to reflect the comments above. Per Part II, Section E.4.e. of the EPA RCRA Corrective Action Permit, the Army is required to revise the draft document and submit a revised draft copy to EPA for review within 60 days of the receipt of EPA comments on the draft document. Part II, Section E.4.f. of the Permit allows for an additional 20 days for issuing the revised draft document to EPA, provided that timely notice is given, i.e. within 10 days. Additional time extensions can be requested under Part II, Section F. of the permit.

If you have any questions, please call me at 215-814-3357.

Sincerely,

Robert Thomson

Robert Thomson, PE
Federal Facilities Branch

cc: Russell Fish, EPA
Leslie Romanchik, VDEQ-RCRA
Mark Leeper, VDEQ-CERCLA

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

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Robert G. Burnley
Director

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01 December 2003

Mr. James McKenna
Radford Army Ammunition Plant
SIORF-SE-EQ
P.O. Box 2
Radford, VA 24141-0099

RE: Corrective Measures Study Report for Building 4343 RFI (4343)

Dear Mr. McKenna:

This office has reviewed the referenced draft document and concurs with the selected corrective action for 4343. Please provide one copy of the Final 4343 CMS document to this office on CD when completed.

If you have any questions, please call me at 804.698.4308.

Sincerely,

Mark S. Leeper
Remedial Project Manager

cc: Norman L. Auldridge - WCRO, DEQ
Robert Thompson, Region III, U.S.EPA, 3HS13

DEPARTMENT OF THE ARMY
U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MARYLAND 21010-5403

REPLY TO
ATTENTION OF

MCHB-TS-REH (40)

25 November 2003

MEMORANDUM FOR Radford Army Ammunition Plant ATTN: SOSRF-OP-EQ (Jim McKenna), PO Box 2, Radford, VA 24143-0002

SUBJECT: Building 4343 RCRA Facility Investigation/Corrective Measures Study Report, October 2003

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 AR 200-1 (Environmental Protection and Enhancement). Thank you for the opportunity to review this document. We concur with the conclusions and recommendations contained in this report.

2. The scientist reviewing this document and our point of contact is Mr. Keith Williams, Environmental Health Risk Assessment Program, at DSN 584-7722 or commercial (410) 436-7722.

FOR THE COMMANDER:

DAVID A. REED
Program Manager
Environmental Health Risk Assessment

CF:
HQDA (DASG-HS-PE)
USACE (CENWO-HX-H)
USAEC (SFIM-AEC-ER)
IMA, NERO (SFIM-NE-PW-ER)

Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, VA 24141
USA

October 30, 2003

Mr. Robert Thomson
U. S. Environmental Protection Agency
Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Subject: Bldg 4343 RCRA Facility Investigation/Corrective Measures Study Report, October 2003
Radford Army Ammunition Plant
EPA ID# VA1 210020730

Dear Mr. Thomson:

Enclosed is one certified copy of the Bldg 4343 RCRA Facility Investigation/Corrective Measures Study Report, October 2003 Radford Army Ammunition Plant, for your review and comment or approval. Your addtional five copies will be sent under separate cover as well as additional copies to the Virginia Department of Environmental Quality (VDEQ),U.S. Army Environmental Center, U.S. Army Center for Health Promotion and Preventive Medicine.

In our August 1, 2003 letter, we provided responses to the comments contained in your June 9, 2003 letter. Since the subject report has been prepared in accordance with our August 1, 2003 letter, we have not enclosed the responses. Note per US Army Environmental Restoration guidance concurrence on the clean up recommendation in this report is being coordinated separately with the U.S. Army Environmental Center and the U.S. Army Center for Health Promotion and Preventive Medicine.

Please coordinate with and provide any questions or comments to Jerry Redder of my staff (540) 639-7536 or Jim McKenna, ACO Staff (540) 639-8641.

Sincerely,

JJ Redder

for C. A. Jake, Environmental Manager
Alliant Ammunition and Powder Company, LLC

Enclosure

w/o enclosure

c: Russell Fish, P.E., EPA Region III

Durwood Willis
Virginia Department of Environmental Quality
P. O. Box 10009
Richmond, VA 23240-0009

Mark Leeper
Virginia Department of Environmental Quality
P. O. Box 10009
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03-815-154
JMcKenna/JJRedder

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John Tesner
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Baltimore, MD 21201

bc: Administrative File
J. McKenna-ACO Staff
Rob Davie-ACO Staff
C. A. Jake
J. J. Redder
Env. File

Coordination: J. McKenna

03-815-154
JMcKenna/JJRedder

Concerning the following:

Bldg 4343 RCRA Facility Investigation/Corrective Measures Study Report, October 2003
Radford Army Ammunition Plant

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: Anthony R Skinner
PRINTED NAME: Anthony R Skinner
TITLE: LTC, CM, Commanding
Radford AAP

SIGNATURE: Anthony Miano
PRINTED NAME: Anthony Miano
TITLE: Vice President Operations
Alliant Ammunition and Powder Company, LLC

03-815-154
JMcKenna/JJRedder

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28 August 03

Mr. James McKenna
Radford Army Ammunition Plant
SIORF-SE-EQ
P.O. Box 2
Radford, VA 24141-0099

RE: Work Plan for Building 4343 RFI (4343)

Dear Mr. McKenna:

This office has reviewed the referenced draft document and concurs with 4343. Please add the revisions to the document that were discussed during the 15 July 03 conference call . This conference call was conducted to discuss the response to comments offered from RAAP to the VDEQ. Please provide one copy of the Final 4343 RFI document to this office on CD when completed.

If you have any questions, please call me at 804.698.4308.

Sincerely,

Mark S. Leeper
Remedial Project Manager

cc: Norman L. Auldridge - WCRO, DEQ
Durwood Willis - DEQ
Robert Thompson, Region III, U.S.EPA, 3HS13

Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, VA 24141
USA

August 1, 2003

Mr. Robert Thomson
U. S. Environmental Protection Agency
Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Subject: Building 4343, RCRA Facility Investigation Report (RFI)
Radford Army Ammunition Plant
EPA ID# VA1 210020730

Reference: EPA Letter dated June 9, 2003 regarding above subject

Dear Mr. Thomson:

In the correspondence from Radford Army Ammunition Plant (RFAAP) dated June 27, 2003, a partial response to the referenced letter's comments was provided regarding the subject report. RFAAP is in the process of resolving the comments by the EPA Biological Toxicity Assessment Group (BTAG) regarding the Master Work Plan and the Building 4343 RFI Report. The BTAG had similar comments on both documents. On July 17, 2003, a conference call was held among team members resulting in a possible resolution to the BTAG comments. Attachment 1 contains the notes from this conference call.

Attachment 2 contains RFAAP's response to the review comments in the above referenced letter. This correspondence supercedes the responses provided on June 27, 2003.

We are requesting an extension of November 7, 2003 to submit the combined Building 4343 RFI and Corrective Measures Study report.

Please coordinate with and provide any questions or comments to myself at (540) 639-8266, Jerry Redder of my staff (540) 639-7536 or Jim McKenna, ACO Staff (540) 639-8641.

Sincerely,

C. A. Jake, Environmental Manager
Alliant Ammunition and Powder Company LLC

Enclosure

w enclosure
c: Russell Fish, P.E., EPA Region III

Durwood Willis
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Coordination: J. McKenna

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J. McKenna, ACO Staff
Rob Davie-ACO Staff
C. A. Jake
J. J. Redder
Env. File

03-815-122
JMcKenna

Attachment 1
Teleconference Meeting Notes
BTAG Discussions regarding Radford AAP Master Work Plan Finalization and Response to Comments Regarding Building 4343 RFI
17 July 2003

On 17 July 2003 a telephone conference was held amongst Radford AAP ecological risk assessment stakeholders regarding the finalization of the Installation's Master Work Plans (MWP) and the Installation's Response to BTAG Comments regarding the Building 4343 RFI. Participants were as follows:

BTAG
Bruce Pluta
John McCloskey
Jeff Tuttle
Jim Mead
RFAAP
Jim McKenna
USACE
John Tesner
Drew Rak
Cliff Opdyke
URS
Cecelia Mancini
Todd Morrison
Shaw
Jeff Parks
Mark Weisberg

These notes are presented in three sections;
1. General Comments
2. MWP Response to Comments (RTC) Discussions
3. Building 4343 RTC Discussions

General Comments
John Tesner recalled the timelines that brought about this discussion, specifically when comments had been received by the Installation and when RTC's were generated. It was stated that the Installation has not purposefully been ignoring or being unresponsive to BTAG comments.

The Installation stated that it is their intent to address ecological risk concerns in the context of human health risk drivers. Cleanups driven solely by ecological risk drivers have been very rare across the Army. If such an instance were to occur at a site, appropriate risk management decisions are the more likely outcome.

The stakeholders agreed that a ongoing dialog will be imperative at Radford AAP in order to meet deliverable review schedules.

Attachment 1
Teleconference Meeting Notes
BTAG Discussions regarding Radford AAP Master Work Plan Finalization and Response to Comments Regarding Building 4343 RFI
17 July 2003

The following is a brief summary of the discussions/agreements reached on MWP and Building 4343 RFI. More extensive RTC documents will be submitted for EPA concurrence.

Master Work Plan RTC Discussions

MWP Comment 1 & 2
Since both comment 1 and 2 dealt with the issue of using BTAG values they were discussed together. There was general discussion of BTAG screening values and the desire on the part of the Installation to use alternate values that they believed to be more current and better referenced. BTAG insisted that BTAG values be used whenever possible and said they would be hesitant to use some of the sources requested by the Installation (specifically Ontario Ministry and EPA soil numbers). Bruce Pluta indicated that there were two documents that BTAG issued (May 2002 and March 2003) that listed the acceptable sources for alternate BTAG values. Post-teleconference, these documents were electronically sent to John Tesner and distributed to the stakeholders. The Installation indicated that they would need to review these documents before a final determination could be made on agreement of ecological risk screening values, but generally agreed to utilize the BTAG-approved sources. The Installation did agree to add text/table information to reports (Work Plan Addenda and RFI's) to make it clear which screening numbers were used in the ecological assessment.

MWP Comment 3 – Background
BTAG said that the focus should be on the baseline risk assessment and that COPCs should not be screened out unnecessarily too early in the process. The Installation countered that carrying COPCs throughout the process only to screen them out in the end was counterproductive and that they had a solid basis for the process of screening out COPCs below background early in the process based on EPA approval of the RFAAP Background Study report. The stakeholders agreed that Radford could screen out background concentrations earlier in the risk assessment process as long as text was added to indicate which COPCs were screened out because they were below background concentrations.

MWP Comment 4- Adding step 3a to SLERA process.
It was agreed that this step will be performed as part of the SLERA. BTAG did not object to performing this step "early".

MWP Comment 5- Plants as receptors
BTAG explained that the intent of this comment was to ensure that the plant community would not be overlooked as potential receptors. BTAG requested that the plant community be evaluated on a site-by-site basis. The Installation agreed and will modify the MWP text to reflect BTAG's request.

Attachment 1
Teleconference Meeting Notes
BTAG Discussions regarding Radford AAP Master Work Plan Finalization and Response to Comments Regarding Building 4343 RFI
17 July 2003

MWP Comment 6-Use of NOAEL and LOAELs
BTAG agreed with the Installation's response.

That response is as follows:
The U.S. Army Center for Health Promotion and Preventative Medicine Technical Guide 254, Standard Practice for Wildlife Toxicity Reference Values (USACHPPM TG 254, 2000) provides current guidance for the derivation of NOAELs. The document generally incorporates the same uncertainty factors presented in the Tri-Service Guidance for Ecological Risk Assessments (Wentsel et al. 1996), although Wentsel et al. 1996 have a more refined (and preferred) approach for interspecies TRV extrapolation. These approaches will be used in the SLERA.

The following text will be revised, Section 7.1.3 Identification of Exposure Pathways and Potential Receptors for Analysis - the last paragraph will read:
"Toxicity values will be used to evaluate potential constituent effects to birds and mammals. Chemical-specific criteria will be developed in order to estimate the dose of a chemical at which no adverse effects are likely to occur in the selected indicator species based on simple food-web modeling. Where available, dietary No Observed Adverse Effect Levels (NOAELs) will be used to evaluate the potential for adverse effects to wildlife. In the absence of these values, the toxicity values from the scientific literature will be reviewed. If a NOAEL is not available for a chemical, a Lowest Observed Adverse Effect Level (LOAEL) or LC_{50} will be used, and uncertainty factors will be applied to estimate a NOAEL as described in the Standard Practice for Wildlife Toxicity Reference Values, USACHPPM TG 254 (2000). For interspecies extrapolations, the more refined approach in Wentsel et al. 1996 (Figure 12) will be used.

MWP Comment 7- step 3a, use of more realistic assumptions in the SLERA rather than the baseline ERA.
BTAG agreed with the Installation's response (based on discussion of comment 4).

That response is as follows:
As discussed in response to comment 4, the SLERA will include both the screening of COPCs and serve as the starting point for the rationale for COPC exclusion from further investigation, if warranted (i.e. the refinement of COPCs as described in Step 3a of 8-Step process). As stated in this comment, these types of discussions may include, but are not limited to, several factors such as 95% UCL media concentrations, exposure area, and receptor area use.

Contaminant exposure from other sites is an inherent uncertainty in risk assessment, as such it will be considered as an uncertainty analysis section.

MWP Comment 8- remove reference
BTAG agreed with the Installation's response.

That response is as follows:

Attachment 1
Teleconference Meeting Notes
BTAG Discussions regarding Radford AAP Master Work Plan Finalization and Response to Comments Regarding Building 4343 RFI
17 July 2003

The comment is noted and the text will be removed from the document.

Building 4343 RFI RTC Discussions

These responses also represent a summary of discussion/agreements communicated during a teleconference on 15 July 2003.

4343 RFI Comment 3- BTAG values
Resolution as in MWP Comments 1 & 2.

4343 RFI Comment 18- statement by BTAG
Agreed that no response/revision was necessary.

4343 RFI Comment 19 – BTAG values
Resolution as in MWP Comments 1 & 2.

4343 RFI Comment 20 - Aluminium concentrations vs. pH.
BTAG agreed that because the RFI was being changed to a RFI/CMS that there was no longer an issue but would like a statement in the uncertainty section to discuss the issue. Installation agreed.

4343 RFI Comment 21 - Earthworms as Assessment endpoint rather the measurement endpoint.
There was much discussion on this subject. The Installation did not believe that earthworms should be an assessment endpoint. It was agreed that the Installation would conduct an assessment for the entire soil community.

4343 RFI Comment 22 – removal of sumps
BTAG agreed with Installation's response that the RFI/CMS would discuss the removal of the sumps and post removal sampling.

4343 RFI Comment 23- Assessment of earthworms
Same as 4343 RFI Comment 21

4343 RFI Comment 24 – BTAG comment regarding cost effectiveness of removal actions versus additional studies
Comment noted. Agreed that no response/revision was necessary.

Attachment 2
Response to USEPA Comments dated 09 June 2003
Received via e-mail on 09 June 2003
for
Draft Building 4343 RCRA Facility Investigation Report
Dated February 2003

The responses to USEPA comments have been revised to incorporate discussions/agreements completed during teleconference discussions with the Biological Technical Assistance Group (BTAG) on 15 and 17 July 2003.

General Comments

EPA Comment 1

The draft RFI Report concludes that the metals detected at the site were not migrating into subsurface soil and that groundwater would not be impacted at the site. It also concludes that the nature and extent of contamination has been determined by the RFI effort. These conclusions can only be reached after the horizontal and vertical extent of contamination at the site has been determined, i.e. at the limit where background concentrations have been realized. It appears that the nature and extent of contamination, as presented in the draft RFI, is defined by the limit of the exceedances above the soil industrial RBC solely. The intent seems to be directed at defining the limits of a removal action. Please note that while this is acceptable for bounding the limits of a removal action, it does not in effect define the limits of contamination for the purpose of closing out the site.

Army Response

Comment noted. The RFI Report will be revised to state "limited migration" of metals into subsurface soil is occurring. Analysis of exceedances of residential RBCs and background 95% UTLs will be added to the report.

RFAAP believes that site characterization and nature and extent should include the delineation of chemical concentrations, as well as, site geology, site history, site processes, fate and transport analysis. Each of these elements are needed to fully evaluate and support nature and extent conclusions. Therefore, RFAAP does not believe that chemical concentrations detected at the site need to be surrounded by additional samples that have concentrations at background levels to be able to make valid nature and extent conclusions and develop risk-based management decisions.

Per discussions with USEPA, the RFI report will be modified to include the CMS.

EPA Comment 2

Please note that the risk screening process should take both the residential and the industrial scenarios into account, and perform the risk screen for both scenarios. This process is needed to ascertain whether a site can be "RCRA-equivalent" clean-closed or not. If a site fails the residential scenario, it cannot undergo "RCRA-equivalent" clean-closure, and may require long-term monitoring and reporting requirements. Given this, it is extremely important to ascertain which constituents exceeded the residential scenario, as the post-removal sampling event can be designed to capture these constituents. In the draft RFI report, the nature and extent assessment

focuses on the EPA Region 3 industrial Risk-Based Concentrations (RBCs) exceedances only. Any constituent that had not exceeded the EPA Region 3 industrial RBC was eliminated from further consideration in the nature and extent evaluation, even when constituents exceed other screening criteria (e.g., residential RBC, Soil Screening Levels (SSLs), etc.), have been detected above detection limits, or exceeded background concentrations. This is misleading. Please revise the RFI Report to discuss why the extent of contamination evaluation was limited to those constituents exceeding the industrial RBC only, and how future efforts will be used to fully define the nature and extent of contamination at Building 4343.

Army Response
Both the residential and industrial risk scenarios are in the report. The residential evaluation will be moved from the appendix to Section 6.0 and discussed. Evaluation of residential RBCs and SSLs will be added to the nature and extent section of the report.

EPA Comment 3
Some of the comparisons required by the screening procedure of the Site Screening Process (SSP) for the Radford Army Ammunition Plant (October 26, 2001) were not conducted. These include the EPA Region 3 SSLs and the EPA Region 3 Biological and Technical Assistance Group (BTAG) Ecological Risk Assessment guidelines. Please revise the RFI Report to compare all the available data to the SSLs and EPA Region 3 BTAG values and revise any conclusion drawn from the current comparisons accordingly.

Army Response
Evaluation of the SSLs will be added to the nature and extent section of the report. As directed by EPA, Region III BTAG Screening Values will be used to identify COPCs in the Screening Level Ecological Risk Assessment (SLERA) despite the following limitations:

- Region III BTAG Screening Values are draft
- derivation/calculation of some of the values is not clearly provided in the document
- no updates have been issued to reflect increased knowledge base in the area since their compilation in 1995. Consequently these values do not reflect the current advances in risk assessment.

In order to account for these limitations and to ensure that the SLERA screening process is adequately conservative but realistic, the RFI/CMS for Building 4343 will incorporate values from sources identified in the following paragraph in subsequent steps of the risk assessment.

Values will be derived from various Federal and State sources as well as relevant and current scientific literature. *Screening values will be developed concurrently with BTAG and may include sources such as Region III BTAG Screening Values, Federal standards for ambient water quality criteria (AWQC), Virginia Criteria for Surface Water (2002), Canadian Environmental Quality Guidelines (Canadian Council of Ministers of the Environment (2002), Great Lakes Research Threshold Effect Levels (TEL) (Smith et. al. 1996) for freshwater habitats, USEPA surface soil screening levels (USEPA 2000b), USEPA Region V Ecological Data Quality Levels (EDQL; USEPA, 1999), and ORNL*

screening levels for surface water, sediment, and soil; Efroymson et al., 1977, Jones and Suter, 1997, Suter and Tsao, 1996, Efroymson, Will, and Suter, 1997)."

Specific Comments

EPA Comment 4

Section 2.4, Facility-Wide Background Study: COPCs were eliminated from the risk assessment by comparing the UTL of the background data to on-site data. While this might be appropriate for site screening, in the case of performing a baseline risk assessment, EPA has guidance on the use of statistical tools for background comparison. That guidance is located at http://www.epa.gov/superfund/programs/risk/tooltrad.htm. The expectation is that the statistical analysis will be consistent with this guidance. In general two questions should be answered regarding site contamination compared to background: One, are there any hotspots on site? Two, is the average concentration on site the same or higher than the average concentration of background? Hotspots can be identified by the UTL, which was done in the report. However, there was no comparison of the means. Means comparison should be done by hypothesis testing (t-test, Wilcoxon Rank Sum test, etc.). The guidance outlines which tests are the most appropriate based on the number of samples and the distribution of the data sets.

Initial Army Response

Means comparison will be conducted by hypothesis testing. Such hypothesis testing will include tests for similarities in shape and location between the site and background data sets. Depending on these initial tests, other tests (e.g., t-test, Mann-Whitney U, or Kolmogarov-Smirnov) will be used to assess whether there is a difference between the means. Likewise, statistical procedures will also be used for assessing outliers.

EPA Reaction: Army response is okay.

Additional Army Response

Acceptance of the Army response is noted. The Army agrees that hot spots are defined by the UTLs. Means testing will be conducted using guidance at the location noted above. The purpose of undertaking a facility-wide background study for Radford AAP was to establish a background data set for use in risk assessment. Based on discussions with USEPA early in the RFI process, it is the Army's understanding that the development of a background data set would allow for the elimination of chemicals from further consideration based on comparisons of site concentrations to background data. USEPA's *Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual* (RAGS; USEPA, 1989), Section 5.7, permits the use of background data as a selection criterion for chemicals of potential concern (COPCs). For several constituents, the 95% UTLs are below the RBCs, which will be used to screen COPCs at the site. Those chemicals detected at concentrations below RBCs would be "screened out" of the risk assessment process and would not be carried forward for further quantitative evaluation. Thus, the potential for carrying naturally occurring elements through the quantitative risk assessment would be minimized. The use of UTLs for defining the nature and extent will not change.

EPA Comment 5

Page 4-1. Sample B43SB34A was analyzed for total organic carbon (TOC), grain size and pH to assess the bioavailability and mobility of constituents in soil. EPA recommends that the Army use the TOC and grain size distribution results and apply the principles/equations presented in Appendix D to calculate mobility of Cd and Cr in the soil at the site. The results from the model prediction can support the statement that the metals were not migrating into the subsurface soil to a depth that groundwater would be potentially impacted at the site.

Army Response

The equations provided in Appendix D and in the Soil Screening Level Guidance documents can be used to calculate theoretical soil concentrations that will result in groundwater concentrations below the MCL (or other criteria). These results are useful for sites where there is no or limited geologic information available. Assumptions built into the Appendix D/SSL equations include:

- contamination is uniformly distributed from the ground surface to the top of the aquifer,
- the aquifer is unconfined, and
- there is an infinite source.

Empirical results from site data indicate that cadmium-impacted soil at Building 4343 is primarily confined to the top six feet of soil at the site and that there is approximately 60 feet of clay between the bottom of the contaminated soil and the top of the aquifer. An aquifer under these conditions would be considered confined or semi-confined.

Also, the equations assume that there is no attenuation of contamination in the soil (i.e., no adsorption, no degradation) or in the groundwater. The analytical results from samples at the site indicate that there is adsorption to the clayey soil that is hindering migration.

One of the underlying assumptions in these equations is that the reaction is instantaneous and the system is in equilibrium. Because instantaneous soil-water partitioning is assumed, results from these equations would show that groundwater is impacted immediately. Therefore, migration rates cannot be estimated from these equations.

Specific calculations are presented in Response to Comment # 16.

A second approach to calculating migration rates would be to use Darcy's Law to calculate rates for the movement of groundwater through soil. Several of the same assumptions built into the SSL equations would apply to this method as well (i.e., no adsorption, no degradation) because the calculation applies to the migration of water through the soil and not the dissolved contaminants.

Using an assumed thickness of 60 ft for the clay above the first aquifer and typical hydraulic conductivities for clay (1E-6 – 1E-9 cm/sec), a theoretical migration time of 57 years (1E-6) to 57,000 (1E-9) years can be calculated.

Because the theoretical approaches incorporate several simplifying assumptions that are not valid at Building 4343, an empirical approach has been adopted instead. Using a maximum timeframe of 40 years for the addition of cadmium to the site soil, and a maximum depth of elevated cadmium concentrations of 6 feet, a migration time of 400 years can be calculated. This rate assumes a linear migration rate, and also does not account for attenuation within the soil column.

EPA Comment 6

Section 4.2.2, Nature and Extent Summary, page 4-12: The third paragraph on this page states "these data suggest that vertical migration of contaminants has not occurred at this location [B43SB35]." This statement is misleading as the subsurface (4 to 6 feet) data presented for this location indicate that aluminum was detected at 38,000 mg/kg, chromium at 95 mg/kg (exceeding background concentration), iron at 37,800 mg/kg, vanadium at 75 mg/kg and cadmium at 37.7 mg/kg (exceeding background concentration). Since no surface samples were analyzed for this location and the subsurface sample shows detection of several metals and no sample below this surface sample was collected, it is inappropriate to conclude that vertical migration of contaminants has not occurred. Please revise the language in the RFI Report to conclude that no exceedances of the industrial RBCs for metals were detected in the subsurface soil.

Initial Army Response

The sentence preceding "these data...." states that "No exceedances of industrial RBCs for metals were detected in the subsurface soil samples." It is emphasized throughout the text of this report and in WPA 12 that the contamination assessment and fate and transport analysis would be based on industrial RBC exceedances. None of the concentrations mentioned in the comment exceed industrial RBCs. The paragraph also mentions that previous soil samples have been collected at this location (referencing Figure 2-3). The preceding paragraph references another sample (4343-05-SVR) collected in the vicinity of the former lead catch tank and references Figure 2-2. Although not directly comparable, TCLP cadmium exceedances ranged from values of 3,890 µg/L and 36,800 µg/L in surface soil at that location. Sample B43SB22A collected at 2-4 ft bgs at the same location as B43SB35B, shows a concentration of cadmium of 57.1 mg/kg. Sample B43SB35B, collected at 4-6 ft bgs shows a cadmium concentration of 37.7 mg/kg. This is a greater than 60 percent decrease in cadmium over two feet of vertical depth. Aluminum, iron, and vanadium concentrations at this location, although above background and residential RBCs, have not shown a pattern of widespread distribution at the site and have not been identified as constituents of concern. It is RFAAP's intent to remove the source area present at Building 4343 using real-time and/or near real-time sampling methods to assess concentrations of metals in the soil. As previously stated, a thorough discussion of the removal action, including PRGs will occur in the CMS.

RFAAP is willing to modify the statement in the RFI report to read "it appears that vertical migration of contaminants to six feet or less has occurred at this location, with no exceedances of industrial RBCs."

EPA Reaction: Army response is okay.

Additional Army Response

Acceptance of the Army response is noted.

EPA Comment 7
Section 4.2.2, Nature and Extent Summary, on page 4-12 discusses the results from the 2002 investigation. The section states that polycyclic aromatic hydrocarbons (PAHs), pesticides, and PCBs were detected, but did not exceed industrial RBCs. It was therefore concluded that these compounds are not a concern at this site. It appears that these criteria were used to eliminate these compounds from consideration in the ecological risk assessment (ERA) since only metals were evaluated. Comparison to RBCs (human health criteria) does not address the potential for ecological risk from these chemicals. Therefore, any detected chemicals should be evaluated in the ERA before deciding that they are not at concentrations of concern.

Initial Army Response
RFAAP agrees with this comment. The nature and extent analysis was not used to eliminate compounds from the SLERA. However, analysis of the PAH and pesticide data was inadvertently left out of the report. The report will be revised so that detected chemicals are evaluated and discussed in the SLERA.

EPA Reaction: Army response is okay.

Additional Army Response
Acceptance of the Army response is noted.

EPA Comment 8
Table 4-3, Soil Sample Summary, pages 4-10 and 4-11: Please revise this table to remove the "zeros" entered for the number of background exceedances for other than the inorganics.

Initial Army Response
Zeros will be replaced with N/A (not applicable) in the column for background exceedances other than inorganics.

EPA Reaction: Army response is okay.

Additional Army Response
Acceptance of the Army response is noted.

EPA Comment 9
Section 4.2.2, Nature and Extent Summary, page 4-13: The third paragraph on this page states that "the results from these borings indicate that cadmium is moving downslope along the ditch, but is not migrating vertically or laterally through soil bounding the ditch. The results are similar to the boring collected at the lead catch tank (sample B43SB35), supporting the absence of vertical migration of cadmium through the clayey site soil." These conclusions are not supported by data as the vertical and horizontal extent of cadmium contamination at the site has not been fully determined. Based on the RFI data presented in Figures 2-3 and 4-2, the vertical extent of cadmium contamination, i.e. the level at which cadmium is present at background, has not been determined at sample locations B43SB22A (57.1 mg/kg), B43SB21A (4.7 mg/kg), B43SB4A (2.9 mg/kg), B43SSD1 (24,300 mg/kg), B43SSD2 (157 mg/kg), B43SSD3 (124 mg/kg), B43SSD4 (134 mg/kg), B43SSD5 (222 mg/kg), B43SSD6 (1040 mg/kg), B43SB34B (18.5 mg/kg), B43SB14A (191 mg/kg), B43SB26A (9.9 mg/kg), B43SB35B (37.7 mg/kg),

B43SS01 (107 mg/kg), B43SB18A (3.2 mg/kg), B43SB33A (10.5 mg/kg) and B43SS02 (273 mg/kg). Similarly, the horizontal extent of cadmium contamination has not been determined at sample locations B43SSD1 (east and west extent not determined), B43SSD2 (east and west), B43SSD3 (east and west), B43SSD5 (east and west), B43SSD6 (east), B43SB14A (east), B43SB26A (east and west), B43SB35B (east), B43SS01 (east, west and south), B43SB18A (north), and B43SS02 (north and east within the drainage ditch). In addition the vertical and horizontal extent of other metals has not been determined at these and other locations presented on Figures 2-3 and 4-2. The RFI appears to concentrate on exceedances of the industrial soil RBCs. While this might serve to define the limits of a removal area, it does not define the nature and extent of contamination that would be required to effectively "clean-close" the site. Please discuss in the RFI how this would be accomplished in the future.

Army Response

As noted in Response to Comment #1, RFAAP does not believe that chemical concentrations detected at the site need to be surrounded by additional samples that have concentrations at background levels to be able to make valid nature and extent conclusions and develop risk-based management decisions. Specific examples are presented below.

Vertical Extent

The two samples, B43SB22A and B43SB35B, near Building 4343 still show elevated concentrations in the subsurface at one of the most impacted areas (near the former lead catch tank). However, these two samples show a greater than 60% decrease in concentration from the 2-4 foot interval to the 4-6 foot interval. For the other two samples, B43SB21A (cadmium 4.7 mg/kg) is slightly above the residential RBC (3.9 mg/kg) and B43SB4A (cadmium 2.9 mg/kg) is below the residential criteria. Further, looking at the surface sample collected above B43SB4A, sample B43SSB4 shows a concentration of 16.2 mg/kg, again demonstrating that cadmium concentrations demonstrate a rapid decrease (greater than 80% decrease from the surface to 2-4 ft bgs).

The process water ditch samples mentioned (B43SSD1 through B43SSD6) also demonstrate a pattern. Samples in depositional areas, i.e., the effluent outfall (B43SSD1) and the alluvial fan (B43SSD6) showing much greater concentrations than the samples collected along the ditch (transit area). Samples in the middle part of the ditch show very consistent concentrations (124 - 222 mg/kg), demonstrating that borings collected outside the trench should not have to be positioned directly opposite sample locations inside the ditch to characterize migration of cadmium concentrations through soil in a vertical or horizontal direction.

Samples such as B43SB34B (18.5 mg/kg) and B43SB26A (9.9 mg/kg) show low concentrations that, to reiterate previous discussions regarding site-specific conditions, indicate rapidly decreasing concentrations within a few feet of vertical depth. Samples B43SB14A (subsurface from a broken pipe) and B43SS01 (low spot collecting runoff from the parking lot) do demonstrate areas of elevated concentrations, but again at concentrations that would be expected to decrease rapidly within 2-4 feet. These concentrations would be more easily refined during the probable remedial action (excavation/post-excavation sampling event).

Horizontal Extent

For horizontal extent characterization, process water ditch samples B43SSD2 through B43SSD5 show a fairly consistent cadmium concentration (157 mg/kg, 124 mg/kg, 134 mg/kg, and 222 mg/kg over a stretch of approximately 125 feet). A correlation could be made that concentrations would be similar along this length of ditch such that borings along the outside of the ditch should not have to be positioned directly opposite the trench samples. Five borings were positioned along and outside the trench. Sample results at 2-4 ft (these would be below the bottom of the trench) indicate cadmium concentrations of B43SB25A - ND, B43SB15A - ND, B43SB26A - 9.9 mg/kg, B43SB27A - ND, and B43SB28A - ND. RFAAP believes that the correlation can be made that these sample results show very little horizontal or vertical movement of cadmium concentrations outside the trench and do bound the horizontal and vertical extent sufficiently in this area.

Samples B43SB14A, B43SB35B and B43SS01 have been discussed previously, and again, RFAAP would argue that the horizontal extent is sufficiently characterized to move forward to a removal action. Sample B43SS02 is bounded to the east by the ND in sample B43SS03. There does not seem to be a reason to believe that cadmium concentrations would move upgradient past the west-east stormwater ditch.

Additional analysis of residential RBCs and background comparison criteria exceedances will be added to the nature and extent section of the report. Information contained in this response will also be added to the report to support the position that nature and extent has been characterized to the appropriate level.

EPA Comment 10

Section 4.2.2, Nature and Extent Summary, page 4-13: The fourth paragraph on page 4-13 states that "there were no industrial exceedances of cadmium and arsenic concentrations were below background in the subsurface samples collected in the alluvial fan area. Again indicating a lack of vertical migration." It is not clear how this conclusion was reached when the vertical extent of cadmium contamination was not determined at most of the sample locations in the alluvial fan area as pointed out in the above comment. The phrase "lack of vertical migration" should be revised.

Initial Army Response

Twelve samples at seven locations were collected in the alluvial fan area of the site. This is an area approximately 75 feet long by 100 feet at its greatest width. The actual square foot area would be half of this (75 x 100 ÷ 2) because the fan is shaped like a triangle. An additional nine samples at five locations were collected surrounding the delta. In surface soil samples, there were four cadmium detections at 1,040 mg/kg, 339 mg/kg, 273 mg/kg, and 137 mg/kg. In four subsurface samples (three at 2-4 ft bgs and one at 4-6 ft bgs), cadmium concentrations were 18.5 mg/kg, 15.9 mg/kg, 10.5 mg/kg and 3.2 mg/kg. This data provides empirical proof that cadmium concentrations are reduced by 90-95% from surface concentrations within the first six feet of depth. While RFAAP agrees that there are no borings with exclusively background concentrations below 6 ft bgs, the subsurface concentrations are below the unadjusted residential RBC of 39 mg/kg and are close to the adjusted (by a factor of 10) residential RBC of 3.9 mg/kg. RFAAP recommends that it is most appropriate to compare cadmium, as the sole constituent of concern in the delta area, to the unadjusted residential RBC.

Regardless, the data supports assessing the cadmium concentrations as attenuating rapidly with depth and that there is no reason to believe that concentrations would be increasing deeper than 6 ft bgs. Therefore, it is RFAAP's position that sufficient data exists to make remedial decisions and that the effort to conduct an additional investigation to define the window between the adjusted residential RBC of 3.9 mg/kg and the average 12 mg/kg cadmium concentrations in the 2-6 ft bgs soil horizon is unnecessary and counterproductive to maintaining progress towards a clean up action at this site. RFAAP proposes to revise the phrase "lack of vertical migration" to read "the vertical migration and cadmium concentrations quickly attenuate at a depth of four feet."

EPA Reaction: Army response is okay.

Additional Army Response
Acceptance of the Army response is noted.

EPA Comment 11
Section 4.2.2.1, Nature and Extent Conclusions, page 4-13: It is stated at the bottom of this page that cadmium is not moving into the stormwater drainage system bordering the site. This is inaccurate as cadmium was detected in the stormwater drainage system at sample location B43SS02 at the concentration of 273 mg/kg, exceeding the industrial RBC. Also, on page 4-14, it is stated that "the lack of exceedances of cadmium in subsurface soil and the fact that groundwater was not encountered at the site (down to 60 ft. bgs) indicates that groundwater would not be impacted at this site." Since the vertical extent of cadmium contamination is not determined and groundwater condition at the site is unknown, it is premature to make such a conclusion. Please remove these statements from the RFI Report.

Initial Army Response
Text will be clarified to state "while there were industrial RBC exceedances of cadmium in two surface soil samples located where the alluvial fan meets the stormwater drainage ditch, samples collected in the drainage ditch to the east and west of the alluvial fan indicate that cadmium is not being transported in the drainage system outside the boundaries of the alluvial fan."

RFAAP's position is that the vertical extent of cadmium concentrations has been established to a sufficient degree (see previous responses). Empirical evidence demonstrates that 95% of cadmium concentrations in surface soil do not go beyond 2-4 ft bgs. Borings through 60 feet of dense clay that underlie the site and associated chemical analyses provide empirical evidence that cadmium is not migrating beyond the near surface. It is significant to note that groundwater was not encountered while advancing the 60 foot boring. Given the absence of groundwater and no evidence of deep vertical migration the assertion that groundwater would not be impacted by cadmium releases at the surface is a reasonable and logical conclusion.

EPA Reaction: Army response is okay.

Additional Army Response
Acceptance of the Army response is noted.

EPA Comment 12

Section 5.0, Contaminant Fate and Transport, page 5-1: The last paragraph on this page states that "arsenic was detected above the industrial RBC (3.8 mg/kg) in 15 soil samples collected from the site. The surface concentrations of arsenic that exceeded the industrial RBC ranged from 3.8 (B43SSD4) to 5.6 (B43SSB10) mg/kg." Based on data presented in Figures 2-3 and 4-2, only two surface soil samples (excluding the two sludge samples B43SL1 and B43SL2) for arsenic exceeded industrial RBC at the concentrations of 4.0 mg/kg (B43SSB28) and 5.0 mg/kg (B43SS01). According to these figures, no arsenic was detected at the reported sampling locations (B43SSD4 and B43SSB10).

It is further stated in this paragraph that arsenic was detected above the industrial RBC in 16 surface subsurface soil samples with a range of 3.9 mg/kg to 9.4 mg/kg. Based on the data presented in Figures 2-3 and 4-2, only seven subsurface samples exceeded the arsenic industrial RBC with the range reported. In addition, Table 4-3 documents 33 exceedances of the industrial RBC for arsenic. However, the location of these exceedances (other than the 9 discussed above) is not shown on the figures.

Please revise the RFI Report to resolve these discrepancies and correct the text, figures and tables accordingly.

Initial Army Response

The text and tables are correct. The figures will be revised. Since the figures were developed to present chemicals and concentrations of concern, only those arsenic concentrations greater than background will be presented on the figures.

EPA Reaction: Army response is okay.

Additional Army Response

Acceptance of the Army response is noted.

EPA Comment 13

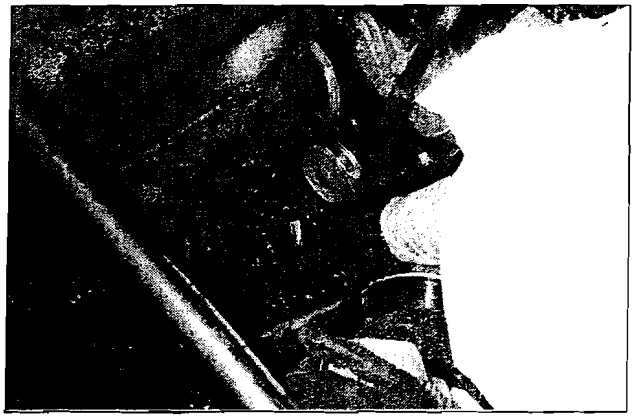
Section 5.0, Contaminant Fate and Transport, page 5-2: The fourth paragraph on page 5-2 states, "it would appear that numerous detections of arsenic at low concentrations in both surface and subsurface soil at the Building 4343 study area is the result of natural soil conditions not related to site activity. The sludge contained within two separate concrete sumps is prevented from migration into the surrounding soil." Since arsenic was detected at a concentration twice the background in the sludge sample (B43SL1), it is inaccurate to conclude that arsenic is the result of natural soil conditions not related to site activity. Also, since the integrity of the sumps has not been investigated and their conditions have not been discussed in the RFI Report, it is inappropriate and premature to conclude that sludge contained in the sumps is prevented from migration into the soil. Please revise the RFI Report to discuss the integrity of the two sumps. Additionally, if a removal of the sumps is planned, please discuss in the RFI and provide for post-removal sampling below the sumps immediately following their removal.

Army Response

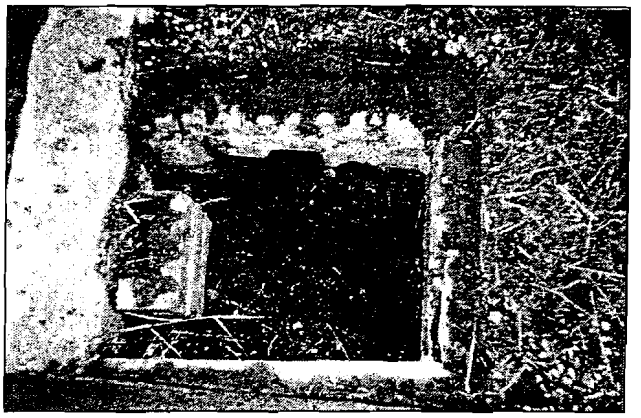
The conclusion that low arsenic concentrations are the result of natural soil conditions will be revised in the report.

The following information on the sumps will be added:

"Inspections of both the interior and exterior sumps prior to sampling gave no indication that there were cracks or breaks in the either of the sumps and no indications of pathways to the subsurface through the sumps. Photographs taken during sludge sampling activities at Building 4343 illustrating the integrity of the sumps are provided below."



Photograph of interior sump during sludge sampling.



Photograph of exterior sump during sludge sampling.

Since arsenic concentrations collected from soil outside the sumps were below the background concentration, the conclusion that arsenic is not a concern at the site remains valid.

Soil samples have been collected at both surface and subsurface locations near to and downgradient of the sumps. The lack of widespread exceedances of most metals except cadmium (and secondarily, chromium) provides indication as to the integrity of the sumps. A removal action is programmed for this site and removal/cleaning of the sumps would be part of this action. Post-removal confirmation sampling would insure that elevated concentrations of metals in soil surrounding the sumps would be identified.

Information on Building 4343 and cadmium plating in general do not indicate the direct use of arsenic or arsenic compounds. Therefore, arsenic is considered a trace contaminant. The probable source of the arsenic in the sumps is identified in Section 2.2 Site History, "This process would also cause trace metals to precipitate and form the sludge contained in the process sumps."

Discussion of the removal of the sumps during proposed remedial actions and post remedial sampling will be added to the text of the report.

EPA Comment 14

Page 5-3: The statement that "Chromium was not used in the plating process and is more likely associated with the acid cleaning of metal parts and as a tract contaminant" is confusing and needs to be modified. Especially in light of the statement on page 2-6, which states that "Rinse water from the cadmium plating operations was process water containing cyanide, cadmium, and chromium."

Army Response
The text will be clarified to indicate that cadmium (ingots) was the sole metal used in the plating process. However, metal parts that may have contained chromium would have been subjected to acid baths for cleaning prior to cadmium plating. This process would be the probable source of chromium in the process water.

EPA Comment 15
Figure 5-2: Please indicate the groundwater elevation on Figure 5-2. This can be done by extrapolation from the neighboring SWMU or close-by wells, as long as a reference map or figure is accompanied showing how the estimated groundwater elevation was obtained. Also, there should be a map showing the location of Building 4343 within the RFAAP.

Army Response
The requested revisions will be made to the report.

EPA Comment 16
Section 5.3, Subsurface Soil Fate and Transport, page 5-4: The last paragraph on page 5-4 states, "cadmium has a default SSL soil transfer to groundwater value of 27 mg/kg. None of the subsurface cadmium concentrations exceeded this number, further indicating that the vertical migration of cadmium to a potential deep aquifer is unlikely." Based on data presented on Figures 2-3 and 4-2, cadmium concentrations at three subsurface sample locations B43SB22A (57.1 mg/kg), B43SB14A (191 mg/kg) and B43SB35B (37.7 mg/kg) exceed the unadjusted EPA Region 3 SSL value (for DAF 20) of 27 mg/kg. When the SSL value is adjusted down by a factor of 10 as required for EPA Region 3 Superfund sites, additional four subsurface sample locations B43SB21A (4.7 mg/kg), B43SB4A (2.9 mg/kg), B43SB18A (3.2 mg/kg) and B43SB34B (18.5 mg/kg) exceed the SSL value of 2.7 mg/kg. Thus, based on the use of SSLs with the data provided in the RFI Report, it cannot be concluded that the potential for further vertical of migration of cadmium and impact on groundwater is unlikely. However, rather than using the SSLs, EPA recommends that the Army use the TOC and grain size distribution results and apply the principles/equations presented in Appendix D to calculate mobility of cadmium and chromium in the soil at the site. The results from the model prediction can be used to support the statement that the metals were not migrating into the subsurface soil to a depth that groundwater would be potentially impacted at the site.

Army Response
RFAAP agrees that there are three subsurface sample locations that exceed the cadmium SSL soil transfer to groundwater value of 27 mg/kg. The location of the greatest exceedance (B43SB14A, 191 mg/kg) is believed to be the result of a broken subsurface pipe and not the result of migration of cadmium from the surface (see first paragraph on page 4-13). The other two samples are both near the same location next to Building 4343 and concentrations are lower (57.1 mg/kg and 37.7 mg/kg). While these SSL exceedances indicate a theoretical potential for impact to groundwater, empirical evidence in the form of 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. The following information:

- There is no groundwater present at the site within 60 feet of the surface,

- Site soil down to 60 feet is composed of tight clays and silts,
- Evidence that chemicals of concern are adsorbing to surface and near surface clay and demonstrating limited mobility (except by surface water transport in the process water ditch),
- Chemical data from 58-60 ft bgs show no elevated concentrations for chemicals of concern, and
- Surface concentrations of chemicals of concern decrease by 95% within the first six feet of soil,

provides solid evidence for the statement "the potential for further vertical migration of cadmium and impact on groundwater is unlikely."

Applying the SSL calculations with site-specific data for the three locations noted in the comment results in the following:

Sample ID	pH	SSL (mg/kg)	Actual Conc. (mg/kg)
B43SB22A	6.95	11	57.1
B43SB35B	5.95	3.7	37.7
B43SB14A	8.35	430	191
Site Average	6.39	4.8	--

These calculations show a range of 3.7 to 430 mg/kg for a site specific SSL. Total organic carbon and grain size are used in the SSL calculations for organic constituents, but are not used in the inorganic equations.

RFAAP has reviewed SSL documentation and guidance (Soil Screening Guidance: User's Guide, EPA, July 1996, Soil Screening Guidance: Fact Sheet, July 1996, USEPA Region III memo, 27 October 99) and cannot find the referenced requirement to adjust SSL values downward by a factor of 10. While the guidance does recognize that there may be cumulative risks from noncarcinogenic contaminants, it further states that "noncancer risks should be added only for those chemicals with the same toxic endpoint or mechanism." Since cadmium is the sole chemical of concern that affects the kidney (target organ/system), the further requirement to adjust the SSL down by a factor of 10 does not seem appropriate. In conclusion, RFAAP believes that the appropriate use of SSLs is for the screening of new sites with limited data. RFAAP further believes that the data collected in two investigations provides a sufficient data set that supercedes the need for SSLs as a screening tool.

EPA Comment 17

Section 6.0, Human Health Risk Assessment, Table 6-1, Selection of Exposure Pathways:
For the "current" scenario time frame, a trespasser is not identified as a receptor. Please explain why a trespasser is not considered a receptor under the current scenario.

In addition, for the "current and future" and "future" scenarios, it is indicated that no analysis will be conducted for the trespasser "due to security at the installation, trespasser exposures are

unlikely. However, the maintenance worker scenario would be protective of the limited exposure that would be experienced by a trespasser." It is not clear how the maintenance worker (an adult) scenario would be protective of a child/adolescent trespasser, unless the child/adolescent trespasser is separately considered. Please clarify this issue.

For the "sludge" medium, the exposure pathway for maintenance excavation worker is excluded from analysis because "excavation worker would not be expected to have constant exposures to the sumps" and "exposures to sludge could not be quantified for this receptor." Please provide additional explanation why this pathway for this medium is excluded from consideration. The reasons provided are not clear. If a removal action is planned, then the removal of the sumps would eliminate them for consideration of a complete pathway. Please discuss in the revised RFI.

Initial Army Response
"Current" exposures were assumed to continue in the "future". These exposures were referred to "current and future" exposures. There was no separate category for "current" exposures.

Text will be added to Section 6.2.1 to clarify the level of security at the Installation. Given the rigorous security at Radford AAP (e.g., strict security at entry gates, guard towers, barbed-wire fences), it is not reasonable to assume that children would be able to trespass at the Installation. Hypothetical future exposures to children were considered, however, in the residential scenario that was evaluated in Appendix E. The exposure parameters for residents are more conservative than those for trespassers.

It would also be extremely difficult for an adolescent to trespass at the site. Even if an older adolescent were able to evade security measures, it would be very difficult to do so on a routine basis. The frequency and duration of exposure for the maintenance worker is 50 days per year (i.e., once per week, except for two weeks while on vacation) and 25 years, respectively.

Because the sumps are below grates and not easily accessible, it is not reasonable to assume that a worker would be exposed to sludge in the sumps on a routine basis. The most likely exposure to sludge would occur during removal of the sumps, which would be a one-time occurrence and should involve the use of personal protective equipment (e.g., gloves, boots, clothing).

EPA Reaction: Army response is okay.

Additional Army Response
Acceptance of the Army response is noted.

EPA Comment 18
Section 7.0, Ecological Risk Assessment: Section 7.7, Results and Conclusions, concludes "based on uncertainties of toxicity, and on the fact that no wildlife RTE [rare, threatened and endangered] species have been confirmed at the Building 4343 study area, remedial measures solely to address ecological concerns are not warranted at this time for soil." Page 7-1 of this section describes the scientific/management decision point (SMDP) expected to be reached from the conduct of the Screening Level Ecological Risk Assessment. The conclusion drawn do not reflect these SMDPs. It is detailed in Section 7.1 of the RFI Report that five representative receptor species are expected or possible in the area of Building 4343 and were used as selected indicator species for the potential effects of the constituents of potential ecological concerns.

The assessment concluded potential adverse impacts to terrestrial wildlife, especially robins, shrews, and voles for potential exposure to primarily cadmium in surface soil. Therefore, the ecological concerns should be addressed. However, since the RFI Report stipulates that the chemical-specific preliminary remediation goals developed for human health may address the ecological concern, EPA reserves the right to pursue addressing the ecological concern at this site after review of the remedial action for the human health concern.

Army Response
Comment noted. No revisions necessary.

EPA Comment 19
Section 7.2.5, Comparison to Risk-Based Screening Ecotoxicity Values, on page 7-11 lists the screening values that were used to assess risk to terrestrial receptors. EPA Region III BTAG values were not used to evaluate risk. For the screening ERA, BTAG strongly recommends that BTAG screening values be used to evaluate risk to terrestrial receptors. Other values will be considered if no BTAG value is available.

Army Response
Refer to Response to Comment #3.

EPA Comment 20
Section 7.2.5, Comparison to Risk-Based Screening Ecotoxicity Values, on page 7-11 states that aluminum was not selected as a contaminant of potential ecological concern (COPEC), since this metal should only be identified as a COPEC for those sites with soil pH less than 5.5. The section also states that of the 24 surface soil samples that had pH measured, four were below a pH of 5.5 (e.g., 5.03, 5.20, 5.25, and 5.35), therefore because the average pH (5.8) is less than 5.5, aluminum was not selected as a COPEC. Because four samples had a pH less than 5.5, potential risk from aluminum at these specific locations should be further evaluated before eliminating from additional consideration.

Army Response
As COPEC concentrations in soil are averaged over the exposure area (for purposes of the SLERA), pH concentrations in soil were also averaged, using the method discussed in the RFI and summarized above (i.e., average soil pH = 5.8). As the average soil pH was greater than 5.5, aluminum was not selected as a COPEC. An additional discussion on the four samples that had a pH less than 5.5, and potential aluminum toxicity, will be added to the uncertainty section of the SLERA. The RFI will be reissued as a RFI/CMS and discussion of remediation of impacted soil will be added to the report.

EPA Comment 21
Section 7.4.1, Assessment Endpoints, on page 7-18 discusses the assessment endpoints that will be evaluated in the ERA. Protection of terrestrial invertebrates (e.g., earthworms) should be listed as an assessment endpoint from direct exposure to soils. The measurement endpoint would be a comparison of soil concentrations to BTAG screening values. Currently the ERA only evaluates risk to upper trophic level receptors exposed through the food chain and does not evaluate direct toxicity to soil invertebrates.

Army Response

Protection of terrestrial invertebrates will be added as a measurement endpoint, as these invertebrates may be an important food source for birds and mammals feeding at the site. The current assessment endpoints for Building 4343 are stated as the protection of long-term survival and reproductive capabilities for populations of herbivorous, insectivorous, and carnivorous mammals, and omnivorous and carnivorous birds. Three of the five site receptors already selected (short-tailed shrews, American robins, and red fox) would be expected to use terrestrial invertebrates are as a food source. Therefore, potential reductions in terrestrial invertebrates (due to direct contact with surface soil COPECs) could reduce the food supply for the selected assessment endpoint species.

EPA Comment 22

Section 7.6, Uncertainty Analysis, on page 7-26 states that chemical results from two Building 4343 sump samples were not included in the ERA because no ecological exposure is expected to these sumps. While direct exposure may not be likely, they still need to be considered as a source area to downgradient areas if migration from these locations could occur. Please discuss the possible removal of the sumps and any planned post-removal sampling of the soil remaining at the site.

Army Response

The revised report will be a combined RFI/CMS report. Discussion of the removal of the sumps during proposed remedial actions and post-remedial sampling will be added to the text of the report.

EPA Comment 23

Section 8.0, Summary and Conclusions, on page 8-1 states that the results of the ERA indicate the potential for adverse effects to the five wildlife receptors evaluated as part of the food chain modeling. As stated earlier, direct toxicity to soil invertebrates should also be evaluated as part of the ERA.

Army Response

Refer to Response to Comment #21.

EPA Comment 24

Section 8.0 also states that based on the uncertainties of toxicity, and on the fact that no rare, threatened and endangered species have been confirmed at the site, remedial measures solely to address ecological concerns are not warranted at this time. The certainty of effects, particularly for invertebrates is relatively high, given the extremely high concentrations of metals found in soil at the site. The magnitude of the soil concentrations should be considered when discussing the uncertainty, and the need for remedial action. Given the limited spatial extent of contamination, it may be more cost effective to remove the soil than to consider additional studies as recommended in Section 7.7. It should also be noted that the fact that no rare, threatened and endangered species have been confirmed at the site has no bearing on whether any subsequent action (including a no action alternative) will be protective of ecological resources.

Army Response

Comment noted. No revisions necessary.

EPA Comment 25

Table E-13, Lead Worksheet: It appears that the worksheet was used to calculate a risk based remedial goal rather than calculate risk from lead exposure. If the calculated risk is greater than the acceptable level, then calculate a RBRG. The concentration for the model run should be the arithmetic average. Also, EPA recommends using a midrange value for both the GSD and the baseline blood lead level. The worksheet used the low end of the GSD range for a homogenous population. While this may be the current situation, the final document must also consider future risk.

Initial Army Response

At the time the lead evaluation was performed for Building 4343, the Lead Hot Line was contacted for guidance regarding the spreadsheet for "forward" calculations of blood lead levels (Adult Lead Model). It was RFAAP's understanding that USEPA would be developing guidance for applying the model and choosing appropriate exposure parameters. Because this guidance was not available, RFAAP chose to back-calculate a risk-based remediation goal (RBRG) based on the model default parameters and compare the arithmetic mean of the soil lead concentrations to it. This approach was used rather than identifying site-specific parameters for the "forward" calculation, especially for non-standard scenarios such as the maintenance worker (e.g., exposed only one day per week for a total of 50 days).

As of 20 May 2003, USEPA published "Adult Lead Model (ALM) Frequently Asked Questions (FAQs)" on its web site. The FAQs address some of the outstanding issues for calculating the risk from lead exposure (i.e., via "forward" calculations). For example, construction worker exposures are discussed in this document. Additional discussion with the Lead Hotline also indicated that intermittent scenarios (e.g., lawn maintenance worker) would soon be included in the FAQs, but are not yet available.

Based on this new information, the HHRA will be revised by incorporating "forward" calculations into the lead evaluation. The exposure frequency for the construction worker will be adjusted as recommended in the recent guidance and the above comments. The current default parameters for the industrial worker would be expected to be sufficiently conservative for the maintenance worker until further information becomes available for the maintenance worker scenario.

EPA Reaction: Army response is okay.

Additional Army Response

Acceptance of the Army response is noted.

EPA Comment 26

Appendix E-2, Resident Risk Assessment: The risk assessment for the residential scenario was put in a separate appendix, and the results were not discussed in the text of the draft RFI report. EPA recommends that all the risk assessment results be discussed in sections 6 and 8 of the final report. The remedial alternatives in the FS should also address all the current and future potential risks from exposure to the site.

Response

As stated in the HHRA, "Since land use is intended to remain industrial, a residential scenario is not considered to be a reasonably anticipated land use. However, the residential scenario was evaluated to meet "clean closure" requirements under RCRA." Because the industrial scenario is the focus of the decision-making process for the Department of Army (DA), the industrial scenario is presented in the main body of the text. However, RFAAP is willing to move the residential evaluation into Section 6.0 and discuss the results in Section 8.0. The CMS will evaluate current and future potential risks related to the site.

EPA Reaction: Army response is okay.

Additional Army Response
Acceptance of the Army response is noted.

Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, VA 24141
USA

June 27, 2003

Mr. Robert Thomson
U. S. Environmental Protection Agency
Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Subject: Building 4343 RCRA Facility Investigation Report (RFI), Radford Army Ammunition Plant EPA ID# VA1 210020730

Dear Mr. Thomson:

We have received your letter dated June 9, 2003 transmitting final comments on the subject report. The June 9, 2003 letter is a follow-up to a May 28, 2003 conference call among you, Jerry Redder, Jim McKenna, John Tenser and personnel from Shaw Group and URS Corp. where the team discussed draft comments on the Building 4343 RFI report. Since May 28, 2003 we have been revising this report however we cannot complete this effort, as we have not been able to resolve EPA Biological Toxicity Assessment Group (BTAG) comments. Please note we have been attempting to contact the BTAG since May 28, 2003 but have been unable to get a response from them. Attachment 1 contains are our responses to date to the review comments. As the resolution of the BTAG comments is beyond our control we request your office facilitate a conference call among the team members to resolve the BTAG comments and further request an extension of 30 days beyond this date to allow us to incorporate and revise the report.

Please coordinate with and provide any questions or comments to myself at (540) 639-8266, Jerry Redder of my staff (540) 639-7536 or Jim McKenna, ACO Staff (540) 639-8641.

Sincerely,

C. A. Jake, Environmental Manager
Alliant Ammunition and Powder Company LLC

Enclosure

w enclosure

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03-815-108
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ATTACHMENT 1
Response to USEPA Comments dated 09 June 2003
for
Draft Building 4343 RCRA Facility Investigation Report
Dated February 2003

General Comments

EPA Comment 1
The draft RFI Report concludes that the metals detected at the site were not migrating into subsurface soil and that groundwater would not be impacted at the site. It also concludes that the nature and extent of contamination has been determined by the RFI effort. These conclusions can only be reached after the horizontal and vertical extent of contamination at the site has been determined, i.e. at the limit where background concentrations have been realized. It appears that the nature and extent of contamination, as presented in the draft RFI, is defined by the limit of the exceedances above the soil industrial RBC solely. The intent seems to be directed at defining the limits of a removal action. Please note that while this is acceptable for bounding the limits of a removal action, it does not in effect define the limits of contamination for the purpose of closing out the site.

Army Response
Comment noted. The RFI Report will be revised to state "limited migration" of metals into subsurface soil is occurring. Analysis of exceedances of residential RBCs and background 95% UTLs will be added to the report.

RFAAP believes that site characterization and nature and extent should include the delineation of chemical concentrations, as well as, site geology, site history, site processes, fate and transport analysis. Each of these elements are needed to fully evaluate and support nature and extent conclusions. Therefore, RFAAP does not believe that chemical concentrations detected at the site need to be surrounded by additional samples that have concentrations at background levels to be able to make valid nature and extent conclusions and develop risk-based management decisions.

Per discussions with USEPA, the RFI report will be modified to include the CMS.

EPA Comment 2
Please note that the risk screening process should take both the residential and the industrial scenarios into account, and perform the risk screen for both scenarios. This process is needed to ascertain whether a site can be "RCRA-equivalent" clean-closed or not. If a site fails the residential scenario, it cannot undergo "RCRA-equivalent" clean-closure, and may require long-term monitoring and reporting requirements. Given this, it is extremely important to ascertain which constituents exceeded the residential scenario, as the post-removal sampling event can be designed to capture these constituents. In the draft RFI report, the nature and extent assessment focuses on the EPA Region 3 industrial Risk-Based Concentrations (RBCs) exceedances only. Any constituent that had not exceeded the EPA Region 3 industrial RBC was eliminated from further consideration in the nature and extent evaluation, even when constituents exceed other screening criteria (e.g., residential RBC, Soil Screening Levels (SSLs), etc.), have been detected

above detection limits, or exceeded background concentrations. This is misleading. Please revise the RFI Report to discuss why the extent of contamination evaluation was limited to those constituents exceeding the industrial RBC only, and how future efforts will be used to fully define the nature and extent of contamination at Building 4343.

Army Response
Both the residential and industrial risk scenarios are in the report. The residential evaluation will be moved from the appendix to Section 6.0 and discussed. Evaluation of residential RBCs and SSLs will be added to the nature and extent section of the report.

EPA Comment 3
Some of the comparisons required by the screening procedure of the Site Screening Process (SSP) for the Radford Army Ammunition Plant (October 26, 2001) were not conducted. These include the EPA Region 3 SSLs and the EPA Region 3 Biological and Technical Assistance Group (BTAG) Ecological Risk Assessment guidelines. Please revise the RFI Report to compare all the available data to the SSLs and EPA Region 3 BTAG values and revise any conclusion drawn from the current comparisons accordingly.

Army Response
Evaluation of the SSLs will be added to the nature and extent section of the report. Use of BTAG values will be discussed with BTAG (refer to Comment/Response #18).

Specific Comments

EPA Comment 4
Section 2.4, Facility-Wide Background Study: COPCs were eliminated from the risk assessment by comparing the UTL of the background data to on-site data. While this might be appropriate for site screening, in the case of performing a baseline risk assessment, EPA has guidance on the use of statistical tools for background comparison. That guidance is located at http://www.epa.gov/superfund/programs/risk/tooltrad.htm. The expectation is that the statistical analysis will be consistent with this guidance. In general two questions should be answered regarding site contamination compared to background: One, are there any hotspots on site? Two, is the average concentration on site the same or higher than the average concentration of background? Hotspots can be identified by the UTL, which was done in the report. However, there was no comparison of the means. Means comparison should be done by hypothesis testing (t-test, Wilcoxon Rank Sum test, etc.). The guidance outlines which tests are the most appropriate based on the number of samples and the distribution of the data sets.

Army Response
Means comparison will be conducted by hypothesis testing. Such hypothesis testing will include tests for similarities in shape and location between the site and background data sets. Depending on these initial tests, other tests (e.g., t-test, Mann-Whitney U, or Kolmogarov-Smirnov) will be used to assess whether there is a difference between the means. Likewise, statistical procedures will also be used for assessing outliers. **Army response is okay.**

Additional Army Response
Acceptance of the Army response is noted. The Army agrees that hot spots are defined by the UTLs. Means testing will be conducted using guidance at the location noted

above. The purpose of undertaking a facility-wide background study for Radford AAP was to establish a background data set for use in risk assessment. Based on discussions with USEPA early in the RFI process, it is the Army's understanding that the development of a background data set would allow for the elimination of chemicals from further consideration based on comparisons of site concentrations to background data. USEPA's *Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual* (RAGS; USEPA, 1989), Section 5.7, permits the use of background data as a selection criterion for chemicals of potential concern (COPCs). For several constituents, the 95% UTLs are below the RBCs, which will be used to screen COPCs at the site. Those chemicals detected at concentrations below RBCs would be "screened out" of the risk assessment process and would not be carried forward for further quantitative evaluation. Thus, the potential for carrying naturally occurring elements through the quantitative risk assessment would be minimized. The use of UTLs for defining the nature and extent will not change.

EPA Comment 5

Page 4-1. Sample B43SB34A was analyzed for total organic carbon (TOC), grain size and pH to assess the bioavailability and mobility of constituents in soil. EPA recommends that the Army use the TOC and grain size distribution results and apply the principles/equations presented in Appendix D to calculate mobility of Cd and Cr in the soil at the site. The results from the model prediction can support the statement that the metals were not migrating into the subsurface soil to a depth that groundwater would be potentially impacted at the site.

Army Response

The equations provided in Appendix D and in the Soil Screening Level Guidance documents can be used to calculate theoretical soil concentrations that will result in groundwater concentrations below the MCL (or other criteria). These results are useful for sites where there is no or limited geologic information available. Assumptions built into the Appendix D/SSL equations include:

- contamination is uniformly distributed from the ground surface to the top of the aquifer,
- the aquifer is unconfined, and
- there is an infinite source.

Empirical results from site data indicate that cadmium-impacted soil at Building 4343 is primarily confined to the top six feet of soil at the site and that there is approximately 60 feet of clay between the bottom of the contaminated soil and the top of the aquifer. An aquifer under these conditions would be considered confined or semi-confined.

Also, the equations assume that there is no attenuation of contamination in the soil (i.e., no adsorption, no degradation) or in the groundwater. The analytical results from samples at the site indicate that there is adsorption to the clayey soil that is hindering migration.

One of the underlying assumptions in these equations is that the reaction is instantaneous and the system is in equilibrium. Because instantaneous soil-water partitioning is

assumed, results from these equations would show that groundwater is impacted immediately. Therefore, migration rates cannot be estimated from these equations.

Specific calculations are presented in Response to Comment # 16.

A second approach to calculating migration rates would be to use Darcy's Law to calculate rates for the movement of groundwater through soil. Several of the same assumptions built into the SSL equations would apply to this method as well (i.e., no adsorption, no degradation) because the calculation applies to the migration of water through the soil and not the dissolved contaminants.

Using an assumed thickness of 60 ft for the clay above the first aquifer and typical hydraulic conductivities for clay (1E-6 – 1E-9 cm/sec), a theoretical migration time of 57 years (1E-6) to 57,000 (1E-9) years can be calculated.

Because the theoretical approaches incorporate several simplifying assumptions that are not valid at Building 4343, an empirical approach has been adopted instead. Using a maximum timeframe of 40 years for the addition of cadmium to the site soil, and a maximum depth of elevated cadmium concentrations of 6 feet, a migration time of 400 years can be calculated. This rate assumes a linear migration rate, and also does not account for attenuation within the soil column.

EPA Comment 6

Section 4.2.2, Nature and Extent Summary, page 4-12: The third paragraph on this page states "these data suggest that vertical migration of contaminants has not occurred at this location [B43SB35]." This statement is misleading as the subsurface (4 to 6 feet) data presented for this location indicate that aluminum was detected at 38,000 mg/kg, chromium at 95 mg/kg (exceeding background concentration), iron at 37,800 mg/kg, vanadium at 75 mg/kg and cadmium at 37.7 mg/kg (exceeding background concentration). Since no surface samples were analyzed for this location and the subsurface sample shows detection of several metals and no sample below this surface sample was collected, it is inappropriate to conclude that vertical migration of contaminants has not occurred. Please revise the language in the RFI Report to conclude that no exceedances of the industrial RBCs for metals were detected in the subsurface soil.

Army Response

The sentence preceding "these data...." states that "No exceedances of industrial RBCs for metals were detected in the subsurface soil samples." It is emphasized throughout the text of this report and in WPA 12 that the contamination assessment and fate and transport analysis would be based on industrial RBC exceedances. None of the concentrations mentioned in the comment exceed industrial RBCs. The paragraph also mentions that previous soil samples have been collected at this location (referencing Figure 2-3). The preceding paragraph references another sample (4343-05-SVR) collected in the vicinity of the former lead catch tank and references Figure 2-2. Although not directly comparable, TCLP cadmium exceedances ranged from values of 3,890 µg/L and 36,800 µg/L in surface soil at that location. Sample B43SB22A collected at 2-4 ft bgs at the same location as B43SB35B, shows a concentration of cadmium of 57.1 mg/kg. Sample B43SB35B, collected at 4-6 ft bgs shows a cadmium concentration of 37.7 mg/kg. This is a greater than 60 percent decrease in cadmium over two feet of vertical depth. Aluminum,

iron, and vanadium concentrations at this location, although above background and residential RBCs, have not shown a pattern of widespread distribution at the site and have not been identified as constituents of concern. It is RFAAP's intent to remove the source area present at Building 4343 using real-time and/or near real-time sampling methods to assess concentrations of metals in the soil. As previously stated, a thorough discussion of the removal action, including PRGs will occur in the CMS.

RFAAP is willing to modify the statement in the RFI report to read "it appears that vertical migration of contaminants to six feet or less has occurred at this location, with no exceedances of industrial RBCs." **Army response is okay.**

Additional Army Response
Acceptance of the Army response is noted.

EPA Comment 7
Section 4.2.2, Nature and Extent Summary, on page 4-12 discusses the results from the 2002 investigation. The section states that polycyclic aromatic hydrocarbons (PAHs), pesticides, and PCBs were detected, but did not exceed industrial RBCs. It was therefore concluded that these compounds are not a concern at this site. It appears that these criteria were used to eliminate these compounds from consideration in the ecological risk assessment (ERA) since only metals were evaluated. Comparison to RBCs (human health criteria) does not address the potential for ecological risk from these chemicals. Therefore, any detected chemicals should be evaluated in the ERA before deciding that they are not at concentrations of concern.

Army Response
RFAAP agrees with this comment. The nature and extent analysis was not used to eliminate compounds from the SLERA. However, analysis of the PAH and pesticide data was inadvertently left out of the report. The report will be revised so that detected chemicals are evaluated and discussed in the SLERA. **Army response is okay.**

Additional Army Response
Acceptance of the Army response is noted.

EPA Comment 8
Table 4-3, Soil Sample Summary, pages 4-10 and 4-11: Please revise this table to remove the "zeros" entered for the number of background exceedances for other than the inorganics.

Army Response
Zeros will be replaced with N/A (not applicable) in the column for background exceedances other than inorganics. **Army response is okay.**

Additional Army Response
Acceptance of the Army response is noted.

EPA Comment 9
Section 4.2.2, Nature and Extent Summary, page 4-13: The third paragraph on this page states that "the results from these borings indicate that cadmium is moving downslope along the ditch, but is not migrating vertically or laterally through soil bounding the ditch. The results are similar

to the boring collected at the lead catch tank (sample B43SB35), supporting the absence of vertical migration of cadmium through the clayey site soil." These conclusions are not supported by data as the vertical and horizontal extent of cadmium contamination at the site has not been fully determined. Based on the RFI data presented in Figures 2-3 and 4-2, the vertical extent of cadmium contamination, i.e. the level at which cadmium is present at background, has not been determined at sample locations B43SB22A (57.1 mg/kg), B43SB21A (4.7 mg/kg), B43SB4A (2.9 mg/kg), B43SSD1 (24,300 mg/kg), B43SSD2 (157 mg/kg), B43SSD3 (124 mg/kg), B43SSD4 (134 mg/kg), B43SSD5 (222 mg/kg), B43SSD6 (1040 mg/kg), B43SB34B (18.5 mg/kg), B43SB14A (191 mg/kg), B43SB26A (9.9 mg/kg), B43SB35B (37.7 mg/kg), B43SS01 (107 mg/kg), B43SB18A (3.2 mg/kg), B43SB33A (10.5 mg/kg) and B43SS02 (273 mg/kg). Similarly, the horizontal extent of cadmium contamination has not been determined at sample locations B43SSD1 (east and west extent not determined), B43SSD2 (east and west), B43SSD3 (east and west), B43SSD5 (east and west), B43SSD6 (east), B43SB14A (east), B43SB26A (east and west), B43SB35B (east), B43SS01 (east, west and south), B43SB18A (north), and B43SS02 (north and east within the drainage ditch). In addition the vertical and horizontal extent of other metals has not been determined at these and other locations presented on Figures 2-3 and 4-2. The RFI appears to concentrate on exceedances of the industrial soil RBCs. While this might serve to define the limits of a removal area, it does not define the nature and extent of contamination that would be required to effectively "clean-close" the site. Please discuss in the RFI how this would be accomplished in the future.

Army Response

As noted in Response to Comment #1, RFAAP does not believe that chemical concentrations detected at the site need to be surrounded by additional samples that have concentrations at background levels to be able to make valid nature and extent conclusions and develop risk-based management decisions. Specific examples are presented below.

Vertical Extent

The two samples, B43SB22A and B43SB35B, near Building 4343 still show elevated concentrations in the subsurface at one of the most impacted areas (near the former lead catch tank). However, these two samples show a greater than 60% decrease in concentration from the 2-4 foot interval to the 4-6 foot interval. For the other two samples, B43SB21A (cadmium 4.7 mg/kg) is slightly above the residential RBC (3.9 mg/kg) and B43SB4A (cadmium 2.9 mg/kg) is below the residential criteria. Further, looking at the surface sample collected above B43SB4A, sample B43SSB4 shows a concentration of 16.2 mg/kg, again demonstrating that cadmium concentrations demonstrate a rapid decrease (greater than 80% decrease from the surface to 2-4 ft bgs).

The process water ditch samples mentioned (B43SSD1 through B43SSD6) also demonstrate a pattern. Samples in depositional areas, i.e., the effluent outfall (B43SSD1) and the alluvial fan (B43SSD6) showing much greater concentrations than the samples collected along the ditch (transit area). Samples in the middle part of the ditch show very consistent concentrations (124 - 222 mg/kg), demonstrating that borings collected outside the trench should not have to be positioned directly opposite sample locations inside the ditch to characterize migration of cadmium concentrations through soil in a vertical or horizontal direction.

Samples such as B43SB34B (18.5 mg/kg) and B43SB26A (9.9 mg/kg) show low concentrations that, to reiterate previous discussions regarding site-specific conditions, indicate rapidly decreasing concentrations within a few feet of vertical depth. Samples B43SB14A (subsurface from a broken pipe) and B43SS01 (low spot collecting runoff from the parking lot) do demonstrate areas of elevated concentrations, but again at concentrations that would be expected to decrease rapidly within 2-4 feet. These concentrations would be more easily refined during the probable remedial action (excavation/post-excavation sampling event).

Horizontal Extent

For horizontal extent characterization, process water ditch samples B43SSD2 through B43SSD5 show a fairly consistent cadmium concentration (157 mg/kg, 124 mg/kg, 134 mg/kg, and 222 mg/kg over a stretch of approximately 125 feet). A correlation could be made that concentrations would be similar along this length of ditch such that borings along the outside of the ditch should not have to be positioned directly opposite the trench samples. Five borings were positioned along and outside the trench. Sample results at 2-4 ft (these would be below the bottom of the trench) indicate cadmium concentrations of B43SB25A - ND, B43SB15A - ND, B43SB26A - 9.9 mg/kg, B43SB27A - ND, and B43SB28A - ND. RFAAP believes that the correlation can be made that these sample results show very little horizontal or vertical movement of cadmium concentrations outside the trench and do bound the horizontal and vertical extent sufficiently in this area.

Samples B43SB14A, B43SB35B and B43SS01 have been discussed previously, and again, RFAAP would argue that the horizontal extent is sufficiently characterized to move forward to a removal action. Sample B43SS02 is bounded to the east by the ND in sample B43SS03. There does not seem to be a reason to believe that cadmium concentrations would move upgradient past the west-east stormwater ditch.

Additional analysis of residential RBCs and background comparison criteria exceedances will be added to the nature and extent section of the report. Information contained in this response will also be added to the report to support the position that nature and extent has been characterized to the appropriate level.

EPA Comment 10

Section 4.2.2, Nature and Extent Summary, page 4-13: The fourth paragraph on page 4-13 states that "there were no industrial exceedances of cadmium and arsenic concentrations were below background in the subsurface samples collected in the alluvial fan area. Again indicating a lack of vertical migration." It is not clear how this conclusion was reached when the vertical extent of cadmium contamination was not determined at most of the sample locations in the alluvial fan area as pointed out in the above comment. The phrase "lack of vertical migration" should be revised.

Army Response

Twelve samples at seven locations were collected in the alluvial fan area of the site. This is an area approximately 75 feet long by 100 feet at its greatest width. The actual square foot area would be half of this (75 x 100 ÷ 2) because the fan is shaped like a triangle. An additional nine samples at five locations were collected surrounding the delta. In surface soil samples, there

were four cadmium detections at 1,040 mg/kg, 339 mg/kg, 273 mg/kg, and 137 mg/kg. In four subsurface samples (three at 2-4 ft bgs and one at 4-6 ft bgs), cadmium concentrations were 18.5 mg/kg, 15.9 mg/kg, 10.5 mg/kg and 3.2 mg/kg. This data provides empirical proof that cadmium concentrations are reduced by 90-95% from surface concentrations within the first six feet of depth. While RFAAP agrees that there are no borings with exclusively background concentrations below 6 ft bgs, the subsurface concentrations are below the unadjusted residential RBC of 39 mg/kg and are close to the adjusted (by a factor of 10) residential RBC of 3.9 mg/kg. RFAAP recommends that it is most appropriate to compare cadmium, as the sole constituent of concern in the delta area, to the unadjusted residential RBC.

Regardless, the data supports assessing the cadmium concentrations as attenuating rapidly with depth and that there is no reason to believe that concentrations would be increasing deeper than 6 ft bgs. Therefore, it is RFAAP's position that sufficient data exists to make remedial decisions and that the effort to conduct an additional investigation to define the window between the adjusted residential RBC of 3.9 mg/kg and the average 12 mg/kg cadmium concentrations in the 2-6 ft bgs soil horizon is unnecessary and counterproductive to maintaining progress towards a clean up action at this site. RFAAP proposes to revise the phrase "lack of vertical migration" to read "the vertical migration and cadmium concentrations quickly attenuate at a depth of four feet." **Army response is okay.**

Additional Army Response
Acceptance of the Army response is noted.

EPA Comment 11
Section 4.2.2.1, Nature and Extent Conclusions, page 4-13: It is stated at the bottom of this page that cadmium is not moving into the stormwater drainage system bordering the site. This is inaccurate as cadmium was detected in the stormwater drainage system at sample location B43SS02 at the concentration of 273 mg/kg, exceeding the industrial RBC. Also, on page 4-14, it is stated that "the lack of exceedances of cadmium in subsurface soil and the fact that groundwater was not encountered at the site (down to 60 ft. bgs) indicates that groundwater would not be impacted at this site." Since the vertical extent of cadmium contamination is not determined and groundwater condition at the site is unknown, it is premature to make such a conclusion. Please remove these statements from the RFI Report.

Army Response
Text will be clarified to state "while there were industrial RBC exceedances of cadmium in two surface soil samples located where the alluvial fan meets the stormwater drainage ditch, samples collected in the drainage ditch to the east and west of the alluvial fan indicate that cadmium is not being transported in the drainage system outside the boundaries of the alluvial fan."

RFAAP's position is that the vertical extent of cadmium concentrations has been established to a sufficient degree (see previous responses). Empirical evidence demonstrates that 95% of cadmium concentrations in surface soil do not go beyond 2-4 ft bgs. Borings through 60 feet of dense clay that underlie the site and associated chemical analyses provide empirical evidence that cadmium is not migrating beyond the near surface. It is significant to note that groundwater was not encountered while advancing the 60 foot boring. Given the absence of groundwater and no evidence of deep vertical migration the assertion that groundwater would not be impacted by cadmium releases at the surface is a reasonable and logical conclusion. **Army response is okay.**

Additional Army Response
Acceptance of the Army response is noted.

EPA Comment 12
Section 5.0, Contaminant Fate and Transport, page 5-1: The last paragraph on this page states that "arsenic was detected above the industrial RBC (3.8 mg/kg) in 15 soil samples collected from the site. The surface concentrations of arsenic that exceeded the industrial RBC ranged from 3.8 (B43SSD4) to 5.6 (B43SSB10) mg/kg." Based on data presented in Figures 2-3 and 4-2, only two surface soil samples (excluding the two sludge samples B43SL1 and B43SL2) for arsenic exceeded industrial RBC at the concentrations of 4.0 mg/kg (B43SSB28) and 5.0 mg/kg (B43SS01). According to these figures, no arsenic was detected at the reported sampling locations (B43SSD4 and B43SSB10).

It is further stated in this paragraph that arsenic was detected above the industrial RBC in 16 surface subsurface soil samples with a range of 3.9 mg/kg to 9.4 mg/kg. Based on the data presented in Figures 2-3 and 4-2, only seven subsurface samples exceeded the arsenic industrial RBC with the range reported. In addition, Table 4-3 documents 33 exceedances of the industrial RBC for arsenic. However, the location of these exceedances (other than the 9 discussed above) is not shown on the figures.

Please revise the RFI Report to resolve these discrepancies and correct the text, figures and tables accordingly.

Army Response
The text and tables are correct. The figures will be revised. Since the figures were developed to present chemicals and concentrations of concern, only those arsenic concentrations greater than background will be presented on the figures. **Army response is okay.**

Additional Army Response
Acceptance of the Army response is noted.

EPA Comment 13
Section 5.0, Contaminant Fate and Transport, page 5-2: The fourth paragraph on page 5-2 states, "it would appear that numerous detections of arsenic at low concentrations in both surface and subsurface soil at the Building 4343 study area is the result of natural soil conditions not related to site activity. The sludge contained within two separate concrete sumps is prevented from migration into the surrounding soil." Since arsenic was detected at a concentration twice the background in the sludge sample (B43SL1), it is inaccurate to conclude that arsenic is the result of natural soil conditions not related to site activity. Also, since the integrity of the sumps has not been investigated and their conditions have not been discussed in the RFI Report, it is inappropriate and premature to conclude that sludge contained in the sumps is prevented from migration into the soil. Please revise the RFI Report to discuss the integrity of the two sumps. Additionally, if a removal of the sumps is planned, please discuss in the RFI and provide for post-removal sampling below the sumps immediately following their removal.

Army Response

The conclusion that low arsenic concentrations are the result of natural soil conditions will be revised in the report.

The following information on the sumps will be added:

"Inspections of both the interior and exterior sumps prior to sampling gave no indication that there were cracks or breaks in the either of the sumps and no indications of pathways to the subsurface through the sumps. Photographs taken during sludge sampling activities at Building 4343 illustrating the integrity of the sumps are provided below."



Photograph of interior sump during sludge sampling.



Photograph of exterior sump during sludge sampling.

Since arsenic concentrations collected from soil outside the sumps were below the background concentration, the conclusion that arsenic is not a concern at the site remains valid.

Soil samples have been collected at both surface and subsurface locations near to and downgradient of the sumps. The lack of widespread exceedances of most metals except cadmium (and secondarily, chromium) provides indication as to the integrity of the sumps. A removal action is programmed for this site and removal/cleaning of the sumps would be part of this action. Post-removal confirmation sampling would insure that elevated concentrations of metals in soil surrounding the sumps would be identified.

Information on Building 4343 and cadmium plating in general do not indicate the direct use of arsenic or arsenic compounds. Therefore, arsenic is considered a trace contaminant. The probable source of the arsenic in the sumps is identified in Section 2.2 Site History, "This process would also cause trace metals to precipitate and form the sludge contained in the process sumps."

Discussion of the removal of the sumps during proposed remedial actions and post remedial sampling will be added to the text of the report.

EPA Comment 14

Page 5-3: The statement that "Chromium was not used in the plating process and is more likely associated with the acid cleaning of metal parts and as a tract contaminant" is confusing and needs to be modified. Especially in light of the statement on page 2-6, which states that "Rinse

water from the cadmium plating operations was process water containing cyanide, cadmium, and chromium."

Army Response
The text will be clarified to indicate that cadmium (ingots) was the sole metal used in the plating process. However, metal parts that may have contained chromium would have been subjected to acid baths for cleaning prior to cadmium plating. This process would be the probable source of chromium in the process water.

EPA Comment 15
Figure 5-2: Please indicate the groundwater elevation on Figure 5-2. This can be done by extrapolation from the neighboring SWMU or close-by wells, as long as a reference map or figure is accompanied showing how the estimated groundwater elevation was obtained. Also, there should be a map showing the location of Building 4343 within the RFAAP.

Army Response
The requested revisions will be made to the report.

EPA Comment 16
Section 5.3, Subsurface Soil Fate and Transport, page 5-4: The last paragraph on page 5-4 states, "cadmium has a default SSL soil transfer to groundwater value of 27 mg/kg. None of the subsurface cadmium concentrations exceeded this number, further indicating that the vertical migration of cadmium to a potential deep aquifer is unlikely." Based on data presented on Figures 2-3 and 4-2, cadmium concentrations at three subsurface sample locations B43SB22A (57.1 mg/kg), B43SB14A (191 mg/kg) and B43SB35B (37.7 mg/kg) exceed the unadjusted EPA Region 3 SSL value (for DAF 20) of 27 mg/kg. When the SSL value is adjusted down by a factor of 10 as required for EPA Region 3 Superfund sites, additional four subsurface sample locations B43SB21A (4.7 mg/kg), B43SB4A (2.9 mg/kg), B43SB18A (3.2 mg/kg) and B43SB34B (18.5 mg/kg) exceed the SSL value of 2.7 mg/kg. Thus, based on the use of SSLs with the data provided in the RFI Report, it cannot be concluded that the potential for further vertical of migration of cadmium and impact on groundwater is unlikely. However, rather than using the SSLs, EPA recommends that the Army use the TOC and grain size distribution results and apply the principles/equations presented in Appendix D to calculate mobility of cadmium and chromium in the soil at the site. The results from the model prediction can be used to support the statement that the metals were not migrating into the subsurface soil to a depth that groundwater would be potentially impacted at the site.

Army Response
RFAAP agrees that there are three subsurface sample locations that exceed the cadmium SSL soil transfer to groundwater value of 27 mg/kg. The location of the greatest exceedance (B43SB14A, 191 mg/kg) is believed to be the result of a broken subsurface pipe and not the result of migration of cadmium from the surface (see first paragraph on page 4-13). The other two samples are both near the same location next to Building 4343 and concentrations are lower (57.1 mg/kg and 37.7 mg/kg). While these SSL exceedances indicate a theoretical potential for impact to groundwater, empirical evidence in the form of 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. The following information:

- There is no groundwater present at the site within 60 feet of the surface,
- Site soil down to 60 feet is composed of tight clays and silts,
- Evidence that chemicals of concern are adsorbing to surface and near surface clay and demonstrating limited mobility (except by surface water transport in the process water ditch),
- Chemical data from 58-60 ft bgs show no elevated concentrations for chemicals of concern, and
- Surface concentrations of chemicals of concern decrease by 95% within the first six feet of soil,

provides solid evidence for the statement "the potential for further vertical migration of cadmium and impact on groundwater is unlikely."

Applying the SSL calculations with site-specific data for the three locations noted in the comment results in the following:

Sample ID	pH	SSL (mg/kg)	Actual Conc. (mg/kg)
B43SB22A	6.95	11	57.1
B43SB35B	5.95	3.7	37.7
B43SB14A	8.35	430	191
Site Average	6.39	4.8	--

These calculations show a range of 3.7 to 430 mg/kg for a site specific SSL. Total organic carbon and grain size are used in the SSL calculations for organic constituents, but are not used in the inorganic equations.

RFAAP has reviewed SSL documentation and guidance (Soil Screening Guidance: User's Guide, EPA, July 1996, Soil Screening Guidance: Fact Sheet, July 1996, USEPA Region III memo, 27 October 99) and cannot find the referenced requirement to adjust SSL values downward by a factor of 10. While the guidance does recognize that there may be cumulative risks from noncarcinogenic contaminants, it further states that "noncancer risks should be added only for those chemicals with the same toxic endpoint or mechanism." Since cadmium is the sole chemical of concern that affects the kidney (target organ/system), the further requirement to adjust the SSL down by a factor of 10 does not seem appropriate. In conclusion, RFAAP believes that the appropriate use of SSLs is for the screening of new sites with limited data. RFAAP further believes that the data collected in two investigations provides a sufficient data set that supercedes the need for SSLs as a screening tool.

EPA Comment 17
Section 6.0, Human Health Risk Assessment, Table 6-1, Selection of Exposure Pathways:
For the "current" scenario time frame, a trespasser is not identified as a receptor. Please explain why a trespasser is not considered a receptor under the current scenario.

In addition, for the "current and future" and "future" scenarios, it is indicated that no analysis will be conducted for the trespasser "due to security at the installation, trespasser exposures are unlikely. However, the maintenance worker scenario would be protective of the limited exposure that would be experienced by a trespasser." It is not clear how the maintenance worker (an adult) scenario would be protective of a child/adolescent trespasser, unless the child/adolescent trespasser is separately considered. Please clarify this issue.

For the "sludge" medium, the exposure pathway for maintenance excavation worker is excluded from analysis because "excavation worker would not be expected to have constant exposures to the sumps" and "exposures to sludge could not be quantified for this receptor." Please provide additional explanation why this pathway for this medium is excluded from consideration. The reasons provided are not clear. If a removal action is planned, then the removal of the sumps would eliminate them for consideration of a complete pathway. Please discuss in the revised RFI.

Army Response
"Current" exposures were assumed to continue in the "future". These exposures were referred to "current and future" exposures. There was no separate category for "current" exposures.

Text will be added to Section 6.2.1 to clarify the level of security at the Installation. Given the rigorous security at Radford AAP (e.g., strict security at entry gates, guard towers, barbed-wire fences), it is not reasonable to assume that children would be able to trespass at the Installation. Hypothetical future exposures to children were considered, however, in the residential scenario that was evaluated in Appendix E. The exposure parameters for residents are more conservative than those for trespassers.

It would also be extremely difficult for an adolescent to trespass at the site. Even if an older adolescent were able to evade security measures, it would be very difficult to do so on a routine basis. The frequency and duration of exposure for the maintenance worker is 50 days per year (i.e., once per week, except for two weeks while on vacation) and 25 years, respectively.

Because the sumps are below grates and not easily accessible, it is not reasonable to assume that a worker would be exposed to sludge in the sumps on a routine basis. The most likely exposure to sludge would occur during removal of the sumps, which would be a one-time occurrence and should involve the use of personal protective equipment (e.g., gloves, boots, clothing). **Army response is okay**.

Additional Army Response
Acceptance of the Army response is noted.

EPA Comment 18
Section 7.0, Ecological Risk Assessment: Section 7.7, Results and Conclusions, concludes "based on uncertainties of toxicity, and on the fact that no wildlife RTE [rare, threatened and endangered] species have been confirmed at the Building 4343 study area, remedial measures solely to address ecological concerns are not warranted at this time for soil." Page 7-1 of this section describes the scientific/management decision point (SMDP) expected to be reached from the conduct of the Screening Level Ecological Risk Assessment. The conclusion drawn do not reflect these SMDPs. It is detailed in Section 7.1 of the RFI Report that five representative

receptor species are expected or possible in the area of Building 4343 and were used as selected indicator species for the potential effects of the constituents of potential ecological concerns. The assessment concluded potential adverse impacts to terrestrial wildlife, especially robins, shrews, and voles for potential exposure to primarily cadmium in surface soil. Therefore, the ecological concerns should be addressed. However, since the RFI Report stipulates that the chemical-specific preliminary remediation goals developed for human health may address the ecological concern, EPA reserves the right to pursue addressing the ecological concern at this site after review of the remedial action for the human health concern.

Army Response
Per teleconference with Rob Thomson (28 May 2003), the Army was requested by USEPA to contact BTAG directly to discuss comments relating to the ecological risk assessment for Building 4343. Numerous attempts have been made by the USACE to contact BTAG members with no success. Messages have been left with John McCloskey on 28 May; 04, 09, 12, and 20 June 2003. Numerous other phone calls have occurred with no message being left. To date there have been no returned phone calls. This effort is ongoing.

EPA Comment 19
Section 7.2.5, Comparison to Risk-Based Screening Ecotoxicity Values, on page 7-11 lists the screening values that were used to assess risk to terrestrial receptors. EPA Region III BTAG values were not used to evaluate risk. For the screening ERA, BTAG strongly recommends that BTAG screening values be used to evaluate risk to terrestrial receptors. Other values will be considered if no BTAG value is available.

Army Response
Refer to Response to Comment #18.

EPA Comment 20
Section 7.2.5, Comparison to Risk-Based Screening Ecotoxicity Values, on page 7-11 states that aluminum was not selected as a contaminant of potential ecological concern (COPEC), since this metal should only be identified as a COPEC for those sites with soil pH less than 5.5. The section also states that of the 24 surface soil samples that had pH measured, four were below a pH of 5.5 (e.g., 5.03, 5.20, 5.25, and 5.35), therefore because the average pH (5.8) is less than 5.5, aluminum was not selected as a COPEC. Because four samples had a pH less than 5.5, potential risk from aluminum at these specific locations should be further evaluated before eliminating from additional consideration.

Army Response
Refer to Response to Comment #18.

EPA Comment 21
Section 7.4.1, Assessment Endpoints, on page 7-18 discusses the assessment endpoints that will be evaluated in the ERA. Protection of terrestrial invertebrates (e.g., earthworms) should be listed as an assessment endpoint from direct exposure to soils. The measurement endpoint would be a comparison of soil concentrations to BTAG screening values. Currently the ERA only evaluates risk to upper trophic level receptors exposed through the food chain and does not evaluate direct toxicity to soil invertebrates.

Army Response
Refer to Response to Comment #18.

EPA Comment 22
Section 7.6, Uncertainty Analysis, on page 7-26 states that chemical results from two Building 4343 sump samples were not included in the ERA because no ecological exposure is expected to these sumps. While direct exposure may not be likely, they still need to be considered as a source area to downgradient areas if migration from these locations could occur. Please discuss the possible removal of the sumps and any planned post-removal sampling of the soil remaining at the site.

Army Response
Discussion of the removal of the sumps during proposed remedial actions and post-remedial sampling will be added to the text of the report.

EPA Comment 23
Section 8.0, Summary and Conclusions, on page 8-1 states that the results of the ERA indicate the potential for adverse effects to the five wildlife receptors evaluated as part of the food chain modeling. As stated earlier, direct toxicity to soil invertebrates should also be evaluated as part of the ERA.

Army Response
Refer to Response to Comment #18.

EPA Comment 24
Section 8.0 also states that based on the uncertainties of toxicity, and on the fact that no rare, threatened and endangered species have been confirmed at the site, remedial measures solely to address ecological concerns are not warranted at this time. The certainty of effects, particularly for invertebrates is relatively high, given the extremely high concentrations of metals found in soil at the site. The magnitude of the soil concentrations should be considered when discussing the uncertainty, and the need for remedial action. Given the limited spatial extent of contamination, it may be more cost effective to remove the soil than to consider additional studies as recommended in Section 7.7. It should also be noted that the fact that no rare, threatened and endangered species have been confirmed at the site has no bearing on whether any subsequent action (including a no action alternative) will be protective of ecological resources.

Army Response
Comment noted.

EPA Comment 25
Table E-13, Lead Worksheet: It appears that the worksheet was used to calculate a risk based remedial goal rather than calculate risk from lead exposure. If the calculated risk is greater than the acceptable level, then calculate a RBRG. The concentration for the model run should be the arithmetic average. Also, EPA recommends using a midrange value for both the GSD and the baseline blood lead level. The worksheet used the low end of the GSD range for a homogenous

population. While this may be the current situation, the final document must also consider future risk.

Army Response
At the time the lead evaluation was performed for Building 4343, the Lead Hot Line was contacted for guidance regarding the spreadsheet for "forward" calculations of blood lead levels (Adult Lead Model). It was RFAAP's understanding that USEPA would be developing guidance for applying the model and choosing appropriate exposure parameters. Because this guidance was not available, RFAAP chose to back-calculate a risk-based remediation goal (RBRG) based on the model default parameters and compare the arithmetic mean of the soil lead concentrations to it. This approach was used rather than identifying site-specific parameters for the "forward" calculation, especially for non-standard scenarios such as the maintenance worker (e.g., exposed only one day per week for a total of 50 days).

As of 20 May 2003, USEPA published "Adult Lead Model (ALM) Frequently Asked Questions (FAQs)" on its web site. The FAQs address some of the outstanding issues for calculating the risk from lead exposure (i.e., via "forward" calculations). For example, construction worker exposures are discussed in this document. Additional discussion with the Lead Hotline also indicated that intermittent scenarios (e.g., lawn maintenance worker) would soon be included in the FAQs, but are not yet available.

Based on this new information, the HHRA will be revised by incorporating "forward" calculations into the lead evaluation. The exposure frequency for the construction worker will be adjusted as recommended in the recent guidance and the above comments. The current default parameters for the industrial worker would be expected to be sufficiently conservative for the maintenance worker until further information becomes available for the maintenance worker scenario. **Army response is okay.**

Additional Army Response
Acceptance of the Army response is noted.

EPA Comment 26
Appendix E-2, Resident Risk Assessment: The risk assessment for the residential scenario was put in a separate appendix, and the results were not discussed in the text of the draft RFI report. EPA recommends that all the risk assessment results be discussed in sections 6 and 8 of the final report. The remedial alternatives in the FS should also address all the current and future potential risks from exposure to the site.

Army Response
As stated in the HHRA, "Since land use is intended to remain industrial, a residential scenario is not considered to be a reasonably anticipated land use. However, the residential scenario was evaluated to meet "clean closure" requirements under RCRA." Because the industrial scenario is the focus of the decision-making process for the Department of Army (DA), the industrial scenario is presented in the main body of the text. However, RFAAP is willing to move the residential evaluation into Section 6.0 and discuss the results in Section 8.0. The CMS will evaluate current and future potential risks related to the site. **Army response is okay.**

Additional Army Response
Acceptance of the Army response is noted.

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

June 9, 2003

In reply
Refer to 3HS13

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

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

C.A. Jake
Environmental Manager
Alliant Techsystems, Inc.
Radford Army Ammunition Plant
P.O. Box 1
Radford, VA 24141-0100

Re: Radford Army Ammunition Plant
Building 4343 *RFI Report*
Document submittal and review

Dear Mr. McKenna and Ms. Jake:

The U.S. Environmental Protection Agency (EPA) has reviewed the Army's draft *RFI Report* for Building 4343, located at the Radford Army Ammunition Plant (RFAAP). Outlined below, please find EPA's comments based upon that review:

General Comments

1. The draft RFI Report concludes that the metals detected at the site were not migrating into subsurface soil and that groundwater would not be impacted at the site. It also concludes that the nature and extent of contamination has been determined by the RFI effort. These conclusions can only be reached after the horizontal and vertical extent of contamination at the site has been determined, i.e. at the limit where background concentrations have been realized. It appears that the nature and extent of contamination, as presented in the draft RFI, is defined by the limit of the exceedances above the soil

industrial RBC solely. The intent seems to be directed at defining the limits of a removal action. Please note that while this is acceptable for bounding the limits of a removal action, it does not in effect define the limits of contamination for the purpose of closing out the site.

2. Please note that the risk screening process should take both the residential and the industrial scenarios into account, and perform the risk screen for both scenarios. This process is needed to ascertain whether a site can be "RCRA-equivalent" clean-closed or not. If a site fails the residential scenario, it cannot undergo "RCRA-equivalent" clean-closure, and may require long-term monitoring and reporting requirements. Given this, it is extremely important to ascertain which constituents exceeded the residential scenario, as the post-removal sampling event can be designed to capture these constituents. In the draft RFI report, the nature and extent assessment focuses on the EPA Region 3 industrial Risk-Based Concentrations (RBCs) exceedances only. Any constituent that had not exceeded the EPA Region 3 industrial RBC was eliminated from further consideration in the nature and extent evaluation, even when constituents exceed other screening criteria (e.g., residential RBC, Soil Screening Levels (SSLs), etc.), have been detected above detection limits, or exceeded background concentrations. This is misleading. Please revise the RFI Report to discuss why the extent of contamination evaluation was limited to those constituents exceeding the industrial RBC only, and how future efforts will be used to fully define the nature and extent of contamination at Building 4343.

3. Some of the comparisons required by the screening procedure of the Site Screening Process (SSP) for the Radford Army Ammunition Plant (October 26, 2001) were not conducted. These include the EPA Region 3 SSLs and the EPA Region 3 Biological and Technical Assistance Group (BTAG) Ecological Risk Assessment guidelines. Please revise the RFI Report to compare all the available data to the SSLs and EPA Region 3 BTAG values and revise any conclusion drawn from the current comparisons accordingly.

Specific Comments

4. **Section 2.4, Facility-Wide Background Study:** COPCs were eliminated from the risk assessment by comparing the UTL of the background data to on-site data. While this might be appropriate for site screening, in the case of performing a baseline risk assessment, EPA has guidance on the use of statistical tools for background comparison. That guidance is located at http://www.epa.gov/superfund/programs/risk/tooltrad.htm. The expectation is that the statistical analysis will be consistent with this guidance. In general two questions should be answered regarding site contamination compared to background: One, are there any hotspots on site? Two, is the average concentration on site the same or higher than the average concentration of background? Hotspots can be identified by the UTL, which was done in the report. However, there was no comparison of the means. Means comparison should be done by hypothesis testing (t-test, Wilcoxon Rank Sum test, etc.). The guidance outlines which tests are the most appropriate based on the number of samples and the distribution of the data sets.

Army Response: Means comparison will be conducted by hypothesis testing. Such hypothesis testing will include tests for similarities in shape and location between the site and background data sets. Depending on these initial tests, other tests (e.g., t-test, Mann-Whitney U, or Kolmogarov-Smirnov) will be used to assess whether there is a difference between the means. Likewise, statistical procedures will also be used for assessing outliers. **Army response is okay.**

5. **Page 4-1.** Sample B43SB34A was analyzed for total organic carbon (TOC), grain size and pH to assess the bioavailability and mobility of constituents in soil. EPA recommends that the Army use the TOC and grain size distribution results and apply the principles/equations presented in Appendix D to calculate mobility of Cd and Cr in the soil at the site. The results from the model prediction can support the statement that the metals were not migrating into the subsurface soil to a depth that groundwater would be potentially impacted at the site.

6. **Section 4.2.2, Nature and Extent Summary, page 4-12:** The third paragraph on this page states "these data suggest that vertical migration of contaminants has not occurred at this location [B43SB35]." This statement is misleading as the subsurface (4 to 6 feet) data presented for this location indicate that aluminum was detected at 38,000 mg/kg, chromium at 95 mg/kg (exceeding background concentration), iron at 37,800 mg/kg, vanadium at 75 mg/kg and cadmium at 37.7 mg/kg (exceeding background concentration). Since no surface samples were analyzed for this location and the subsurface sample shows detection of several metals and no sample below this surface sample was collected, it is inappropriate to conclude that vertical migration of contaminants has not occurred. Please revise the language in the RFI Report to conclude that no exceedances of the industrial RBCs for metals were detected in the subsurface soil.

   Army Response :The sentence preceding "these data...." states that "No exceedances of industrial RBCs for metals were detected in the subsurface soil samples." It is clearly stated throughout the text of this report and in WPA 12 that the contamination assessment and fate and transport analysis would be based on industrial RBC exceedances. None of the concentrations mentioned in the comment exceed industrial RBCs. The paragraph also clearly states that previous soil samples have been collected at this location (referencing Figure 2-3). The preceding paragraph references another sample (4343-05-SVR) collected in the vicinity of the former lead catch tank and references Figure 2-2. Although not directly comparable, TCLP cadmium exceedances ranged from values of 3,890 µg/L and 36,800 µg/L in surface soil at that location. Sample B43SB22A collected at 2-4 ft bgs at the same location as B43SB35B, shows a concentration of cadmium of 57.1 mg/kg. Sample B43SB35B, collected at 4-6 ft bgs shows a cadmium concentration of 37.7 mg/kg. This is a greater than 60 percent decrease in cadmium over two feet of vertical depth. Aluminum, iron, and vanadium concentrations at this location, although above background and residential RBCs, have not shown a pattern of widespread distribution at the site and have not been identified as constituents of concern. It is RFAAP's intent to remove the source area present at Building 4343 using real-time

and/or near real-time sampling methods to assess concentrations of metals in the soil. As previously stated, a thorough discussion of the removal action, including PRGs will occur in the CMS.

RFAAP is willing to modify the statement in the RFI report to read "it appears that vertical migration of contaminants to six feet or less has occurred at this location, with no exceedances of industrial RBCs." **Army response is okay.**

7. **Section 4.2.2, Nature and Extent Summary, on page 4-12** discusses the results from the 2002 investigation. The section states that polycyclic aromatic hydrocarbons (PAHs), pesticides, and PCBs were detected, but did not exceed industrial RBCs. It was therefore concluded that these compounds are not a concern at this site. It appears that these criteria were used to eliminate these compounds from consideration in the ecological risk assessment (ERA) since only metals were evaluated. Comparison to RBCs (human health criteria) does not address the potential for ecological risk from these chemicals. Therefore, any detected chemicals should be evaluated in the ERA before deciding that they are not at concentrations of concern.

   Army response: RFAAP agrees with this comment. The nature and extent analysis was not used to eliminate compounds from the SLERA. However, analysis of the PAH and pesticide data was inadvertently left out of the report. The report will be revised so that detected chemicals are evaluated and discussed in the SLERA. **Army response is okay.**

8. **Table 4-3, Soil Sample Summary, pages 4-10 and 4-11:** Please revise this table to remove the "zeros" entered for the number of background exceedances for other than the inorganics.

   Army response: Zeros will be replaced with N/A (not applicable) in the column for background exceedances other than inorganics. **Army response is okay.**

9. **Section 4.2.2, Nature and Extent Summary, page 4-13:** The third paragraph on this page states that "the results from these borings indicate that cadmium is moving downslope along the ditch, but is not migrating vertically or laterally through soil bounding the ditch. The results are similar to the boring collected at the lead catch tank (sample B43SB35), supporting the absence of vertical migration of cadmium through the clayey site soil." These conclusions are not supported by data as the vertical and horizontal extent of cadmium contamination at the site has not been fully determined. Based on the RFI data presented in Figures 2-3 and 4-2, the vertical extent of cadmium contamination, i.e. the level at which cadmium is present at background, has not been determined at sample locations B43SB22A (57.1 mg/kg), B43SB21A (4.7 mg/kg), B43SB4A (2.9 mg/kg), B43SSD1 (24,300 mg/kg), B43SSD2 (157 mg/kg), B43SSD3 (124 mg/kg), B43SSD4 (134 mg/kg), B43SSD5 (222 mg/kg), B43SSD6 (1040 mg/kg), B43SB34B (18.5 mg/kg), B43SB14A (191 mg/kg), B43SB26A (9.9 mg/kg), B43SB35B (37.7 mg/kg), B43SS01 (107 mg/kg), B43SB18A (3.2 mg/kg), B43SB33A (10.5 mg/kg) and B43SS02 (273 mg/kg). Similarly, the horizontal extent of cadmium contamination

has not been determined at sample locations B43SSD1 (east and west extent not determined), B43SSD2 (east and west), B43SSD3 (east and west), B43SSD5 (east and west), B43SSD6 (east), B43SB14A (east), B43SB26A (east and west), B43SB35B (east), B43SS01 (east, west and south), B43SB18A (north), and B43SS02 (north and east within the drainage ditch). In addition the vertical and horizontal extent of other metals has not been determined at these and other locations presented on Figures 2-3 and 4-2. The RFI appears to concentrate on exceedances of the industrial soil RBCs. While this might serve to define the limits of a removal area, it does not define the nature and extent of contamination that would be required to effectively "clean-close" the site. Please discuss in the RFI how this would be accomplished in the future.

10. **Section 4.2.2, Nature and Extent Summary, page 4-13:** The fourth paragraph on page 4-13 states that "there were no industrial exceedances of cadmium and arsenic concentrations were below background in the subsurface samples collected in the alluvial fan area. Again indicating a lack of vertical migration." It is not clear how this conclusion was reached when the vertical extent of cadmium contamination was not determined at most of the sample locations in the alluvial fan area as pointed out in the above comment. The phrase "lack of vertical migration" should be revised.

    Army response: Twelve samples at seven locations were collected in the alluvial fan area of the site. This is an area approximately 75 feet long by 100 feet at its greatest width. The actual square foot area would be half of this (75 x 100 ÷ 2) because the fan is shaped like a triangle. An additional nine samples at five locations were collected surrounding the delta. In surface soil samples, there were four cadmium detections at 1,040 mg/kg, 339 mg/kg, 273 mg/kg, and 137 mg/kg. In four subsurface samples (three at 2-4 ft bgs and one at 4-6 ft bgs), cadmium concentrations were 18.5 mg/kg, 15.9 mg/kg, 10.5 mg/kg and 3.2 mg/kg. This data provides empirical proof that cadmium concentrations are reduced by 90-95% from surface concentrations within the first six feet of depth. While RFAAP agrees that there are no borings with exclusively background concentrations below 6 ft bgs, the subsurface concentrations are below the unadjusted residential RBC of 39 mg/kg and are close to the adjusted (by a factor of 10) residential RBC of 3.9 mg/kg. RFAAP recommends that it is most appropriate to compare cadmium, as the sole constituent of concern in the delta area, to the unadjusted residential RBC.

    Regardless, the data supports assessing the cadmium concentrations as attenuating rapidly with depth and that there is no reason to believe that concentrations would be increasing deeper than 6 ft bgs. Therefore, it is RFAAP's position that sufficient data exists to make remedial decisions and that the effort to conduct an additional investigation to define the window between the adjusted residential RBC of 3.9 mg/kg and the average 12 mg/kg cadmium concentrations in the 2-6 ft bgs soil horizon is unnecessary and counterproductive to maintaining progress towards a clean up action at this site. RFAAP proposes to revise the phrase "lack of vertical migration" to read "the vertical migration and cadmium concentrations quickly attenuate at a depth of four feet." **Army response is okay.**

11. **Section 4.2.2.1, Nature and Extent Conclusions, page 4-13:** It is stated at the bottom of

this page that cadmium is not moving into the stormwater drainage system bordering the site. This is inaccurate as cadmium was detected in the stormwater drainage system at sample location B43SS02 at the concentration of 273 mg/kg, exceeding the industrial RBC. Also, on page 4-14, it is stated that "the lack of exceedances of cadmium in subsurface soil and the fact that groundwater was not encountered at the site (down to 60 ft. bgs) indicates that groundwater would not be impacted at this site." Since the vertical extent of cadmium contamination is not determined and groundwater condition at the site is unknown, it is premature to make such a conclusion. Please remove these statements from the RFI Report.

Army response: Text will be clarified to state "while there were industrial RBC exceedances of cadmium in two surface soil samples located where the alluvial fan meets the stormwater drainage ditch, samples collected in the drainage ditch to the east and west of the alluvial fan indicate that cadmium is not being transported in the drainage system outside the boundaries of the alluvial fan."

RFAAP's position is that the vertical extent of cadmium concentrations has been established to a sufficient degree (see previous responses). Empirical evidence demonstrates that 95% of cadmium concentrations in surface soil do not go beyond 2-4 ft bgs. Borings through 60 feet of dense clay that underlie the site and associated chemical analyses provide empirical evidence that cadmium is not migrating beyond the near surface. It is significant to note that groundwater was not encountered while advancing the 60 foot boring. Given the absence of groundwater and no evidence of deep vertical migration the assertion that groundwater would not be impacted by cadmium releases at the surface is a reasonable and logical conclusion. **The Army response is okay**.

12. **Section 5.0, Contaminant Fate and Transport, page 5-1**: The last paragraph on this page states that "arsenic was detected above the industrial RBC (3.8 mg/kg) in 15 soil samples collected from the site. The surface concentrations of arsenic that exceeded the industrial RBC ranged from 3.8 (B43SSD4) to 5.6 (B43SSB10) mg/kg." Based on data presented in Figures 2-3 and 4-2, only two surface soil samples (excluding the two sludge samples B43SL1 and B43SL2) for arsenic exceeded industrial RBC at the concentrations of 4.0 mg/kg (B43SSB28) and 5.0 mg/kg (B43SS01). According to these figures, no arsenic was detected at the reported sampling locations (B43SSD4 and B43SSB10).

    It is further stated in this paragraph that arsenic was detected above the industrial RBC in 16 surface subsurface soil samples with a range of 3.9 mg/kg to 9.4 mg/kg. Based on the data presented in Figures 2-3 and 4-2, only seven subsurface samples exceeded the arsenic industrial RBC with the range reported. In addition, Table 4-3 documents 33 exceedances of the industrial RBC for arsenic. However, the location of these exceedances (other than the 9 discussed above) is not shown on the figures.

    Please revise the RFI Report to resolve these discrepancies and correct the text, figures and tables accordingly.

Army response: The text and tables are correct. The figures will be revised. Since the figures were developed to present chemicals and concentrations of concern, only those arsenic concentrations greater than background will be presented on the figures. **Army response is okay.**

13. **Section 5.0, Contaminant Fate and Transport, page 5-2:** The fourth paragraph on page 5-2 states, "it would appear that numerous detections of arsenic at low concentrations in both surface and subsurface soil at the Building 4343 study area is the result of natural soil conditions not related to site activity. The sludge contained within two separate concrete sumps is prevented from migration into the surrounding soil." Since arsenic was detected at a concentration twice the background in the sludge sample (B43SL1), it is inaccurate to conclude that arsenic is the result of natural soil conditions not related to site activity. Also, since the integrity of the sumps has not been investigated and their conditions have not been discussed in the RFI Report, it is inappropriate and premature to conclude that sludge contained in the sumps is prevented from migration into the soil. Please revise the RFI Report to discuss the integrity of the two sumps. Additionally, if a removal of the sumps is planned, please discuss in the RFI and provide for post-removal sampling below the sumps immediately following their removal.

14. **Page 5-3**: The statement that "Chromium was not used in the plating process and is more likely associated with the acid cleaning of metal parts and as a tract contaminant" is confusing and needs to be modified. Especially in light of the statement on page 2-6, which states that "Rinse water from the cadmium plating operations was process water containing cyanide, cadmium, and chromium".

15. **Figure 5-2**: Please indicate the groundwater elevation on Figure 5-2. This can be done by extrapolation from the neighboring SWMU or close-by wells, as long as a reference map or figure is accompanied showing how the estimated groundwater elevation was obtained. Also, there should be a map showing the location of Building 4343 within the RFAAP.

16. **Section 5.3, Subsurface Soil Fate and Transport, page 5-4:** The last paragraph on page 5-4 states, "cadmium has a default SSL soil transfer to groundwater value of 27 mg/kg. None of the subsurface cadmium concentrations exceeded this number, further indicating that the vertical migration of cadmium to a potential deep aquifer is unlikely." Based on data presented on Figures 2-3 and 4-2, cadmium concentrations at three subsurface sample locations B43SB22A (57.1 mg/kg), B43SB14A (191 mg/kg) and B43SB35B (37.7 mg/kg) exceed the unadjusted EPA Region 3 SSL value (for DAF 20) of 27 mg/kg. When the SSL value is adjusted down by a factor of 10 as required for EPA Region 3 Superfund sites, additional four subsurface sample locations B43SB21A (4.7 mg/kg), B43SB4A (2.9 mg/kg), B43SB18A (3.2 mg/kg) and B43SB34B (18.5 mg/kg) exceed the SSL value of 2.7 mg/kg. Thus, based on the use of SSLs with the data provided in the RFI Report, it cannot be concluded that the potential for further vertical of migration of cadmium and impact on groundwater is unlikely. However, rather than using the SSLs, EPA recommends that the Army use the TOC and grain size distribution results and apply the principles/equations presented in Appendix D to calculate mobility of cadmium and chromium in the soil at the site. The results from the model prediction can be used to

support the statement that the metals were not migrating into the subsurface soil to a depth that groundwater would be potentially impacted at the site.

17. **Section 6.0, Human Health Risk Assessment, Table 6-1, Selection of Exposure Pathways:** For the "current" scenario time frame, a trespasser is not identified as a receptor. Please explain why a trespasser is not considered a receptor under the current scenario.

    In addition, for the "current and future" and "future" scenarios, it is indicated that no analysis will be conducted for the trespasser "due to security at the installation, trespasser exposures are unlikely. However, the maintenance worker scenario would be protective of the limited exposure that would be experienced by a trespasser." It is not clear how the maintenance worker (an adult) scenario would be protective of a child/adolescent trespasser, unless the child/adolescent trespasser is separately considered. Please clarify this issue.

    For the "sludge" medium, the exposure pathway for maintenance excavation worker is excluded from analysis because "excavation worker would not be expected to have constant exposures to the sumps" and "exposures to sludge could not be quantified for this receptor." Please provide additional explanation why this pathway for this medium is excluded from consideration. The reasons provided are not clear. If a removal action is planned, then the removal of the sumps would eliminate them for consideration of a complete pathway. Please discuss in the revised RFI.

    Army response: "Current" exposures were assumed to continue in the "future". These exposures were referred to "current and future" exposures. There was no separate category for "current" exposures.

    Text will be added to Section 6.2.1 to clarify the level of security at the Installation. Given the rigorous security at Radford AAP (e.g., strict security at entry gates, guard towers, barbed-wire fences), it is not reasonable to assume that children would be able to trespass at the Installation. Hypothetical future exposures to children were considered, however, in the residential scenario that was evaluated in Appendix E. The exposure parameters for residents are more conservative than those for trespassers.

    It would also be extremely difficult for an adolescent to trespass at the site. Even if an older adolescent were able to evade security measures, it would be very difficult to do so on a routine basis. The frequency and duration of exposure for the maintenance worker is 50 days per year (i.e., once per week, except for two weeks while on vacation) and 25 years, respectively.

    Because the sumps are below grates and not easily accessible, it is not reasonable to assume that a worker would be exposed to sludge in the sumps on a routine basis. The most likely exposure to sludge would occur during removal of the sumps, which would be a one-time occurrence and should involve the use of personal protective equipment (e.g., gloves, boots, clothing). **Army response is okay.**

18. **Section 7.0, Ecological Risk Assessment: Section 7.7, Results and Conclusions**, concludes "based on uncertainties of toxicity, and on the fact that no wildlife RTE [rare, threatened and endangered] species have been confirmed at the Building 4343 study area, remedial measures solely to address ecological concerns are not warranted at this time for soil." Page 7-1 of this section describes the scientific/management decision point (SMDP) expected to be reached from the conduct of the Screening Level Ecological Risk Assessment. The conclusion drawn do not reflect these SMDPs. It is detailed in Section 7.1 of the RFI Report that five representative receptor species are expected or possible in the area of Building 4343 and were used as selected indicator species for the potential effects of the constituents of potential ecological concerns. The assessment concluded potential adverse impacts to terrestrial wildlife, especially robins, shrews, and voles for potential exposure to primarily cadmium in surface soil. Therefore, the ecological concerns should be addressed. However, since the RFI Report stipulates that the chemical-specific preliminary remediation goals developed for human health may address the ecological concern, EPA reserves the right to pursue addressing the ecological concern at this site after review of the remedial action for the human health concern.

19. **Section 7.2.5, Comparison to Risk-Based Screening Ecotoxicity Values, on page 7-11** lists the screening values that were used to assess risk to terrestrial receptors. EPA Region III BTAG values were not used to evaluate risk. For the screening ERA, BTAG strongly recommends that BTAG screening values be used to evaluate risk to terrestrial receptors. Other values will be considered if no BTAG value is available.

20. **Section 7.2.5, Comparison to Risk-Based Screening Ecotoxicity Values, on page 7-11** states that aluminum was not selected as a contaminant of potential ecological concern (COPEC), since this metal should only be identified as a COPEC for those sites with soil pH less than 5.5. The section also states that of the 24 surface soil samples that had pH measured, four were below a pH of 5.5 (e.g., 5.03, 5.20, 5.25, and 5.35), therefore because the average pH (5.8) is less than 5.5, aluminum was not selected as a COPEC. Because four samples had a pH less than 5.5, potential risk from aluminum at these specific locations should be further evaluated before eliminating from additional consideration.

21. **Section 7.4.1, Assessment Endpoints, on page 7-18** discusses the assessment endpoints that will be evaluated in the ERA. Protection of terrestrial invertebrates (e.g., earthworms) should be listed as an assessment endpoint from direct exposure to soils. The measurement endpoint would be a comparison of soil concentrations to BTAG screening values. Currently the ERA only evaluates risk to upper trophic level receptors exposed through the food chain and does not evaluate direct toxicity to soil invertebrates.

22. **Section 7.6, Uncertainty Analysis, on page 7-26** states that chemical results from two Building 4343 sump samples were not included in the ERA because no ecological exposure is expected to these sumps. While direct exposure may not be likely, they still need to be considered as a source area to downgradient areas if migration from these

locations could occur. Please discuss the possible removal of the sumps and any planned post-removal sampling of the soil remaining at the site.

23. **Section 8.0, Summary and Conclusions, on page 8-1** states that the results of the ERA indicate the potential for adverse effects to the five wildlife receptors evaluated as part of the food chain modeling. As stated earlier, direct toxicity to soil invertebrates should also be evaluated as part of the ERA.

24. **Section 8.0** also states that based on the uncertainties of toxicity, and on the fact that no rare, threatened and endangered species have been confirmed at the site, remedial measures solely to address ecological concerns are not warranted at this time. The certainty of effects, particularly for invertebrates is relatively high, given the extremely high concentrations of metals found in soil at the site. The magnitude of the soil concentrations should be considered when discussing the uncertainty, and the need for remedial action. Given the limited spatial extent of contamination, it may be more cost effective to remove the soil than to consider additional studies as recommended in Section 7.7. It should also be noted that the fact that no rare, threatened and endangered species have been confirmed at the site has no bearing on whether any subsequent action (including a no action alternative) will be protective of ecological resources.

25. **Table E-13, Lead Worksheet**: It appears that the worksheet was used to calculate a risk based remedial goal rather than calculate risk from lead exposure. If the calculated risk is greater than the acceptable level, then calculate a RBRG. The concentration for the model run should be the arithmetic average. Also, EPA recommends using a midrange value for both the GSD and the baseline blood lead level. The worksheet used the low end of the GSD range for a homogenous population. While this may be the current situation, the final document must also consider future risk.

    Army response: At the time the lead evaluation was performed for Building 4343, the Lead Hot Line was contacted for guidance regarding the spreadsheet for "forward" calculations of blood lead levels (Adult Lead Model). It was RFAAP's understanding that USEPA would be developing guidance for applying the model and choosing appropriate exposure parameters. Because this guidance was not available, RFAAP chose to back-calculate a risk-based remediation goal (RBRG) based on the model default parameters and compare the arithmetic mean of the soil lead concentrations to it. This approach was used rather than identifying site-specific parameters for the "forward" calculation, especially for non-standard scenarios such as the maintenance worker (e.g., exposed only one day per week for a total of 50 days).

    As of 20 May 2003, USEPA published "Adult Lead Model (ALM) Frequently Asked Questions (FAQs)" on its web site. The FAQs address some of the outstanding issues for calculating the risk from lead exposure (i.e., via "forward" calculations). For example, construction worker exposures are discussed in this document. Additional discussion with the Lead Hotline also indicated that intermittent scenarios (e.g., lawn maintenance worker) would soon be included in the FAQs, but are not yet available.

    Based on this new information, the HHRA will be revised by incorporating "forward"

calculations into the lead evaluation. The exposure frequency for the construction worker will be adjusted as recommended in the recent guidance and the above comments. The current default parameters for the industrial worker would be expected to be sufficiently conservative for the maintenance worker until further information becomes available for the maintenance worker scenario. **Army response is okay.**

26. **Appendix E-2, Resident Risk Assessment**: The risk assessment for the residential scenario was put in a separate appendix, and the results were not discussed in the text of the draft RFI report. EPA recommends that all the risk assessment results be discussed in sections 6 and 8 of the final report. The remedial alternatives in the FS should also address all the current and future potential risks from exposure to the site.

    Army response: As stated in the HHRA, "Since land use is intended to remain industrial, a residential scenario is not considered to be a reasonably anticipated land use. However, the residential scenario was evaluated to meet "clean closure" requirements under RCRA." Because the industrial scenario is the focus of the decision-making process for the Department of Army (DA), the industrial scenario is presented in the main body of the text. However, RFAAP is willing to move the residential evaluation into Section 6.0 and discuss the results in Section 8.0. The CMS will evaluate current and future potential risks related to the site. **Army response is okay.**

This concludes EPA's review of the Army's draft *RFI Report* for Building 4343, located at the RFAAP. The referenced draft *RFI Report* is disapproved by EPA in its current form, and must be revised to reflect the comments above. Per Part II, Section E.4.e. of the EPA RCRA Corrective Action Permit, the Army is required to revise the draft document and submit a revised draft copy to EPA for review within 60 days of the receipt of EPA comments on the draft document. Part II, Section E.4.f. of the Permit allows for an additional 20 days for issuing the revised draft document to EPA, provided that timely notice is given, i.e. within 10 days. Additional time extensions can be requested under Part II, Section F. of the permit.

If you have any questions, please call me at 215-814-3357.

Sincerely,

Robert Thomson

Robert Thomson, PE
Federal Facilities Branch

cc: Russell Fish, EPA
Leslie Romanchik, VDEQ-RCRA
Mark Leeper, VDEQ-CERCLA

McKenna, Jim

›m: Leeper,Mark [msleeper@deq.state.va.us]
nt: Wednesday, July 30, 2003 9:51 AM
ro: McKenna, Jim
Subject: RE: Bldg 4343 response to VDEQ comments

Hey Jim,

I'm good with all of the comments.

****
Mark S. Leeper
Project Manager
Federal Facilities Restoration
804.698.4308 O
804.698.4383 F
msleeper@deq.state.va.us
****

-----Original Message-----
From: McKenna, Jim [SMTP:jim.mckenna@us.army.mil]
Sent: Wednesday, July 30, 2003 9:42 AM
To: Leeper,Mark
Cc: Redder, Jerome; 'john e tesner'
Subject: FW: Bldg 4343 response to VDEQ comments
Importance: High

Mark,

We had a conference call on Tuesday July 15 with Jennifer Jones, VDEQ and discussed our responses to her comments from the attached file. She was ok with them but she said the last three 13, 14 and 15 were your comments. Are these responses ok? Like to close this loop.

Thanks,
Jim

> -----Original Message-----
> From: McKenna, Jim
> Sent: Thursday, June 26, 2003 3:01 PM
> To: 'mark leeper'
> Cc: 'rob thomson'; 'john e tesner'; Redder, Jerome
> Subject: Bldg 4343 response to VDEQ comments
> Importance: High
>
> Mark:
>
> Attached file contains SAB. Might be helpful if we could discuss them in
> a conference call. What's your availability?
>
> Jim

>
> <<B4343 VDEQ RTCs- Final.doc>>
<< File: B4343 VDEQ RTCs- Final.doc >>

McKenna, Jim

›m:	McKenna, Jim
ıt:	Thursday, June 26, 2003 3:01 PM
.ɔ:	'mark leeper'
Cc:	'rob thomson'; 'john e tesner'; Redder, Jerome
Subject:	Bldg 4343 response to VDEQ comments
Importance:	High

Mark:

Attached file contains SAB. Might be helpful if we could discuss them in a conference call. What's your availability?

Jim



4343 VDEQ RTCs-Final.doc

Response to VDEQ Comments dated 2 April 2003
on
Building 4343 RCRA Facility Investigation Report
February 2003

VDEQ Comment 1
Table 6.2. Footnote (e) states that the tap water RBC for water was used for cadmium. Reword the footnote to state that the residential soil RBC for Cadmium (water) was used because it is a more conservative value. The tap water RBC and soil RBC are different values.

Army Response
Text will be added to clarify that that the residential soil RBC for cadmium (water) was used.

VDEQ Comment 2
Section 6.1.2.1, page 6-6, line 7. "...the probability of developing cancer" should be changed to "the excess probability of developing cancer.

Army Response
The suggested text will be added for clarification.

VDEQ Comment 3
Section 6.1.2.3. Generally, background comparisons may not be used to screen out potential COPCs during the screening risk assessment. All constituents with concentrations exceeding an RBC should be retained as a COPC and carried through the risk assessment. Background comparisons may be discussed in the Risk Characterization section. Consequently, arsenic, aluminum, manganese and vanadium should be retained in Table E-1 and arsenic, thallium and manganese should be retained in Table E-2. These changes should also be made in the text in Sections 6.1.3.1 and 6.1.3.2 and Table 6-4.

Army Response
The purpose of undertaking a facility-wide background study for Radford AAP was to establish a background data set for use in risk assessment. Based on discussions with USEPA early in the RFI process, it is the Army's understanding that the development of a background data set would allow for the elimination of chemicals from further consideration based on comparisons of site concentrations to background data. USEPA's *Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual* (RAGS; USEPA, 1989), Section 5.7, permits the use of background data as a selection criterion for chemicals of potential concern (COPCs). In addition, VDEQ's Voluntary Remediation Program (VRP), which follows RAGS, permits the use of background comparisons as part of Tier I screening. According to Section 2.4.1 of the VRP *Risk Assessment Guidance* (VDEQ, 2002), "In Tier I screening, contaminant concentrations from the site for all media of concern are compared to those from background samples collected from nearby areas that have not been affected by the substances of concern. If concentrations from the affected area exceed background levels, the participant may choose to employ Tier II or Tier III screening methods."

VDEQ Comment 4
Section 6.1.3.1. Generally, surface soil samples are taken from 0-6 inches.

Army Response
The data set for the risk assessment consists of results from samples collected during several investigations. The surface soil samples that were collected in accordance with *Work Plan Addendum 12* (IT, 2002) represent the 0–6 inches soil interval. The purpose of obtaining these samples was to address data gaps in the previous investigations. As described in the *Work Plan*, some surface soil samples from previous investigations were collected from deeper soil intervals (e.g., 0 to 2 ft). However, USEPA Region III and VDEQ approved the use of these samples in the RFI as part of the *Work Plan*.

VDEQ Comment 5
The residential scenarios should have been included with the other receptors in Section 6 to prevent excessive repetition by including these receptors in a separate Appendix.

Army Response
Residential land use scenarios have been included in the HHRA at the request of the regulatory agencies as well as to fulfill requirements per Department of Defense (DoD) guidance. Land use at Radford AAP is expected to remain industrial and the future development of the property for residential use is unlikely. However, the residential risk evaluation will be moved from the Appendix to Section 6, as requested.

VDEQ Comment 6
There seem to be duplicate copies of Table E-5 in Appendix E. The only difference noted is that one lists "Site" 4343 as the exposure point, while the other lists "Building" 4343. Please explain.

Army Response
A previous version of the table was inadvertently left in the document. The extraneous table will be removed.

VDEQ Comment 7
Section 6.3.2. Chromium is assumed to be in hexavalent state unless speciation is conducted. Toxicity factors for chromium VI should replace those for chromium III in Tables E-9 through E-12 and be used throughout the risk calculations.

Army Response
It was assumed that the majority of the chromium that was detected at the site would be in the trivalent form. As described in Section 6.3.2 of the HHRA, hexavalent chromium is relatively unstable in the environment and is typically converted to trivalent chromium. As stated in *Water-Related Environmental Fate of 129 Priority Pollutants* (USEPA, 1979), hexavalent chromium or Cr(VI) is a moderately strong oxidizing agent and reacts with reducing materials to form trivalent chromium or Cr(III). Chemical speciation is an important fate process for chromium and in aquatic environments (such as the process water discharge at Building 4343). Cr(VI), if present, would be expected to remain in a soluble form, while trivalent chromium would be expected to hydrolyze and precipitate as $Cr(OH)_3$. Cr(III) the most stable form under reducing conditions normally found in

natural waters and sediments, and when in solution at pH greater than 5, quickly precipitates due to formation of the insoluble hydroxide or oxide.

Cr (III) is the stable form of chromium in soil (FRTR, 2002). Cr (III) hydroxy compounds precipitate at pH 4.5 and complete precipitation of the hydroxy species occurs at pH 5.5. In contrast to Cr (VI), Cr (III) is relatively immobile in soil. Soil at Building 4343 had an average pH of 5.8, which would favor precipitation.

Because of its anionic nature, Cr (VI) associates only with soil surfaces at positively charged exchange sites (FRTR, 2002). This association decreases with increasing soil pH. Regardless of pH and redox potential, most Cr(VI) in soil is reduced to Cr(III). Soil organic matter and iron (Fe II) minerals donate electrons in this reaction. The reduction reaction in the presence of organic matter proceeds at a slow rate under normal environmental pH and temperatures, but the rate of reaction increases with decreasing soil pH.

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

Chromium concentrations in soil at Building 4343 were also evaluated with respect to organic matter at the site. Total chromium (mg/kg) was plotted against organic matter (mg/kg) (see attached). Increasing chromium concentrations are associated with increasing levels of organic matter. These results would suggest that elevated chromium at the site might be due to the organic matter available to reduce Cr(VI) to Cr(III). Even if trace amounts of Cr(VI) were present at the site, the environmental conditions at RFAAP, including typical precipitation events over the years, would tend to favor the conversion of this form of chromium to the more stable (less toxic) trivalent state. For these reasons, it was assumed that toxicity associated with chromium would be most accurately represented by the use of chromium III toxicity data.

References:

Bolan, N.S., Adriano, D.C, Natesa, R., and Koo, B.J., 2003, Effects of organic amendments on the reduction and phytoavailability of chromate in mineral soil, *Journal of Environmental Quality*, Volume 32, Number 1, pages 120-128.

Federal Remediation Technology Roundtable (FRTR), 2002, *Remediation Technologies Screening Matrix and Reference Guide, 4th Edition*. U.S. Army Environmental Center, SFIM-AEC-PCT, Aberdeen Proving Ground, MD. January.

Jardine, P.M., Fendorf, S.E., Mayes, M.A., Larsen, I.L., Brooks, S.M, and Bailey, W.B., 1999, *Environmental Science & Technology*, Volume 33, Number 17, pages 2939-2944.

Tokunaga, T.K, Wan, J.N., Firestone, M.K., Hazen, T.C., Schwartz, E., Sutton, S.R, and Newville, M., 2001, *Environmental Science & Technology*, Volume 35, Number 15, pages 3169-3174.

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VDEQ Comment 8
Table E-9. The following target organs should be changed: copper – GI tract, iron – blood (added with GI tract), Aroclor 1254 – eyes, vanadium – kidney.

Army Response
The target organs for this HHRA were based on best available information because target organ information for provisional toxicity values is not readily available. Therefore, it would be helpful to obtain references from VDEQ for the target organ information given in the comment. If the information can be obtained, the requested changes will be incorporated into the report.

VDEQ Comment 9
Table E-10. Cadmium is classified a B1carcinogen for the inhalation pathway only and should be listed as N/A on the Oral/Dermal table.

Army Response
The table will be revised, as requested.

VDEQ Comment 10
Table E-12. The inhalation CSF for Aroclor 1254 should be 2 $(mg/kg\text{-}day)^{-1}$.

Army Response
There is no inhalation cancer slope factor (CSF) provided in the Integrated Risk Information System (IRIS) for Aroclor 1254. Although the inhalation CSF for polychlorinated biphenyls (PCBs) is 0.4 $(mg/kg\text{-}day)^{-1}$, the CSF will be changed to 2 $(mg/kg\text{-}day)^{-1}$, which reflects "high risk and persistence", as recommended in IRIS for the evaluation of exposures to aerosol or dust contaminated by PCBs via inhalation.

VDEQ Comment 11
Tables E-22 and E-23. Future excavation workers and maintenance workers would be exposed to total soil only. Surface soil should be subtracted from these tables since total soil includes a mixture of current surface soil and subsurface soil. Sections 6.4.2 and 6.4.3 should report that risks (based on total soil only) for future maintenance and excavation workers were within the target risk range for cancer risks and that the HQ for excavation workers was above an HQ of 1.

Army Response
Exposure to surface soil was maintained in Tables E-22 and E-23 as a future exposure pathway to account for the possibility that there may not be any excavation or construction at Bldg 4343 in the future. In this case, the future maintenance worker would still be exposed to surface soil. To avoid "double-counting" risk estimates and hazard indices, the most conservative risk estimate and hazard index (i.e., surface soil) was used to represent the cumulative risk estimate and hazard index. As a result, no revisions to the text and tables are recommended.

VDEQ Comment 12
The SLERA may also include BTAG screening levels for soil, which may decrease the EEQs for certain receptors.

Army Response
Comment noted.

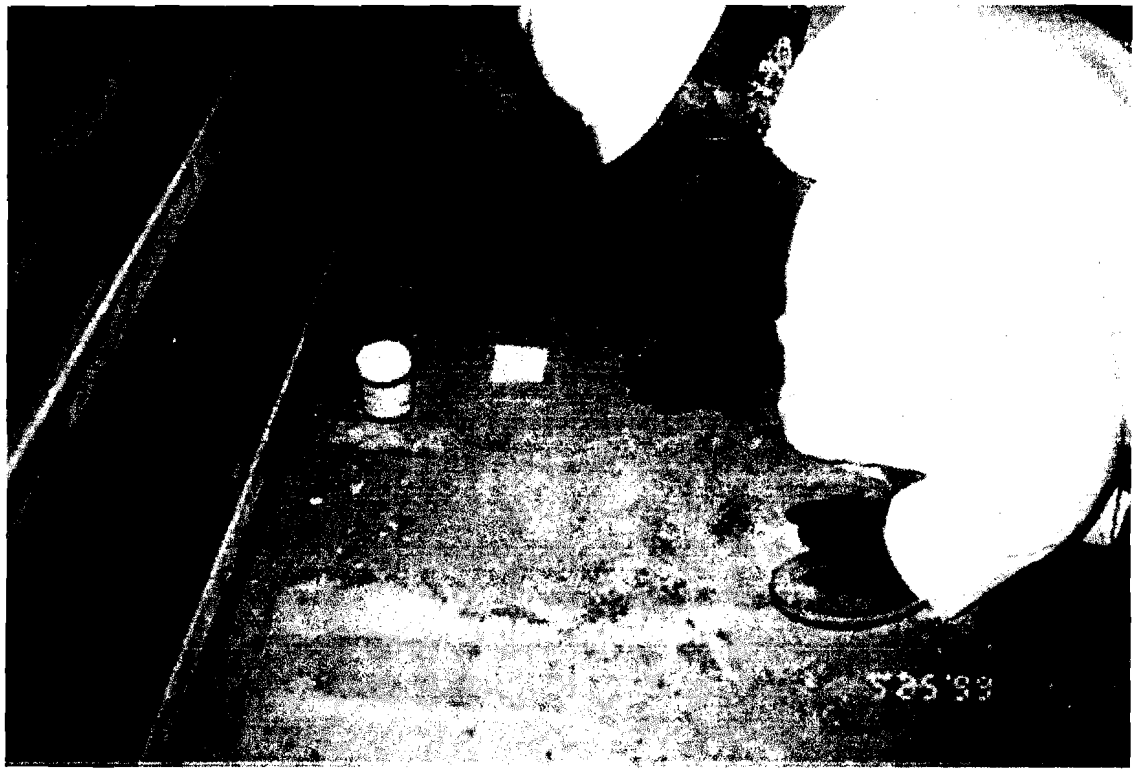
VDEQ Comment 13
Page 2-6, section 2.3, the first paragraph states that it is not *believed* cadmium dust or volatile would have been transported through the exhaust system. Page 2-14 states that wipe samples were collected from the floor of Building 4343 (4343). Why wasn't the same wipe test applied to the exhaust system to ensure volatiles were not transported through the exhaust system as well as to the ceiling. Perhaps cyanide and chromium are present in both of those areas as well.

Army Response
Wipe sampling for volatiles was not conducted because operations had not been conducted in the building for thirty years and it was considered that volatiles would not still be present on exposed surfaces. Wipe samples were conducted on flooring because this was considered to be the area that would be impacted the most and therefore provide a worst-case scenario of impacted building material.

VDEQ Comment 14
Page 2-14, Section 2.3.1, wipe samples were collected from the concrete floor of 4343 and it is documented that there is no criteria to which samples can be compared. However, it does prove to be an indicator of contaminants that are present. What was the integrity of the floor when that samples were collected? If the integrity of the floor has been breached, the wipe samples could be an indication of subsurface contamination.

Army Response
Inspections of the concrete floor prior to sampling indicated that there were no cracks or breaks in the floor and no indications of pathways to the subsurface through the floor. A

photograph taken during wipe sampling activities at Building 4343 illustrating the integrity of the building floor is provided below.



VDEQ Comment 15
Page 5-9, Section 5.4.1, third paragraph states that cadmium was exceeded adjacent to the 12" terra cotta process pipe at 2-4 feet. How deep is the bottom of the pipe?

Army Response
The pipe is covered by 8-12 inches of soil. This would put the bottom of the pipe at about 2 feet below ground surface.

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

WASTE DIVISON

OFFICE OF REMEDIATION PROGRAMS

MEMORANDUM

TO: Jim McKenna

FROM: Mark Leeper

DATE: 2 April 2003

SUBJECT: DRAFT Comments for Building 4343 RFI

After reviewing the RCRA Facility Investigation Report for Building 4343 at Radford Army Ammunition Plant, please address the following DRAFT comments.

1. Table 6.2. Footnote (e) states that the tap water RBC for water was used for cadmium. Reword the footnote to state that the residential soil RBC for Cadmium (water) was used because it is a more conservative value. The tap water RBC and soil RBC are different values.

2. Section 6.1.2.1, page 6-6, line 7. "...the probability of developing cancer" should be changed to "the excess probability of developing cancer.

3. Section 6.1.2.3. Generally, background comparisons may not be used to screen out potential COPCs during the screening risk assessment. All constituents with concentrations exceeding an RBC should be retained as a COPC and carried through the risk assessment. Background comparisons may be discussed in the Risk Characterization section. Consequently, arsenic, aluminum, manganese and vanadium should be retained in Table E-1 and arsenic, thallium and manganese should be retained in Table E-2. These changes should also be made in the text in Sections 6.1.3.1 and 6.1.3.2 and Table 6-4.

4. Section 6.1.3.1. Generally, surface soil samples are taken from 0-6 inches.

5. The residential scenarios should have been included with the other receptors in Section 6 to prevent excessive repetition by including these receptors in a separate Appendix.

6. There seem to be duplicate copies of Table E-5 in Appendix E. The only difference noted is that one lists "Site" 4343 as the exposure point, while the other lists "Building" 4343. Please explain.

7. Section 6.3.2. Chromium is assumed to be in hexavalent state unless speciation is conducted. Toxicity factors for chromium VI should replace those for chromium III in Tables E-9 through E-12 and be used throughout the risk calculations.

8. Table E-9. The following target organs should be changed: copper – GI tract, iron – blood (added with GI tract), Aroclor 1254 – eyes, vanadium – kidney.

9. Table E-10. Cadmium is classified a B1carcinogen for the inhalation pathway only and should be listed as N/A on the Oral/Dermal table.

10. Table E-12. The inhalation CSF for Aroclor 1254 should be 2 $(mg/kg\text{-}day)^{-1}$.

11. Tables E-22 and E-23. Future excavation workers and maintenance workers would be exposed to total soil only. Surface soil should be subtracted from these tables since total soil includes a mixture of current surface soil and subsurface soil. Sections 6.4.2 and 6.4.3 should report that risks (based on total soil only) for future maintenance and excavation workers were within the target risk range for cancer risks and that the HQ for excavation workers was above an HQ of 1.

12. The SLERA may also include BTAG screening levels for soil, which may decrease the EEQs for certain receptors.

13. Page 2-6, section 2.3, the first paragraph states that it is not *believed* cadmium dust or volatile would have been transported through the exhaust system. Page 2-14 states that wipe samples were collected from the floor of Building 4343 (4343). Why wasn't the same wipe test applied to the exhaust system to ensure volatiles were not transported through the exhaust system as well as to the ceiling. Perhaps cyanide and chromium are present in both of those areas as well.

14. Page 2-14, section 2.3.1, wipe samples were collected from the concrete floor of 4343 and it is documented that there is no criteria to which samples can be compared. However it does prove to be an indicator of contaminants that are present. What was the integrity of the floor when that samples were collected? If the integrity of the floor has been breached, the wipe samples could be an indication of subsurface contamination.

15. Page 5-9, section 5.4.1, third paragraph states that cadmium was exceeded adjacent to the 12" terra cotta process pipe at 2-4 feet. How deep is the bottom of the pipe?

Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, VA 24141
USA

February 25, 2003

Mr. Robert Thomson
U. S. Environmental Protection Agency
Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Subject: Building 4343 RCRA Facility Investigation Report, February 2003, Radford Army Ammunition Plant
EPA ID# VA1 210020730

Dear Mr. Thomson:

Enclosed is one certified copy of Building 4343 RCRA Facility Investigation Report, February 2003, Radford Army Ammunition Plant for your review and comment or approval. Your five additional five copies will be sent under separate cover as well as additional copies to the Virginia Department of Environmental Quality (VDEQ), U.S. Army Environmental Center, U.S. Army Center for Health Promotion and Preventive Medicine.

Please coordinate with and provide any questions or comments to myself at (540) 639-8266, Jerry Redder of my staff (540) 639-7536 or Jim McKenna, ACO Staff (540) 639-8641.

Sincerely,

For C. A. Jake, Environmental Manager
Alliant Ammunition and Powder Company, LLC

Enclosure

w/o enclosure

c: Russell Fish, P.E., EPA Region III

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bc: Administrative File
[redacted]
Rob Davie-ACO Staff
C. A. Jake
J. J. Redder
Env. File

Coordination: J. McKenna
J. McKenna

03-815-26
JMcKenna/JJRedder

Concerning the following:

BUILDING 4343

RCRA FACILITY INVESTIGATION REPORT
FEBRUARY 2003

Radford Army Ammunition Plant

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: Brian A. Butler
TITLE: LTC, CM, Commanding
Radford AAP

SIGNATURE: _____
PRINTED NAME: for Anthony Miano
TITLE: Vice President Operations
Alliant Ammunition and Powder Company, LLC

03-815-26
JMcKenna/JJRedder

17

McKenna, Jim

m:	McKenna, Jim
t:	Friday, January 24, 2003 2:45 PM
o:	'john e tesner'
Cc:	'Tony Perry'; 'wayne mandell'; 'katie watson'; Redder, Jerome; 'Parks, Jeffrey N'
Subject:	FW: Bldg 4343 RFI

John, USACHPPM comment/s. Good news. Jim

-----Original Message-----
From: Williams, Keith J Mr USACHPPM [mailto:Keith.Williams@APG.AMEDD.ARMY.MIL]
Sent: Friday, January 24, 2003 2:23 PM
To: 'McKenna, Jim'
Subject: RE: Bldg 4343 RFI

Radford 4343 RFI.doc

Hi Jim,
Attached is my review of the 4343 RFI. A hard copy will follow in the mail. Call with questions or concerns.
Thanks,
Keith

-----Original Message-----
From: McKenna, Jim [mailto:Jim.McKenna@ATK.COM]
Sent: Friday, January 17, 2003 9:36 AM
To: 'Williams, Keith J Mr USACHPPM'; 'Tony Perry'; 'wayne mandell'
Cc: 'dennis druck'; 'john e tesner'; 'katie watson'
Subject: Bldg 4343 RFI
Importance: High

1. Keith, understand from Dennis's phone message this Monday you have received your copy of the Bldg 4343 RCRA Facility Investigation. In order to keep this on schedule we need your comments no later than 27 January 2003.
2. Tony, this goes the same for you. One copy of this document was sent to you at the same time.
3. Wayne, from the November 2002 DERP workshop it was my understanding that the geologists would not be routinely getting copies of these. If you are then we can provide you with a copy. Bldg 4343 doesn't really have any geology/geophysics associated with it.

Jim McKenna
540 639 8641

MCHB-TS-REH (40)

MEMORANDUM FOR Radford Army Ammunition Plant ATTN: SOSRF-OP-EQ (Jim McKenna), PO Box 2, Radford, VA 24143-0002

SUBJECT: Draft Building 4343 RCRA Facility Investigation Report, January 2003

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 AR 200-1 (Environmental Protection and Enhancement). Thank you for the opportunity to review this document. One comment follows. We concur with the conclusions and recommendations contained in this report.

2. Section 7.7, Ecological Risk Assessment Summary. The SLERA determined potential adverse risks to ecological receptors. The ecological risk assessment summary accurately states that given the small size of this site, and the uncertainties inherent in conducting a SLERA, remedial activities solely based on ecological receptors are not warranted. CHPPM strongly concurs with this statement.

3. The scientist reviewing this document and our point of contact is Mr. Keith Williams, Environmental Health Risk Assessment Program, at DSN 584-7722 or commercial (410) 436-7722.

FOR THE COMMANDER:

DAVID L. DAUGHDRILL
Program Manager
Environmental Health Risk
Assessment

CF:
HQDA(DASG-HS-PE)
USAMEDCOM (MCHO-CL-W)
USACE (CENWO-HX-H)
USAEC (SFIM-AEC-ER)

RADFORD ARMY AMMUNITION PLANT, VIRGINIA

Building 4343
RCRA Facility Investigation/
Corrective Measures Study 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
Contract No. DACA31-01-F-0085

Final Document **February 2004**

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Appendix H Remedial Goal Calculation Details
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LIST OF ACRONYMS AND ABBREVIATIONS

ADD ..... Average Daily Dose
ADI..... Allowable Daily Intake
AOC ..... Area of Concern
ARAR..... Applicable or Relevant and Appropriate Requirement
ATK..... Alliant Techsystems, Inc.
ATSDR..... Agency for Toxic Substances and Disease Registry
AUF..... Area Use Factor
BAF(s)..... Bioaccumulation Factor(s)
BCF(s) ..... Bioconcentration Factor(s)
BTAG..... Biological Technical Assistance Group
^{o}C..... Degrees Celsius
CAMU..... Corrective Action Management Unit
CD ..... Compact Disc
CFR ..... Code of Federal Regulations
CMO..... Corrective Measures Objectives
CMS ..... Corrective Measures Study
COI..... Contaminant of Interest
COPC ..... Chemical of Potential Concern
COPEC..... Chemical of Potential Ecological Concern
CSEM..... Conceptual Site Exposure Model
CSFs ..... Cancer Slope Factors
CSM ..... Conceptual Site Model
DAF..... Dilution Attenuation Factor
DQO ..... Data Quality Objective
DDT..... Dichlorodiphenyl-trichloroethane
EDQL ..... Ecological Data Quality Level
EEQ..... Environmental Effects Quotient
EPC..... Exposure Point Concentration
ERAGS..... Ecological Risk Assessment Guidance for Superfund
ERIS ..... Environmental Restoration Information System
FAR ..... Federal Acquisition Regulation
ft bgs.....feet below ground surface
ft msl .....feet mean sea level
FML .....Flexible Membrane Liner
FWBSR.....Facility-Wide Background Study Report
GPS .....Global Positioning System
GSD.....Geometric Standard Deviation
HDPE .....High-Density Polyethylene
HEAST.....Health Effects Assessment Summary Tables
HHRA .....Human Health Risk Assessment
HI .....Hazard Index
HQ.....Hazard Quotient
HSWA.....Hazardous and Solid Waste Amendments
ICF KE.....ICF Kaiser Engineers
IDM.....Investigative-derived Materials
IEUBK .....Integrated Exposure Uptake Biokinetic
IRIS.....Integrated Risk Information System
IT.....IT Corporation
LADD .....Lifetime Average Daily Dose
LANL.....Los Alamos National Laboratory
LDR.....Land Disposal Regulation
LOAEL .....Lowest Observable Adverse Effect Level
LOC.....Level of Concern
MBS .....Molecular Bonding System
MCL.....Maximum Contaminant Level
MDC .....Maximum Detected Concentration
mg/kg .....Milligrams per Kilogram
MHSP.....Master Health and Safety Plan
MMA.....Main Manufacturing Area
MQAP.....Master Quality Assurance Plan
MTR.....minimum technology requirements
MWP.....Master Work Plan

NCEA ..... National Center for Environmental Assessment
NCP ..... National Contingency Plan
NG ..... Nitroglycerin
NIBC ..... Not Important Bioaccumulative Constituents
NOAEL ..... No Observable Adverse Effect Level
NRU ..... New River Unit
O&M ..... Operation and Maintenance
ORNL ..... Oak Ridge National Laboratory
OSHA ..... Occupational Safety and Health Administration
PAH ..... Polynuclear Aromatic Hydrocarbon
PCB ..... Polychlorinated Biphenyl
PEF ..... Particulate Emission Factor
PETN ..... Pentaerythritol tetranitrate
PID ..... Photoionization Detector
PPE ..... Personal Protective Equipment and Clothing
ppm ..... Parts per Million
PPRTVs ..... Provisional Peer Reviewed Toxicity Values
PRGs ..... Preliminary Remediation Goals
QA ..... Quality Assurance
QA/QC ..... Quality Assurance/Quality Control
QC ..... Quality Control
RAGS ..... Risk Assessment Guidance for Superfund
RBC ..... Risk-Based Concentration
RBRG ..... Risk-Based Remediation Goal
RCRA ..... Resource Conservation and Recovery Act
RDA ..... Recommended Daily Allowance
RFAAP ..... Radford Army Ammunition Plant
RfCs ..... Risk Reference Concentrations
RfDs ..... Risk Reference Doses
RFI ..... RCRA Facility Investigation
RG ..... Remediation Goal
RME ..... Reasonable Maximum Exposure
RTE ..... Rare, Threatened, or Endangered
RTEC ..... Registry of Toxic Effects Concentration
Shaw ..... Shaw Environmental, Inc.
SLERA ..... Screening Level Ecological Risk Assessment
SMDP ..... Scientific/Management Decision Point
SQL ..... Sample Quantitation Limit
SSL ..... Soil Screening Level
STSC ..... Superfund Health Risk Technical Support Center
SVOC ..... Semivolatile Organic Compound
TAL ..... Target Analyte List
TAT ..... Turn Around Time
TCL ..... Target Compound List
TCLP ..... Toxicity Characteristic Leachate Procedure
TCLPRL ..... Toxicity Characteristic Leachate Procedure Regulatory Limit
TMV ..... Toxicity, Mobility, or Volume
TOC ..... Total Organic Carbon
TRVs ..... Toxicity Reference Values
TSDF ..... Treatment, Storage, and Disposal Facility
TU ..... Temporary Unit
UCL ..... Upper Confidence Limit
µg/L ..... Micrograms per Liter
USACE ..... U.S. Army Corps of Engineers
USACHPPM .. U.S. Army Center for Health Promotion and Preventive Medicine
USEPA ..... U.S. Environmental Protection Agency
UST ..... Underground Storage Tank
UTL ..... Upper Tolerance Limit
UTS ..... Universal Treatment Standard
VDEQ ..... Virginia Department of Environmental Quality
VOC ..... Volatile Organic Compound

EXECUTIVE SUMMARY

Shaw Environmental, Inc. (Shaw) conducted a Resource Conservation and Recovery Act (RCRA) Facility Investigation at Building 4343, the Former Cadmium Plating Facility, during the month of July 2002. The investigation is required by the 2000 RCRA Corrective Action permit (USEPA, 2000a) for the Radford Army Ammunition Plant (RFAAP) and was performed in accordance with Master Work Plan (MWP) Addendum 012 (IT 2002a). MWP Addendum 012 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 Environmental Protection Agency (USEPA) Region III and the Virginia Department of Environmental Quality (VDEQ).

Two previous investigations were conducted at Building 4343 in 1996 and 1999, which had identified cadmium concentrations in soil and building sumps at levels exceeding regulatory screening criteria. Previous investigation sampling strategies were targeted towards chemicals that may have been used at Building 4343. Per the 2000 RCRA permit, a broader sampling strategy was required to complete the delineation of known site contaminants and characterize the site for chemical parameters not previously investigated.

A sampling strategy was developed in MWP Addendum 012 (IT, 2002a) to complete the delineation and characterization of the site. RCRA Facility Investigation (RFI) activities included the collection and chemical and physical analysis of five surface and two subsurface soil samples. These samples and chemical results from previous investigations were combined for the nature and extent assessment. This assessment indicated that cadmium is the primary constituent presenting a concern. Three other metals, chromium, iron, and lead, were detected at concentrations greater than their respective industrial screening levels (USEPA, 2003a) in soil and aluminum, antimony, copper, vanadium, and one organic compound (Aroclor-1254) exceeded the residential screening levels (USEPA, 2003a) in soil. The most elevated concentrations of detected metals in soil were at the point where process water was discharged from Building 4343 to an unlined process water drainage ditch.

Nature and extent analysis indicated that cadmium is the major constituent migrating into the environment. Elevated levels of cadmium were detected in surface soil near the former lead catch tank, in the process water drainage ditch, and in the alluvial fan/storm water drainage ditch area. Boundary samples in the storm water drainage ditch indicate that cadmium is not being transported from the site. Boundary samples along the process water drainage ditch indicate that there is minimal migration of cadmium into the subsurface of the process water ditch. Subsurface soil samples in the alluvial fan area indicate that cadmium concentrations decrease 95 percent from respective surface soil concentrations within the first six feet below the surface. Cadmium has the greatest vertical and horizontal extent of each of the metals with comparison criteria exceedances. Analysis indicates that defining the extent of cadmium also defines the extent of these other metals. Fate and transport analysis of subsurface soil sample results and empirical data for the site indicates that vertical migration of cadmium is limited and it is unlikely that groundwater would be impacted at the site.

A Human Health Risk Assessment (HHRA) was performed to evaluate the potential human health effects associated with chemical contamination from past activities at Building 4343. Soil data collected in 1999 and 2002 was evaluated and chemicals of potential concern (COPCs) were selected for quantitative evaluation in the HHRA. Organic and inorganic compounds detected at

concentrations above screening criteria were selected as COPCs. The human exposure assessment was performed to assess which human exposure pathways could potentially be complete at Building 4343 under both current land-use conditions and future land-use conditions. For each complete exposure pathway, an exposure point concentration (EPC) was derived. The human toxicity assessment was performed in order to identify numerical toxicity criteria with which to assess human health exposures.

Using the results of the human exposure assessment and the toxicity information, potential human health risks for each COPC and selected exposure pathway were evaluated. Upper bound excess lifetime cancer risks for carcinogenic chemicals and hazard quotients (HQs) and hazard index (HI) values for noncarcinogenic chemicals were estimated. The upper-bound lifetime excess cancer risks derived in this report can be compared to USEPA's target risk range for health protectiveness at Superfund sites of $1x10^{-6}$ to $1x10^{-4}$. In addition, the noncarcinogenic HIs can be compared to a value of 1, because HIs greater than 1 indicate a potential for adverse health effects.

Maintenance Worker. For the current and future maintenance worker exposures at Building 4343, the risk characterization results showed total cancer risk associated with surface soil is within the target risk range. The total hazard index (HI) for the current maintenance worker's exposure to surface soil is greater than 1, due to cadmium.

For the future maintenance worker exposures at Building 4343, the risk characterization results showed total cancer risk associated with total soil is below the target risk range. The total HI is less than 1.

Excavation Worker. For the future excavation worker, the risk characterization results showed total cancer risk associated with total soil is below the target risk range. The total HI is greater than 1, primarily due to cadmium.

Adult Resident. For the future adult resident, the risk characterization results showed total cancer risks associated with total soil were below the target risk range. The total HI was greater than 1, primarily due to cadmium.

Child Resident. For the future child resident, the risk characterization results showed total cancer risks associated with total soil were below the target risk range. The total HI was greater than 1, primarily due to cadmium and iron. Based on a margin of exposure evaluation for iron, however, the intake calculated for total soil at Building 4343 is within the allowable range.

A screening level ecological risk assessment (SLERA) was performed to provide an estimate of current and future ecological risk associated with potential hazardous substance releases at Building 4343. In the risk characterization, Tier 1 and Tier 2 chemicals of potential ecological concern (COPEC) environmental effects quotients (EEQs) and HIs (summed EEQs) were estimated for the five selected receptor species. The Tier 1 EEQs were based on very conservative exposure assumptions, such as maximum intakes rates, minimum body weights, maximum bioconcentration factors (BCFs), area use factors of 100 percent, and maximum detected COPEC concentrations in surface soil. The Tier 1 EEQs were considerably greater than 100 for the five receptor species. The short-tailed shrew was predicted to be the most impacted, followed by the American robin, the red fox, the meadow vole, and red-tailed hawk.

More realistic Tier 2 EEQs were also elevated, however, they were considerably lower than the Tier 1 estimates. Tier 2 HIs (rounded to two significant figures), were 280 for the American

robin, 800 for the short-tailed shrew, 66 for the meadow vole, 1.4 for the red fox, and less than 1 for the red-tailed hawk. Cadmium was the COPEC contributing the most to the summed EEQ for each of the five wildlife receptors, while the robin was potentially impacted by concentrations of chromium and dichlorodiphenyl-trichloroethane (DDT), in addition to cadmium. Exposure pathways of most concern, based on the results of the food-chain modeling, were earthworm ingestion and plant ingestion. Incidental soil ingestion was also a significant contributor to the total estimated hazard for the meadow vole.

A potential reduction in wildlife food supply was evaluated using a direct contact toxicity evaluation for soil invertebrates (such as earthworms) exposed to COPECs in surface soil. Maximum detected concentrations were used to estimate a Tier 1 EEQ, and EPCs more appropriate for invertebrate populations [e.g., the 95% upper confidence limit (UCL) concentration] were used to estimate a Tier 2 EEQ. Tier 1 EEQs ranged from 0.2 to 4,550, with both chromium and cadmium having EEQs above 1,000. If chromium is assumed to be in the trivalent form, and not hexavalent, the chromium EEQ drops from 4,550 to 57. Tier 2 EEQs ranged from 0.1 to 1,215, with both chromium and cadmium having EEQs above 500. If chromium is assumed to be in the trivalent form, and not hexavalent, the chromium EEQ drops from 558 to 7. Based on the Tier 2 EEQ results, and assuming chromium is in the trivalent form (based on site-specific information), cadmium, chromium, and zinc are the direct contact COPECs in soil that are estimated to adversely impact the terrestrial invertebrate community, and therefore potentially reduce the food supply for higher trophic level wildlife such as the American robin, and short-tailed shrew.

Because the RFI demonstrated that cadmium contamination is present at concentrations associated with unacceptable human health concerns and potential impacts to ecological receptors, an evaluation of corrective measures to address cadmium in soil was performed.

Four corrective measures alternatives were evaluated as part of this RFI/Corrective Measures Study (CMS) Report. These alternatives consist of the following:

- Alternative One: No Further Action;
- Alternative Two: Excavation of Soil with Waste in Place, Off-site Disposal, Removal of Sumps, Demolition of Building 4343, and Land Use Controls;
- Alternative Three: Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Demolition of Building 4343; and,
- Alternative Four: Stabilization, Removal of Sumps, Demolition of Building 4343, and Land Use Controls.

These four alternatives were evaluated using the selection criteria: effectiveness, implementability, and cost. The corrective measures objective (CMO) for this RFI/CMS is to reduce contaminant concentrations in soil to levels that are protective of industrial workers at the site. However, the Army has also elected to evaluate residential exposure pathways to assess what the increase in remedial effort would be to remediate the site for unrestricted future reuse and facilitate clean close out. Therefore, a Residential Remedial Goal (RG) and credit was given to those alternatives that met this more stringent criterion.

Alternative Three was selected as the final alternative for Building 4343 because it is implementable and provides a greater level of protection to human health and the environment

not provided by Alternatives Two and Four. Alternative Three facilitates clean close out and is cost effective. By achieving clean close out, Alternative Three accomplishes the Army Installation Restoration Program goal by cleaning up the Building 4343 site and restoring it for beneficial reuse. The other two clean up alternatives do not achieve such a goal and cost more. This alternative can be implemented in approximately one year. This time frame is considered an estimate and the actual time to complete the corrective measures will be impacted by site-specific conditions. The total estimated cost for this alternative is $656,000.

This alternative includes the following:

- Delineation of soil containing cadmium above the Residential RG;
- Excavation of the delineated area such that the remaining soil is below the Residential Remedial Goal (RG);
- Removal of the sumps (2) where elevated metals have been identified;
- Demolition of Building 4343;
- Transporation and off-site disposal of soil, sump material, and building debris;
- Site restoration activities.

Implementation of this alternative will reduce the concentrations of cadmium to below the Residential RG and facilitate clean close out. In addition, the proposed human health Remedial Goal for residential land use is expected to result in residual COPEC soil concentrations in surface soil that are protective of the environment. Therefore, implementation of this alternative meets the corrective action objective and is protective of human health and the environment.

1.0 INTRODUCTION

Shaw Environmental, Inc. (Shaw) was tasked by the U.S. Army Corps of Engineers (USACE), Baltimore District, to perform additional characterization activities and evaluate alternatives to address risks to human health and the environment, if identified, at eight sites in the Main Manufacturing Area (MMA) and six sites at the New River Unit (NRU) of Radford Army Ammunition Plant (RFAAP), in accordance with Contract No. DACA31-01-F-0085.

Samples were collected for most analyte classes during previous investigations at these sites; however, data gaps existed in certain chemical parameters and in delineating the extent of identified contamination. A data review, including the development of a conceptual site model and conducting a data gap analysis, was performed for each site in Master Work Plan (MWP) Addendum 012 (IT, 2002a). Once the data needs were identified, sampling strategies were developed to complete characterization and delineation for each site.

The 2002 Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) field investigation at Building 4343 was specifically conducted to (1) further assess the extent of cadmium contamination in soil, resulting from former cadmium plating activities, and (2) characterize site soil for previously untested analyte classes which included, volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), polynuclear aromatic hydrocarbons (PAHs), pesticides, polychlorinated biphenyls (PCBs), herbicides, and explosives (including nitroglycerin [NG] and pentaerythritol tetranitrate [PETN]). In addition, soil samples were analyzed for total organic carbon (TOC), grain size, and pH to assess the bioavailability and mobility of constituents in the soil. This data, in conjunction with the existing data, provided a sufficient data set for completion of a Nature and Extent of Contamination Assessment (*Section 4.0*), Fate and Transport Evaluation (*Section 5.0*), and a Human Health Risk Assessment (HHRA) (*Section 6.0*) and a Screening Level Ecological Risk Assessment (SLERA) (*Section 7.0*) for the Building 4343 study area.

Based on the results of the contamination, human health and ecological risk assessments, it was decided that evaluation of potential remedial actions to address cadmium contamination in soil was necessary. The purpose of the Corrective Measures Study (CMS) portion of this document was to develop and evaluate corrective measure alternatives and to recommend corrective measures to be implemented at Building 4343. The CMS portion of this report presents corrective action objectives (*Section 8.0*), development of alternatives (*Section 9.0*), a detailed analysis of alternatives (*Section 10.0*), and a ranking (*Section 11.0*) and substantiation (*Section 12.0*) for the selection of the final remedy for Building 4343.

Field activities were conducted in July 2002 in accordance with the MWP, Master Quality Assurance Plan (MQAP), the Master Health and Safety Plan (MHSP) (URS, 2003), and MWP Addendum 012 (IT, 2002a), as approved by U.S. Environmental Protection Agency (USEPA) Region III and the Virginia Department of Environmental Quality (VDEQ). Modifications to MWP Addendum 012 proposed sampling activities are presented in *Section 3.5*.

This CMS was performed in compliance with the RFAAP RCRA Permit requirements (EPA ID No. VA1210020730) and the Final RCRA Corrective Action Plan (USEPA, 1994d). These documents provided guidance on the scope and the approach for the CMS portion of this report.

2.0 SITE BACKGROUND

2.1 Site Description

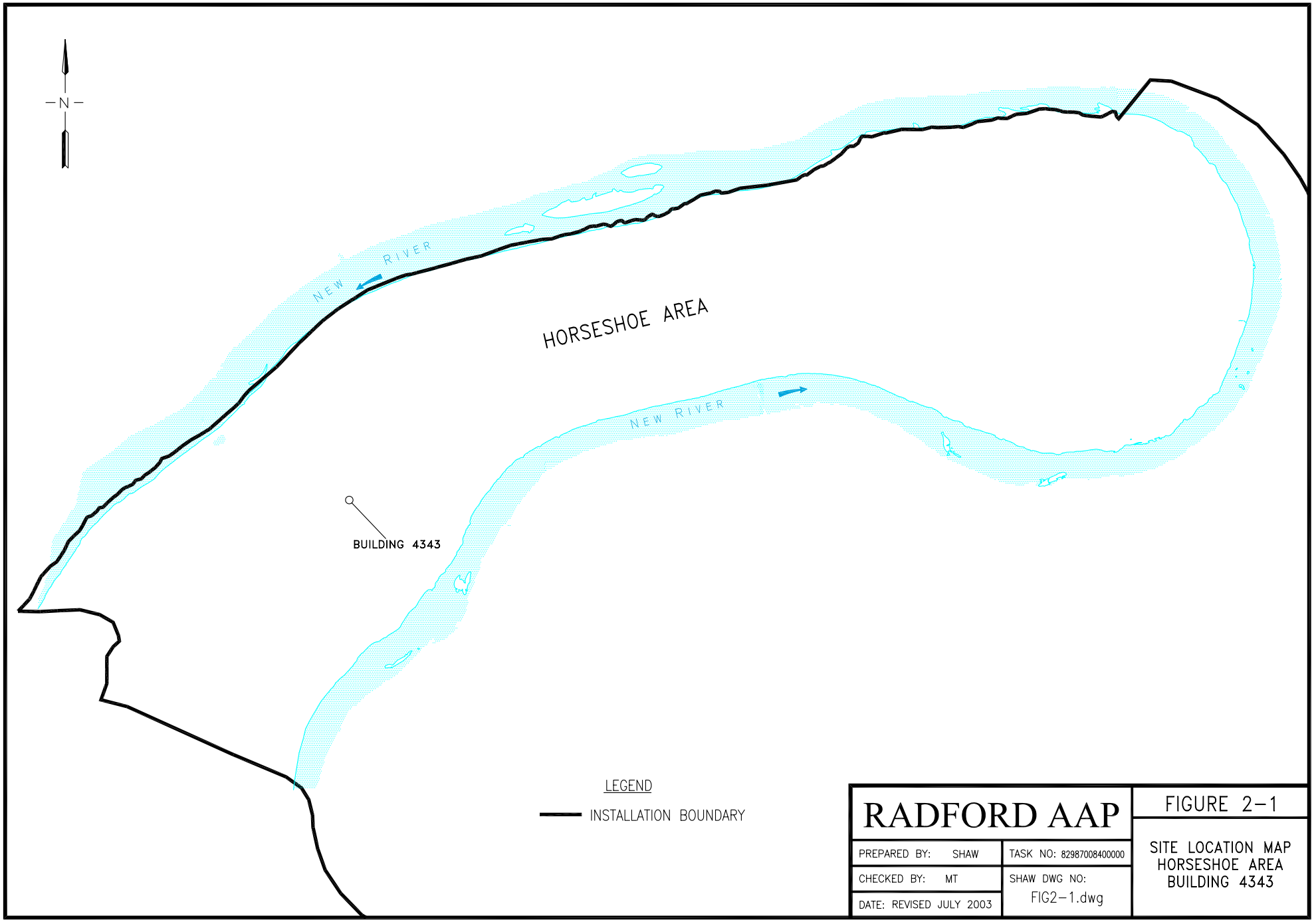
Building 4343, the Former Cadmium Plating Facility, is situated in the west central portion of the Horseshoe Area **(Figure 2-1)**. The area surrounding the building is mowed grass at an elevation of approximately 1,830 feet mean sea level (ft msl). Surface water runoff flows to the north to an east-west trending storm water drainage ditch that grades to approximately 1,810 ft msl. Site features, as shown on **Figure 2-2**, include:

- Building 4343, approximately 34 ft long by 16 ft wide building, which housed the former cadmium plating operations equipment and a floor sump **(Photo 1 and Figure 2-3)**;



Photo 1. Northwest view of Building 4343

- an asphalt driveway leading to an asphalt parking lot southwest of Building 4343;
- underground piping that discharged to a north-south trending process water ditch (unlined) used to drain the sump within Building 4343, an exterior sump outside the building, and the former lead catch tank;
- cement footers used to support the former fire water tanks;
- above ground fire water valves; and,
- an east-west trending storm water drainage ditch that receives overland flow from Building 4343.

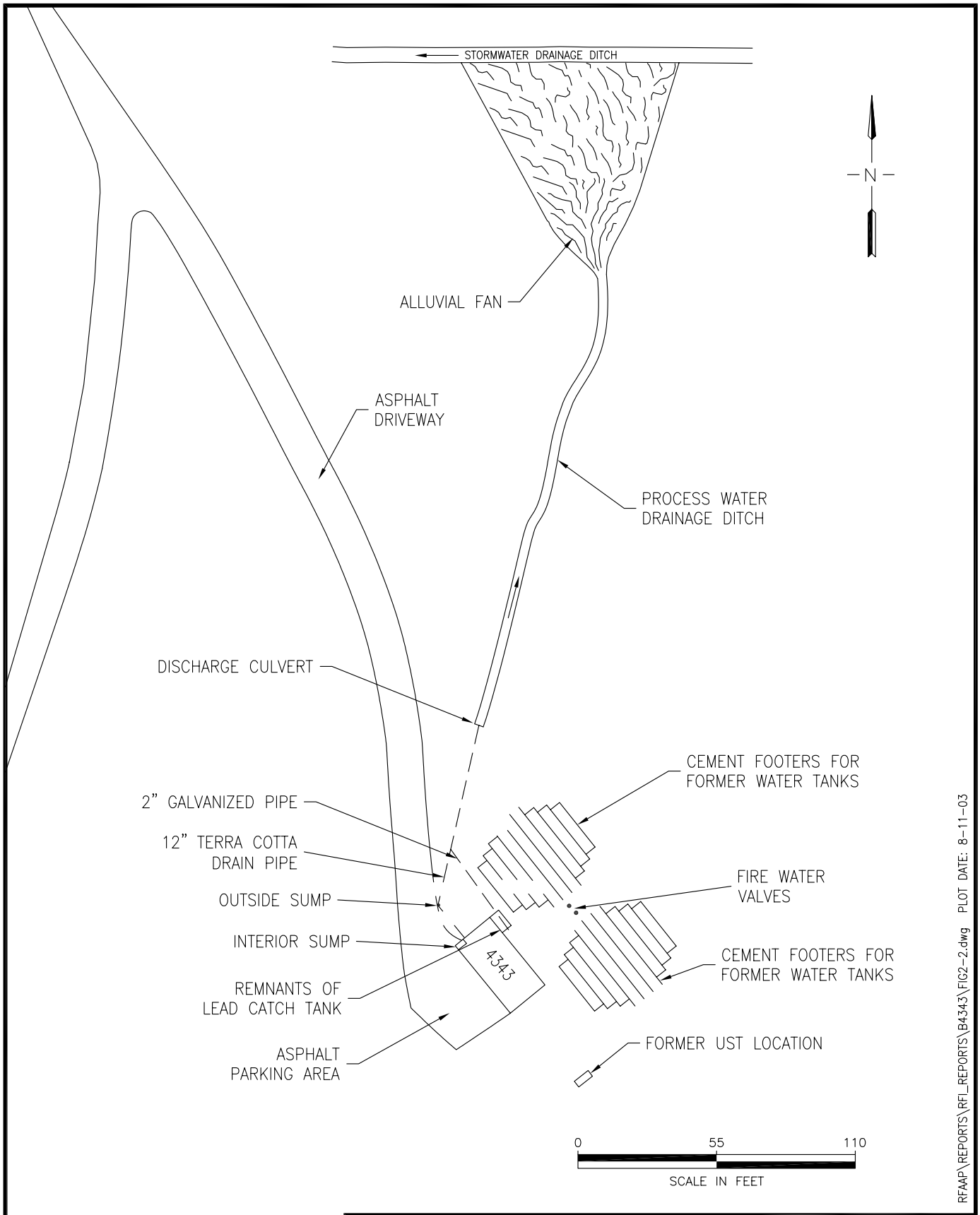


RADFORD AAP

FIGURE 2-1

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DATE: REVISED JULY 2003	

SITE LOCATION MAP
HORSESHOE AREA
BUILDING 4343



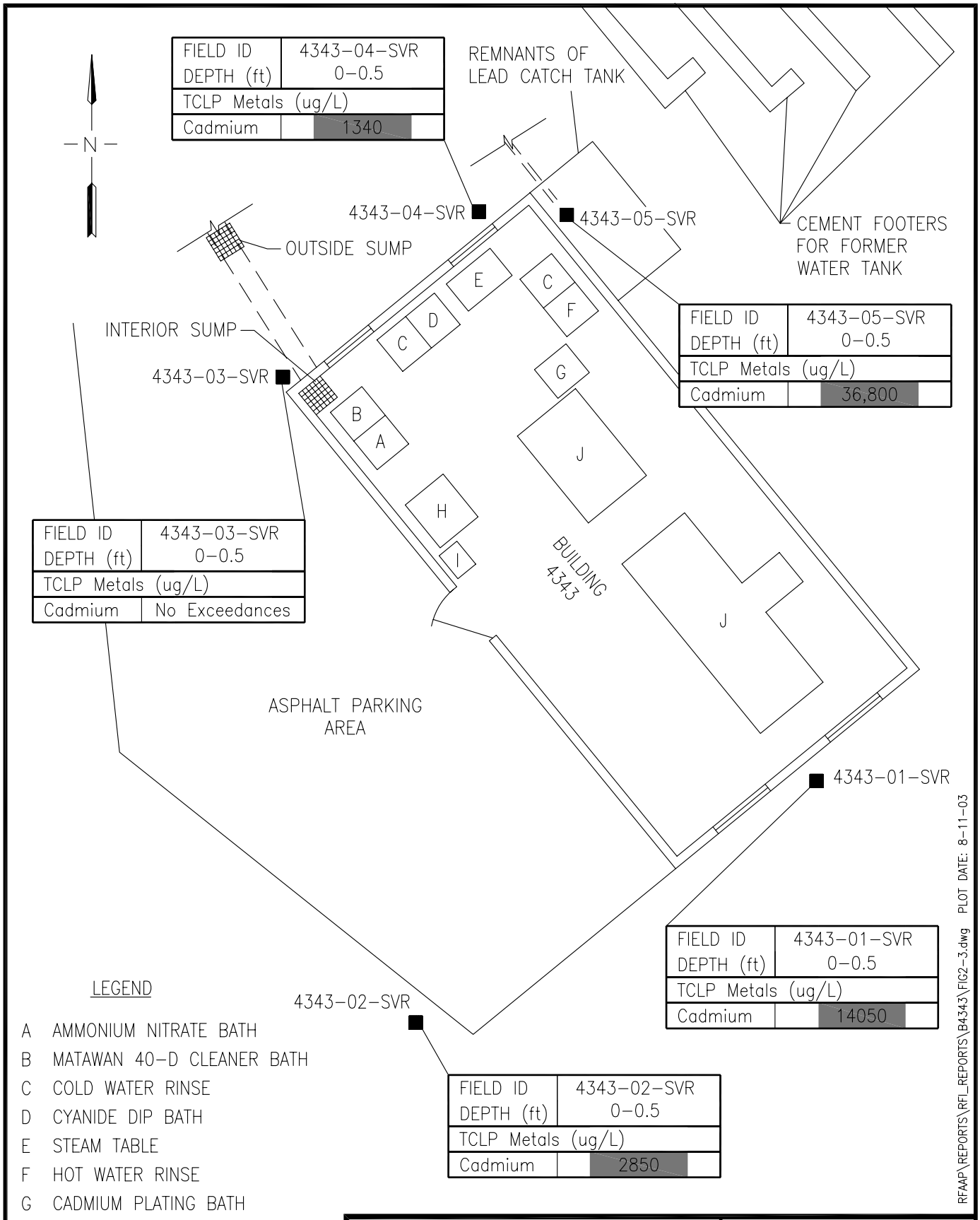
RFAAP\REPORTS\RFI_REPORTS\B4343\FIG2-2.dwg PLOT DATE: 8-11-03

RADFORD AAP

FIGURE 2-2

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DATE: REVISED JULY 2003	

BUILDING 4343
SITE LAYOUT MAP



RADFORD AAP

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DATE: REVISED JULY 2003	

FIGURE 2-3

BUILDING 4343
INTERIOR LAYOUT AND
1996 TCLP CADMIUM SOIL
SAMPLE LOCATIONS MAP

2.2 Site Geology

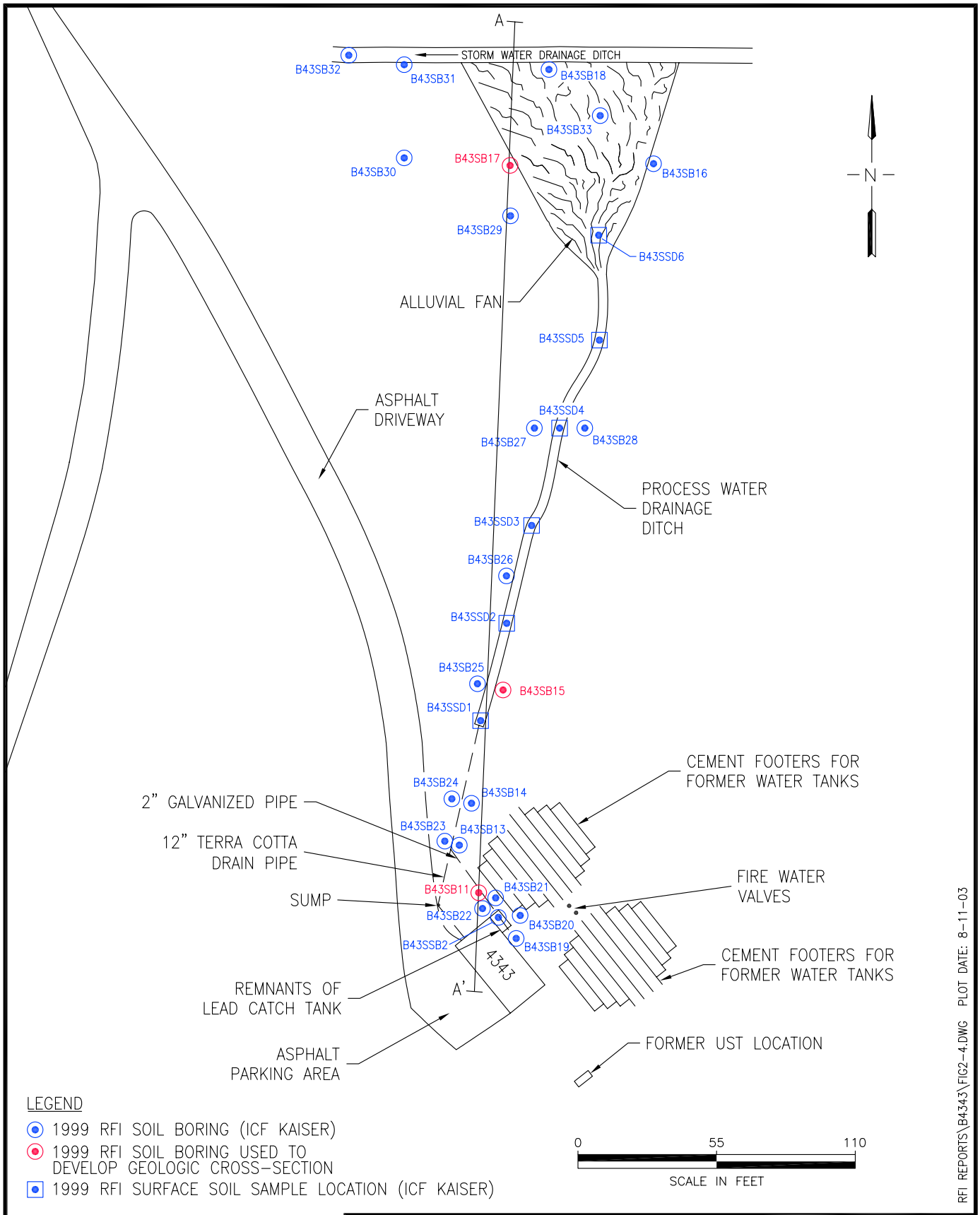
Detailed discussion about the regional geology of the MMA is presented in the Facility-Wide Background Study Report (IT, 2001). Building 4343 is underlain by the Braddock Loam soil type. This soil type has a variable slope between 2% and 30% and does not have a seasonal high water table within six feet of the surface. Typically, the surface layer is seven inches thick and is dark yellowish-brown. Permeability of the Braddock Loam soil is moderate, natural fertility is low, and organic matter content is moderately low. This soil type is generally acidic or very strongly acidic (pH of 4.5–5.5). However, the pH for twenty-two surface soil samples collected from the site ranged from 5.03–7.4, with a mean pH of 6.2 (slightly acidic). The pH of nineteen subsurface soil samples ranged from 5.90–8.35, with a mean pH of 6.6 (neutral). TOC detected in site soil ranged in concentration from 2,038 to 6,160 milligrams per kilogram (mg/kg).

Subsurface soil samples were collected from borings located around Building 4343, parallel to and below the process water drainage ditch, and in the alluvial fan at the toe of the ditch. The deepest of these borings was advanced to a depth of 60 feet below ground surface (ft bgs). Information from these borings was used to construct a geologic cross-section of the site. **Figure 2-4** shows the location of the cross-sectional line A-A' and the borings used to create the geologic cross section. **Figure 2-5** presents the geologic cross-section of the Building 4343 study area. Logging descriptions **(Appendix B-2)** indicate that the subsoil is yellowish-red and red clay down to bedrock. The clay is the result of the weathering of carbonate bedrock formations. The clay has low to medium plasticity and is dry to slightly moist. Groundwater was not encountered in the borings. The clays are underlain by bedrock of the Elbrook Formation. Depth to bedrock ranges from 18 to more than 60 ft bgs. The Elbrook Formation is composed of thickly bedded, blue-gray dolomite interspersed with blue-gray to white limestone; brown, green, and red shale; argillaceous limestone; and brecciated limestone (colors range from mottled light- to dark-gray and yellow-brown).

2.3 Site History

Building 4343 was originally designated as the Fire Water Pump House. The building was used to house a 5-inch, one-stage, 500-gallon/minute gasoline-powered pump. A 550-gallon underground storage tank (UST), located approximately 40 ft south of Building 4343, was used to store the pump fuel. The tank and approximately seven tons of soil were subsequently removed in June 1998 (ATK, 1998). A letter from VDEQ dated 24 August 1998 approved the closure and agreed that no further action was warranted at that time. The letter and tank closure report are presented in **Appendix G-1**. The location of the former UST and remnants of the fire water valves and cement footers used to support the fire water tanks are shown on **Figure 2-2**.

In 1956, the pump and pump engine were removed and the building was converted to conduct cadmium plating operations in support of the NIKE missile program. Conversion activities included the installation of a drying cabinet, cadmium plating, ammonium nitrate, and cyanide dip baths, an exterior lead catch tank, and an exhaust system for the acid fumes. Because cadmium ingots in an acid bath were used in the plating process, it is not believed that cadmium as a dust or volatile would be transported through the exhaust system. The location of these features housed within the building is shown on **Figure 2-3**. The initial procedures of the plating process involved the cleaning of parts using ammonium nitrate, cold water, Matawan 40-



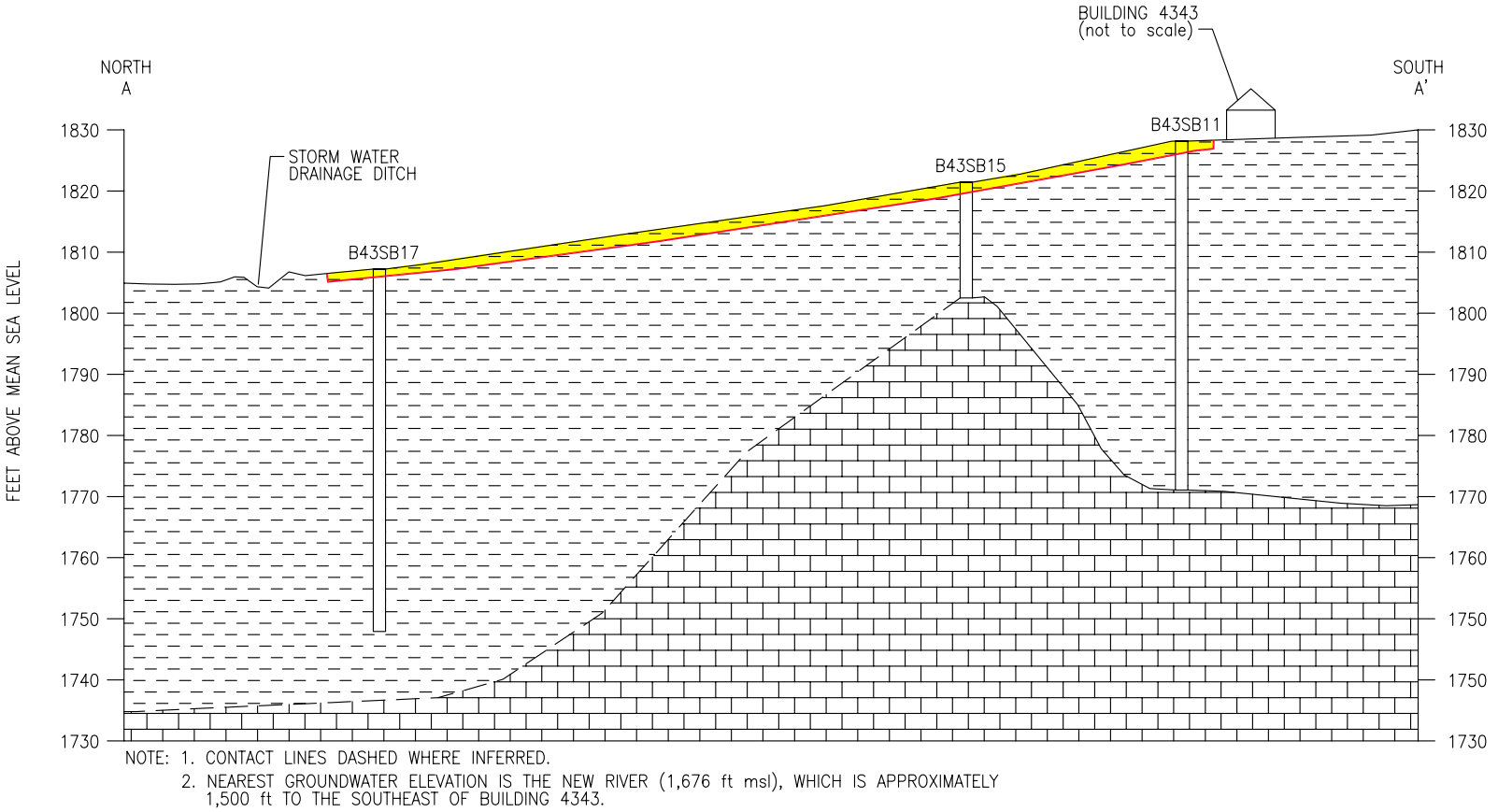
RFI REPORTS\B4343\FIG2-4.DWG PLOT DATE: 8-11-03

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FIGURE 2-4

BUILDING 4343
GEOLOGIC CROSS SECTION
LINE A-A'



NOTE: 1. CONTACT LINES DASHED WHERE INFERRED.
2. NEAREST GROUNDWATER ELEVATION IS THE NEW RIVER (1,676 ft msl), WHICH IS APPROXIMATELY 1,500 ft TO THE SOUTHEAST OF BUILDING 4343.

LEGEND

- CLAY AND SILT, LITTLE SAND, RED–BROWN (CL)
- LIMESTONE, GRAY–BROWN, ARGILLACEOUS (LMSN)
- DEPTH OF CADMIUM IMPACTED SOIL IN WASTEWATER DRAINAGE DITCH

HORIZ. SCALE: 0 20 60

VERT. SCALE: 0 10 30

RADFORD AAP

FIGURE 2–5

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DATE: REVISED JULY 2003	

BUILDING 4343
GEOLOGIC
CROSS SECTION A–A'

FILE: RFI REPORTS\B4343\FIG2–5.DWG PLOTTED: 8–11–03

D, and hydrochloric acid baths. Following the cleaning process, the parts went through a series of baths including: cold and hot water, sodium cyanide dip, cadmium plating [using ingots of cadmium (Cd^o) and small amounts of cadmium oxide (CdO)], and sodium cyanide rinse water. Rinse water used in the plating process was then neutralized as described in the following paragraph.

Rinse water from the cadmium plating operations was process water containing cyanide, cadmium, and chromium. The probable source of the chromium contained in the process water most likely resulted from the cleaning of metal parts that may have contained chromium. The metal parts were subjected to acid bath cleaning prior to cadmium plating. The process water was collected and stored in the exterior lead-lined catch tank located on the northeast corner of the building **(Figures 2-2 and 2-3)**. When a sufficient amount of process water accumulated in the tank, it was treated with an alkaline chlorine solution to neutralize the cyanide. This process would also cause trace metals to precipitate and form the sludge contained in the process sumps. Following treatment, the process water was checked for chlorine residual. If no free chlorine was found, additional chlorine solution was added to the process water. If free chlorine was found, the process water was then drained through underground pipes to the process water ditch north of Building 4343. The amount of cadmium and chromium present in the process water was not considered sufficient to require further treatment (Hercules, 1959).

2.3.1 Previous Investigations

Two previous investigations have been conducted at this Area of Concern (AOC). In 1996, Alliant Techsystems, Inc. (ATK) performed surface soil sampling for cadmium to assess whether cadmium was present at elevated levels. In 1999, ICF Kaiser Engineers (ICF KE) performed an RFI to further delineate the extent of cadmium contamination identified during the 1996 surface soil sampling for cadmium. These investigations and results of the chemical data are summarized below.

TCLP Cadmium Sampling (ATK). Five surface soil samples were collected around Building 4343 to assess the extent of cadmium contamination **(Appendix G-2)**. These sample locations and a summary of chemical constituents that exceeded levels of concern (LOCs) are depicted on **Figure 2-3**. Samples were analyzed for toxicity characteristic leachate procedure (TCLP) cadmium. Analytical results indicated that concentrations of leachable cadmium exceeded the toxicity characteristic leachate procedure regulatory limit (TCLPRL) of 1,000 micrograms per liter (µg/L) in four of the five samples collected, with concentrations ranging from 1,340 to 36,800 µg/L. Analytical results are presented in **Appendix B-1, Table B-1**. This investigation was successful in meeting the goal of verifying whether cadmium was present at elevated levels. Based on these results, an additional investigation was recommended to delineate the extent of elevated cadmium concentrations.

1999 RCRA Facility Investigation (ICF KE). In 1999, ICF KE conducted an RFI at Building 4343 to characterize the extent of cadmium concentrations detected during the 1996 investigation. To meet this investigative goal, the following sampling program was performed:

- 39 surface and 36 subsurface soil samples were collected from the vicinity of Building 4343 and along the drainage ditches,
- Two sludge samples were collected from sumps associated with the building, and
- Six wipe samples were collected from the concrete floor inside the building.

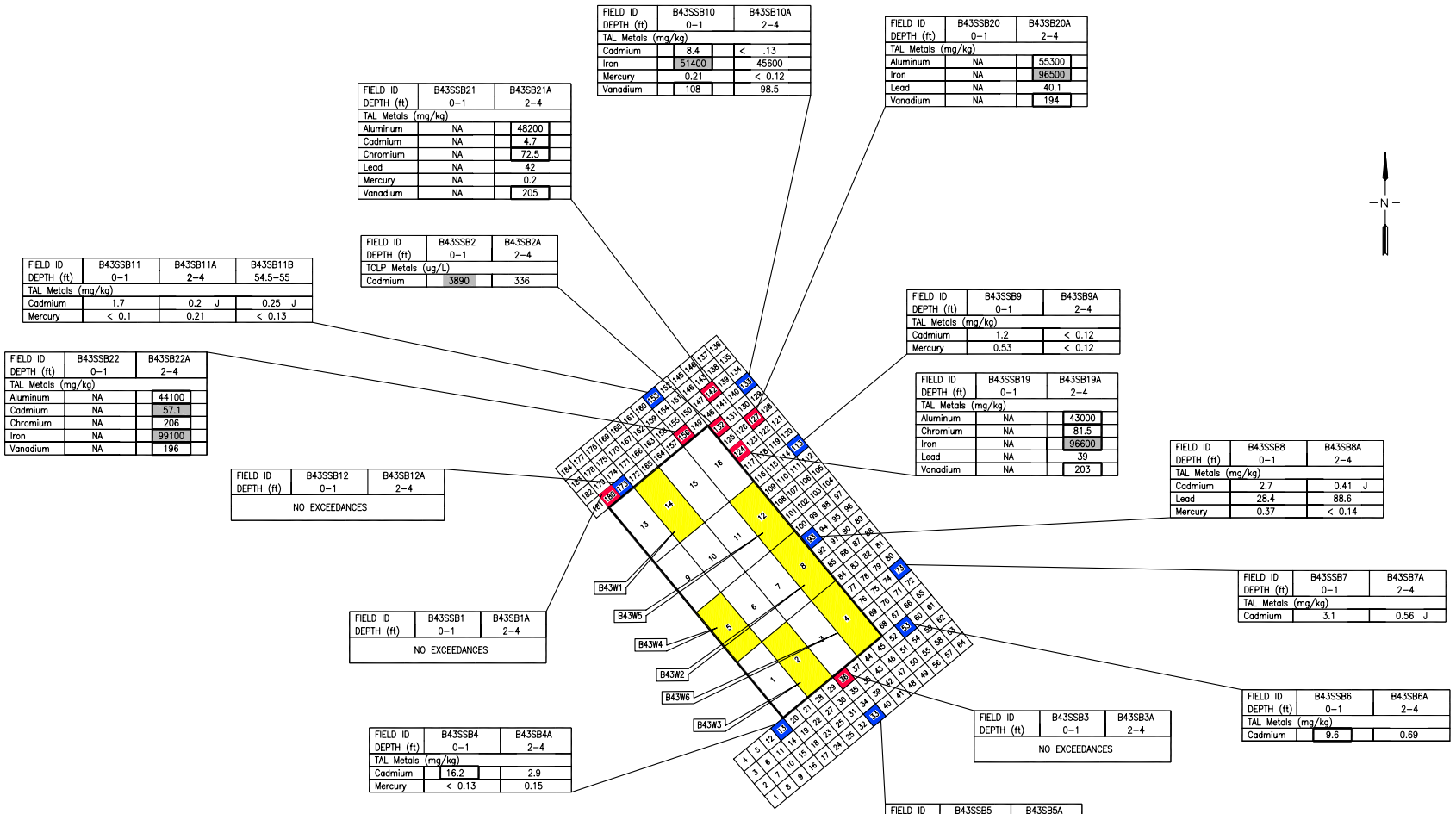
Sampling locations and a summary of chemical constituents which exceeded LOCs are depicted on **Figures 2-6 and 2-7. Figure 2-6** shows the systematic grid and biased sampling locations within and directly surrounding Building 4343. **Figure 2-7** depicts the sump sampling locations and soil sampling locations north of Building 4343. **Table 2-1** provides a summary of environmental samples collected and analyzed in support of the 1999 RFI. Analytical results for inorganics are indicated on the tables and figures as exceedances when they exceed both the background value and a screening value. Eliminating screening level exceedances that are below the background value allows site-specific constituents to be more clearly indicated on the tables and figures.

Soil. Samples with target analyte list (TAL) cadmium and/or TCLP cadmium concentrations above screening levels or TCLPRL were predominantly collected in surface soil (0–1 ft bgs) within the process water drainage ditch and alluvial fan. Cadmium was detected at or below the detection limits in every subsurface soil sample (2-4 ft bgs) collected immediately adjacent to the process water drainage ditch. One sample (B43SB14A) collected along the subsurface process water pipe, leading to the process water drainage ditch, upgradient of the ditch and midway between the building and the process water drainage ditch, contained concentrations of cadmium and TCLP cadmium above the industrial screening level and TCLPRL. These concentrations most likely indicate a leaking pipe rather than migration from the surface. One surface soil sample (B43SSD1), collected at the head of the process water ditch (immediately below the discharge point of the process water outfall) contained the highest concentrations of cadmium (24,300 mg/kg).

Analytical results indicated that four metals (aluminum, antimony, copper, and vanadium) were detected in soil at concentrations above their respective residential and background (IT, 2001) screening levels. These exceedances were located in the same areas where cadmium was detected above its screening levels. Three additional metals (chromium, iron, and lead) were found to exceed their respective industrial and background (IT, 2001) screening levels. Besides cadmium, the other three metals had three or less exceedances located along the process water drainage ditch. Detected results for soil samples are presented in **Appendix B-1, Tables B-2 through B-5**.

Sludge. Analytical results indicated that six metals (antimony, arsenic, cadmium, chromium, iron, and lead) were detected above industrial soil screening levels in sludge samples collected from the interior and exterior sumps. Barium, copper, and zinc were detected above residential soil screening levels in the interior sump and antimony exceeded its residential soil screening level in the outside sump. Analytical results for sludge samples collected from the sumps are presented in **Appendix B-1, Table B-6**.

Inspections of both the interior and exterior sumps prior to sampling gave no indication that there were cracks or breaks in the either of the sumps and no indications of pathways to the subsurface through the sumps. Photographs taken during sludge sampling activities at Building 4343 illustrating the integrity of the sumps are provided in **Appendix F-1 (Photos 9 and 10)**.



NOTE:

J = ESTIMATED CONCENTRATION

NA = ANALYTE NOT TESTED

DARK BORDER = VALUE EXCEEDS THE RESIDENTIAL SCREENING LEVEL (USEPA; APRIL, 2003)

SHADING = VALUE EXCEEDS THE INDUSTRIAL SCREENING LEVEL (USEPA; APRIL, 2003) OR TCLP CRITERIA (USEPA, 40 CFR 261.4)

BOLD = VALUE EXCEEDS THE BACKGROUND CRITERION (IT, 2001)

VALUES DETECTED BELOW BACKGROUND ARE NOT SHOWN

Sample Summary

Investigation	Contractor	TAL Metals			Cyanide			TCLP Metals		VOCs		SVOCs		Pest		PCBs		Herb		Explosives		PAHs		Total
		SS	SB	SE	SS	SB	SE	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	
1996 SS Sampling	ATK	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5
1999 RFI	ICF Kaiser	22	33	2 (SL)	17	12	2 (SL)	26	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	138
2002 RFI	Shaw	3	2	--	--	--	--	--	--	2	2	2	2	2	1	4	2	2	1	2	2	2	2	33

RADFORD AAP

FIGURE 2-6

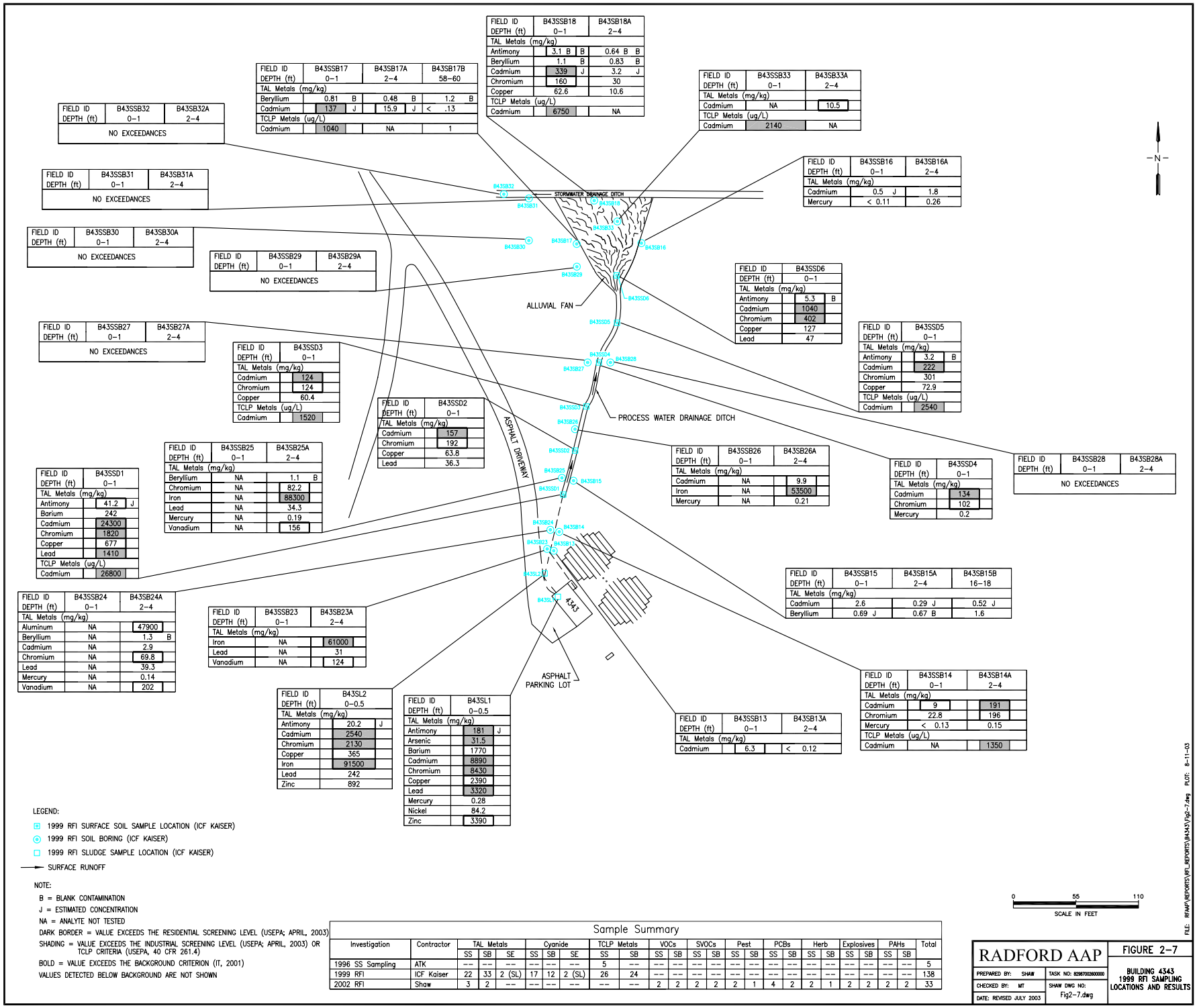
BUILDING 4343 SYSTEMATIC GRID AND BIASED SAMPLING LOCATIONS AND RESULTS

PREPARED BY: SHAW | TASK NO: 8296702600000

CHECKED BY: MT | SHAW DWG NO: Fig2-6.dwg

DATE: REVISED JULY 2003

FILE: RFAAP\REPORTS\RFI_REPORTS\B4343\Fig2-6.dwg PLOT: 8-11-03



FIELD ID	B43SSB18	B43SB18A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Antimony	3.1 B	0.64 B B
Beryllium	1.1 B	0.83 B
Cadmium	339 J	3.2 J
Chromium	160	30
Copper	62.6	10.6
TCLP Metals (ug/L)		
Cadmium	6750	NA

FIELD ID	B43SSB17	B43SB17A	B43SB17B
DEPTH (ft)	0–1	2–4	58–60
TAL Metals (mg/kg)			
Beryllium	0.81 B	0.48 B	1.2 B
Cadmium	137 J	15.9 J	< .13
TCLP Metals (ug/L)			
Cadmium	1040	NA	1

FIELD ID	B43SSB33	B43SB33A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	NA	10.5
TCLP Metals (ug/L)		
Cadmium	2140	NA

FIELD ID	B43SSB32	B43SB32A
DEPTH (ft)	0–1	2–4
NO EXCEEDANCES		

FIELD ID	B43SSB16	B43SB16A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	0.5 J	1.8
Mercury	< 0.11	0.26

FIELD ID	B43SSB31	B43SB31A
DEPTH (ft)	0–1	2–4
NO EXCEEDANCES		

FIELD ID	B43SSB30	B43SB30A
DEPTH (ft)	0–1	2–4
NO EXCEEDANCES		

FIELD ID	B43SSB29	B43SB29A
DEPTH (ft)	0–1	2–4
NO EXCEEDANCES		

FIELD ID	B43SSD6
DEPTH (ft)	0–1
TAL Metals (mg/kg)	
Antimony	5.3 B
Cadmium	1040
Chromium	402
Copper	127
Lead	47

FIELD ID	B43SSD5
DEPTH (ft)	0–1
TAL Metals (mg/kg)	
Antimony	3.2 B
Cadmium	222
Chromium	301
Copper	72.9
TCLP Metals (ug/L)	
Cadmium	2540

FIELD ID	B43SSB27	B43SB27A
DEPTH (ft)	0–1	2–4
NO EXCEEDANCES		

FIELD ID	B43SSD3
DEPTH (ft)	0–1
TAL Metals (mg/kg)	
Cadmium	124
Chromium	124
Copper	60.4
TCLP Metals (ug/L)	
Cadmium	1520

FIELD ID	B43SSD2
DEPTH (ft)	0–1
TAL Metals (mg/kg)	
Cadmium	157
Chromium	192
Copper	63.8
Lead	36.3

FIELD ID	B43SSB28	B43SB28A
DEPTH (ft)	0–1	2–4
NO EXCEEDANCES		

FIELD ID	B43SSB25	B43SB25A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Beryllium	NA	1.1 B
Chromium	NA	82.2
Iron	NA	88300
Lead	NA	34.3
Mercury	NA	0.19
Vanadium	NA	156

FIELD ID	B43SSB26	B43SB26A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	NA	9.9
Iron	NA	53500
Mercury	NA	0.21

FIELD ID	B43SSD4
DEPTH (ft)	0–1
TAL Metals (mg/kg)	
Cadmium	134
Chromium	102
Mercury	0.2

FIELD ID	B43SSD1
DEPTH (ft)	0–1
TAL Metals (mg/kg)	
Antimony	41.2 J
Barium	242
Cadmium	24300
Chromium	1820
Copper	677
Lead	1410
TCLP Metals (ug/L)	
Cadmium	26800

FIELD ID	B43SSB24	B43SB24A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Aluminum	NA	47900
Beryllium	NA	1.3 B
Cadmium	NA	2.9
Chromium	NA	69.8
Lead	NA	39.3
Mercury	NA	0.14
Vanadium	NA	202

FIELD ID	B43SSB23	B43SB23A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Iron	NA	61000
Lead	NA	31
Vanadium	NA	124

FIELD ID	B43SSB15	B43SB15A	B43SB15B
DEPTH (ft)	0–1	2–4	16–18
TAL Metals (mg/kg)			
Cadmium	2.6	0.29 J	0.52 J
Beryllium	0.69 J	0.67 B	1.6

FIELD ID	B43SL2
DEPTH (ft)	0–0.5
TAL Metals (mg/kg)	
Antimony	20.2 J
Cadmium	2540
Chromium	2130
Copper	365
Iron	91500
Lead	242
Zinc	892

FIELD ID	B43SL1
DEPTH (ft)	0–0.5
TAL Metals (mg/kg)	
Antimony	181 J
Arsenic	31.5
Barium	1770
Cadmium	8890
Chromium	8430
Copper	2390
Lead	3320
Mercury	0.28
Nickel	84.2
Zinc	3390

FIELD ID	B43SSB13	B43SB13A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	6.3	< 0.12

FIELD ID	B43SSB14	B43SB14A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	9	191
Chromium	22.8	196
Mercury	< 0.13	0.15
TCLP Metals (ug/L)		
Cadmium	NA	1350

LEGEND:

- 1999 RFI SURFACE SOIL SAMPLE LOCATION (ICF KAISER)
- 1999 RFI SOIL BORING (ICF KAISER)
- 1999 RFI SLUDGE SAMPLE LOCATION (ICF KAISER)
- SURFACE RUNOFF

NOTE:

B = BLANK CONTAMINATION
J = ESTIMATED CONCENTRATION
NA = ANALYTE NOT TESTED
DARK BORDER = VALUE EXCEEDS THE RESIDENTIAL SCREENING LEVEL (USEPA; APRIL, 2003)
SHADING = VALUE EXCEEDS THE INDUSTRIAL SCREENING LEVEL (USEPA; APRIL, 2003) OR TCLP CRITERIA (USEPA, 40 CFR 261.4)
BOLD = VALUE EXCEEDS THE BACKGROUND CRITERION (IT, 2001)
VALUES DETECTED BELOW BACKGROUND ARE NOT SHOWN

Sample Summary

Investigation	Contractor	TAL Metals			Cyanide			TCLP Metals		VOCs		SVOCs		Pest		PCBs		Herb		Explosives		PAHs		Total
		SS	SB	SE	SS	SB	SE	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	
1996 SS Sampling	ATK	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5
1999 RFI	ICF Kaiser	22	33	2 (SL)	17	12	2 (SL)	26	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	138
2002 RFI	Shaw	3	2	--	--	--	--	--	--	2	2	2	2	2	1	4	2	2	1	2	2	2	2	33

0 55 110
SCALE IN FEET

RADFORD AAP

FIGURE 2-7

BUILDING 4343
1999 RFI SAMPLING LOCATIONS AND RESULTS

PREPARED BY: SHAW
TASK NO: 829870028000000
CHECKED BY: MT
SHAW DWG NO: Fig2-7.dwg
DATE: REVISED JULY 2003

FILE: R:\AAP\REPORTS\RFI_REPORTS\B4343\Fig2-7.dwg PLOT: 8-11-03

Table 2-1
1999 RFI Environmental Samples and Analyses

Media	Sample ID	Depth (ft bgs)	Analyses
Surface Soil	B43SSB1	0-1	TCLP metals
	B43SSB2	0-1	TCLP metals, pH
	B43SSB3	0-1	TCLP metals, pH
	B43SSB4	0-1	TAL metals, cyanide, TOC, pH
	B43SSB5	0-1	TAL metals, cyanide, pH
	B43SSB6	0-1	TAL metals, cyanide, pH
	B43SSB7	0-1	TAL metals, cyanide, pH
	B43SSB8	0-1	TAL metals, cyanide, pH
	B43SSB9	0-1	TAL metals, cyanide, pH
	B43SSB10	0-1	TAL metals, cyanide, pH
	B43SSB11	0-1	TAL metals, cyanide, pH
	B43SSB12	0-1	TAL metals, cyanide, pH
	B43SSB13	0-1	TAL metals, cyanide, pH, TCLP metals
	B43SSB14	0-1	TAL metals, cyanide, pH, TCLP metals
	B43SSB15	0-1	TAL metals, pH, TCLP metals
	B43SSB16	0-1	TAL metals, pH
	B43SSB17	0-1	TAL metals, TCLP metals
	B43SSB18	0-1	TAL metals, TCLP metals
	B43SSB19	0-1	TCLP metals
	B43SSB20	0-1	TCLP metals
	B43SSB21	0-1	TCLP metals
	B43SSB22	0-1	TCLP metals
	B43SSB23	0-1	TCLP metals
	B43SSB24	0-1	TCLP metals
	B43SSB25	0-1	TCLP metals
	B43SSB26	0-1	TCLP metals
	B43SSB27	0-1	TCLP metals
	B43SSB28	0-1	TAL metals, TCLP metals
	B43SSB29	0-1	TCLP metals
	B43SSB30	0-1	TCLP metals
	B43SSB31	0-1	TCLP metals
	B43SSB32	0-1	TCLP metals
	B43SSB33	0-1	TCLP metals
	B43SSD1	0-1	TAL metals, cyanide, pH, TCLP metals
	B43SSD2	0-1	TAL metals, cyanide, pH
	B43SSD3	0-1	TAL metals, cyanide, pH, TCLP metals
	B43SSD4	0-1	TAL metals, cyanide
	B43SSD5	0-1	TAL metals, cyanide, TOC, pH, TCLP metals
	B43SSD6	0-1	TAL metals, cyanide, pH

Table 2-1 (Continued)
1999 RFI Environmental Samples and Analyses

Media	Sample ID	Depth (ft bgs)	Analyses
Subsurface Soil	B43SB1A	2-4	TCLP metals
	B43SB2A	2-4	TCLP metals, pH
	B43SB3A	2-4	TCLP metals, pH
	B43SB4A	2-4	TAL metals, cyanide, TOC, pH
	B43SB5A	2-4	TAL metals, cyanide, pH
	B43SB6A	2-4	TAL metals, cyanide, pH
	B43SB7A	2-4	TAL metals, cyanide, pH
	B43SB8A	2-4	TAL metals, cyanide, pH
	B43SB9A	2-4	TAL metals, cyanide, pH
	B43SB10A	2-4	TAL metals, cyanide, pH
	B43SB11A	2-4	TAL metals, cyanide, pH
	B43SB11B	54.5-55	TAL metals, cyanide, pH
	B43SB12A	2-4	TAL metals, cyanide, pH
	B43SB13A	2-4	TAL metals, cyanide, pH, TCLP metals
	B43SB14A	2-4	TAL metals, cyanide, pH, TCLP metals
	B43SB15A	2-4	TAL metals, pH, TCLP metals
	B43SB15B	16-18	TAL metals, pH, TCLP metals
	B43SB16A	2-4	TAL metals, pH, TCLP metals
	B43SB17A	2-4	TAL metals
	B43SB17B	58-60	TAL metals, pH, TCLP metals
	B43SB18A	2-4	TAL metals
	B43SB19A	2-4	TAL metals, TCLP metals
	B43SB20A	2-4	TAL metals, TCLP metals
	B43SB21A	2-4	TAL metals, TCLP metals
	B43SB22A	2-4	TAL metals, TCLP metals
	B43SB23A	2-4	TAL metals, TCLP metals
	B43SB24A	2-4	TAL metals, TCLP metals
	B43SB25A	2-4	TAL metals, TCLP metals
	B43SB26A	2-4	TAL metals, TCLP metals
	B43SB27A	2-4	TAL metals, TCLP metals
	B43SB28A	2-4	TAL metals, TCLP metals
	B43SB29A	2-4	TAL metals, TCLP metals
	B43SB30A	2-4	TAL metals, TCLP metals
	B43SB31A	2-4	TAL metals, TCLP metals
	B43SB32A	2-4	TAL metals, TCLP metals
	B43SB33A	2-4	TAL metals, TCLP metals
Sump Sludge	B43SL1	NA	TAL metals, cyanide
	B43SL2	NA	TAL metals, cyanide
Wipe Samples	B43W1	NA	TAL metals
	B43W2	NA	TAL metals
	B43W3	NA	TAL metals
	B43W4	NA	TAL metals
	B43W5	NA	Mercury
	B43W6	NA	Mercury

Soil samples have been collected at both surface and subsurface locations near to and downgradient of the sumps **(Figures 2-6 and 2-7)**. The lack of widespread exceedances of most metals except cadmium (and secondarily, chromium) provides indication as to the integrity of the sumps. As will be discussed in *Section 12.0*, a remedial action is programmed for this site and removal/cleaning of the sumps would be part of this action. Post-removal confirmation sampling would insure that there are no elevated concentrations of metals in soil surrounding the sumps.

Wipe samples. Several metals were detected in the six wipe samples collected from the floor of the building. However, no comparison criteria are available for wipe samples. Analytical results for the wipe samples collected from the concrete floor are presented in **Appendix B-1, Table B-7**.

The 1999 RFI further delineated the extent of cadmium and established the concentrations of other inorganic compounds in site media. The investigation demonstrated that elevated levels of TAL metals, primarily cadmium, exist in the sumps and shallow soil around the building and in the process water drainage ditch. Evaluation of 1999 RFI data identified data gaps and an additional investigation was recommended to complete the delineation of elevated cadmium concentrations and to characterize available site media for previously untested analyte classes.

2.4 Facility-Wide Background Study (IT, 2001)

A Facility-Wide Background Study was conducted at the MMA and NRU at RFAAP in 2001. Task objectives were to characterize naturally occurring background soil inorganic concentrations to establish a baseline for inorganic compounds of concern at RFAAP. Data was statistically evaluated across soil types, soil horizons, and study areas to assess the potential for expanding the effective data into one set. Statistical tests demonstrated that the data was statistically similar across soil types and study areas, resulting in one set of background values for both surface and subsurface soil. Facility-wide point estimates for background soil data were calculated as 95% UTLs and are presented in **Table 2-2.** In general, UTLs were calculated as follows:

$$UTL = \overline{X} + k(a)$$

where:

UTL	=	upper tolerance limit (confidence factor of 0.95 and coverage of 95 percent)
$\overline{x}$	=	arithmetic mean
a	=	standard deviation
k	=	tolerance factor

It should be noted that for seven (aluminum, arsenic, chromium, iron, manganese, thallium, and vanadium) of the constituents, the 95% UTLs are greater than their respective residential screening levels. In addition, the 95% UTLs for arsenic, iron, and manganese are greater than their industrial screening levels.

Table 2-2
Facility-Wide Point Estimates for Background Soil

Chemical Name	Range of Data (mg/kg)	Background Concentration 95 % UTL (mg/kg)
Aluminum	3,620 - 47,900	40,041
Arsenic	1.2 - 35.9	15.8
Barium	23.4 - 174	209
Beryllium	0.61 - 5.4	1.02
Cadmium	0.62 - 2.5	0.69
Chromium	6.3 - 75.8	65.3
Cobalt	5.9 - 130	72.3
Copper	1.6 - 38.7	53.5
Iron	7,250 - 67,700	50,962
Lead	2.1 - 256	26.8
Manganese	16.7 - 2,040	2,543
Mercury	0.038 - 1.2	0.13
Nickel	4.6 - 94.2	62.8
Thallium	1.3 - 5.0	2.11
Vanadium	12.2 - 114	108
Zinc	4.7 - 598	202

Inorganic constituents detected at concentrations exceeding screening levels are compared to the background concentrations to assess whether these metals are present at concentrations greater than naturally occurring levels. Inorganics detected at concentrations less than background levels are not considered site-related constituents.

3.0 FIELD INVESTIGATION PROGRAM

3.1 Soil Sampling

Surface and subsurface soil samples were collected for chemical and physical analysis during 2002 RFI sampling activities at Building 4343 **(Table 3-1)**. Upon retrieval of soil for sample processing, the soil was field screened for the presence of volatile organic vapors using a properly calibrated photoionization detector (PID). Field screening consisted of cutting a cross-sectional slice from the core or center of the sample with a decontaminated stainless steel trowel and inserting the PID probe. There were no elevated PID readings at this site. After the PID readings were recorded, a sample for VOC analysis was immediately collected from the appropriate interval using a disposable EnCore sampler.

Once the fraction for VOC analysis was completed, or if soil samples were just collected for non-VOC analyses, the boring was examined and classified by the site geologist and recorded in the field logbook. Soil for non-VOC analysis was then extracted from the appropriate interval, placed in a stainless steel bowl, and homogenized. The appropriate sample containers were filled, labeled, and placed into coolers with ice and maintained at 4 degrees Celsius (^{o}C).

Table 3-1
2002 RFI Environmental Samples and Analyses

Media	Sample ID	Depth	Analyses	Purpose
Surface Soil	B43SS01	0–0.5 ft bgs	TAL metals	Complete delineation of previously identified cadmium contamination
	B43SS02	0–0.5 ft bgs	TAL metals, PCBs	
	B43SS03	0–0.5 ft bgs	TAL metals, PCBs	
	B43SB34A	0–0.5 ft bgs (VOCs @ 0.5-1.0 ft bgs)	TCL VOCs, SVOCs, pesticides/PCBs, herbicides, PAHs, explosives, TOC, grain size, pH	Characterize for previously untested analyte classes
	B43SB35A	0–0.5 ft bgs (VOCs @ 0.5-1.0 ft bgs)	TCL VOCs, SVOCs, pesticides/PCBs, herbicides, PAHs, explosives	
Subsurface Soil	B43SB34B	4–6 ft bgs	TCL VOCs, SVOCs, PCBs, PAHs, TAL metals, explosives	
	B43SB35B	4–6 ft bgs	TCL VOCs, SVOCs, pesticides/PCBs, herbicides, PAHs, TAL metals, explosives	

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

3.1.1 Surface Soil

Five surface soil samples were collected from below the vegetative mat. Once the vegetative mat was removed using a decontaminated spade shovel, soil for non-VOC analysis was collected from 0 to 0.5 ft. Soil for VOC analysis was then collected from 0.5-1.0 ft using an EnCore sampler. If a subsurface soil sample was proposed below the surface interval at the same location, then the surface soil sample was collected from a boring advanced by direct push methodologies.

As described in *Section 5.2.9* of the MWP (URS, 2003), surface soil samples will be collected from 0 to 0.5 ft for non-VOC analyses. Surface soil samples for VOC analysis will be collected

from 0.5-1.0 ft. For combined analysis of previous sampling data (*Section 4.2.2* of this report), soil samples collected from 0 to 2 ft will be considered surface soil.

3.1.2 Subsurface Soil

Two subsurface soil samples were collected from 4-6 ft bgs. Soil borings were advanced using a truck-mounted direct push Geoprobe. The direct push rig was equipped with 1.25-in diameter push rods; 4-ft long, 2-in diameter stainless steel open-tube macro-core samplers; and stainless steel cutting shoes. The macro-core samplers were lined with a dedicated 4 ft long, 1.5-in diameter Teflon sample tube. Using a hydraulic percussion hammer, the Geoprobe drove the open-tube macro-core sampler to the proposed sampling depth. Following the withdrawal of the macro-core and the removal of the Teflon tube, a cutting device was used to remove a 1-3/8-in section along the length of the tube to access the soil stratigraphic characterization and sample processing. Once adequate sample volume was achieved, the boring hole was backfilled with bentonite chips. Excess soil cuttings remaining after sample processing were temporarily stored in a 55-gallon drum at an Installation-approved area.

3.2 Global Positioning System Activities

Sample location coordinates and elevations were obtained using a Trimble Pathfinder Pro XRS global positioning system (GPS). The Pathfinder Pro XRS system was used to obtain real-time position information with submeter 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 1983. The vertical control was measured in feet using the National Geodetic Vertical Datum of 1929. Position information will be entered into the Environmental Restoration Information System (ERIS) database. Sample location coordinates and elevations are presented in **Appendix C**.

3.3 Management of Investigative-Derived Material

Activities were performed in accordance with MWP Addendum 012 (IT, 2002a), as approved by USEPA Region III and the VDEQ, regarding the identification, handling, and disposal of nonhazardous investigative-derived materials (IDM). Material disposal was documented in the field logbook. Specific compliance issues that were confronted during investigative activities included the following:

- **Accumulation and storage.** IDM accumulated during field sampling activities included soil cuttings, decontamination water, direct push acetate liners, and personal protective equipment and clothing (PPE). Soil cuttings and decontamination water were stored in separate appropriately labeled 55-gallon steel drums. Direct push acetate liners and used PPE were stored together in 55-gallon drums. Containerized materials were stored at Installation-approved areas.
- **Material characterization.** Soil cuttings and decontamination water were sampled before disposal to assess waste characteristics, in accordance with 40 Code of Federal Regulations (CFR) 264 and Virginia Hazardous Waste Management Regulations. Based on analytical results, soil and decontamination water sampled were classified as nonhazardous materials.
- **Transporter, storage, and disposal facility.** Soil cuttings, acetate liners, and PPE were disposed of at Cloyds Mountain Landfill in Pulaski County, VA. Before disposal, waste profile results were provided to the Installation, IDM management

subcontractor, and the disposal facility for review and approval. An alternate straight bill of lading was obtained before transport of IDM from the accumulation and storage areas to the disposal facility. Disposal records were provided to the Installation and are kept on file by Shaw.

- **Decontamination water.** Following analysis, the Installation and RFAAP Process water Treatment Plant engineers were provided with a copy of the decontamination water sample results for review. After receiving approval, decontamination water from both the MMA and the NRU was disposed into the collection system of the Process water Treatment Plant.

3.4 Quality Assurance

Quality Assurance (QA) is defined as the overall system for assuring the reliability of data produced. The system integrates the quality planning, assessment, and improvement efforts of Shaw and its subcontractors, to provide the independent QA program necessary to establish and maintain an effective system for collection and analysis of environmental samples and related activities. The program encompasses the review and assessment of the documentation, data validation, and the data quality indicators including precision, accuracy, completeness (generation of usable and complete data), representativeness, comparability, and sensitivity.

The accuracy and integrity of RFI data were ensured through the implementation of internal quality control measures in accordance with MWP Addendum 012 (IT, 2002a), as approved by USEPA Region III and the VDEQ. QA and quality control (QC) activities, including field quality control, laboratory quality control, 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 quality assurance/quality control (QA/QC) analysis and activities are presented in **Appendices A-1 and A-2**. Chemical data validation reports and analytical data are provided on a compact disc (CD) found at the back of the appendices of this report.

3.5 Modifications to the Sampling Plan

In some cases, modifications to the Work Plan are necessary to adjust for field conditions as they occur during field sampling. One adjustment to MWP Addendum 012 (IT, 2002a) was necessary during sampling activities at Building 4343, as described below.

The drainage ditches at Building 4343 are normally dry except when influenced by rain events. Surface water was not present in the drainage ditches during sampling activities; therefore, proposed surface water sample B43SW01 was not collected in support of the field sampling program.

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 soil and sludge at the Former Cadmium Plating Facility (Building 4343). Chemical results from this report are compared to adjusted USEPA Region III industrial and residential risk-based concentrations (RBCs) (USEPA, 2003a), where non-carcinogenic analytes are adjusted downward to a hazard index (HI) of 0.1, as well as facility-wide background inorganic concentrations (IT, 2001), and other regulatory criteria. Industrial and residential RBCs 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, 2003) RBC screening values and background 95% UTLs are presented for comparison in **Table 4-1** (surface soil), **Table 4-2** (subsurface soil), and **Figure 4-1**. Analytical results for inorganics are indicated on the tables and figures as exceedances when they exceed both the background value and a screening value. Eliminating screening level exceedances that are below the background value allows site-specific constituents to be more clearly indicated on the tables and figures.

4.1 2002 RCRA Facility Investigation (Shaw)

Additional sampling and analysis was performed to further characterize the extent of elevated cadmium in soil and to assess the soil for chemical classes not analyzed during previous investigations. Specifically, the parameters of interest not previously tested were VOCs, SVOCs, PAHs, PCBs, pesticides, herbicides, and explosives (IT, 2002a). The new data collected supplements existing data and provides a sufficient data set for completion of a human health and ecological risk assessment. Sampling locations are presented on **Figure 4-1**. Sampling locations were selected based on previous sample results, site visit observations, negotiations with regulators, and the conceptual site model (CSM). The sampling program included the following media samples and analyses:

Surface soil. Five surface soil samples were collected from the site. Two surface soil samples (B43SB34A and B43SB35A) were collected from 0–1 ft bgs from soil borings **(Figure 4-1)** to characterize the site for untested constituents. Boring B43SB35 was located on the northeast corner of Building 4343 where high levels of cadmium were previously detected. Boring B43SB34 was located downslope of the process water drainage ditch in the center of the alluvial fan. Both samples were analyzed for target compound list (TCL) VOCs, TCL SVOCs, TCL pesticides/PCBs, herbicides, PAHs, and explosives. In addition, sample B43SB34A was analyzed for TOC, grain size and pH to assess the bioavailability and mobility of constituents in soil.

Three surface soil samples (B43SS01, B43SS02 and B43SS03) were collected to complete the delineation of previously identified cadmium contamination. Sample B43SS01 was collected in a low area west of Building 4343, across the asphalt parking lot from the building. This sample was analyzed for TAL metals. The second delineation sample (B43SS02) was located in the storm water drainage ditch downslope of the alluvial fan. The third sample (B43SS03) was located further east in the drainage ditch. These two samples were analyzed for TAL metals and PCBs.

Table 4-1
Analytes Detected in Building 4343 Surface Soil - 2002

Analyte	i-RBC	r-RBC	Background	SSL Transfer	B43SS01 7/8/02 0-0.5					B43SS02 7/8/02 0-0.5					B43SS03 7/8/02 0-0.5					B43SB34A 7/8/02 0-0.5					B43SB35A 7/8/02 0-0.5				
				Sample ID	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
				Sample Date																								
				Sample Depth																								
VOCs (ug/kg)	**None detected**																												
PAHs (ug/kg)																													
2-Methylnaphthalene	2000000	160000	na	22000	NT					NT					NT					1.7	JB	B	*0.63*	*1.9*	11	B		*0.6*	*1.8*
Acenaphthene	6100000	470000	na	100000	NT					NT					NT					1.9	U		*1*	*1.9*	5.5		B	*0.98*	*1.8*
Acenaphthylene	3100000	230000	na	680000	NT					NT					NT					0.77	J	J	*0.25*	*1.9*	6.9			*0.23*	*1.8*
Anthracene	31000000	2300000	na	470000	NT					NT					NT					1.9	U		*0.2*	*1.9*	3.4			*0.19*	*1.8*
Benzo(a)anthracene	3900	870	na	1500	NT					NT					NT					3.1			*0.25*	*1.9*	8.7			*0.23*	*1.8*
Benzo(a)pyrene	390	87	na	370	NT					NT					NT					3.1			*0.21*	*1.9*	7.4			*0.2*	*1.8*
Benzo(b)fluoranthene	3900	870	na	4500	NT					NT					NT					7.6			*0.35*	*1.9*	27			*0.34*	*1.8*
Benzo(g,h,i)perylene	3100000	230000	na	680000	NT					NT					NT					3.3			*0.65*	*1.9*	6.5			*0.62*	*1.8*
Benzo(k)fluoranthene	39000	8700	na	45000	NT					NT					NT					2			*0.32*	*1.9*	8.1			*0.31*	*1.8*
Chrysene	390000	87000	na	150000	NT					NT					NT					7.3			*0.3*	*1.9*	16			*0.28*	*1.8*
Dibenz(a,h)Anthracene	390	87	na	1400	NT					NT					NT					0.8	J	J	*0.63*	*1.9*	1.9		J	*0.6*	*1.8*
Fluoranthene	4100000	310000	na	6300000	NT					NT					NT					9.3			*0.32*	*1.9*	15			*0.3*	*1.8*
Fluorene	4100000	310000	na	140000	NT					NT					NT					1.9	U		*0.49*	*1.9*	4.7			*0.47*	*1.8*
Indeno(1,2,3-cd)pyrene	3900	870	na	13000	NT					NT					NT					3.3			*0.6*	*1.9*	8.4			*0.57*	*1.8*
Naphthalene	2000000	160000	na	150	NT					NT					NT					2.7	B	B	*0.72*	*1.9*	11	B		*0.68*	*1.8*
Phenanthrene	3100000	230000	na	680000	NT					NT					NT					7.1			*0.28*	*1.9*	12			*0.27*	*1.8*
Pyrene	3100000	230000	na	680000	NT					NT					NT					13		J	*0.42*	*1.9*	20		J	*0.4*	*1.8*
SVOCs (ug/kg)																													
Benzo(a)anthracene	3900	870	na	1500	NT					NT					NT					180	U		*5.3*	*180*	8	J	J	*5*	*170*
Benzo(b)fluoranthene	3900	870	na	4500	NT					NT					NT					12	J	J	*3.9*	*180*	10	J	J	*3.7*	*170*
Benzo(g,h,i)perylene	3100000	230000	na	680000	NT					NT					NT					180	U		*5.2*	*180*	11	J	J	*4.9*	*170*
Bis(2-ethylhexyl)phthalate	200000	46000	na	2900000	NT					NT					NT					55	JB	B	*12*	*180*	53	JB	B	*12*	*170*
Chrysene	390000	87000	na	150000	NT					NT					NT					15	J	J	*4.3*	*180*	8.6	J	J	*4*	*170*
Di-n-octylphthalate	2000000	160000	na	2400000000	NT					NT					NT					51	JB	B	*8.2*	*180*	170	U		*7.8*	*170*
Fluoranthene	4100000	310000	na	6300000	NT					NT					NT					16	J	J	*6*	*180*	8.8	J	J	*5.7*	*170*
Indeno(1,2,3-cd)pyrene	3900	870	na	13000	NT					NT					NT					180	U		*7.1*	*180*	12	J	J	*6.7*	*170*
Phenanthrene	3100000	230000	na	680000	NT					NT					NT					14	J	J	*5.7*	*180*	7.7	J	J	*5.5*	*170*
Pyrene	3100000	230000	na	680000	NT					NT					NT					15	J	J	*5.6*	*180*	8.2	J	J	*5.4*	*170*
Pesticides (ug/kg)																													
4,4'-DDD	12000	2700	na	11000	NT					NT					NT					0.57	J	J	*0.154*	*0.73*	0.479	J	J	*0.147*	*0.693*
4,4'-DDT	8400	1900	na	1200	NT					NT					NT					15.3			*0.258*	*0.73*	21.8			*0.245*	*0.693*
Endosulfan II	610000	47000	na	20000	NT					NT					NT					2.26			*0.26*	*0.73*	2.46			*0.247*	*0.693*
Endrin aldehyde	na	na	na	na	NT					NT					NT					0.73	U	UL	*0.369*	*0.73*	2.89		L	*0.35*	*0.693*
Endrin	31000	2300	na	5400	NT					NT					NT					0.498	J	J	*0.175*	*0.73*	0.693	U		*0.166*	*0.693*
Methoxychlor	510000	39000	na	310000	NT					NT					NT					1.97			*0.557*	*0.73*	0.693	U		*0.529*	*0.693*
PCBs (mg/kg)																													
PCB-1254	1.4	0.16	na	1.1	NT					0.0404			*0.0115*	*0.0389*	0.0212	J	J	*0.0111*	*0.0376*	0.0416			*0.0108*	*0.0364*	0.344			*0.0102*	*0.0346*
Explosives (mg/kg)	**None detected**																												
Herbicides (ug/kg)	**None detected**																												
Metals (mg/kg)																													
Aluminum	100000	7800	40041	na	15200			*6.3*	*22.9*	7660			*6.5*	*23.4*	11700			*6.2*	*22.6*	NT					NT				
Antimony	41	3.1	na	13	0.39	B	B	*0.19*	*0.571*	0.2	B	B	*0.2*	*0.584*	0.2	B	B	*0.19*	*0.564*	NT					NT				
Arsenic	1.9	0.43	15.8	0.026	4.97			*0.4*	*0.571*	2.05			*0.41*	*0.584*	3.04			*0.39*	*0.564*	NT					NT				
Barium	7200	550	209	2100	62.1			*0.38*	*2.29*	41.1			*0.39*	*2.34*	60			*0.38*	*2.26*	NT					NT				
Beryllium	200	16	1.02	1200	0.46	B	J	*0.0394*	*0.571*	0.57	B	J	*0.0403*	*0.584*	0.46	B	J	*0.0389*	*0.564*	NT					NT				
Cadmium	51	3.9	0.69	27	107		**J**	*0.054*	*0.114*	273		**J**	*0.056*	*0.117*	**2.36**		**J**	*0.054*	*0.113*	NT					NT				
Calcium	na	na	na	na	31500			*3.2*	*11.4*	9190			*3.3*	*11.7*	1940			*3.2*	*11.3*	NT					NT				
Chromium	310	23	65.3	42	41			*0.43*	*1.14*	27.2			*0.44*	*1.17*	19.9			*0.42*	*1.13*	NT					NT				
Cobalt	2000	160	72.3	na	5.98			*0.93*	*5.71*	10.3			*0.95*	*5.84*	10.6			*0.91*	*5.64*	NT					NT				
Copper	4100	310	53.5	11000	20			*0.71*	*2.29*	19.6			*0.72*	*2.34*	10			*0.7*	*2.26*	NT					NT				
Iron	31000	2300	50962	na	16800		J	*3.8*	*5.71*	13800		J	*3.9*	*5.84*	15200		J	*3.8*	*5.64*	NT					NT				
Lead	750	400	26.8	na	**58.9**		**J**	*0.035*	*0.343*	**27.1**		**J**	*0.035*	*0.35*	**29.2**		**J**	*0.034*	*0.339*	NT					NT				
Magnesium	na	na	na	na	19400			*2.7*	*11.4*	7300			*2.8*	*11.7*	2400			*2.7*	*11.3*	NT					NT				
Manganese	2000	160	2543	950	269		J	*0.064*	*1.14*	290		J	*0.065*	*1.17*	561		J	*0.063*	*1.13*	NT					NT				
Mercury	31	2.3	0.13	na	0.0871		L	*0.023*	*0.0571*	0.025	B	L	*0.023*	*0.0584*	0.0584		L	*0.022*	*0.0564*	NT					NT				
Nickel	2000	160	62.8	na	8.82			*1*	*4.57*	16.1			*1.1*	*4.67*	11.7			*1*	*4.51*	NT					NT				
Potassium	na	na	na	na	966			*38*	*343*	1070			*39*	*350*	1100			*38*	*339*	NT					NT				
Silver	510	39	na	31	0.69	B	B	*0.56*	*1.14*	0.66	B	B	*0.58*	*1.17*	0.73	B	B	*0.56*	*1.13*	NT					NT				
Sodium	na	na	na	na	39.1			*4.3*	*22.9*	13	B	B	*4.4*	*23.4*	8.5	B	B	*4.2*	*22.6*	NT					NT				
Thallium	7.2	0.55	2.11	3.6	0.18	B	J	*0.034*	*0.343*	0.09	B	J	*0.035*	*0.35*	0.12	B	J	*0.034*	*0.339*	NT					NT				
Vanadium	720	55	108	5100	35			*0.66*	*5.71*	15.8			*0.68*	*5.84*	25.4			*0.65*	*5.64*	NT					NT				
Zinc	31000	2300	202	14000	53		J	*0.41*	*2.29*	30.6		J	*0.42*	*2.34*	31.5		J	*0.4*	*2.26*	NT					NT				

Note: Refer to the Master Table Legend following Table 4-2 for a list of definitions and table notes

Table 4-2
Analytes Detected in Building 4343 Subsurface Soil - 2002

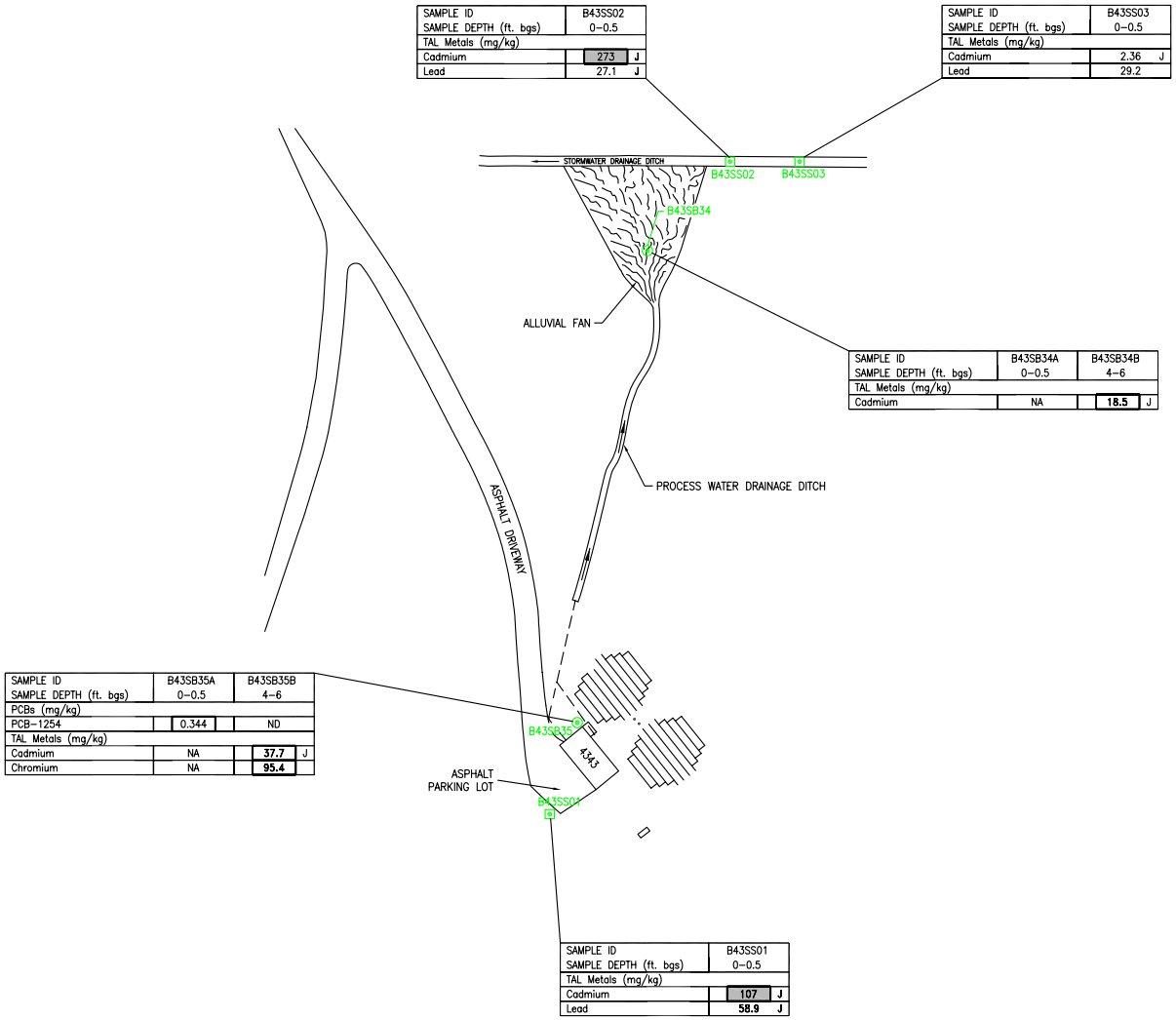
Analyte					Sample ID	B43SB34B				B43SB35B				
					Sample Date	7/8/02				7/8/02				
					Sample Depth	4-6				4-6				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
VOCs (ug/kg)	**None detected**													
PAHs (ug/kg)														
Benzo(a)anthracene	3900	870	na	1500	0.96	J	J	*0.29*	*2.2*	2.1	U		*0.28*	*2.1*
Benzo(a)pyrene	390	87	na	370	0.96	J	J	*0.25*	*2.2*	2.1	U		*0.24*	*2.1*
Benzo(b)fluoranthene	3900	870	na	4500	1.3	J	J	*0.42*	*2.2*	2.1	U		*0.41*	*2.1*
Chrysene	390000	87000	na	150000	1.4	J	J	*0.35*	*2.2*	2.1	U		*0.34*	*2.1*
Fluoranthene	4100000	310000	na	6300000	1.6	J	J	*0.38*	*2.2*	2.1	U		*0.37*	*2.1*
Naphthalene	2000000	160000	na	150	2	JB	B	*0.86*	*2.2*	1.7	JB	B	*0.82*	*2.1*
Phenanthrene	3100000	230000	na	680000	1.3	J	J	*0.34*	*2.2*	2.1	U		*0.33*	*2.1*
Pyrene	3100000	230000	na	680000	3.3		J	*0.5*	*2.2*	2.1	U		*0.48*	*2.1*
SVOCs (ug/kg)														
Bis(2-ethylhexyl)phthalate	200000	46000	na	2900000	66	JB	B	*15*	*220*	86	JB	B	*14*	*210*
Di-n-octylphthalate	2000000	160000	na	2400000000	11	JB	B	*9.8*	*220*	23	JB	B	*9.4*	*210*
Pesticides (ug/kg)														
4,4'-DDD	12000	2700	na	11000	NT					0.222	J	J	*0.177*	*0.837*
PCBs (mg/kg)	**None detected**													
Explosives (mg/kg)	**None detected**													
Herbicides (ug/kg)	**None detected**													
Metals (mg/kg)														
Aluminum	100000	7800	40041	na	30100			*7.2*	*26.1*	38000			*6.9*	*25.1*
Arsenic	1.9	0.43	15.8	0.026	4.25			*0.46*	*0.652*	0.841			*0.44*	*0.627*
Barium	7200	550	209	2100	78.3			*0.44*	*2.61*	45.8			*0.42*	*2.51*
Beryllium	200	16	1.02	1200	0.34	B	J	*0.045*	*0.652*	0.57	B	J	*0.0433*	*0.627*
Cadmium	51	3.9	0.69	27	**18.5**		**J**	*0.062*	*0.13*	**37.7**		**J**	*0.06*	*0.125*
Calcium	na	na	na	na	794			*3.6*	*13*	909			*3.5*	*12.5*
Chromium	310	23	65.3	42	40.5			*0.49*	*1.3*	**95.4**			*0.47*	*1.25*
Cobalt	2000	160	72.3	na	2.5	B	J	*1.1*	*6.52*	7.11			*1*	*6.27*
Copper	4100	310	53.5	11000	16.2			*0.8*	*2.61*	24.9			*0.77*	*2.51*
Iron	31000	2300	50962	na	17200		J	*4.4*	*6.52*	37800		J	*4.2*	*6.27*
Lead	750	400	26.8	na	14.7		J	*0.039*	*0.391*	19.3		J	*0.038*	*0.376*
Magnesium	na	na	na	na	1060			*3.1*	*13*	1070			*3*	*12.5*
Manganese	2000	160	2543	950	29.8		J	*0.073*	*1.3*	159		J	*0.07*	*1.25*
Mercury	31	2.3	0.13	na	0.114		L	*0.026*	*0.0652*	0.026	B	L	*0.025*	*0.0627*
Nickel	2000	160	62.8	na	7.91			*1.2*	*5.22*	13.7			*1.2*	*5.02*
Potassium	na	na	na	na	756			*44*	*391*	1090			*42*	*376*
Silver	510	39	na	31	1.3	U		*0.64*	*1.3*	0.8	B	B	*0.62*	*1.25*
Sodium	na	na	na	na	31.1		B	*4.9*	*26.1*	12	B	B	*4.7*	*25.1*
Thallium	7.2	0.55	2.11	3.6	0.16	B	J	*0.039*	*0.391*	0.14	B	J	*0.038*	*0.376*
Vanadium	720	55	108	5100	42.5			*0.75*	*6.52*	75.4			*0.73*	*6.27*
Zinc	31000	2300	202	14000	35.9		J	*0.47*	*2.61*	36.8		J	*0.45*	*2.51*

Note: Refer to the Master Table Legend following this table (Table 4-2) for a list of definitions and table notes

Tables 4-1 and 4-2
Master Table Legend

12	J	Shading and black font indicates an industrial RBC exceedence
12	J	Bold outline indicates a residential RBC exceedence.
12	**J**	Bold, underlined font indicates a background exceedence.
12	J	Shading and white font indicates a SSL exceedence.
12	J	Mixed shading indicates an industrial RBC and a SSL exceedence.
12	*12*	Shading in the MDL/MRL columns indicates the MDL exceeds a criterion.

RBCs for non-Carcinogenic compounds have been recalculated to an HI of 0.1.
The pyrene RBCs and SSL were used for acenaphthylene, benzo(g,h,i)perylene and phenanthrene.
Inorganic results below background UTLs are not indicated as exceedences on the table.
RBC = Risk Based Concentration (April, 2003).
RBC values in table are for the more conservative chromium VI
RBC values for chromium III are 150,000 (ind) and 12,000 (res), which were not exceeded
Lead screening values from Technical Review Workgroup for Lead: Guidance Document (April, 1999)
ug/kg = micrograms per kilogram (parts per billion).
mg/kg = milligrams per kilogram (parts per million).
NA = not applicable.
NT = analyte not tested.
LQ = Lab Data Qualifiers
B = (organics) Blank contamination. Value detected in sample and associated blank.
B = (metals) Value <MRL and >MDL and is considered estimated.
E (metals) = Reported value is estimated because of the presence of interferences.
J = (organics) Value <MRL and >MDL and is considered estimated.
JP = Estimated value <CRQL or <RL and MDL
U = Analyte not-detected at the method reporting limit.
VQ = 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
U = analyte not detected
UJ = estimated concentration non-detect
UL = estimated concentration non-detect bias low



LEGEND:

- 2002 RFI SOIL BORING (SHAW)
- 2002 RFI SURFACE SOIL SAMPLE LOCATION (SHAW)
- SURFACE RUNOFF

NOTE:

B = BLANK CONTAMINATION
J = ESTIMATED CONCENTRATION
NA = ANALYTE NOT TESTED
ND = ANALYTE NOT DETECTED
DARK BORDER = VALUE EXCEEDS THE RESIDENTIAL SCREENING LEVEL (USEPA; APRIL, 2003)
SHADING = VALUE EXCEEDS THE INDUSTRIAL SCREENING LEVEL (USEPA; APRIL, 2003) OR TCLP CRITERIA (USEPA, 40 CFR 261.4)
BOLD = VALUE EXCEEDS THE BACKGROUND CRITERION (IT, 2001)
VALUES DETECTED BELOW BACKGROUND ARE NOT SHOWN

Sample Summary

Investigation	Contractor	TAL Metals			Cyanide			TCLP Metals		VOCs		SVOCs		Pest		PCBs		Herb		Explosives		PAHs		Total
		SS	SB	SE	SS	SB	SE	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	
1996 SS Sampling	ATK	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5
1999 RFI	ICF Kaiser	22	33	2 (SL)	17	12	2 (SL)	26	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	138
2002 RFI	Shaw	3	2	--	--	--	--	--	--	2	2	2	2	2	1	4	2	2	1	2	2	2	2	33

0 55 110
SCALE IN FEET

RADFORD AAP

FIGURE 4–1

BUILDING 4343
2002 RFI SAMPLING
LOCATIONS AND RESULTS

PREPARED BY: SHAW
TASK NO: 8298702800000
CHECKED BY: MT
SHAW DWG NO: Fig4–1.dwg
DATE: REVISED JULY 2003

FILE: R:\AAP\REPORTS\RFI_REPORTS\Fig4–1.dwg PLOT: 7–30–03

Subsurface soil. Two samples were collected at a depth of 4–6 ft bgs to characterize the subsurface soil for previously untested analyte classes **(Figure 4-1)** and to assess the vertical extent of cadmium in these areas. As previously described, boring B43SB35 was located on the northeast corner of Building 4343 where high levels of cadmium were detected. Boring B43SB34 was located downslope of the drainage ditch in the center of the alluvial fan. Subsurface soil samples were analyzed for TCL VOCs, TCL SVOCs, TCL PCBs, PAHs, TAL metals and explosives. In addition, sample B43SB35B was also analyzed for pesticides and herbicides.

Surface water/sediment. No surface water/sediment samples were collected because the storm water drainage ditch was dry.

4.2 Nature and Distribution of Chemicals at Building 4343

Surface and subsurface soil samples were collected from the Building 4343 area to assess the nature and distribution of potential chemical contaminants and to assess potential risk to human health and the environment. Analytical parameters for each sample are presented in **Table 3-1**.

4.2.1 Soil Sample Results - 2002 RCRA Facility Investigation (Shaw)

Analytical results for detected constituents are presented in **Tables 4-1 and 4-2**. Exceedances of regulatory criteria are presented on **Figure 4-1**.

VOCs. Three surface soil (B43SS01, B43SS02 and B43SS03) and two subsurface soil samples (B43SB34B and B43SB35B) were analyzed for VOCs. VOCs were not detected in the soil samples.

SVOCs/PAHs. Surface and subsurface soil samples from the two soil borings (B43SB34A/B and B43SB35A/B) were analyzed for SVOCs/PAHs. Seventeen PAHs were detected in the surface soil samples and eight PAHs were detected in the subsurface soil. Two non-PAH SVOCs [bis(2-ethylhexyl)phthalate and di-n-octylphthalate] were detected in both the surface and subsurface soil samples. Results for the non-PAH SVOCs were qualified with a "B" flag during data validation, indicating that these compounds were also detected in associated laboratory blanks and are not necessarily site-related contaminants. Low-level concentrations of PAHs are believed to be related to the deteriorating asphalt road and parking lot at Building 4343 and are not associated with process activities. Detected concentrations of SVOCs/PAHs were below their respective residential screening levels.

TAL Metals. Three surface soil and two subsurface soil samples were analyzed for metals. Cadmium exceeded its industrial screening level (51 mg/kg) in two surface soil samples (B43SS01 – 107 mg/kg and B43SS02 – 273 mg/kg). The cadmium concentration in the third surface soil sample (B43SS03 – 2.36 mg/kg) was below the residential screening level (3.9 mg/kg), but slightly above the background concentration of 0.69 mg/kg (IT, 2001). There were no industrial screening level exceedances of cadmium in subsurface soil. Concentrations in both subsurface soil samples (B43SB34B – 18.5 mg/kg and B43SB35B – 37.7 mg/kg), however, were greater than the residential and background screening levels. Chromium was detected above its residential screening level of 23 mg/kg and background value of 65.3 mg/kg (IT, 2001) in subsurface soil sample B43SB35B at a concentration of 95.4 mg/kg. However, chromium concentrations were below background in the remaining soil samples. Lead was detected in the three surface soil samples below the residential screening value (400 mg/kg), but slightly above the background concentration of 26.8 mg/kg (IT, 2001). Lead concentrations in the subsurface

soil were less than the background screening value. Concentrations of the remaining detected TAL metals were below their respective background values in both surface and subsurface soil.

Pesticides. Two surface soil samples (B43SB34A and B43SB35A) and one subsurface soil sample (B43SB35B) were analyzed for TCL pesticides. Six pesticides were detected in surface soil and one pesticide was detected in subsurface soil. None of the detected pesticide concentrations exceeded their respective residential screening levels.

Herbicides. Two surface soil samples (B43SB34A and B43SB35A) and one subsurface soil sample (B43SB35B) were analyzed for herbicides. Herbicides were not detected in surface or subsurface soil.

PCBs. Four surface soil samples (B43SS02, B43SS03, B43SB34A and B43SB35A) and both subsurface soil samples were analyzed for PCBs. One PCB (Aroclor-1254) was detected in four of the surface soil samples. The concentration in sample B43SB35A (0.344 mg/kg) exceeded the residential screening level of 0.16 mg/kg, but was below the industrial screening level (1.4 mg/kg). Concentrations in the other three surface soil samples were below the residential screening level. PCBs were not detected in the subsurface soil samples.

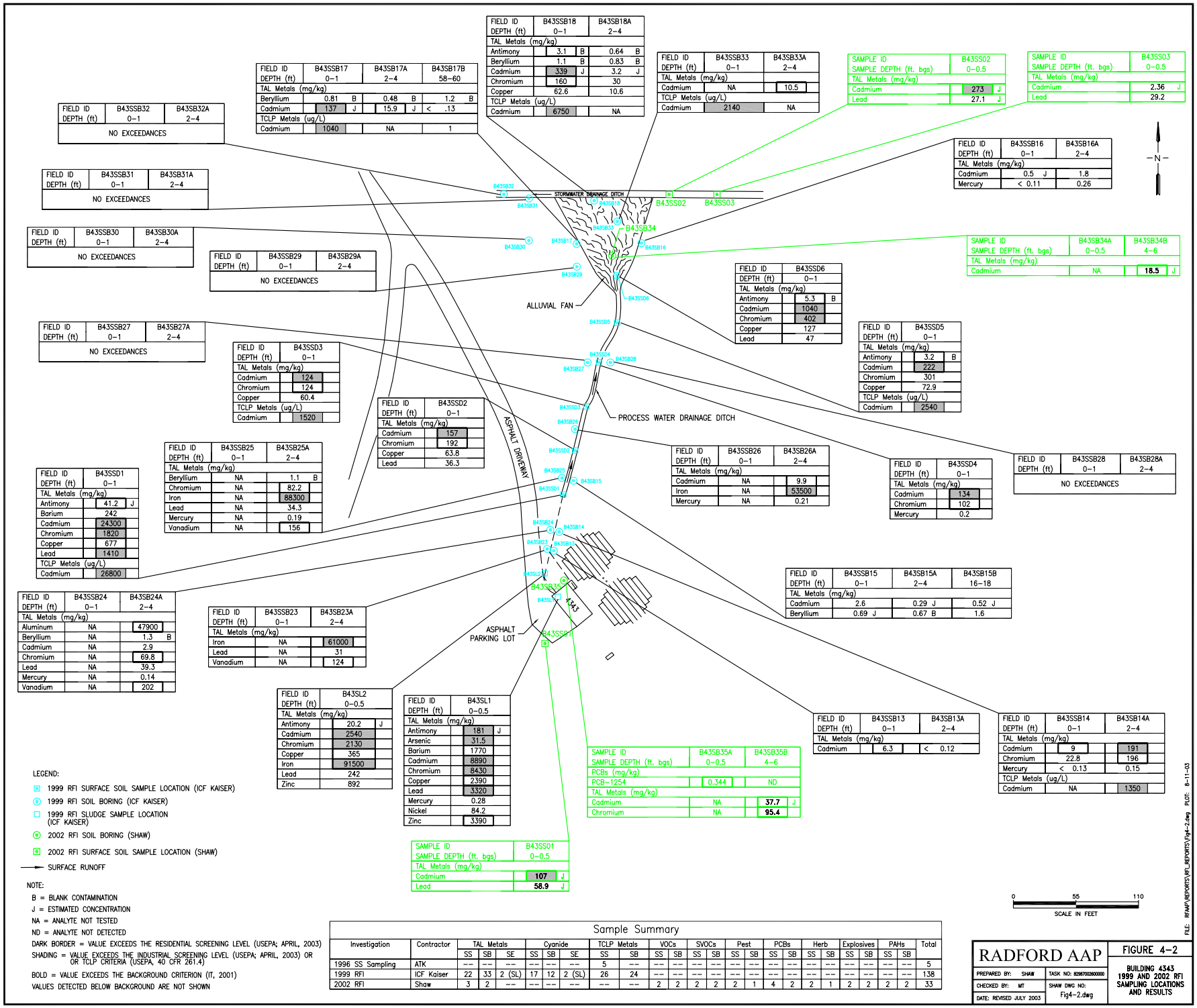
Explosives. Although there is no history of explosives use, disposal or storage at the site, surface and subsurface soil samples from the two soil borings (B43SB34A/B and B43SB35A/B) were analyzed for explosives to ensure that these compounds are not present in environmental media. Explosive compounds were not detected in the surface or subsurface soil samples.

4.2.2 Nature and Extent Summary

This section evaluates the combined analytical data collected from previous investigations and the 2002 RFI. Previous investigation analytical data is presented in **Appendix B-1**. **Figures 4-2 and 4-3** present exceedances of analytes from both the current and previous investigations. Evaluating the combined chemical database from each of the Building 4343 investigations **(Table 4-3)**, the chemical parameters presenting a concern are metals in surface and subsurface soil. **Figures 4-4 through 4-9** illustrate the extent of cadmium, chromium, and lead concentrations detected in surface and subsurface soil at the Building 4343 study area.

VOCs, herbicides, and explosive compounds were not detected in soil samples, and are not a concern at the Building 4343 study area. SVOCs/PAHs and pesticides were detected, but did not exceed residential screening levels; therefore, these compounds also are not a concern at this site. One PCB, Aroclor-1254, was detected in sample B43SB35A at a concentration of 0.344 mg/kg, slightly exceeding the residential screening level of 0.16 mg/kg. Because of the single low-level concentration and the fact that PCBs were not used in Building 4343 process operations, PCBs are not considered to be a concern at the site.

Metals. Results from the sampling conducted at Building 4343 indicate that cadmium is the primary constituent presenting a concern. Three other metals, chromium, iron, and lead, were detected at concentrations greater than their respective industrial screening levels in soil and aluminum, antimony, copper and vanadium exceeded the residential screening levels in soil. Cadmium, however, is present at the locations where these other metals exceed their screening criteria. Because cadmium has the greatest lateral extent and the other metals were introduced to the environment through the cadmium plating process, defining the extent of cadmium should also define the extent of these other metals.



FIELD ID	B43SSB18	B43SB18A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Antimony	3.1 B	0.64 B
Beryllium	1.1 B	0.83 B
Cadmium	339 J	3.2 J
Chromium	160	30
Copper	62.6	10.6
TCLP Metals (ug/L)		
Cadmium	6750	NA

FIELD ID	B43SSB17	B43SB17A	B43SB17B
DEPTH (ft)	0–1	2–4	58–60
TAL Metals (mg/kg)			
Beryllium	0.81 B	0.48 B	1.2 B
Cadmium	137 J	15.9 J	< .13
TCLP Metals (ug/L)			
Cadmium	1040	NA	1

FIELD ID	B43SSB33	B43SB33A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	NA	10.5
TCLP Metals (ug/L)		
Cadmium	2140	NA

SAMPLE ID	B43SS02
SAMPLE DEPTH (ft. bgs)	0–0.5
TAL Metals (mg/kg)	
Cadmium	273 J
Lead	27.1 J

SAMPLE ID	B43SS03
SAMPLE DEPTH (ft. bgs)	0–0.5
TAL Metals (mg/kg)	
Cadmium	2.36 J
Lead	29.2

FIELD ID	B43SSB16	B43SB16A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	0.5 J	1.8
Mercury	< 0.11	0.26

FIELD ID	B43SSB32	B43SB32A
DEPTH (ft)	0–1	2–4
NO EXCEEDANCES		

FIELD ID	B43SSB31	B43SB31A
DEPTH (ft)	0–1	2–4
NO EXCEEDANCES		

FIELD ID	B43SSB30	B43SB30A
DEPTH (ft)	0–1	2–4
NO EXCEEDANCES		

FIELD ID	B43SSB29	B43SB29A
DEPTH (ft)	0–1	2–4
NO EXCEEDANCES		

SAMPLE ID	B43SB34A	B43SB34B
SAMPLE DEPTH (ft. bgs)	0–0.5	4–6
TAL Metals (mg/kg)		
Cadmium	NA	18.5 J

FIELD ID	B43SSD6
DEPTH (ft)	0–1
TAL Metals (mg/kg)	
Antimony	5.3 B
Cadmium	1040
Chromium	402
Copper	127
Lead	47

FIELD ID	B43SSD5
DEPTH (ft)	0–1
TAL Metals (mg/kg)	
Antimony	3.2 B
Cadmium	222
Chromium	301
Copper	72.9
TCLP Metals (ug/L)	
Cadmium	2540

FIELD ID	B43SSB27	B43SB27A
DEPTH (ft)	0–1	2–4
NO EXCEEDANCES		

FIELD ID	B43SSD3
DEPTH (ft)	0–1
TAL Metals (mg/kg)	
Cadmium	124
Chromium	124
Copper	60.4
TCLP Metals (ug/L)	
Cadmium	1520

FIELD ID	B43SSD2
DEPTH (ft)	0–1
TAL Metals (mg/kg)	
Cadmium	157
Chromium	192
Copper	63.8
Lead	36.3

FIELD ID	B43SSB25	B43SB25A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Beryllium	NA	1.1 B
Chromium	NA	82.2
Iron	NA	88300
Lead	NA	34.3
Mercury	NA	0.19
Vanadium	NA	156

FIELD ID	B43SSB26	B43SB26A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	NA	9.9
Iron	NA	53500
Mercury	NA	0.21

FIELD ID	B43SSD4
DEPTH (ft)	0–1
TAL Metals (mg/kg)	
Cadmium	134
Chromium	102
Mercury	0.2

FIELD ID	B43SSB28	B43SB28A
DEPTH (ft)	0–1	2–4
NO EXCEEDANCES		

FIELD ID	B43SSD1
DEPTH (ft)	0–1
TAL Metals (mg/kg)	
Antimony	41.2 J
Barium	242
Cadmium	24300
Chromium	1820
Copper	677
Lead	1410
TCLP Metals (ug/L)	
Cadmium	26800

FIELD ID	B43SSB24	B43SB24A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Aluminum	NA	47900
Beryllium	NA	1.3 B
Cadmium	NA	2.9
Chromium	NA	69.8
Lead	NA	39.3
Mercury	NA	0.14
Vanadium	NA	202

FIELD ID	B43SSB23	B43SB23A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Iron	NA	61000
Lead	NA	31
Vanadium	NA	124

FIELD ID	B43SSB15	B43SB15A	B43SB15B
DEPTH (ft)	0–1	2–4	16–18
TAL Metals (mg/kg)			
Cadmium	2.6	0.29 J	0.52 J
Beryllium	0.69 J	0.67 B	1.6

FIELD ID	B43SSB13	B43SB13A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	6.3	< 0.12

FIELD ID	B43SSB14	B43SB14A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	9	191
Chromium	22.8	196
Mercury	< 0.13	0.15
TCLP Metals (ug/L)		
Cadmium	NA	1350

FIELD ID	B43SL2
DEPTH (ft)	0–0.5
TAL Metals (mg/kg)	
Antimony	20.2 J
Cadmium	2540
Chromium	2130
Copper	365
Iron	91500
Lead	242
Zinc	892

FIELD ID	B43SL1
DEPTH (ft)	0–0.5
TAL Metals (mg/kg)	
Antimony	181 J
Arsenic	31.5
Barium	1770
Cadmium	8890
Chromium	8430
Copper	2390
Lead	3320
Mercury	0.28
Nickel	84.2
Zinc	3390

SAMPLE ID	B43SB35A	B43SB35B
SAMPLE DEPTH (ft. bgs)	0–0.5	4–6
PCBs (mg/kg)		
PCB-1254	0.344	ND
TAL Metals (mg/kg)		
Cadmium	NA	37.7 J
Chromium	NA	95.4

SAMPLE ID	B43SS01
SAMPLE DEPTH (ft. bgs)	0–0.5
TAL Metals (mg/kg)	
Cadmium	107 J
Lead	58.9 J

LEGEND:

- 1999 RFI SURFACE SOIL SAMPLE LOCATION (ICF KAISER)
- 1999 RFI SOIL BORING (ICF KAISER)
- 1999 RFI SLUDGE SAMPLE LOCATION (ICF KAISER)
- 2002 RFI SOIL BORING (SHAW)
- 2002 RFI SURFACE SOIL SAMPLE LOCATION (SHAW)
- SURFACE RUNOFF

NOTE:

B = BLANK CONTAMINATION
J = ESTIMATED CONCENTRATION
NA = ANALYTE NOT TESTED
ND = ANALYTE NOT DETECTED
DARK BORDER = VALUE EXCEEDS THE RESIDENTIAL SCREENING LEVEL (USEPA; APRIL, 2003)
SHADING = VALUE EXCEEDS THE INDUSTRIAL SCREENING LEVEL (USEPA; APRIL, 2003) OR OR TCLP CRITERIA (USEPA, 40 CFR 261.4)
BOLD = VALUE EXCEEDS THE BACKGROUND CRITERION (IT, 2001)
VALUES DETECTED BELOW BACKGROUND ARE NOT SHOWN

Sample Summary

Investigation	Contractor	TAL Metals			Cyanide			TCLP Metals		VOCs		SVOCs		Pest		PCBs		Herb		Explosives		PAHs		Total
		SS	SB	SE	SS	SB	SE	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	
1996 SS Sampling	ATK	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5
1999 RFI	ICF Kaiser	22	33	2 (SL)	17	12	2 (SL)	26	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	138
2002 RFI	Shaw	3	2	--	--	--	--	--	--	2	2	2	2	2	1	4	2	2	1	2	2	2	2	33

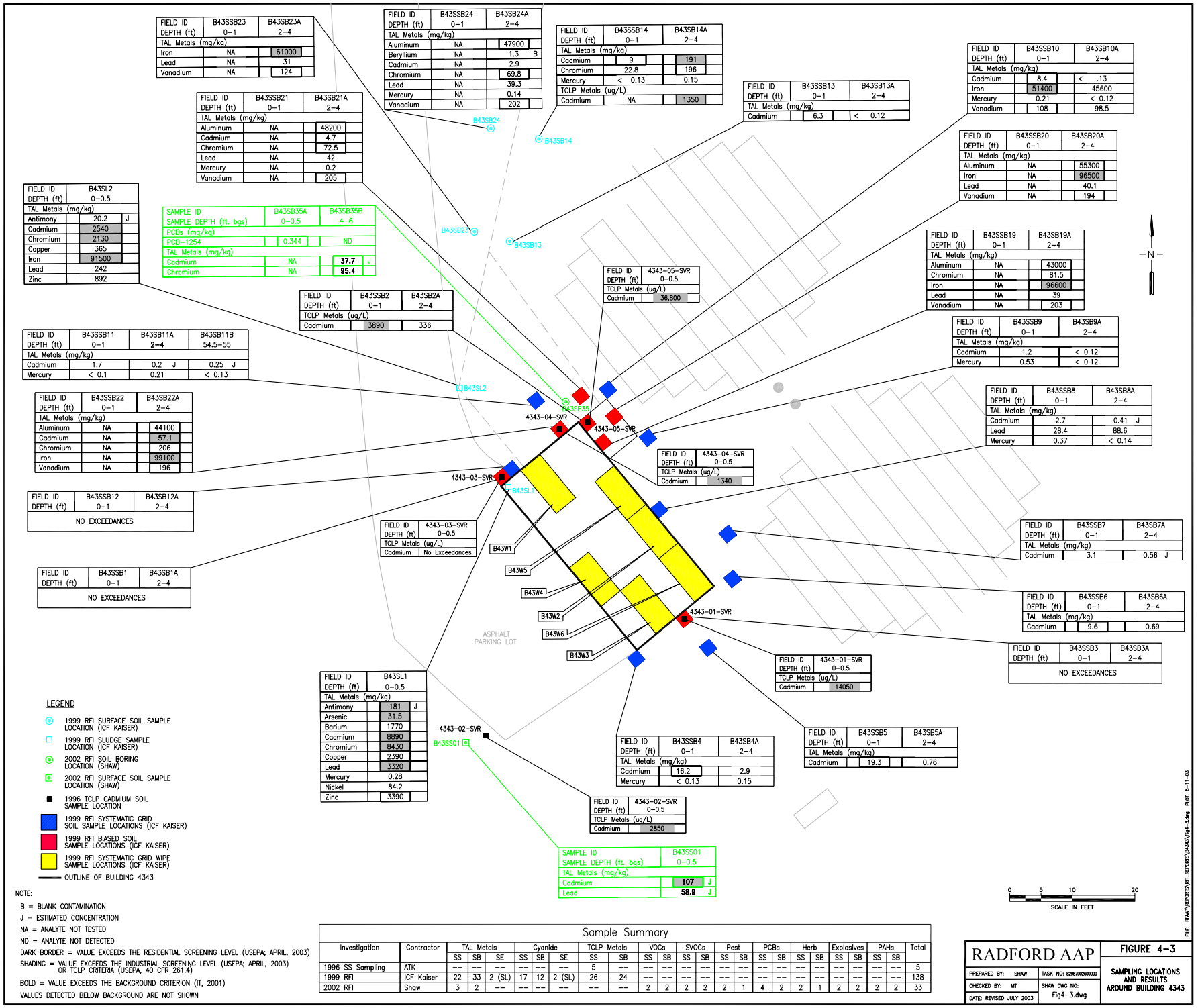
RADFORD AAP

FIGURE 4-2

BUILDING 4343
1999 AND 2002 RFI
SAMPLING LOCATIONS
AND RESULTS

PREPARED BY: SHAW
CHECKED BY: MT
DATE: REVISED JULY 2003
TASK NO: 8296702800000
SHAW DWG NO: Fig4-2.dwg

FILE: R:\AAP\REPORTS\RFI_REPORTS\Fig4-2.dwg PLOT: 8-11-03



FIELD ID	B43SSB23	B43SB23A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Iron	NA	61000
Lead	NA	31
Vanadium	NA	124

FIELD ID	B43SSB24	B43SB24A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Aluminum	NA	47900
Beryllium	NA	1.3 B
Cadmium	NA	2.9
Chromium	NA	69.8
Lead	NA	39.3
Mercury	NA	0.14
Vanadium	NA	202

FIELD ID	B43SSB14	B43SB14A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	9	191
Chromium	22.8	196
Mercury	< 0.13	0.15
TCLP Metals (ug/L)		
Cadmium	NA	1350

FIELD ID	B43SSB13	B43SB13A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	6.3	< 0.12

FIELD ID	B43SSB10	B43SB10A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	8.4	< .13
Iron	51400	45600
Mercury	0.21	< 0.12
Vanadium	108	98.5

FIELD ID	B43SSB21	B43SB21A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Aluminum	NA	48200
Cadmium	NA	4.7
Chromium	NA	72.5
Lead	NA	42
Mercury	NA	0.2
Vanadium	NA	205

FIELD ID	B43SSB20	B43SB20A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Aluminum	NA	55300
Iron	NA	96500
Lead	NA	40.1
Vanadium	NA	194

FIELD ID	B43SL2
DEPTH (ft)	0–0.5
TAL Metals (mg/kg)	
Antimony	20.2 J
Cadmium	2540
Chromium	2130
Copper	365
Iron	91500
Lead	242
Zinc	892

SAMPLE ID	B43SB35A	B43SB35B
SAMPLE DEPTH (ft. bgs)	0–0.5	4–6
PCBs (mg/kg)		
PCB-1254	0.344	ND
TAL Metals (mg/kg)		
Cadmium	NA	37.7 J
Chromium	NA	95.4

FIELD ID	4343-05-SVR
DEPTH (ft)	0–0.5
TCLP Metals (ug/L)	
Cadmium	36,800

FIELD ID	B43SSB19	B43SB19A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Aluminum	NA	43000
Chromium	NA	81.5
Iron	NA	96800
Lead	NA	39
Vanadium	NA	203

FIELD ID	B43SSB2	B43SB2A
DEPTH (ft)	0–1	2–4
TCLP Metals (ug/L)		
Cadmium	3890	336

FIELD ID	B43SSB9	B43SB9A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	1.2	< 0.12
Mercury	0.53	< 0.12

FIELD ID	B43SSB11	B43SB11A	B43SB11B
DEPTH (ft)	0–1	2–4	54.5–55
TAL Metals (mg/kg)			
Cadmium	1.7	0.2 J	0.25 J
Mercury	< 0.1	0.21	< 0.13

FIELD ID	B43SSB8	B43SB8A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	2.7	0.41 J
Lead	28.4	88.6
Mercury	0.37	< 0.14

FIELD ID	B43SSB22	B43SB22A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Aluminum	NA	44100
Cadmium	NA	57.1
Chromium	NA	206
Iron	NA	99100
Vanadium	NA	196

FIELD ID	4343-04-SVR
DEPTH (ft)	0–0.5
TCLP Metals (ug/L)	
Cadmium	1340

FIELD ID	B43SSB12	B43SB12A
DEPTH (ft)	0–1	2–4
NO EXCEEDANCES		

FIELD ID	4343-03-SVR
DEPTH (ft)	0–0.5
TCLP Metals (ug/L)	
Cadmium	No Exceedances

FIELD ID	B43SSB7	B43SB7A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	3.1	0.56 J

FIELD ID	B43SSB1	B43SB1A
DEPTH (ft)	0–1	2–4
NO EXCEEDANCES		

FIELD ID	B43SSB6	B43SB6A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	9.6	0.69

FIELD ID	B43SSB3	B43SB3A
DEPTH (ft)	0–1	2–4
NO EXCEEDANCES		

FIELD ID	4343-01-SVR
DEPTH (ft)	0–0.5
TCLP Metals (ug/L)	
Cadmium	14050

FIELD ID	B43SL1
DEPTH (ft)	0–0.5
TAL Metals (mg/kg)	
Antimony	181 J
Arsenic	31.5
Barium	1770
Cadmium	8890
Chromium	8430
Copper	2390
Lead	3320
Mercury	0.28
Nickel	84.2
Zinc	3390

FIELD ID	B43SSB4	B43SB4A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	16.2	2.9
Mercury	< 0.13	0.15

FIELD ID	B43SSB5	B43SB5A
DEPTH (ft)	0–1	2–4
TAL Metals (mg/kg)		
Cadmium	19.3	0.76

FIELD ID	4343-02-SVR
DEPTH (ft)	0–0.5
TCLP Metals (ug/L)	
Cadmium	2850

SAMPLE ID	B43SS01
SAMPLE DEPTH (ft. bgs)	0–0.5
TAL Metals (mg/kg)	
Cadmium	107 J
Lead	58.9 J

LEGEND

- 1999 RFI SURFACE SOIL SAMPLE LOCATION (ICF KAISER)
- 1999 RFI SLUDGE SAMPLE LOCATION (ICF KAISER)
- 2002 RFI SOIL BORING LOCATION (SHAW)
- 2002 RFI SURFACE SOIL SAMPLE LOCATION (SHAW)
- 1996 TCLP CADMIUM SOIL SAMPLE LOCATION
- 1999 RFI SYSTEMATIC GRID SOIL SAMPLE LOCATIONS (ICF KAISER)
- 1999 RFI BIASED SOIL SAMPLE LOCATIONS (ICF KAISER)
- 1999 RFI SYSTEMATIC GRID WIPE SAMPLE LOCATIONS (ICF KAISER)
- OUTLINE OF BUILDING 4343

NOTE:

B = BLANK CONTAMINATION
J = ESTIMATED CONCENTRATION
NA = ANALYTE NOT TESTED
ND = ANALYTE NOT DETECTED
DARK BORDER = VALUE EXCEEDS THE RESIDENTIAL SCREENING LEVEL (USEPA; APRIL, 2003)
SHADING = VALUE EXCEEDS THE INDUSTRIAL SCREENING LEVEL (USEPA; APRIL, 2003) OR TCLP CRITERIA (USEPA, 40 CFR 261.4)
BOLD = VALUE EXCEEDS THE BACKGROUND CRITERION (IT, 2001)
VALUES DETECTED BELOW BACKGROUND ARE NOT SHOWN

Sample Summary

Investigation	Contractor	TAL Metals			Cyanide			TCLP Metals		VOCs		SVOCs		Pest		PCBs		Herb		Explosives		PAHs		Total
		SS	SB	SE	SS	SB	SE	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	SS	SB	
1996 SS Sampling	ATK	--	--	--	--	--	--	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5
1999 RFI	ICF Kaiser	22	33	2 (SL)	17	12	2 (SL)	26	24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	138
2002 RFI	Shaw	3	2	--	--	--	--	--	--	2	2	2	2	2	1	4	2	2	1	2	2	2	2	33

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FIGURE 4–3

SAMPLING LOCATIONS AND RESULTS AROUND BUILDING 4343

PREPARED BY: SHAW	TASK NO: 829670029000
CHECKED BY: MT	SHAW DWG NO: Fig4–3.dwg
DATE: REVISED JULY 2003	

FILE: RFAAP\REPORTS\RFI_REPORTS\BA343\Fig4-3.dwg PLOT: 8-11-03

Table 4-3
Building 4343 Soil Sampling Summary

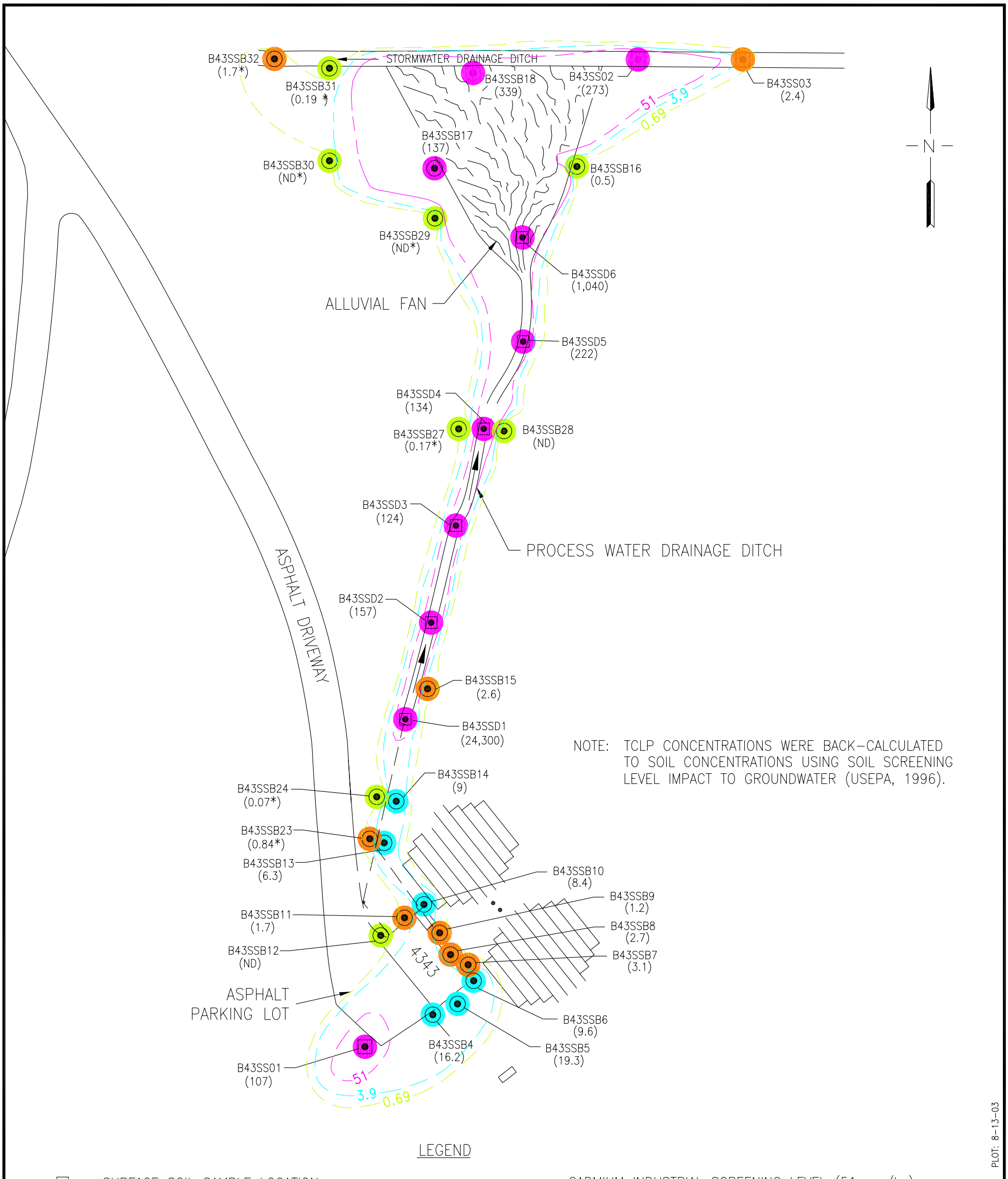
Analyte	i-RBC	r-RBC	Background	SSL Transfer	# of i-RBC Exceedances	# of r-RBC Exceedances	# of Background Exceedances	# of SSL Transfer Exceedances	# of Detections	# of Samples	Maximum Concentration	Location of Maximum
VOCs (ug/kg)	***None detected***											
PAHs (ug/kg)												
2-Methylnaphthalene	2000000	160000	na	22000	0	0	na	0	2	4	11	B43SB35A
Acenaphthene	6100000	470000	na	100000	0	0	na	0	1	4	5.5	B43SB35A
Acenaphthylene	3100000	230000	na	680000	0	0	na	0	2	4	6.9	B43SB35A
Anthracene	31000000	2300000	na	470000	0	0	na	0	1	4	3.4	B43SB35A
Benzo(a)anthracene	3900	870	na	1500	0	0	na	0	3	4	8.7	B43SB35A
Benzo(a)pyrene	390	87	na	370	0	0	na	0	3	4	7.4	B43SB35A
Benzo(b)fluoranthene	3900	870	na	4500	0	0	na	0	3	4	27	B43SB35A
Benzo(g,h,i)perylene	3100000	230000	na	680000	0	0	na	0	2	4	6.5	B43SB35A
Benzo(k)fluoranthene	39000	8700	na	45000	0	0	na	0	2	4	8.1	B43SB35A
Chrysene	390000	87000	na	150000	0	0	na	0	3	4	16	B43SB35A
Dibenz(a,h)Anthracene	390	87	na	1400	0	0	na	0	2	4	1.9	B43SB35A
Fluoranthene	4100000	310000	na	6300000	0	0	na	0	3	4	15	B43SB35A
Fluorene	4100000	310000	na	140000	0	0	na	0	1	4	4.7	B43SB35A
Indeno(1,2,3-cd)pyrene	3900	870	na	13000	0	0	na	0	2	4	8.4	B43SB35A
Naphthalene	2000000	160000	na	150	0	0	na	0	4	4	11	B43SB35A
Phenanthrene	3100000	230000	na	680000	0	0	na	0	3	4	12	B43SB35A
Pyrene	3100000	230000	na	680000	0	0	na	0	3	4	20	B43SB35A
SVOCs (ug/kg)												
Benzo(a)anthracene	3900	870	na	1500	0	0	na	0	1	4	8	B43SB35A
Benzo(b)fluoranthene	3900	870	na	4500	0	0	na	0	2	4	12	B43SB34A
Benzo(g,h,i)perylene	3100000	230000	na	680000	0	0	na	0	1	4	11	B43SB35A
Bis(2-ethylhexyl)phthalate	200000	46000	na	2900000	0	0	na	0	4	4	86	B43SB35B
Chrysene	390000	87000	na	150000	0	0	na	0	2	4	15	B43SB34A
Di-n-octylphthalate	2000000	160000	na	2400000000	0	0	na	0	3	4	51	B43SB34A
Fluoranthene	4100000	310000	na	6300000	0	0	na	0	2	4	16	B43SB34A
Indeno(1,2,3-cd)pyrene	3900	870	na	13000	0	0	na	0	1	4	12	B43SB35A
Phenanthrene	3100000	230000	na	680000	0	0	na	0	2	4	14	B43SB34A
Pyrene	3100000	230000	na	680000	0	0	na	0	2	4	15	B43SB34A
Pesticides (ug/kg)												
4,4'-DDD	12000	2700	na	11000	0	0	na	0	3	3	0.57	B43SB34A
4,4'-DDT	8400	1900	na	1200	0	0	na	0	2	3	21.8	B43SB35A
Endosulfan II	610000	47000	na	20000	0	0	na	0	2	3	2.46	B43SB35A
Endrin aldehyde	na	na	na	na	na	na	na	na	1	3	2.89	B43SB35A
Endrin	31000	2300	na	5400	0	0	na	0	1	3	0.498	B43SB34A
Methoxychlor	510000	39000	na	310000	0	0	na	0	1	3	1.97	B43SB34A
PCBs (mg/kg)												
PCB-1254	1.4	0.16	na	1.1	0	1	na	0	4	6	0.344	B43SB35A
Explosives (mg/kg)	***None detected***											
Herbicides (ug/kg)	***None detected***											

Table 4-3
Building 4343 Soil Sampling Summary

Analyte	i-RBC	r-RBC	Background	SSL Transfer	# of i-RBC Exceedances	# of r-RBC Exceedances	# of Background Exceedances	# of SSL Transfer Exceedances	# of Detections	# of Samples	Maximum Concentration	Location of Maximum
Metals (mg/kg)												
Aluminum	100000	7800	40041	na	0	5	5	na	60	60	55300	B43SB20A
Antimony	41	3.1	na	13	1	4	na	1	29	60	41.2	B43SSD1
Arsenic	1.9	0.43	15.8	0.026	0	0	0	0	60	60	9.4	B43SB17B
Barium	7200	550	209	2100	0	0	1	0	60	60	242	B43SSD1
Beryllium	200	16	1.02	1200	0	0	1	0	36	60	1.6	B43SB15B
Cadmium	51	3.9	0.69	27	12	24	36	13	43	60	24300	B43SSD1
Calcium	na	na	na	na	na	na	na	na	60	60	91000	B43SSB11
Chromium	310	23	65.3	42	2	14	14	14	60	60	1820	B43SSD1
Cobalt	2000	160	72.3	na	0	0	0	na	59	60	19.8	B43SSB18
Copper	4100	310	53.5	11000	0	1	6	0	60	60	677	B43SSD1
Iron	31000	2300	50962	na	7	7	7	na	60	60	99100	B43SB22A
Lead	750	400	26.8	na	1	1	15	na	60	60	1410	B43SSD1
Magnesium	na	na	na	na	na	na	na	na	60	60	19400	B43SS01
Manganese	2000	160	2543	950	0	0	0	0	60	60	1220	B43SB32A
Mercury	31	2.3	0.13	na	0	0	12	na	17	60	0.53	B43SSB9
Nickel	2000	160	62.8	na	0	0	0	na	59	60	32.7	B43SB17B
Potassium	na	na	na	na	na	na	na	na	60	60	2990	B43SB17B
Selenium	510	39	na	19	0	0	na	0	4	60	1.1	B43SSB11
Silver	510	39	na	31	0	0	na	1	47	60	36	B43SSD1
Sodium	na	na	na	na	na	na	na	na	60	60	443	B43SSB11
Thallium	7.2	0.55	2.11	3.6	0	0	0	0	6	60	1.2	B43SB12A
Vanadium	720	55	108	5100	0	8	8	0	60	60	205	B43SB21A
Zinc	31000	2300	202	14000	0	0	1	0	60	60	1780	B43SSD1

Notes: 1) Sludge samples (B43SL1 and B43SL2) and QA/QC samples were not included in totals

2) RBCs (USEPA; April, 2003) were adjusted downward to a HQ of 0.1



NOTE: TCLP CONCENTRATIONS WERE BACK-CALCULATED TO SOIL CONCENTRATIONS USING SOIL SCREENING LEVEL IMPACT TO GROUNDWATER (USEPA, 1996).

LEGEND

- SURFACE SOIL SAMPLE LOCATION
- SOIL BORING LOCATION
- CADMIUM CONCENTRATION EXCEEDED THE CADMIUM INDUSTRIAL SCREENING LEVEL (51 mg/kg)
- CADMIUM CONCENTRATION EXCEEDED THE CADMIUM RESIDENTIAL SCREENING LEVEL (3.9 mg/kg)
- CADMIUM CONCENTRATION EXCEEDED THE CADMIUM BACKGROUND VALUE (0.69 mg/kg)
- CADMIUM CONCENTRATION WAS BELOW THE BACKGROUND VALUE (0.69 mg/kg)
- CONTOUR INTERVAL
- INFERRED CONTOUR INTERVAL

- CADMIUM INDUSTRIAL SCREENING LEVEL (51 mg/kg) ISOCONCENTRATION LINE
- CADMIUM RESIDENTIAL SCREENING LEVEL (3.9 mg/kg) ISOCONCENTRATION LINE
- CADMIUM BACKGROUND VALUE (0.69 mg/kg) ISOCONCENTRATION LINE
- (0.19*) CADMIUM SOIL CONCENTRATION (mg/kg) BACK-CALCULATED FROM TCLP CONCENTRATION (ug/L)
- (2.6) CADMIUM SOIL CONCENTRATION (mg/kg)
- (ND) CADMIUM NOT DETECTED

0 20 40 80
SCALE IN FEET

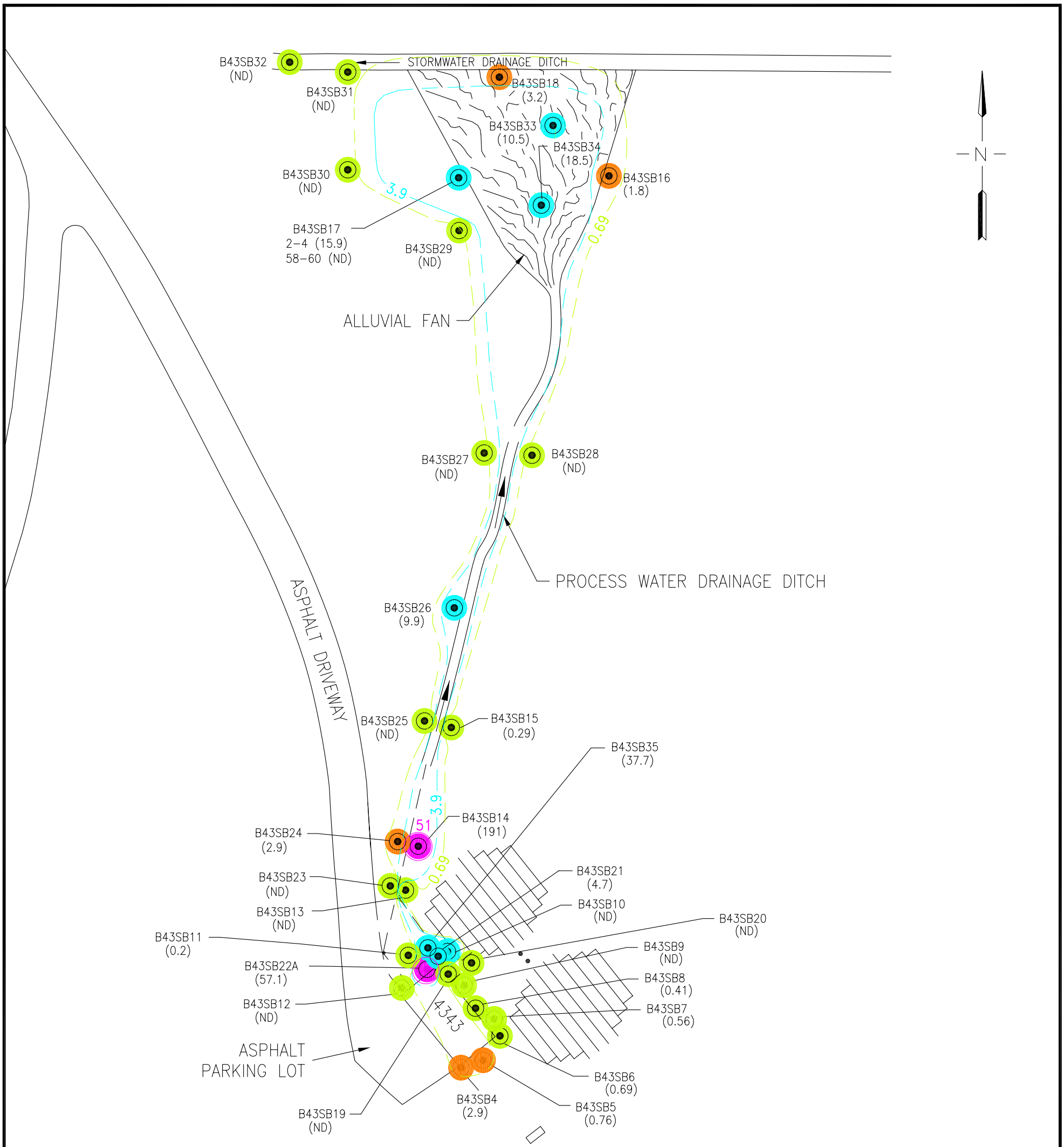
RADFORD AAP

PREPARED BY: SHAW	TASK NO: 82987002600000
CHECKED BY: MT	SHAW DWG NO: Fig4-4.dwg
DATE: REVISED JULY 2003	

FIGURE 4-4

BUILDING 4343
CADMIUM
SURFACE SOIL
ISOCONCENTRATIONS

FILE: RFAAP\REPORTS\RFI_REPORTS\Fig4-4.dwg PLOT: 8-13-03



LEGEND

- SOIL BORING LOCATION
- CADMIUM CONCENTRATION EXCEEDED THE CADMIUM INDUSTRIAL SCREENING LEVEL (51 mg/kg)
- CADMIUM CONCENTRATION EXCEEDED THE CADMIUM RESIDENTIAL SCREENING LEVEL (3.9 mg/kg)
- CADMIUM CONCENTRATION EXCEEDED THE CADMIUM BACKGROUND VALUE (0.69 mg/kg)
- CADMIUM CONCENTRATION WAS BELOW THE BACKGROUND VALUE (0.69 mg/kg)
- CONTOUR INTERVAL
- INFERRED CONTOUR INTERVAL
- CADMIUM INDUSTRIAL SCREENING LEVEL (51 mg/kg) ISOCONCENTRATION LINE
- CADMIUM RESIDENTIAL SCREENING LEVEL (3.9 mg/kg) ISOCONCENTRATION LINE
- CADMIUM BACKGROUND VALUE (0.69 mg/kg) ISOCONCENTRATION LINE
- (2.6) CADMIUM SOIL CONCENTRATION (mg/kg)
- (ND) CADMIUM NOT DETECTED

0 20 40 80

SCALE IN FEET

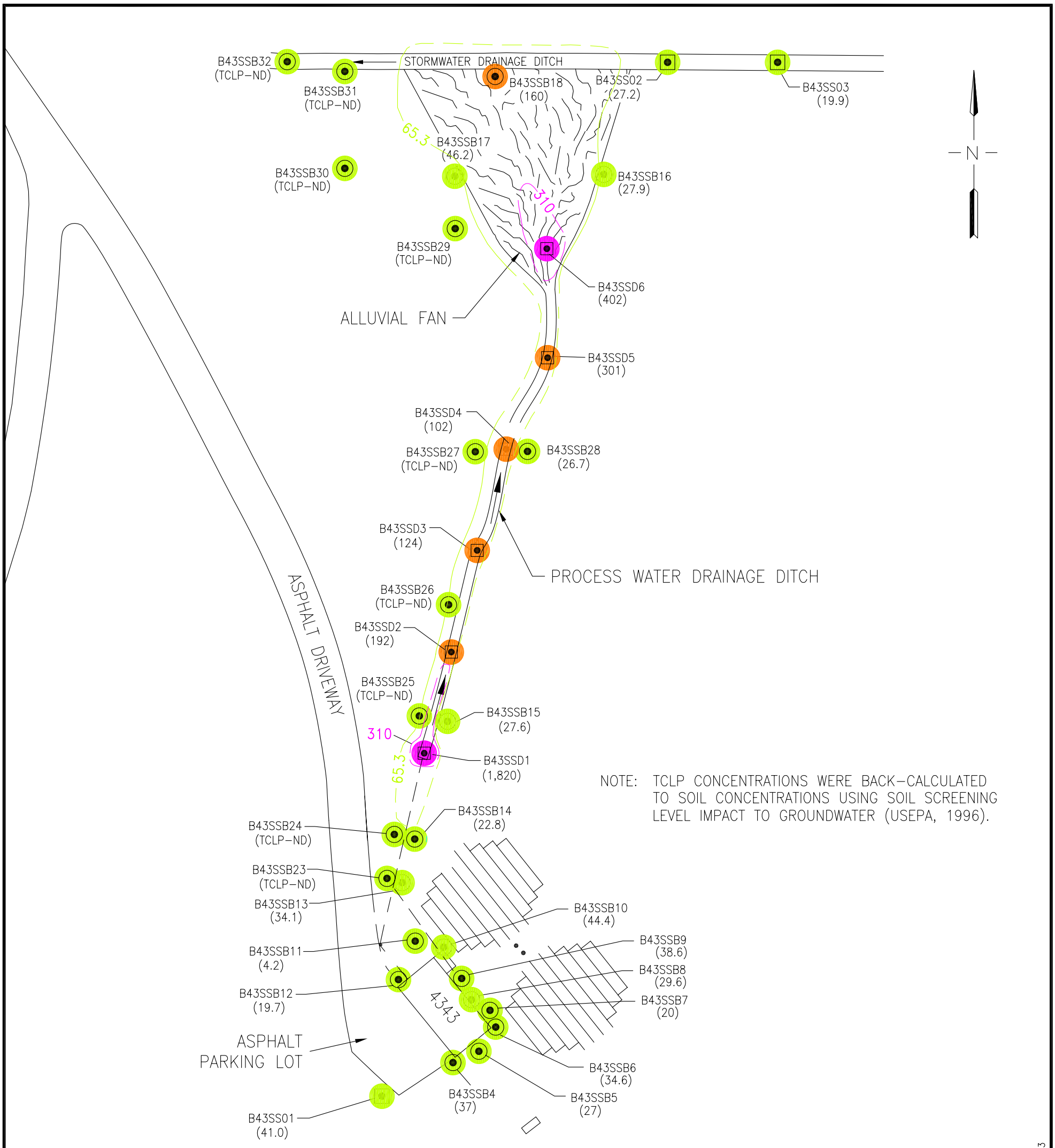
FILE: RFAAE\REPORTS\RFI_REPORTS\Fig4-5.dwg PLOT: 8-13-03

RADFORD AAP

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CHECKED BY: MT	SHAW DWG NO: Fig4-5.dwg
DATE: REVISED JULY 2003	

FIGURE 4-5

BUILDING 4343
CADMIUM
SUBSURFACE SOIL
ISOCONCENTRATIONS



NOTE: TCLP CONCENTRATIONS WERE BACK–CALCULATED TO SOIL CONCENTRATIONS USING SOIL SCREENING LEVEL IMPACT TO GROUNDWATER (USEPA, 1996).

LEGEND

- SURFACE SOIL SAMPLE LOCATION
- SOIL BORING LOCATION
- CHROMIUM CONCENTRATION EXCEEDED THE CHROMIUM INDUSTRIAL SCREENING LEVEL (310 mg/kg)
- CHROMIUM CONCENTRATION EXCEEDED THE CHROMIUM BACKGROUND VALUE (65.3 mg/kg)
- CHROMIUM CONCENTRATION WAS BELOW THE BACKGROUND VALUE (65.3 mg/kg)
- CONTOUR INTERVAL
- INFERRED CONTOUR INTERVAL
- CHROMIUM INDUSTRIAL SCREENING LEVEL (310 mg/kg) ISOCONCENTRATION LINE
- CHROMIUM BACKGROUND VALUE (65.3 mg/kg) ISOCONCENTRATION LINE
- (2.6) CHROMIUM SOIL CONCENTRATION (mg/kg)
- (ND) CHROMIUM NOT DETECTED

0 20 40 80
SCALE IN FEET

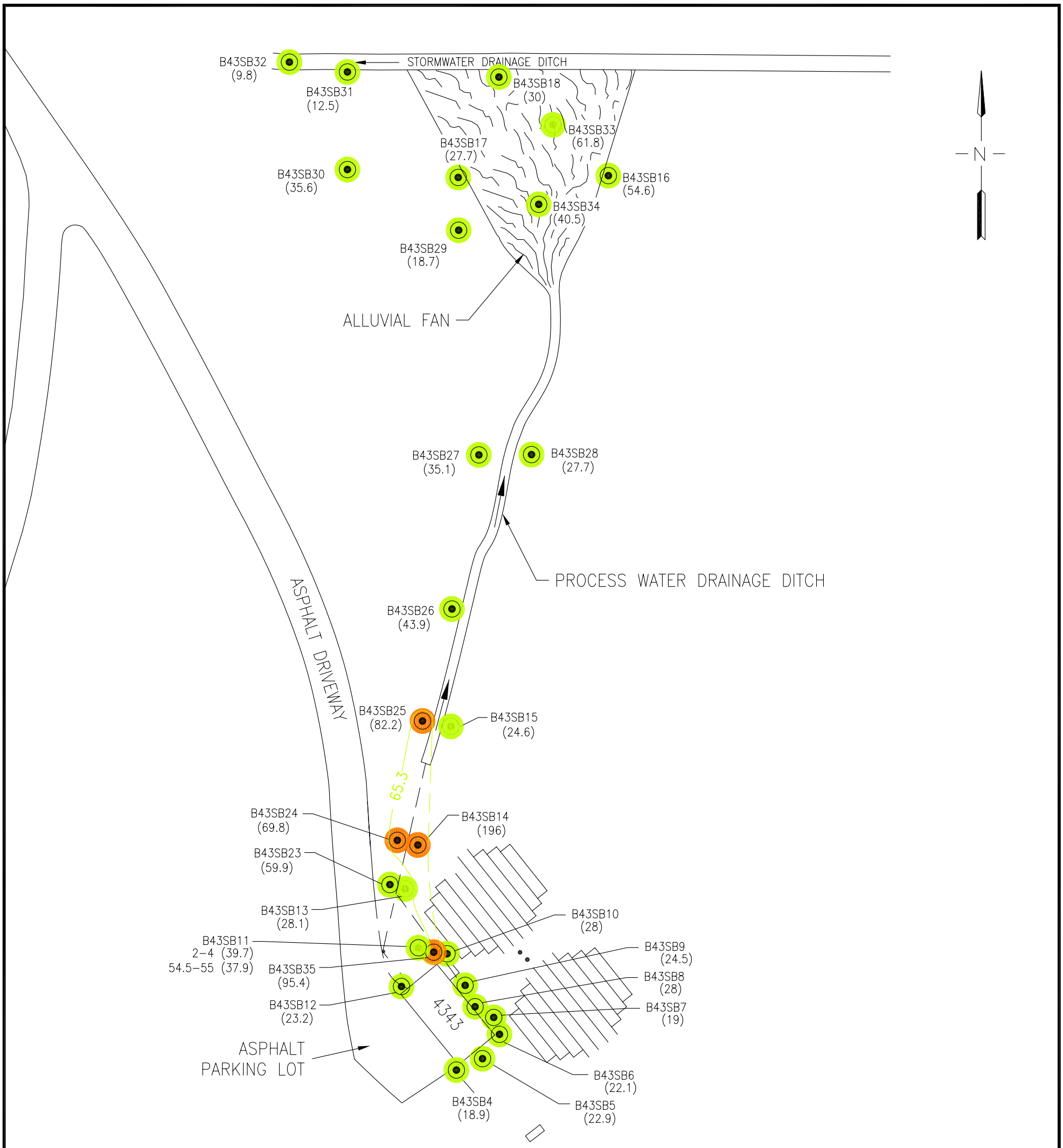
RADFORD AAP

FIGURE 4–6

BUILDING 4343
CHROMIUM
SURFACE SOIL
ISOCONCENTRATIONS

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CHECKED BY: MT	SHAW DWG NO: Fig4–6.dwg
DATE: REVISED JULY 2003	

FILE: RFAAP\REPORTS\RFI_REPORTS\Fig4–6.dwg PLOT: 8–13–03



LEGEND

- SOIL BORING LOCATION
- CHROMIUM CONCENTRATION EXCEEDED THE CHROMIUM BACKGROUND VALUE (65.3 mg/kg)
- CHROMIUM CONCENTRATION WAS BELOW THE BACKGROUND VALUE (65.3 mg/kg)
- CONTOUR INTERVAL
- INFERRED CONTOUR INTERVAL
- CHROMIUM BACKGROUND VALUE (65.3 mg/kg) ISOCONCENTRATION LINE
- (2.6) CHROMIUM SOIL CONCENTRATION (mg/kg)
- (ND) CHROMIUM NOT DETECTED

0 20 40 80

SCALE IN FEET

PLOT: 8-13-03

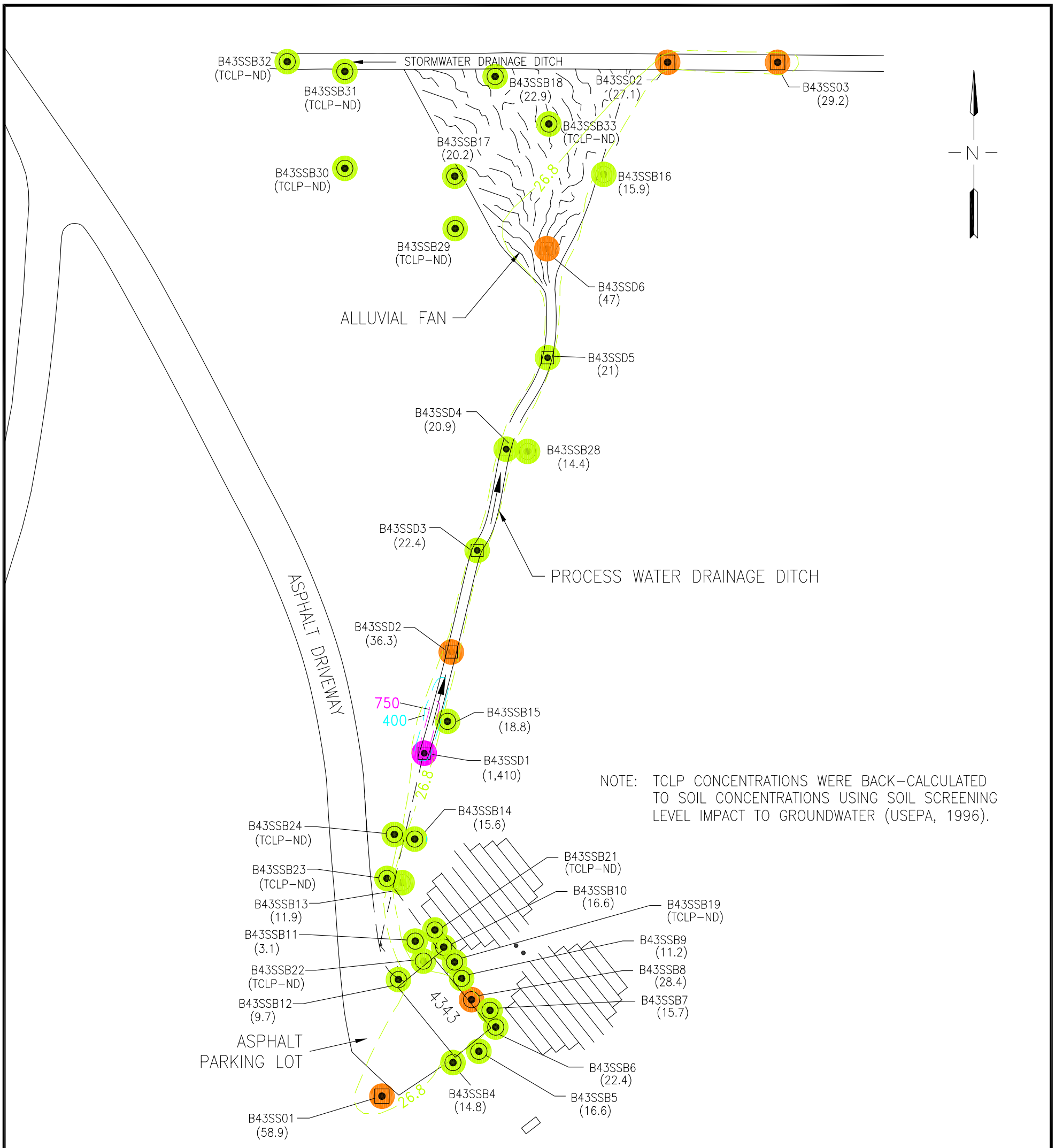
FILE: RFAAE\REPORTS\RFI_REPORTS\Fig4-7.dwg

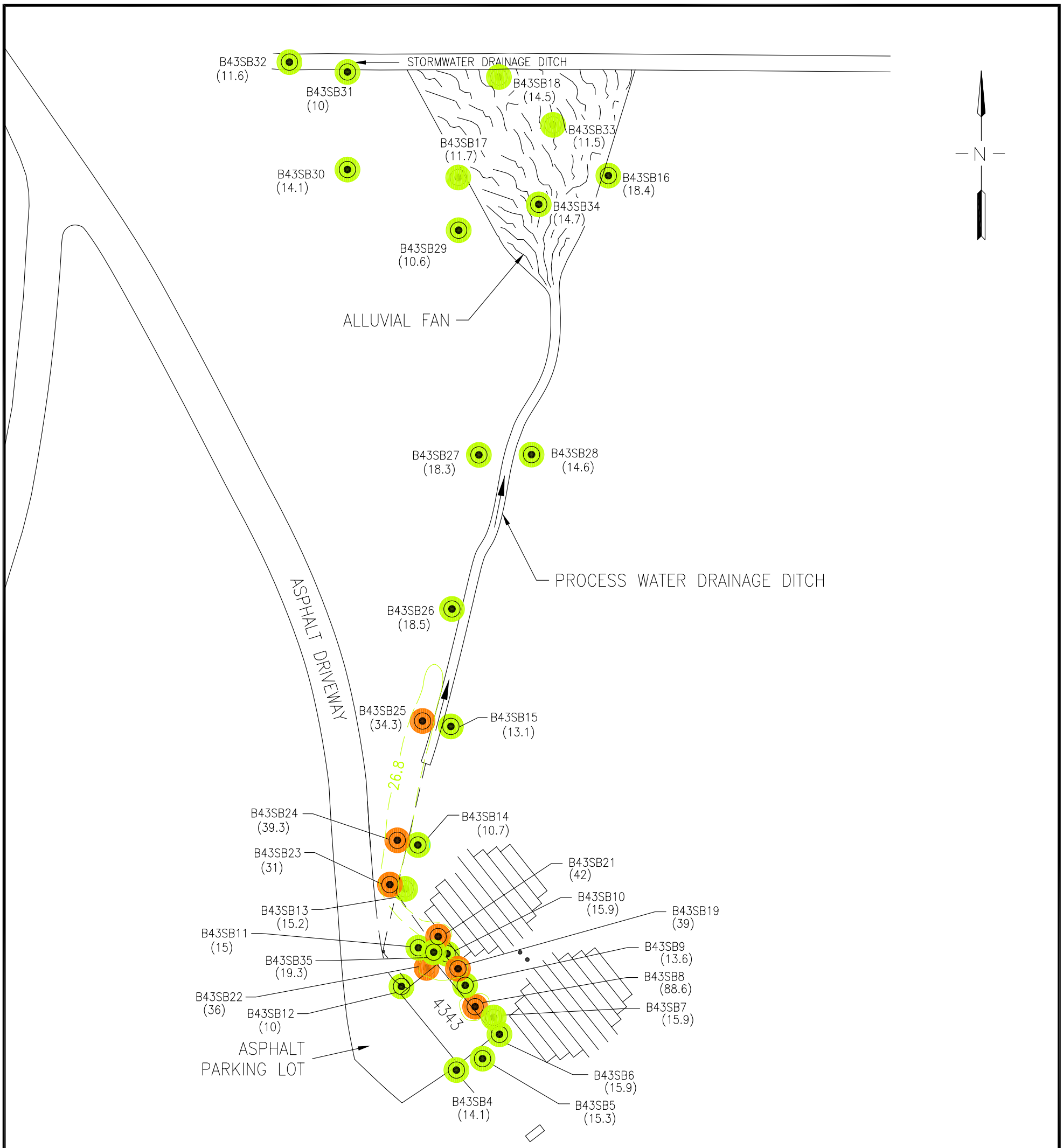
RADFORD AAP

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CHECKED BY: MT	SHAW DWG NO: Fig4-7.dwg
DATE: REVISED JULY 2003	

FIGURE 4-7

BUILDING 4343
CHROMIUM
SUBSURFACE SOIL
ISOCONCENTRATIONS


B43SSB32
(TCLP–ND)
B43SSB31
(TCLP–ND)
STORMWATER DRAINAGE DITCH
B43SSB18
(22.9)
B43SS02
(27.1)
B43SS03
(29.2)
B43SSB33
(TCLP–ND)
B43SSB17
(20.2)
B43SSB30
(TCLP–ND)
26.8
B43SSB16
(15.9)
B43SSB29
(TCLP–ND)
B43SSD6
(47)
ALLUVIAL FAN
B43SSD5
(21)
B43SSD4
(20.9)
B43SSB28
(14.4)
B43SSD3
(22.4)
PROCESS WATER DRAINAGE DITCH
ASPHALT DRIVEWAY
B43SSD2
(36.3)
750
400
B43SSB15
(18.8)
B43SSD1
(1,410)
26.8
B43SSB14
(15.6)
B43SSB24
(TCLP–ND)
B43SSB21
(TCLP–ND)
B43SSB23
(TCLP–ND)
B43SSB10
(16.6)
B43SSB13
(11.9)
B43SSB19
(TCLP–ND)
B43SSB11
(3.1)
B43SSB9
(11.2)
B43SSB22
(TCLP–ND)
B43SSB8
(28.4)
B43SSB12
(9.7)
B43SSB7
(15.7)
4343
ASPHALT
PARKING LOT
B43SSB6
(22.4)
B43SSB4
(14.8)
B43SSB5
(16.6)
26.8
B43SS01
(58.9)
N
NOTE: TCLP CONCENTRATIONS WERE BACK–CALCULATED TO SOIL CONCENTRATIONS USING SOIL SCREENING LEVEL IMPACT TO GROUNDWATER (USEPA, 1996).
LEGEND
SURFACE SOIL SAMPLE LOCATION
SOIL BORING LOCATION
LEAD CONCENTRATION EXCEEDED THE LEAD INDUSTRIAL SCREENING CRITERION (750 mg/kg)
LEAD CONCENTRATION EXCEEDED THE LEAD RESIDENTIAL SCREENING CRITERION (400 mg/kg)
LEAD CONCENTRATION EXCEEDED THE LEAD BACKGROUND VALUE (26.8 mg/kg)
LEAD CONCENTRATION WAS BELOW THE BACKGROUND VALUE (26.8 mg/kg)
CONTOUR INTERVAL
INFERRED CONTOUR INTERVAL
LEAD INDUSTRIAL SCREENING CRITERION (750 mg/kg) ISOCONCENTRATION LINE
LEAD RESIDENTIAL SCREENING CRITERION (400 mg/kg) ISOCONCENTRATION LINE
LEAD BACKGROUND VALUE (26.8 mg/kg) ISOCONCENTRATION LINE
(2.6) LEAD SOIL CONCENTRATION (mg/kg)
(ND) LEAD NOT DETECTED
0 20 40 80
SCALE IN FEET
FILE: RFAAP\REPORTS\RFI_REPORTS\Fig4-8.dwg PLOT: 8-13-03
RADFORD AAP
FIGURE 4–8
PREPARED BY: SHAW
TASK NO: 82987002600000
CHECKED BY: MT
SHAW DWG NO: Fig4–8.dwg
DATE: JULY 2003
BUILDING 4343
LEAD
SURFACE SOIL
ISOCONCENTRATIONS



LEGEND

- SOIL BORING LOCATION
- LEAD CONCENTRATION EXCEEDED THE LEAD BACKGROUND VALUE (26.8 mg/kg)
- LEAD CONCENTRATION WAS BELOW THE BACKGROUND VALUE (26.8 mg/kg)
- CONTOUR INTERVAL
- INFERRED CONTOUR INTERVAL
- LEAD BACKGROUND VALUE (26.8 mg/kg) ISOCONCENTRATION LINE
- (2.6) LEAD SOIL CONCENTRATION (mg/kg)
- (ND) LEAD NOT DETECTED

0 20 40 80

SCALE IN FEET

FILE: RFAAB\REPORTS\RFI_REPORTS\Fig4-9.dwg PLOT: 8-13-03

RADFORD AAP

PREPARED BY: SHAW	TASK NO: 82987002600000
CHECKED BY: MT	SHAW DWG NO: Fig4-9.dwg
DATE: JULY 2003	

FIGURE 4-9

BUILDING 4343
LEAD
SUBSURFACE SOIL
ISOCONCENTRATIONS

Results from the investigations at Building 4343 indicate that there are three areas at the site impacted by cadmium through slightly different processes. The first area is the immediately around the building and parking lot. This area was likely impacted by maintenance and wash down activities in the building. The second area at the site is the sumps and piping at the site. Results from sump samples indicate that material collected in the sumps had high concentrations of metals, and samples collected adjacent to the underground piping indicate that the pipes may have leaked. The third area is the process water drainage ditch. Piping from the former lead catch tank and sumps discharged plating process water into the ditch approximately 80 ft north of Building 4343. The process water flowed north in an unlined ditch approximately 250 ft to an east-west stormwater drainage ditch that drains to the west. The process water incised a 2 ft deep channel in the hillside leading from Building 4343 to the stormwater drainage ditch. An alluvial fan consisting of the eroded soil begins at the end of the process water drainage ditch and extends approximately 75 ft to where it meets the east-west trending storm water drainage ditch.

Area Around Building 4343. Samples collected on the eastern side of the northeast corner of Building 4343 during previous investigations indicated that cadmium is present at elevated levels in the surface soil at the former location of the lead catch tank. TCLP cadmium concentrations in these samples ranged from 3,890 µg/L (sample B43SSB2) to 36,800 µg/L (sample 4343-05-SVR) **(Figures 2-6 and 4-3)**. Samples collected from the west side of the northeast corner were also above industrial screening levels, with a TCLP cadmium result of 1,340 µg/L (sample 4343-04-SVR), and a TAL cadmium result of 57.1 mg/kg (B43SB22A). A surface soil sample collected at this location in 2002 (B43SB35A) contained Aroclor-1254 at a concentration of 0.344 mg/kg, slightly exceeding the residential screening level. No other samples contained PCBs at concentrations exceeding the residential screening level at the site. Additional surface and subsurface soil samples collected three to five feet laterally from the northeast corner showed levels of cadmium significantly lower than those collected on either side of the corner. Cadmium concentrations in these samples (B43SSB19/A through 22/A) ranged from non-detect to 8.4 mg/kg, slightly above the residential screening level of 3.9 mg/kg. A subsurface soil sample (B43SB35B) was collected at 4-6 ft bgs at the northeast corner of the building during the 2002 investigation to assess the vertical migration of cadmium in this area **(Figure 4-3)**. Cadmium was detected at a concentration of 37.7 mg/kg in this sample between the residential and industrial screening level. Additional samples collected around the building in 1999 **(Figures 2-6 and 4-3)** indicated that elevated cadmium is primarily confined to the location of the former lead catch tank.

Surface soil sample B43SS01 was collected from a low area west of Building 4343, located across the asphalt parking lot from the building **(Figures 4-2 and 4-3)**. Cadmium was detected at a concentration of 107 mg/kg in this sample, exceeding the industrial screening level of 51 mg/kg. The lead concentration in this sample (58.9 mg/kg) was also elevated above background (26.8 mg/kg), although the concentration was below the residential screening level of 400 mg/kg. Migration of contaminants due to runoff from this area is unlikely, due to this sample point being located in a topographic low. No subsurface soil samples were collected at this location. Surface soil sample 4343-02-SVR was collected in this area in 1996 and analyzed for TCLP cadmium. Cadmium was detected at a concentration of 2,850 µg/L. The exceedances of cadmium at this location (in front of the building door across the parking lot) are most likely the result of clean-up/maintenance activities.

Sumps and Piping. Two sumps, one located inside the building and one located outside the north wall, are connected by pipes to the outfall at the top of the process water drainage ditch **(Figure 2-2)**. The highest concentrations and greatest number of metals exceedances were detected in sludge samples collected from the two sumps (B43SL1 and B43SL2). There were industrial exceedances of five metals (antimony, arsenic, cadmium, chromium, and lead) in the interior sump (sludge sample B43SL1) of Building 4343. This is where the single exceedance of antimony was detected. The exterior sump (sludge sample B43SL2) (to which the interior sump drained) had industrial exceedances of cadmium, chromium, and iron.

Surface soil sample B43SSD1 was located immediately below the outfall where the sumps and former lead catch tank drained to the process water drainage ditch **(Figures 4-2 and 4-3)**. This sample contained the highest concentrations of metals found in soil at the site. Cadmium, chromium, and lead exceeded industrial screening levels and antimony and copper exceeded residential screening levels in this sample.

Three sample locations, B43SL1, B43SL2, and B43SSD1, contained antimony, chromium, and lead at concentrations exceeding the industrial screening level. Concentrations of these three metals also decreased with distance from the building, indicating that the sumps were accomplishing their function of separating out these metals.

Subsurface soil sample B43SB14A (2-4 ft bgs) was collected between Building 4343 and the head of the process water ditch and was collected just below the elevation of the underground process water pipe leading to the ditch. Cadmium was detected at concentration of 191 mg/kg in this sample, exceeding its industrial screening level; and chromium (196 mg/kg) exceeded its residential screening level **(Figure 4-2)**. The surface soil sample collected at this location (B43SSB14) contained no exceedances of industrial screening levels. The lower concentration of contaminants in the surface soil immediately above B43SB14A suggests that the underground process water pipe may have leaked effluent into the subsurface soil during its operation.

Process Water Drainage Ditch. Cadmium plating process water from the lead catch tank and sumps was drained through underground pipes and discharged into a north-south trending process water drainage ditch where the water traveled for approximately 200 ft before the ditch widens into an alluvial fan at a break in the slope. The discharge has eroded into the clayey soil up to approximately 1.5 ft. The alluvial fan (consisting of the eroded soil) continues northward for approximately 75 ft where runoff would discharge into a shallow east-west trending storm water ditch **(Figure 2-2)**.

The highest cadmium concentration in soil (24,300 mg/kg) was reported in surface soil sample B43SSD1, collected at the head of the ditch where the sumps discharged to the ditch **(Figures 2-7 and 4-2)**. Chromium (1,820 mg/kg) and lead (1,410 mg/kg) concentrations were also above their respective industrial screening levels (chromium – 310 mg/kg; lead – 750 mg/kg) in this sample.

Cadmium concentrations in ditch surface soil are fairly consistent between the upslope end of the ditch and the alluvial fan area. Four samples collected from the ditch in 1999 (B43SSD2 through B43SSD5) had concentrations above the industrial screening level (51 mg/kg) ranging from 124 mg/kg to 222 mg/kg. Cadmium concentrations in borings positioned immediately adjacent to the ditch were below industrial and residential screening levels in surface and subsurface samples (collected below the bottom of the ditch), except for one sample. Boring sample B43SB26A contained cadmium at a concentration of 9.9 mg/kg, above the residential screening level of 2.7

mg/kg. This result is an order of magnitude lower than concentrations found in soil from the ditch. The lack of cadmium exceedances in soil adjacent to the process water ditch indicate minimal infiltration of cadmium into surrounding soil.

Three subsurface soil samples had industrial screening level exceedances of iron (B43SB26A – 53,500 mg/kg; B43SB25A – 88,300 mg/kg; B43SB23A – 61,000 mg/kg). These three samples were collected from 2-4 ft from borings along the west side the process water drainage ditch. The elevated levels of iron are likely due to the acidic process water mobilizing iron. The fact that the iron has re-precipitated at the 2-4 ft interval suggests that vertical migration of metals-impacted process water is largely inhibited by the clay-rich soil.

Cadmium concentrations increase (relative to the transit area of the process water ditch) in the low energy environment where the process water drainage ditch opens into the alluvial fan. Sample B43SSD6, collected at the head of the alluvial fan, had a cadmium concentration of 1,040 mg/kg. Chromium (402 mg/kg) also exceeded its industrial screening level (310 mg/kg) in this sample. Additional samples collected from the alluvial fan show cadmium concentrations are lower in the downgradient portion of the alluvial fan and in the east-west trending drainage ditch (e.g., B43SSB17 – 137 mg/kg; B43SSB18 – 337 mg/kg; B43SS02 – 273 mg/kg). The pattern of exceedances in the trench and alluvial fan suggests that cadmium was transported via overland flow and mass transport of cadmium rich soil down the length of the ditch. Limited vertical migration of effluent likely occurred in the alluvial fan area. Results from soil samples collected from the alluvial fan [B43SSD6 – (0-1 ft bgs) cadmium – 1,040 mg/kg; B43SB34B – (4-6 ft bgs) cadmium – 18.5 mg/kg] suggest that metals were adsorbed to the clayey soil in the top four feet.

There were no industrial exceedances of cadmium in the subsurface samples collected in the alluvial fan area. Soil samples were collected in the east-west storm water drainage ditch to bound the extent of elevated cadmium. Samples collected in the downslope direction (west) in the stormwater drainage ditch indicate that cadmium concentrations attenuate rapidly (B43SSB32 – non-detect; B43SSB31- non-detect) in this direction. Because the drainage ditch is relatively flat, bounding samples were collected upslope (east) to assess ponding at the base of the alluvial fan. The cadmium concentration in sample B43SS03 was 2.36 mg/kg, slightly above background (0.69 mg/kg); but below the residential screening level of 2.7 mg/kg.

4.2.2.1 Soil Screening Level Comparison

As shown in **Tables 4-1, 4-2, and Appendix B-2, Tables B-2 and B-4**, chemical concentrations detected in surface and subsurface soil samples collected from the Building 4343 study area were compared to USEPA Region III Soil Screening Level (SSL) soil transfer to groundwater values, using a dilution attenuation factor (DAF) of 20 (USEPA, 2003a). As shown in the tables and summarized in **Table 4-3**, four TAL metals (antimony, cadmium, chromium, and silver) were found to exceed SSLs. Antimony (41.2 mg/kg) and silver (36 mg/kg) each were found to exceed SSL criteria (13 and 31 mg/kg, respectively) in one single sample out of 60 samples collected from the entire study area. Cadmium concentrations found to exceed the cadmium SSL of 27 mg/kg ranged from 37.7 mg/kg in subsurface soil sample B43SB35B (4-6 ft bgs) to 24,300 mg/kg in surface soil sample B43SSD1 (0-1 ft bgs). Soil samples containing chromium concentrations exceeding the chromium SSL of 42 mg/kg ranged from 69.8 mg/kg in subsurface soil sample B43SB24A to 1,820 mg/kg in surface soil sample B43SSD1.

While these SSL exceedances indicate a theoretical potential for impact to groundwater, empirical evidence in the form of 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. The following information indicates that the potential for further vertical migration of cadmium and impact on groundwater is unlikely:

- There is no groundwater present at the site within 60 feet of the surface;
- Site soil down to 60 feet is composed of tight clays and silts;
- Evidence that chemicals of concern are adsorbing to surface and near surface clay and demonstrating limited mobility (except by surface water transport in the process water ditch);
- Chemical data from 58-60 ft bgs show no elevated concentrations for chemicals of concern; and,
- Surface concentrations of chemicals presenting a concern decrease by 95% within the first six feet of soil.

The SSL exceedances are discussed in further detail in *Section 5.2.3*.

4.2.2.2 Nature and Extent Conclusions

VOCs, herbicides and explosive compounds have not been detected at Building 4343 and are not a concern at the Building 4343 study area. SVOCs/PAHs and pesticides were detected at the site, but did not exceed residential screening criteria and are also not a concern at the site. One PCB (Aroclor-1254) exceeded its residential screening level in one sample (B43SB35A). This sample was located next to the former lead catch tank, on the northeast corner of the building. It should be noted that this sample was collected in an area that has been impacted by cadmium, and removal of the soil to mitigate cadmium would also remove the elevated detection of Aroclor-1254.

There are exceedances of metals, primarily cadmium, around Building 4343 and in the process water drainage ditch north of the building. Cadmium has the greatest extent of elevated concentrations in soil **(Figures 4-4 and 4-5)**, and industrial screening level exceedances of chromium **(Figures 4-6 and 4-7)** and lead **(Figures 4-8 and 4-9)** were found in samples where cadmium also exceeded its industrial screening level. Iron exceedances were found immediately west of the process water drainage ditch at 2-4 ft bgs. These exceedances are likely due to acidic process water mobilizing iron in the soil. The iron is then reprecipitated once the process water has been neutralized by interaction with the soil. Biased and random grid sampling around the building indicates that metals exceedances around Building 4343 are limited to sumps and piping to which metals-impacted process water would drain and low areas that would collect wash down maintenance water. Soil samples collected from within and along the process water and storm water drainage ditches indicate that cadmium has migrated downslope in the process water ditch to the alluvial fan. The stormwater drainage ditch has been impacted by cadmium where the alluvial fan intersects the ditch. Subsurface soil samples collected in the alluvial fan area indicate that cadmium concentrations decrease 95 percent from respective surface soil concentrations within the first six feet below the surface. Samples collected in the stormwater drainage ditch east and west of the alluvial fan indicate that cadmium concentrations attenuate rapidly in these directions.

Borings advanced to 60 ft bgs indicate that the site is underlain by a thick layer of clays and silty clays with low permeability. As will be discussed in *Section 5.0*, clayey soil has a tendency to adsorb metals like Cd^{+2}. The lack of exceedances of cadmium in subsurface soil and the fact that groundwater was not encountered at the site (down to 60 ft bgs) indicates that groundwater is not likely to be impacted at this site.

5.0 CONTAMINANT FATE AND TRANSPORT

This section presents a discussion of the fate and transport of the chemicals identified in the nature and extent assessment as exceeding both the residential screening levels (USEPA, 2003a) and the established background concentrations (IT, 2001). Physical and chemical properties of the impacted media and of the contaminant(s) affect the fate and persistence of contamination in the environment (Rosenblatt, 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**.

It should be noted that analytes detected in the sludge samples are not considered in this section as analytes in the sump are contained and not anticipated to either change in concentration over time, be transported to other areas, or affect other media. Therefore, the impacted medium at Building 4343 is soil.

One organic compound (Aroclor-1254) and eight metals (aluminum, antimony, cadmium, chromium, copper, iron, lead, and vanadium) were detected in soil above residential screening levels and established background concentrations (IT, 2001). The fate and transport of these constituents are presented in the following sections.

5.1 Organic Compounds

5.1.1 Aroclor-1254

This PCB was detected above the residential screening level in one soil sample. This is a man-made compound, so comparison to background is not appropriate. The residential screening level exceedance occurred in surface soil sample B43SB35A, which was collected at the northernmost corner of Building 4343. The subsurface soil sample from this same location (B43SB35B) did not contain PCBs above detection limits. In addition, industrial screening levels for Aroclor-1254 were not exceeded in surface or subsurface soil samples collected from the remainder of the site. PCBs were not used in the treatment process during cadmium plating activities.

PCBs are a group of aromatic compounds containing two benzene rings with two or more substituted chlorine atoms. Aroclor-1254 is not soluble in water and has low volatility. Aroclor -1254 will tend to stay bound to the organic fraction of the soil instead of leaching into groundwater or surface water runoff. Aroclor-1254 prefers non-polar soil particles to a polar water phase.

PCBs are very persistent in the environment and are extremely resistant to oxidation and hydrolysis. The properties that made PCBs applicable for industrial use are the same properties that cause its persistence in the environment: chemical stability; thermal stability; resistance to hydrolysis by water, alkalis, and acids; and low flammability. PCBs tend to remain in surface soil once they are released into the environment. This is evidenced at Building 4343 by the lack of detections in the subsurface soil samples (4-6 ft bgs).

The most probable mechanism for PCB migration at Building 4343 is surface water runoff. Due to the high clay content of soil at the Building 4343 study area, it is highly unlikely that migration of Aroclor -1254 to groundwater has occurred.

Another means of contaminant transport involves the wind erosion of soil particles which have contaminants sorbed to them. The extent to which this occurs is dependent upon such factors as

wind velocity, soil particle size, and the percent of vegetative cover. Due to the location of the sample in which Aroclor-1254 was detected (near Building 4343) and its lack of detection in surrounding soil samples, there is no evidence that wind transport of the compound occurred.

5.2 Inorganic Compounds

Metal constituents, including aluminum, antimony, cadmium, chromium, copper, iron, lead, and vanadium, were detected in soil above residential screening levels and background concentrations at Building 4343. Because most metals are indigenous to the earth, they are usually found at varying concentration levels in most environmental media. The majority of the metals are non-toxic while some metals are toxic to human health and the environment. Non-toxic metals such as barium are required for the growth of young animals and plants, while heavy metals such as lead may inhibit their growth. Humans are good examples for both scenarios. Some metals build up in animal tissue (e.g., zinc accumulation in fish) while some metals accumulate in plants (e.g., vanadium).

Trace levels of metals may be released into the atmosphere from the off-gas of open-hearth furnaces in steel mills, metal smelters (e.g., lead) and incinerators. The airborne particulates are present mainly as oxides or in the form of chlorides in some incinerator emissions. Significant coagulation and interaction can occur in the atmosphere between emitted species and ambient particles of both natural and artificial origin. The particulate matter eventually will be removed from the atmosphere by wet or dry deposition and will be dispersed to a wide area of soil, causing soil contamination or damage to plants.

In soil, metal contaminants are dissolved in the soil solution, adsorbed or ion-exchanged on inorganic soil constituents, complexed with soluble soil organic matter, and precipitated as pure or mixed solids. Metals in the soil solution are subject to movement with soil water and may be transported through the vadose zone to groundwater, taken up by plants and aquatic organisms or volatilized. Unlike organic constituents, metals cannot be degraded, however, some metals such as arsenic and chromium can be transformed among various oxidation states altering their mobility and toxicity. Metal contaminants participate in chemical reactions with the solid soil phase. Immobilization of metals by adsorption, ion exchange, complexation and precipitation can prevent the movement of metal contaminants to groundwater. Changes in soil conditions, such as degradation of organic matrices and changes in pH, redox potential or soil solution composition, due to various remediation schemes or to natural weathering processes, also may change metal mobility in soil.

Fate and transportation mechanisms of the metals with concentrations found to exceed residential screening levels and background concentrations are discussed in more detail in the following sections.

5.2.1 Aluminum

Aluminum (Al) was detected above the residential screening level of 7,800 mg/kg and the background concentration of 40,041 mg/kg in five soil samples at concentrations ranging from 43,000 mg/kg (B43SB19A) to 55,300 mg/kg (B43SB20A). Four of the residential screening level exceedances occurred in subsurface soil samples (2-4 ft bgs) located at the northeast corner of Building 4343 (samples B43SB19A, B43SB20A, B43SB21A, and B43SB22A). The fifth exceedance was detected in sample B43SB24A, which was also collected from 2-4 ft bgs near the process water outfall. Al was not detected above residential screening levels in surface soil samples. Industrial screening levels for Al were not exceeded in soil samples collected from the

site. Historical records do not indicate that Al was used in the treatment process during cadmium plating activities.

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, 1999a). 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, 1999a).

Aluminum cannot be destroyed in the environment. It can change its form or become attached or separated from particles. Aluminum particles released from power plants and other combustion processes are usually attached to very small 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 bioconcentrate up the food chain and therefore, vegetables, fruits, fish, and meat will not generally contain high concentrations of aluminum (ATSDR, 1999a). An exception is tea plants, which can accumulate aluminum. 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, 1999a).

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.

5.2.2 Antimony

Antimony (Sb) was detected above the residential screening level of 3.1 mg/kg in four soil samples. The residential screening level exceedances occurred in surface soil samples B43SSD1, which was collected at the head of the process water drainage ditch; B43SSD5, collected near the bottom of the process water ditch; and, B43SSD6 and B43SSB18, collected from the alluvial fan. Antimony was not detected above residential screening levels in subsurface soil samples. Industrial screening levels for antimony were not exceeded in soil samples collected from the site. Because antimony was not detected during the Facility-Wide Background Study, there is no background value established for antimony at RFAAP (IT, 2001). Historical records do not indicate that antimony was used in the treatment process during cadmium plating activities. A major use of antimony is for hardening lead in batteries and in lead soldering. It is most likely that the limited antimony detections are associated with the lead-lined catch tank. In addition, antimony was detected in the sludge sample, which may indicate that it precipitated as a trace metal during the acid/neutralization treatment of the process water prior to its discharge to the sump.

Antimony exists in the +3 oxidation state under reducing conditions, which are prevalent in Building 4343 soil. The dominant species under these conditions is $Sb(OH)_3^0$. Because most antimony compounds are highly soluble, antimony concentrations in soil are usually not

solubility-limited (Rai et al., 1984). Therefore, adsorption may play an important role in limiting antimony mobility at the Building 4343 study area.

5.2.3 Cadmium

Cadmium (Cd) exceeded the residential screening level of 3.9 mg/kg in 24 samples at concentrations ranging from 4.7 mg/kg (B43SB21A) to 24,300 mg/kg (B43SSD1). The established background value for cadmium is 0.69 mg/kg (IT, 2001). These exceedances were located near the northeast corner of the building, within the process water drainage ditch, and the alluvial fan. In addition, residential and industrial screening level exceedances of cadmium were detected in the surface soil adjacent to Building 4343, and in a topographic low located adjacent to the parking lot **(Figure 4-4)**. Concentrations in soil decrease with depth and distance from the source.

Cadmium is not prevalent in the subsurface soil **(Figure 4-5)**. The industrial screening level value for cadmium was exceeded in one subsurface soil sample collected from a depth of 2–4 ft bgs immediately adjacent to an underground process water pipe at a concentration of 191 mg/kg. However, the absence of contaminants in the surface soil immediately above and adjacent to this location suggests that the cadmium contamination is confined mainly to the process water drainage ditch.

Clay content, levels of humic and fulvic acids, cation-exchange capacity, and alkalinity are factors in controlling Cd transport in soil (USEPA, 1997e and **Appendix D**). Dissolved organic material and hydroxides, such as iron and manganese, are responsible for the adsorption of the Cd ion. The cation exchange capacity, pH of the soil, and the solution pH play a significant role in controlling both adsorption and precipitation of Cd. The process water ditch has eroded into the clay soil underlying the site (*Section 2.2*). The clay soil is retarding vertical movement through adsorption and low permeability and the drainage slope encourages transport down the ditch channel.

Cadmium was introduced into the environment during the plating process at Building 4343 as cadmium ingots (Cd^{o}). At a lower soil/water pH value, Cd tends to precipitate, while at increasing pH levels, adsorption of Cd occurs. Surface soil samples collected from the site had pHs ranging between 5.03-7.4, with a mean pH of 6.2 (*Section 2.2*). At these pHs, cadmium would tend to be in the Cd^{+2} state rather than the $Cd(OH)_2$ state. The slightly acidic pH in site soil would favor the precipitation of cadmium onto surface soil. As Cd^{+2}, cadmium would have a tendency to adsorb to clayey soil. Logging descriptions **(Appendix B-2)** indicate that subsurface soil is mostly non-plastic, low permeability, dry to slightly moist, clays and silty clays down to bedrock. Cadmium as Cd^{+2} would have very low mobility in these types of soil. The clays at the site would also tend to inhibit vertical migration of cadmium because of their low permeability. The pH values detected in soil at Building 4343 (average 6.2) do not exceed the lower critical threshold (pH<5) that inhibits mobilization and migration. The lack of subsurface soil detections suggests that the high clay and silt content of soil at the site inhibit vertical migration of cadmium. However, it should be noted that speciation analysis of cadmium was not performed during the laboratory analysis of samples collected from the Building 4343 study area.

No groundwater was encountered in the unconsolidated soil (to a depth of 60 ft bgs). However, the migration potential of cadmium was evaluated by comparison to the conservative, default SSL soil transfer to groundwater value of 27 mg/kg. Three subsurface cadmium concentrations [B43SB22A (57.1 mg/kg), B43SB14A (191 mg/kg) and B43SB35B (37.7 mg/kg)] exceeded this number, indicating that the vertical migration of cadmium to a potential deep bedrock aquifer is

very limited. Therefore, cadmium contamination of groundwater has a low probability at this site.

Although some transport of cadmium may occur as stormwater runoff, the physical data suggests that cadmium is being transported primarily through mass transport (soil erosion). Cadmium distribution data suggest that cadmium is precipitated to surface soil from the outfall of the process water drainage ditch and transported by soil erosion downslope in the confines of the ditch. It is possible that acid rain might cause the cadmium to mobilize as a dissolved metal. Due to the limited vertical migration, it is unlikely that cadmium would migrate to a deep bedrock aquifer potentially present under the site and therefore, would not be expected to impact groundwater.

5.2.4 Chromium

Chromium (Cr) was detected above the chromium VI residential screening level (23 mg/kg) and background concentrations (65.3 mg/kg) in 14 soil samples at concentrations ranging from 69.8 mg/kg (B23SB24A from 2-4 ft bgs) to 1,820 mg/kg (B43SSD1 from 0-1 ft bgs). Chromium was also detected above industrial screening levels in both sludge samples collected from the interior and outside sumps, indicating that its presence in soil samples is due to site activities. Because chromium was not speciated during analysis, the screening level for chromium VI was applied as a conservative measure. The USEPA Region III Residential RBC for chromium III is 120,000 mg/kg. No samples contained concentrations of chromium that exceeded the chromium III USEPA Region III Residential RBC.

Chromium exists in two valence states in the environment: trivalent (Cr III) or hexavalent (Cr VI). Typically, Cr (III) in an aqueous environment would be associated with particles, while Cr (VI) would remain in solution. Cr (III), a positively charged particle, is the most thermodynamically stable form of chromium under common environmental conditions. Trivalent chromium has a strong tendency to sorb to negatively charged soil particles. As a result, Cr (III) is generally immobile and remains close to the origin of deposition. In addition, adsorption of Cr (III) will occur at slightly acidic soil pHs. Cr (VI) is also positively charged, however, it commonly occurs in the environment within negatively charged compounds: chromate (CrO_4^{-2}) and dichromate (CrO_7^{-2}). Negatively charged chromium compounds are less likely to sorb to soil because soil particles are negatively charged (USEPA, 1997e). As a result, Cr (VI) tends to be mobile in the environment. Cr (VI) that does sorb to soil will likely be reduced to Cr (III) by organic matter (USEPA, 1998b). As previously stated, site surface soil ranges in pH from 5.03 to 7.4, with a mean pH of 6.2 (slightly acidic). Mobility of chromium is further inhibited and adsorption increased by soil with high clay content such as the soil found at the site. The fate of chromium in the soil would be very similar to cadmium. Although chromium was not used in the plating process, metal parts that may have contained chromium would have been subjected to acid baths for cleaning prior to cadmium plating. This process would be the probable source of chromium in the plating process water.

Evaluation of the physical data and the lack of chromium detections in surface and subsurface soil **(Figures 4-7 and 4-8)** indicate limited mobility (within the top 4 ft bgs) of chromium at the Building 4343 study area.

5.2.5 Copper

Copper (Cu) was detected above the residential screening level (310 mg/kg) and established background concentration (53.5 mg/kg; IT, 2001) in one surface soil sample (B43SSD1) at a concentration of 677 mg/kg. This surface soil sample is located slightly downslope of the

process water outfall at the head of the process water drainage ditch. There are no specific past disposal activities and no identified nearby sources that could be associated with the presence of Cu at the site. Therefore, the primary source of copper identified soil at Building 4343 is natural, with some contribution from laboratory waste streams.

Copper is strongly sorbed by soil particles (e.g., clays, metal oxides, and organic matter). Copper binds to soil much more strongly than other divalent cations, and the distribution of copper in the soil solution is less affected by pH than other metals (Gerritse and Van Driel, 1984). The slightly acidic soil condition prevalent at Building 4343 favors the solubility of Cu, thereby, promoting its mobility. The adsorption of Cu generally increases with increasing pH. Like other heavy metals, the movement of Cu in soil is also influenced by the permeability of the soil and the amount of clay, lime, and hydrous iron oxides present. These factors tend to attenuate the mobility of Cu through adsorption and cation exchange.

Volatilization of copper happens to a slight degree, but is insignificant relative to other processes that aid in the reduction of copper concentrations. It sorbs significantly to suspended to organic materials and bed sediments, thus reducing its mobility. Much of copper discharged to waterways is in particulate matter and settles out, precipitates out, or adsorbs to organic matter, hydrous iron and manganese oxides, and clay in sediment or in the water column. A significant fraction of the copper is adsorbed within the first hour, and in most cases, equilibrium is obtained with 24 hours (Harrison and Bishop, 1984).

5.2.6 Iron

Iron (Fe) was detected above the residential (2,300 mg/kg) and industrial screening (31,000 mg/kg) level in seven soil samples at a maximum concentration of 99,100 mg/kg. The established background value for iron is 50,962 mg/kg (IT, 2001). Elevated iron concentrations are present surrounding the northeast corner of Building 4343 (location of former lead catch tank), adjacent to the head of the process water ditch, and the intersection where the underground galvanized process water pipe from the former lead catch tank joins the terra cotta pipe leading from the outside sump. With the exception of surface soil sample B43SSB10, iron concentrations exceeding the residential screening criteria are present in subsurface soil samples (greater than 2 ft bgs). This is likely due to migration of the iron released to the surface (from rusting infrastructure, natural sources, etc.) to the subsurface via infiltration during rain events.

Corrosion (chemical and biological) of equipment utilized during the cadmium plating process (e.g., former lead catch tank) is the primary environmental degradation process for iron at Building 4343. Corrosion 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 anodic reaction (also referred to as oxidation reaction) involves the production of electrons, an increase in the valence state of iron, or the conversion of the metal to its ion.

$$Fe(solid) \rightarrow Fe^{2+} + 2e^{-}$$

In the above equation, the iron atom has been transformed into an ion and two electrons are released.

At the cathode, electrons are consumed to complete the corrosion process. This is usually the rate-controlling step, and it can occur in a variety of ways. The most common cathodic (reduction) reactions are the following:

Oxygen reduction

$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$ (neutral or basic solutions)
$O_2 + 2H_2O + 2e^- \rightarrow 2OH^- + H_2O_2$ (neutral or basic solutions)
$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ (acidic solutions)

Hydrogen evolution

$2H^+ + 2e^- \rightarrow H_2$
$2H_3O^+ + 2e^- \rightarrow H_2 + 2H_2O$

Metal ion reduction

$Fe^{3+} + e^- \rightarrow Fe^{2+}$

Metal deposition

$Fe^{2+} + 2e^- \rightarrow Fe$

Hydrogen evolution and oxygen reduction are the more common cathodic reactions in the environment where an aqueous medium (acidic, basic or neutral) and air (oxygen) are often present.

The anodic and cathodic reactions occur simultaneously and at the same rate in terms of electron activity such that the iron metal does not become electrically charged. Thus, in the presence of oxygen and water molecules, iron would undergo an electrochemical reaction to produce ferrous hydroxide as follows:

$$2Fe + 2H_2O + O_2 \rightarrow 2Fe^{2+} + 4OH^- \rightarrow 2Fe(OH)_2$$

Ferrous hydroxide would precipitate from solution at elevated pH; but in the presence of oxygen and water, ferrous hydroxide is unstable and would readily oxidize to the ferric salt (rust).

$$2Fe(OH)_2 + H_2O + \tfrac{1}{2}O_2 \rightarrow 2Fe(OH)_3$$

The locations of anodes and cathodes on a metal surface area can be a grain size apart. The surface characteristics and oxygen availability vary slightly from one grain to another. At a given time, therefore, some of the grains would act as anodes while others would act as cathodes. This condition may be reversed a fraction of a second later. This changing anodic and cathodic sites explains the occurrence of uniform corrosion over an entire area. Thus, when a piece of iron encounters a low pH environment, such as the soil at Building 4343, the metal would tend to dissolve uniformly over its entire surface, the surface would become thinner, and would eventually fail.

On the other hand, when anodic and cathodic reaction sites are permanently separated either microscopically or macroscopically, localized corrosion is said to occur. Localized corrosion has been identified as a reliable signature for the occurrence of biocorrosion. Localized corrosion can be caused by a microbial colony that creates a differential oxygen availability. Pitting corrosion is an intense form of localized corrosion, which occurs when discrete sites on a surface undergo rapid attack, causing the formation of holes in the metal. The area under the microbial colony (area with the lowest oxygen availability) becomes the anode, while the area outside the

deposit acts as the cathode. In general, biological activity that enhances or restricts either the anodic or cathodic reactions or permanently separates the reaction sites will promote corrosion.

Evaluation of the physical data and the lack of iron detections in surface soil indicate that iron is undergoing corrosion reactions at the Building 4343 study area. Iron is migrating from the surface to the subsurface where it is not anticipated to impact human health or ecological receptors.

5.2.7 Lead

Lead (Pb) was detected above its residential comparison criterion value of 400 mg/kg (USEPA, 1999a) in one surface soil (B43SSD1) sample collected at the outfall of the process water ditch. In addition, lead was detected above the industrial screening criterion (750 mg/kg) in the sludge sample collected from the interior sump that drains to the process water drainage ditch, indicating that its presence may be due to site activities. Lead was not used in the plating process and is most likely associated with the lead-lined catch tank where acidic process water was stored and treated. The residential comparison criterion for lead was not exceeded in the subsurface samples collected from the site **(Figure 4-9)**.

The most common form of lead found in nature is Pb^{+2}, although lead also exists to a lesser extent as Pb^{+4} and in the organic form with up to four Pb-carbon bonds (USEPA, 1997e). Most lead deposited on surface soil is retained and eventually becomes mixed into the surface layer. The migration of lead in the subsurface environment is controlled by the solubility of lead complexes and adsorption to aquifer materials (USEPA, 1997e). Adsorption to soil greatly limits the mobility of lead in the environment. Lead may be immobilized by ion exchange with hydrous oxides or clays or by chelation with humic or fulvic acids (USEPA, 1997e) in the soil at the Building 4343 study area.

Adsorption of lead increases with increasing pH with most lead precipitating out at a pH greater than 6 (USEPA, 1990). The pH of the surface soil where lead was detected above its industrial screening level (B43SSD1) is 7.1. The soil at this sample location consists of silt and clay. Lead was not detected in adjacent surface/subsurface soil samples indicating that lead is not migrating further into the environment.

Based on the relatively few detections of lead in surface soil **(Figure 4-8)** and the lack of lead detections in subsurface soil **(Figure 4-9)**, it appears that lead is forming insoluble compounds and adsorbing to surface soil, which limits its mobility. In addition, the lead detected in the sludge is contained within a separate concrete sump and is prevented from migration into the surrounding soil.

5.2.8 Vanadium

Vanadium (V) was detected in eight soil samples above its residential screening level of 55 mg/kg and background concentration of 108 mg/kg (IT, 2001). These exceedances occurred in one surface soil sample (B43SSB10), where the detected concentration was equal to the vanadium background screening level, and seven subsurface soil samples (B43SB19A through B43SB25A) located on the northeast corner of Building 4343 and near the outfall of the process water drainage ditch. Review of the data indicates that, with the exception of subsurface soil sample B43SB24A, vanadium exceedances were collocated with iron exceedances at the site. These samples were collected from the subsurface (2-4 ft bgs). Vanadium was not used in the plating process and is not likely associated with site activities. The industrial screening level for vanadium was not exceeded in site samples.

The behavior of vanadium in soil is not yet fully understood (Mermut et al., 1996). The mobility of vanadium in soil is affected by the pH of the soil (ATSDR, 1992). Vanadium is fairly mobile in neutral or alkaline soil relative to other metals, but its mobility decreases in acidic soil (ATSDR, 1992). In the presence of humic acids, mobile metavanadate anions can be converted to the immobile vanadyl cations resulting in local accumulation of vanadium (ATSDR, 1992). Under oxidizing, unsaturated conditions some mobility is observed, but under reducing, saturated conditions vanadium is immobile (ATSDR, 1992). Vanadium may be important in soil with high iron oxides and soil experiencing redox reactions, as this element has four oxidation states (Mermut et al., 1996). It occurs in iron oxides and is also adsorbed by silicate clay materials (Mermut et al., 1996). Clay soil studied has more vanadium than other soil (Mermut et al., 1996). When mafic rocks weather in a humid climate, the vanadium remains in the trivalent state or is weakly oxidized to the relatively insoluble tetravalent state (Hilliard, 1992). In either case, the vanadium is captured along with aluminum in the residual clays (Hilliard, 1992). Subsequent leaching of the clays can produce bauxite and lateritic iron ores that contain 400 to 500 parts per million (ppm) vanadium (Hilliard, 1992). When mafic rocks are intensely oxidized in an arid climate, some of the vanadium is converted to the pentavalent state (Hilliard, 1992). The pentavalent cation is considerably more soluble than the trivalent cation, is readily dissolved by groundwater, and can be transported over long distances (Hilliard, 1992).

6.0 HUMAN HEALTH RISK ASSESSMENT

The HHRA has been prepared to evaluate the probability and magnitude of potential adverse effects on human health associated with actual or potential exposure to site-related chemicals at Building 4343.

The HHRA is consistent with Section 300.430(d)(4) of the National Contingency Plan (NCP), which directs that a HHRA be conducted "to characterize the current and potential threats to human health and the environment that may be posed by contaminants migrating to groundwater or surface water, releasing to air, leaching through soil, remaining in the soil, and bioaccumulating in the food chain." This section of the NCP was applied to the HHRA in which human health effects associated with site-related chemicals in surface soil and subsurface soil were evaluated. This HHRA is consistent with USEPA guidance and standards (USEPA, 1986a,b; 1989; 1991a,b; 1992b,c,d; 1995a,b; 1997b,c; 1998a; 2001a,b,d; 2003a,b). In addition, site-specific guidance was applied, as appropriate. This guidance included the *RFAAP Final Master Work Plan* (URS, 2003) and the *RFAAP Site Screening Process* (USEPA, 2001c). The exposure media and exposure pathways that will be quantitatively evaluated in the HHRA are summarized in **Table 6-1**.

The HHRA is organized as follows:

- Data Summary and Selection of COPCs (*Section 6.1*). The chemicals detected in environmental media are identified and discussed. The data are summarized by presenting the frequency of detection and the range of detected concentrations in site-related samples, and the concentrations in background samples. In addition, COPCs are selected for quantitative evaluation in the HHRA based on a review of the data and a comparison to appropriate screening levels.
- Human Health Exposure Assessment (*Section 6.2*). The potential pathways by which individuals may be exposed to COPCs are discussed, and exposure pathways are selected for further evaluation. The chemical concentrations at the points of potential exposure are presented for each complete exposure pathway. Standard exposure factors and health-protective assumptions are used to assess the magnitude, frequency, and duration of exposure for each pathway, and potential exposures (intakes) are then estimated.
- Human Health Toxicity Assessment (*Section 6.3*). The potential toxicity of chemicals to humans and the chemical-specific health effects criteria to be used in the quantitative assessment are presented.
- Human Health Risk Characterization (*Section 6.4*). Quantitative risk estimates are calculated for each complete exposure pathway by combining the toxicity criteria with estimated intakes of potentially exposed individuals.
- Uncertainties in the HHRA (*Section 6.5*). Major sources of uncertainty in the HHRA are discussed.
- HHRA Summary (*Section 6.6*). The HHRA is briefly summarized.

Table 6-1
Selection of Exposure Pathways

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Groundwater	Groundwater	Building 4343	None	None	None	On-site	None	Groundwater is being addressed under MWP Work Plan Addendum 009, "Horseshoe Area Groundwater Study" (IT, 2002b).
	Total Soil (Surface and Subsurface)	Total Soil (Surface and Subsurface)	Building 4343	None	None	None	On-site	None	Current excavation or construction activities are not occurring at Building 4343.
	Sludge	Sludge	Two sumps in Building 4343	None	None	None	On-site	None	There is currently no exposure to the sumps.
Current and Future	Surface Soil	Surface Soil	Building 4343	Maintenance Worker	Adult	Ingestion	On-site	Quant	Maintenance workers could contact surface soil at Building 4343 and be exposed to COPCs via incidental ingestion.
						Dermal	On-site	Quant	Maintenance workers could contact surface soil at Building 4343 and be exposed to COPCs via dermal absorption.
				Trespasser	Adolescent	Ingestion	On-site	None	Due to security at the Installation, trespasser exposures are unlikely. However, the maintenance worker scenario would be protective of the limited exposures that would be experienced by a trespasser.
						Dermal	On-site	None	Due to security at the Installation, trespasser exposures are unlikely. However, the maintenance worker scenario would be protective of the limited exposures that would be experienced by a trespasser.
		Air	Building 4343	Maintenance Worker	Adult	Inhalation	On-site	Quant	Maintenance workers could be exposed to airborne volatiles or particulate matter released from surface soil at Building 4343.
				Trespasser	Adolescent	Inhalation	On-site	None	Due to security at the Installation, trespasser exposures are unlikely. However, the maintenance worker scenario would be protective of the limited exposures that would be experienced by a trespasser.
Future	Total Soil (Surface and Subsurface)	Total Soil (Surface and Subsurface)	Building 4343	Maintenance Worker	Adult	Ingestion	On-site	Quant	Maintenance workers could contact soil at Building 4343 and be exposed to COPCs via incidental ingestion.
						Dermal	On-site	Quant	Maintenance workers could contact soil at Building 4343 and be exposed to COPCs via dermal absorption.
				Excavation Worker	Adult	Ingestion	On-site	Quant	Excavation workers could contact soil at Building 4343 and be exposed to COPCs via incidental ingestion.
						Dermal	On-site	Quant	Excavation workers could contact soil at Building 4343 and be exposed to COPCs via dermal absorption.
				Resident	Adult	Ingestion	On-site	Quant	If the Building 4343 site were to be further developed for residential purposes, residents could be exposed to COPCs in total soil via ingestion. The residential scenario is not considered to be a reasonably anticipated land use; however, it is being included in this evaluation to meet "clean closure" requirements under RCRA.
						Dermal	On-site	Quant	If the Building 4343 site were to be further developed for residential purposes, residents could be exposed to COPCs in total soil via dermal absorption.
					Child	Ingestion	On-site	Quant	If the Building 4343 site were to be further developed for residential purposes, residents could be exposed to COPCs in total soil via ingestion. The residential scenario is not considered to be a reasonably anticipated land use; however, it is being included in this evaluation to meet "clean closure" requirements under RCRA.
						Dermal	On-site	Quant	If the Building 4343 site were to be further developed for residential purposes, residents could be exposed to COPCs in total soil via dermal absorption.

Table 6-1
Selection of Exposure Pathways

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future (con't)	Total Soil (Surface and Subsurface) (con't)	Total Soil (Surface and Subsurface) (con't)		Trespasser	Adolescent	Ingestion	On-site	None	Given the industrial nature of the site, trespasser exposures are unlikely. However, the maintenance worker scenario would be protective of the limited exposures that would be experienced by a trespasser.
	(con't)					Dermal	On-site	None	Given the industrial nature of the site, trespasser exposures are unlikely. However, the maintenance worker scenario would be protective of the limited exposures that would be experienced by a trespasser.
		Air	Building 4343	Maintenance Worker	Adult	Inhalation	On-site	Quant	Maintenance workers could be exposed to airborne volatiles or particulate matter released from soils at Building 4343.
				Excavation Worker	Adult	Inhalation	On-site	Quant	Excavation workers could be exposed to airborne volatiles or particulate matter released from soils at Building 4343.
				Resident	Adult	Inhalation	On-site	Quant	If the Building 4343 site were to be further developed for residential purposes, residents could be exposed to airborne volatiles or particulate matter released from total soil.
					Child	Inhalation	On-site	Quant	If the Building 4343 site were to be further developed for residential purposes, residents could be exposed to airborne volatiles or particulate matter released from total soil.
				Trespasser	Adolescent	Inhalation	On-site	None	Given the industrial nature of the site, trespasser exposures are unlikely. However, the maintenance worker scenario would be protective of the limited exposures that would be experienced by a trespasser.
	Sludge	Sludge	Two sumps in Building 4343	Maintenance Worker	Adult	None	On-site	None	Maintenance workers would not be expected to have constant exposures to the sumps. Exposures to sludge could not be quantified for this receptor.
				Excavation Worker	Adult	None	On-site	None	Excavation workers would not be expected to have constant exposures to the sumps. Exposures to sludge could not be quantified for this receptor.
				Resident	Adult	None	On-site	None	If the Building 4343 site were to be further developed for residential purposes, it is likely that the building would be removed. There would be no exposures to the sludge from the sumps.
					Child	None	On-site	None	If the Building 4343 site were to be further developed for residential purposes, it is likely that the building would be removed. There would be no exposures to the sludge from the sumps.

6.1 Data Summary and Selection of COPCs

This section of the HHRA discusses the methodologies used to summarize the data for the HHRA (*Section 6.1.1*) and to select COPCs for detailed evaluation in the HHRA (*Section 6.1.2*). The summarization of data and selection of human health COPCs are then presented for the sampled medium at Building 4343 in *Section 6.1.3*. Finally, a summary of the COPCs selected in each medium is provided in *Section 6.1.4*.

6.1.1 Methodology for Data Summary

The first step of the HHRA process was to summarize the analytical data collected at Building 4343. Detailed discussions of the QA/QC activities implemented during the collection of the data are provided in **Appendix A-2**.

The following steps, which are in accordance with USEPA (1989) guidance, were used to summarize the analytical data for this HHRA:

- Analytical data collected between May 1999 through October 1999 and July 2002 were summarized by environmental medium (i.e., surface soil and total soil). Surface soil was defined as soil samples that were collected between 0 to 2 ft bgs. Total soil consisted of surface soil and subsurface soil, assuming that soil would mix as a result of potential disturbance (e.g., excavation, construction) in the future. Subsurface soil samples used in the HHRA were collected between 2 to 10 ft bgs. In addition, the samples were divided into groups that describe conditions relevant to potential exposure by receptors or were pertinent to site environmental factors. The sample groupings used in the HHRA are described in the sections below.

  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, 1995c; 2000b), it cannot be unequivocally stated that the report result is not “non-detected” at that concentration. Therefore, B-qualified data are typically eliminated from the data set.

  Data sets for this HHRA were evaluated for B-qualified data on an “analyte-by-analyte” basis. Because of the amount of B-qualified data reported for some analytes, one-half of the sample quantitation limit (SQL) was used as a proxy value for B-qualified data points to address potential uncertainty associated with eliminating these data. If the proportion of B-qualified results in the data set for Building 4343 was greater than 50 percent, one-half of the SQL was used to represent the concentration. If the proportion of B-qualified results in the data set was less than 50 percent, the B-qualified data for the analyte were eliminated.

- Data that were considered estimated values (e.g., J-qualified) were used in the HHRA without modification.

- Arithmetic mean chemical concentrations were calculated by averaging the detected concentrations with one-half the sample quantitation limit of non-detects. One-half of the SQL is typically used in assessments (USEPA, 1989) when averaging non-detect

concentrations, because the actual value can be between zero and a value just below the SQL. In accordance with USEPA Region III guidance (USEPA, 1995c), this procedure was used even when the non-detect SQL was two or more times higher than the maximum detected concentration in that medium. The uncertainties associated with this methodology will be discussed in *Section 6.5*.

- Data from duplicate samples were averaged together and treated as one result. If a chemical was detected in one of two duplicate samples, one-half of the SQL was used for the non-detected value and averaged together with the detected result.
- Frequency of detection was calculated as the number of samples in which the chemical was detected over the total number of samples analyzed. The frequency of detection was assessed after the exclusion of B-qualified data, and after the treatment of duplicate sample data. Because samples were sometimes analyzed for different sets of analytes, the frequencies of detection varied by analyte. Frequency of detection, however, was generally not used as a selection criterion for COPCs in this HHRA.
- If a constituent was analyzed by two different methods, results from the more sensitive analytical method were generally 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.

6.1.2 Methodology for Selection of COPCs for Human Health

Once the sampling data for Building 4343 were grouped and summarized, COPCs for the HHRA were selected. The purpose of selecting COPCs is to identify those chemicals that are present as a result of past activities at the site and most likely to be of concern to human health. Therefore, the screening process eliminates from the HHRA:

- those chemicals present in surface soil and total soil at concentrations below conservative health-based screening levels, represented by the USEPA Region III RBCs corresponding to a carcinogenic risk of $1x10^{-6}$ or adjusted to reflect one-tenth (0.1) of the HI for noncarcinogenic effects (USEPA, 2003a);
- those chemicals below background concentrations (inorganics); and,
- those chemicals that are essential human nutrients and unlikely to pose risks to human health.

The following methodologies were used to eliminate chemicals detected at maximum concentrations below screening levels from quantitative evaluation in the HHRA, and to compare inorganic chemicals detected above screening levels to background concentrations. The RBCs used for this HHRA are presented in **Table 6-2**.

6.1.2.1 Comparison of Detected Chemicals to Relevant Health-Based Levels

The maximum concentrations of detected chemicals were compared to RBCs (USEPA, 2003a), in accordance with Region III guidance. The RBCs presented in the USEPA Region III RBC table are health-protective chemical concentrations that are back-calculated using conservative exposure parameters and either carcinogenic toxicity criteria and a $1x10^{-6}$ target risk level, or noncarcinogenic toxicity criteria and an HI of 1.0 (whichever results in a lower RBC).

Table 6-2
USEPA Region III RBCs for Chemicals Detected at Building 4343

Chemical	USEPA Region III RBC (a) Residential Soil (organics - mg/kg; inorganics - mg/kg)
Organics	
Acenaphthylene (b)	2.3E+02
Anthracene	2.3E+03
Aroclor 1254	1.6E-01
Benz(a)anthracene	8.7E-01
Benzo(a)pyrene	8.7E-02
Benzo(b)fluoranthene	8.7E-01
Benzo(g,h,i)perylene (b)	2.3E+02
Benzo(k)fluoranthene	8.7E+00
Chrysene	8.7E+01
4,4'-DDD	2.7E+00
4,4'-DDT	1.9E+00
Dibenz(a,h)anthracene	8.7E-02
Endosulfan II (c)	4.7E+01
Endrin	2.3E+00
Endrin aldehyde (d)	2.3E+00
Fluoranthene	3.1E+02
Fluorene	3.1E+02
Indeno(1,2,3-c,d)pyrene	8.7E-01
Methoxychlor	3.9E+01
2-Methylnaphthalene	1.6E+02
Naphthalene	1.6E+02
Phenanthrene (b)	2.3E+02
Pyrene	2.3E+02
Total Organic Carbon	NRA
Inorganics	
Aluminum	7.8E+03
Antimony	3.1E+00
Arsenic	4.3E-01
Barium	5.5E+02
Beryllium	1.6E+01
Cadmium (e)	3.9E+00
Calcium (f)	1.0E+06
Chromium (g)	2.3E+01
Cobalt	1.6E+02
Copper	3.1E+02
Cyanide (h)	1.6E+02
Iron	2.3E+03
Lead (i)	4.0E+02
Magnesium (f)	1.0E+06
Manganese (j)	1.6E+02
Mercury (k)	2.3E+00

Table 6-2
USEPA Region III RBCs for Chemicals Detected at Building 4343 (Continued)

Chemical	USEPA Region III RBC (a) Residential Soil (organics - mg/kg; inorganics - mg/kg)
Nickel	1.6E+02
Potassium (f)	1.0E+06
Selenium	3.9E+01
Silver	3.9E+01
Sodium (f)	1.0E+06
Thallium	5.5E-01
Vanadium	5.5E+01
Zinc	2.3E+03

(a) USEPA Region III residential soil RBCs are used as screening values for soil (USEPA, 2003a). RBCs for noncarcinogenic chemicals are conservatively based on a hazard quotient of 0.1, following USEPA Region III guidance.

(b) The RBC for pyrene was used for non-carcinogenic polynuclear aromatic hydrocarbons (PAHs) lacking RBCs.

(c) The RBC for endosulfan was used.

(d) The RBC for endrin was used.

(e) The residential soil RBC for cadmium (water) was used because it is a more conservative value.

(f) Value is an allowable daily intake (ADI) level for essential human nutrients.

(g) The RBC for chromium VI was used, although not all of the chromium at the site will be in this form.

(h) The RBC for free cyanide was used.

(i) Because lead does not have an RBC, the 400 mg/kg residential screening level (USEPA, 1994a) was used for soil.

(j) The RBC for non-food was used.

(k) The RBC for mercury chloride was used.

NRA = No RBC Available.

For the purposes of this HHRA, RBCs that were back-calculated using carcinogenic toxicity criteria were used directly as screening criteria, whereas RBCs that were back-calculated using noncarcinogenic toxicity criteria were adjusted downward by a factor of 10 in order to add a ten-fold measure of safety (i.e., to ensure that compounds that could combine to result in an HI greater than 1 for a specific target organ/critical effect were not eliminated from the assessment). If the maximum detected on-site chemical concentration was less than the RBC (or adjusted RBC for noncarcinogenic chemicals), the excess probability of developing cancer would be less than 1 in 1 million, and adverse noncarcinogenic effects would not be expected to occur. As a result, those chemicals detected at levels greater than RBCs (or adjusted RBCs) were retained for evaluation.

Although current and future land-uses at Building 4343 are most likely to be industrial in nature (see *Section 6.2*), residential (rather than industrial) soil RBCs were used for comparisons to soil concentrations. Because the resident scenario was evaluated for this HHRA, residential soil RBCs were used to screen chemicals in soil as a conservative measure.

RBCs are not available for lead. For screening purposes, however, the maximum detected lead concentrations in soil were conservatively compared to USEPA's residential soil screening level

of 400 mg/kg (USEPA, 1994a). Per 40 CFR 745, the lead concentration of 400 mg/kg applies to areas where children play. Lead was selected for further evaluation in the HHRA where maximum detected concentrations of lead exceeded the screening level.

6.1.2.2 Comparison of Essential Human Nutrients to Allowable Daily Intakes

The maximum concentrations of the four essential human nutrients that do not have RBCs (i.e., calcium, magnesium, potassium, and sodium) were compared to dietary Allowable Daily Intakes (ADIs). As recommended in both the *Site Screening Process* (USEPA, 2001c) and the *Final Master Work Plan* (URS, 2003) the essential nutrients calcium, magnesium, potassium and sodium were eliminated as COPCs.

6.1.2.3 Comparison of Inorganic Compounds to Background Levels

Inorganic chemicals detected at concentrations exceeding RBCs and ADIs were compared to background data contained in the Facility-Wide Background Study Report (FWBSR) (IT, 2001) to assess whether these chemicals were present at concentrations below naturally occurring levels. For the HHRA, the evaluation of site concentrations to background concentrations was achieved using two methods of comparison. First, the maximum detected concentration for each inorganic constituent was compared to the background UTL, as established in the FWBSR. A brief description of background determination is provided in *Section 2.4* and the background UTLs are presented in **Table 2-2**. A detailed discussion can be found in the FWBSR (IT, 2001).

The second method involved the statistical comparison of site concentrations to background concentrations to evaluate whether the populations were similar. This approach paralleled the methodology applied to population comparisons for the FWBSR. Chemicals with data sets containing non-detects at a frequency less than 80 percent were first evaluated to assess whether data were normally distributed. The site data sets and background data sets were tested individually. The Shapiro-Wilk test was used for data sets with sample sizes less than or equal to 50. The Shapiro-Francia test was used for data sets with sample sizes greater than 50. If these tests indicated that the data sets did not follow a normal distribution, data points were log-transformed and the tests were used to assess whether the data were lognormally distributed.

When onsite and background data for a particular compound were found to follow a normal distribution, the F-test was applied to assess whether there was a statistical difference between the variances of the two groups. When data from both the site and background data sets were log-normally distributed, the F-test was applied to log-transformed data.

Results from the F-test were used to identify whether a t-test would be conducted. For example, when the variances were found to be similar, the t-test was calculated using equal variances. Conversely, the nonparametric Mann-Whitney U test was used when the F-test demonstrated that the variances between the data sets were not similar.

The t-test was used to assess whether the means of the data sets for the site concentrations were similar to or greater than the background concentrations. If the t-test indicated that the means between the two data groups were similar, site concentrations were considered to be within or below background levels. If the t-test indicated that the mean for the site data set was greater than the mean for the background data set, then site concentrations were considered to be above background concentrations.

When site and background data sets had different distributions or did not pass the normal or lognormal distribution test, the Mann-Whitney U test was used to assess whether the medians of

the data sets for the site concentrations were similar or greater than the background concentrations. The Mann-Whitney U test is a nonparametric test that involves ranking the data. This test is not dependent upon the distribution of the data. If the Mann-Whitney U test indicated that the medians between the two data groups were similar, site concentrations were considered to be within or below background levels. If the Mann-Whitney U indicated that the median for the site data set was greater than the mean for the background concentrations, then site concentrations were considered to be above background concentrations.

Based on these evaluations, chemicals were eliminated from further quantitative evaluation if they met both of the following conditions:

- The maximum detected concentration was below the UTL, and
- Based on statistical comparisons, site concentrations are within or below background concentrations.

The results of these analyses are included in **Appendix E-2, Tables 1 through 4**. For surface soil, arsenic exceeded screening criterion, but was shown to be within background concentrations and was eliminated from the quantitative HHRA. For total soil, arsenic and manganese exceeded screening criteria, but were excluded on the basis of background comparisons.

6.1.3 Data Summary and Selection of COPCs for Sampled Media

The following sections describe the environmental samples collected at Building 4343, the sample groupings selected for the HHRA, and the COPCs selected within each of the sample groupings. In addition, the background data obtained from the FWBSR (IT, 2001) for each medium are discussed. Summary tables present chemical data by timeframe, medium, and data grouping and contain parameters such as the range of detected concentrations, location of the maximum detected concentration, frequency of detection, screening criteria, and the 95% UTL of the background concentrations. The tables presenting the summarized data should be referred to for the identification of selected COPCs.

6.1.3.1 Surface Soil

Surface soil samples (i.e., samples collected from the 0 to 2 ft soil interval) included in the HHRA for evaluation are shown in **Table 6-3**. A total of 28 surface soil samples collected between May 1999 through October 1999 and July 2002 at Building 4343 were evaluated in the HHRA. Surface soil samples were analyzed for VOCs, SVOCs, PAHs, pesticides, herbicides, PCBs, TAL metals, cyanide, and explosives. It is noted that sludge samples (B43SL1 and B43SL2 and its duplicate) from two sumps were not included in this HHRA. One sump is located within Building 4343 and one is located just outside the building. These samples were both collected under metal grates. Due to the sample location, it was assumed that the surface soil exposure scenarios in this HHRA would not be representative of exposures to sludge because routine exposure to the sludge would be unlikely. The sludge samples were therefore, excluded from the HHRA. The potential uncertainty of excluding these data is discussed in *Section 6.5*.

Surface soil background samples selected from the FWBSR (IT, 2001) for use in the HHRA are also listed in **Table 6-3**. A total of 28 surface soil background samples were included for use in the HHRA.

Table 6-3
Building 4343 Sample Groupings

SURFACE SOIL			
Building 4343	B43SS01	B43SSB11	B43SSB28
	B43SS02	B43SSB12	B43SSD1
	B43SS03	B43SSB13	B43SSD2
	B43SSB4	B43SSB14	B43SSD3
	B43SSB5	B43SSB15	B43SSD4
	B43SSB6	B43SSB16	B43SSD4D
	B43SSB7	B43SSB17	B43SSD5
	B43SSB8	B43SSB18	B43SSD6
	B43SSB9	B43SB34A	
	B43SSB10	B43SB35A	
Surface Soil Background Samples from FWBSR (IT, 2001)	MMAB1A	MMAW3A	NRUC1A
	MMAB2A	MMAW4A	NRUC2A
	MMAB3A	NRUL1A	NRUC3A
	MMAB4A	NRUL2A	NRUC4A
	MMAU1A	NRUL3A	NRUG1A
	MMAU2A	NRUL4A	NRUG2A
	MMAU3A	NRUW1A	NRUG3A
	MMAU4A	NRUW2A	NRUG4A
	MMAW1A	NRUW3A	
	MMAW2A	NRUW4A	
SUBSURFACE SOIL			
Building 4343	B43SB2A	B43SB15A	B43SB27A
	B43SB3A	B43SB16A	B43SB28A
	B43SB4A	B43SB17A	B43SB28AD
	B43SB5A	B43SB18A	B43SB29A
	B43SB6A	B43SB19A	B43SB30A
	B43SB7A	B43SB20A	B43SB31A
	B43SB7AD	B43SB20AD	B43SB31AD
	B43SB8A	B43SB21A	B43SB32A
	B43SB9A	B43SB22A	B43SB33A
	B43SB10A	B43SB23A	B43SB34B
	B43SB11A	B43SB23AD	B43SB35B
	B43SB12A	B43SB24A	
	B43SB13A	B43SB25A	
	B43SB14A	B43SB26A	
Subsurface Soil Background Samples from FWBSR (IT, 2001)	MMAB1B	MMAW2C	NRUW3B
	MMAB1C	MMAW3B	NRUW3C
	MMAB2B	MMAW3C	NRUW4B
	MMAB3B	MMAW4B	NRUW4C
	MMAB4B	MMAW4C	NRUC1B
	MMAB4C	NRUL1B	NRUC2B
	MMAU1B	NRUL1C	NRUC3B
	MMAU1C	NRUL2B	NRUC4B
	MMAU2B	NRUL2C	NRUC4C
	MMAU2C	NRUL3B	NRUG1B
	MMAU3B	NRUL3C	NRUG1C
	MMAU3C	NRUL4B	NRUG2B
	MMAU4B	NRUL4C	NRUG2C
	MMAU4C	NRUW1B	NRUG3B
	MMAW1B	NRUW1C	NRUG3C
	MMAW1C	NRUW2B	NRUG4B
	MMAW2B	NRUW2C	NRUG4C

Note: Sample numbers that end in "D" are sample duplicates.

Summaries of the ranges of detected concentrations, locations of the maximum detected concentrations, and frequencies of detection of chemicals in the surface soil evaluated in the HHRA are presented in **Appendix E-1, Table E-1a**. Surface soil COPCs were selected by comparing maximum concentrations of detected chemicals to residential soil RBCs and inorganic chemical background concentrations (total soil), and by comparing maximum concentrations of essential human nutrients to ADIs.

As shown in **Appendix E-1, Table E-1a**, 24 inorganics were detected in surface soil at Building 4343. Nine inorganics were detected at concentrations above residential soil RBCs, or other screening criteria, and were selected as COPCs. These inorganics include: aluminum, antimony, cadmium, chromium, copper, iron, lead, manganese, and vanadium. Cyanide was also detected in surface soil, but was not selected as a COPC. Twenty-three organic compounds were detected in surface soil. One PCB (Aroclor-1254) was detected at a concentration above the residential soil RBC and was selected as a COPC.

Chemicals that were not detected in at least one medium have not been included in the HHRA. The detection limits for the non-detected constituents were screened against the RBCs to ensure that the range of detection limits was generally low enough to detect constituents that would exceed RBCs. The maximum detection limits for these constituents were compared to RBCs. For those constituents with RBCs, the maximum detection limits for MCPA, MCPP, 4,6-dinitro-o-cresol, and n-nitroso-di-n-propylamine exceeded RBCs. The results of the screening are included in **Appendix E-1, Table E-1b**.

6.1.3.2 Total Soil

Total soil samples (i.e., surface soil and subsurface soil samples collected from the 0 to 10 ft soil interval) included in the HHRA for evaluation are shown in **Table 6-3**. A total of 28 surface and 39 subsurface soil samples collected between May 1999 through October 1999 and July 2002 at Building 4343 were evaluated in the HHRA. Surface and subsurface soil samples were analyzed for VOCs, SVOCs, PAHs, pesticides, herbicides, PCBs, metals, cyanide, and explosives.

Surface soil and subsurface soil background samples selected from the FWBSR (IT, 2001) for use in the HHRA are also listed in **Table 6-3**. A total of 28 surface soil background samples and 51 subsurface soil background samples were included for use in the HHRA.

Summaries of the ranges of detected concentrations, locations of the maximum detected concentrations, and frequencies of detection of chemicals in total soil evaluated in the HHRA are presented in **Appendix E-1, Table E-2a**. Total soil COPCs were selected by comparing maximum concentrations of detected chemicals to residential soil RBCs and inorganic chemical background concentrations (total soil), and by comparing maximum concentrations of essential human nutrients to ADIs.

As shown in **Appendix E-1, Table E-2a**, 24 inorganics were detected in total soil at Building 4343. Nine inorganics were detected at concentrations above residential soil RBCs, or other screening criteria, and were selected as COPCs. These inorganics include: aluminum, antimony, cadmium, chromium, copper, iron, lead, thallium, and vanadium. Cyanide was also detected in total soil, but was not selected as a COPC. Twenty-three organic compounds were detected. One PCB (Aroclor-1254) was detected at a concentration above the residential soil RBC and was selected as a COPC.

Chemicals that were not detected in at least one medium have not been included in the HHRA. The detection limits for the non-detected constituents were screened against the RBCs to ensure that the range of detection limits was generally low enough to detect constituents that would exceed RBCs. The maximum detection limits for these constituents were compared to RBCs. For those constituents with RBCs, the maximum detection limits for MCPA, MCPP, 4,6-dinitro-cresol, and n-nitroso-di-n-propylamine exceeded RBCs. The results of the screening are included in **Appendix E-1, Table E-2b**.

6.1.4 Summary of Chemicals Selected as COPCs

COPCs selected at Building 4343 are summarized in **Table 6-4**. Contamination at this site is primarily due to inorganics and PCBs in soil.

6.2 Human Health Exposure Assessment

In this section, the potential pathways by which individuals may be exposed to the COPCs in each environmental medium are identified and exposures are quantified. A discussion of potential current and future exposure pathways through which populations could be exposed to chemicals at or originating from Building 4343 is presented in *Section 6.2.1*. For each pathway selected for quantitative evaluation, the chemical concentrations at the points of exposure are estimated (*Section 6.2.2*), and the methodology for calculating potential chemical intakes for each pathway selected for quantitative evaluation is discussed (*Section 6.2.3*).

6.2.1 Potential Human Exposure Pathways

An exposure pathway describes the course a chemical takes from the source to the exposed individual, and is defined by four elements: 1) a source and mechanism of chemical release to the environment; 2) an environmental transport medium (e.g., groundwater) for the released chemical; 3) a point of potential contact with the contaminated medium (referred to as the exposure point); and, 4) an exposure route (e.g., ingestion) at the contact point. An exposure pathway is considered complete when each of the four elements are present. In risk assessments, complete exposure pathways are quantitatively evaluated.

When conducting an exposure assessment, USEPA (1989, 1991b) guidance requires that plausible exposures under both current and future land-use scenarios be evaluated in a HHRA. Accordingly, potential human exposure pathways are identified for current and potential future land-use conditions at Building 4343 in the following sections. The current land-use scenario is based on conditions as they currently exist, while the future land-use scenario evaluates potential risks that may be associated with probable changes in site use, assuming no remedial action occurs.

The potential exposure pathways through which humans could currently be exposed to contamination resulting from past activities at Building 4343 are discussed below. **Table 6-1** presents an exposure pathway analysis for potential current/future land-use conditions, indicating the exposure media, exposure points, potential receptors, and exposure routes. This table also indicates whether a quantitative analysis was conducted for the pathway and the rationale for selection or exclusion of the pathway.

Receptor Characterization. The area around MMA is not highly developed and land use in the vicinity of the facility is mostly rural, with less rugged areas having been primarily used for agriculture. Residential and recreational areas are located adjacent to the Installation (IT, 2001). It is unlikely, however, that land use within MMA will change significantly in the future.

Table 6-4
Summary of Chemicals of Potential Concern

Chemical (a)	Surface Soil	Total Soil
Aluminum	X	X
Antimony	X	X
Arsenic		
Barium		
Beryllium		
Cadmium	X	X
Calcium		
Chromium	X	X
Cobalt		
Copper	X	X
Iron	X	X
Lead	X	X
Magnesium		
Manganese	X	
Mercury (Inorganic)		
Nickel		
Potassium		
Selenium		
Silver		
Sodium		
Thallium		X
Total Cyanide		
Vanadium	X	X
Zinc		
Total Organic Carbon		
4,4'-DDD		
4,4'-DDT		
Endosulfan II		
Endrin		
Endrin aldehyde		
Methoxychlor		
Aroclor 1254	X	X
2-Methylnaphthalene		
Acenaphthylene		
Anthracene		
Benzo(a)anthracene		
Benzo(a)pyrene		
Benzo(b)fluoranthene		
Benzo(g,h,i)perylene		
Benzo(k)fluoranthene		
Chrysene		
Dibenz(a,h)anthracene		
Fluoranthene		
Fluorene		
Indeno(1,2,3-cd)pyrene		
Naphthalene		
Phenanthrene		
Pyrene		

(a) Chemicals detected in soil at Building 4343.
X = Selected as a COPC.

The MMA contains numerous buildings and facilities, and it is likely that the area (including Building 4343) will remain industrial in nature.

Building 4343 is located in an open field and is surrounded by open space. Although there are other buildings down the hill from Building 4343, there are no buildings in the immediate vicinity. There are also no residential areas near the site. An aerial photograph of the surrounding land use is presented in **Appendix F-1, Photo 3**.

Because Building 4343 is not currently in use, maintenance workers are the most likely receptors at the building. If future development occurs, excavation workers could be receptors. Therefore, maintenance worker and excavation worker exposures at Building 4343 were evaluated in the HHRA.

Due to security at the Installation (e.g., strict security at entry gates, guard towers, barbed-wire fences), it is not likely that children would be able to trespass at the Installation. It would also be difficult for an adolescent to trespass at the site. Even if an older adolescent were able to evade security measures, it would be difficult to do so on a routine basis. Therefore, a trespasser scenario was not evaluated. However, hypothetical future exposures to children were considered in the residential scenario described below. The exposure parameters for residents are more conservative than those for children trespassers. Also, the maintenance worker scenario that is being evaluated would be similar to the limited exposure that an adolescent trespasser could experience at the site and would be protective of the trespasser.

Because land use is expected to remain industrial, a residential scenario is not considered to be a reasonably anticipated land use. However, the residential scenario was evaluated to meet "clean closure" requirements under RCRA. Therefore, adult resident and child resident exposures at Building 4343 were evaluated in the HHRA.

Exposure Pathway Identification. The exposure pathways associated with maintenance and excavation workers and residents at Building 4343 were identified based on consideration of the sources and releases of chemicals. The exposure pathways considered for evaluation under current land-use conditions are described below.

Groundwater. Due to the nature of the groundwater system at the Installation, it is difficult to associate specific sites with groundwater exposures. Groundwater at the site is being addressed in MWP Addendum 009, "Horseshoe Area Groundwater Study" (IT, 2002b). Therefore, groundwater exposures were not evaluated in this HHRA.

Surface Soil. Human exposures to chemicals in surface soil could occur by direct contact and subsequent dermal absorption and/or incidental ingestion of COPCs. As a result, maintenance worker exposures to COPCs in surface soil via incidental ingestion and dermal absorption were evaluated under current land-use conditions for the Building 4343. Because current land-use of the site does not include residents, adult and child resident exposures to chemicals in surface soil would not occur. Therefore, residential exposures to chemicals in surface soil were not evaluated under current land-use conditions.

Total Soil. Because ground-intrusive or construction/excavation activities are not currently taking place, potential excavation worker exposures to chemicals in surface and subsurface soil (i.e., total soil) would not occur. In addition, it is not likely that maintenance workers would have the opportunity to be exposed to total soil when on-site; thus, exposures to chemicals in total soil were not evaluated under current land-use conditions. Because current land-use of the

site does not include residents, adult and child resident exposures to chemicals in surface and subsurface soil (i.e., total soil) would not occur. Therefore, residential exposures to chemicals in total soil were not evaluated under current land-use conditions.

Air. Airborne releases of COPCs can occur via the direct volatilization of chemicals and the wind entrainment of chemicals on dust particles. Maintenance workers could potentially be exposed to airborne chemicals released from soil at Building 4343. Excavation worker and residential exposures were not evaluated under current land-use conditions.

Sludge. There is no exposure to the sludge. Because the sumps are below metal grates and not easily accessible, it is assumed that workers would not be exposed to sludge in the sumps on a routine basis. The most likely exposure to sludge would occur during removal of the sumps, which would be a one-time occurrence and should involve the use of PPE, such as gloves, boots, and appropriate clothing.

6.2.1.1 Summary of Potential Exposure Pathways under Current Land-Use Conditions

In summary, the potential exposure pathways that were quantitatively evaluated under current land-use conditions are:

- Incidental ingestion, dermal absorption, and inhalation of chemicals in surface soil at Building 4343 by a maintenance worker.

6.2.1.2 Potential Exposure Pathways under Future Land-Use Conditions

According to USEPA (1995a), a risk assessment evaluating potential future exposures should reflect the most reasonably anticipated future land uses. The potential future exposure pathways through which humans could be exposed to environmental media at Building 4343 are discussed below. **Table 6-1** presents an exposure pathway analysis for potential future land-use conditions, indicating the exposure media, exposure points, potential receptors, and exposure routes. This table also indicates whether a quantitative analysis was conducted for the pathway and the rationale for selection or exclusion of the pathway.

As described in *Section 6.2.1.1,* future land use at Building 4343 is expected to remain industrial. Maintenance workers are considered the most likely receptors to potential contamination at Building 4343. Given the industrial nature of the site, the maintenance worker scenario would be protective of exposures to trespassers. If future development occurs, excavation workers could also be receptors. Assuming that future construction/excavation activities could occur, future maintenance worker and excavation worker exposures to surface and subsurface soil at Building 4343 were evaluated in the HHRA. It is assumed that surface and subsurface soil would mix as a result of these activities. Therefore, future exposures to these sites were evaluated as exposures to total soil.

Although it is unlikely, the site could potentially be used for residential land-use in the future; therefore, hypothetical residential exposures were evaluated.

Groundwater. Due to the nature of the groundwater system at the Installation, it is difficult to associate specific sites with groundwater exposures. Groundwater at the site is being addressed in MWP Addendum 009, "Horseshoe Area Groundwater Study" (IT, 2002b). Therefore, groundwater exposures were not evaluated in this HHRA.

Surface Soil. Maintenance worker exposures to surface soil under future industrial land-use conditions will be the same as those described under current industrial land-use conditions.

Excavation worker exposures to surface soil were not evaluated in the HHRA because excavation worker exposures would involve both surface and subsurface soil (i.e., total soil) that would be mixed during construction/excavation activities. Resident exposures to surface soil were not evaluated in the HHRA because it was assumed that both surface and subsurface soil (i.e., total soil) would have become mixed during construction/excavation activities for the future development area.

Total Soil. Future development at Building 4343 could result in exposures to individuals performing excavation activities via contact with chemicals in total soil. In addition, maintenance workers may contact soil after the site has been disturbed and soil has been dispersed after construction or excavation activities. Therefore, potential incidental ingestion and dermal absorption exposures to chemicals in total soil by maintenance workers and excavation workers were evaluated. Although future residential development of these sites is unlikely, the residential scenario was evaluated for total soil. Hypothetical future residents may contact soil after the site has been developed and soil has been dispersed after construction or excavation activities. Therefore, potential incidental ingestion and dermal absorption exposures to chemicals in total soil by residents were evaluated. (It is assumed that surface and subsurface soil would mix as a result of construction/excavation activities and future exposures to these sites were evaluated as exposures to total soil.)

Air. Airborne releases of COPCs can occur via the direct volatilization of chemicals and the wind entrainment of chemicals on dust particles. Maintenance and excavation workers and residents could potentially be exposed to airborne chemicals released from soil at Building 4343.

Sludge. The sumps are expected to be removed. Therefore, no exposure to the sludge is anticipated in the future.

6.2.1.3 Summary of Potential Exposure Pathways under Future Land-Use Conditions

In summary, the following exposure pathways were selected for quantitative evaluation under future land-use conditions:

- Incidental ingestion, dermal absorption, and inhalation of chemicals in surface soil at Building 4343 by a maintenance worker.
- Incidental ingestion, dermal absorption, and inhalation of chemicals in total soil at Building 4343 by a maintenance worker.
- Incidental ingestion, dermal absorption, and inhalation of chemicals in total soil at Building 4343 by an excavation worker.
- Incidental ingestion, dermal absorption, and inhalation of chemicals in total soil at Building 4343 by a resident (adult and child).

6.2.2 Determination of Exposure Point Concentrations

To evaluate the magnitude of exposures and risks that may be experienced by an individual, the concentration of the COPCs in the exposure medium must be known or estimated. This concentration is referred to as an EPC. The EPCs used in the HHRA are based on the data summarized in *Section 6.1.1*, and were assessed for each of the selected COPCs. EPCs for surface soil and total soil are shown in **Appendix E-1, Tables E-3 and E-4**, respectively.

The approach used to estimate EPCs in the media sampled at Building 4343 follows that recommended by USEPA (1989, 1992b, 2002a) guidance. According to this guidance, the most appropriate measurement of central tendency for exposure to environmental chemical concentrations is the arithmetic mean. To account for uncertainty associated with this value, USEPA guidance requires the use of the 95% upper confidence limit (UCL) on the arithmetic mean concentration for the estimation of the Reasonable Maximum Exposure (RME) risk. The term RME is defined as the maximum exposure that is reasonably expected to occur at a site (USEPA, 1989). The RME concentration of each COPC in each medium was assumed to represent the concentration to which receptors could be exposed at these sites. The exception to this approach was lead. As further described in *Section 6.3.2*, lead was evaluated using a variation of the Integrated Exposure Uptake Biokinetic (IEUBK) Model. Because the IEUBK model is a probabilistic model, the arithmetic mean is used in the quantitative evaluation of lead.

Because of the uncertainty associated with characterizing contamination in environmental media, the 95 percent UCL of the mean has been estimated for chemicals selected as COPCs. In general, outliers are included in the calculation of the UCL because high values in environmental data are seldom true statistical outliers. Inclusion of outliers increases the overall conservatism of the risk estimate, and the likelihood of rejecting the null hypothesis (i.e., there are no chemical stressors at the site).

Data sets have been tested for normality and lognormality based on the Shapiro-Wilk test (USEPA, 1992b). Statistical analysis has been performed on chemicals selected as COPCs. If statistical tests support the assumption that the data set is normally distributed, the UCL for a normal distribution is calculated. If the statistical analysis shows the data to be lognormally distributed, the UCL is calculated for a lognormal distribution. It should be noted that the designation of normal or lognormal data distributions also included data sets that were "close" to their respective categorizations, i.e., within 5 percent of being categorized as normal or lognormal, using the Shapiro-Wilk test criterion. This is a conservative approach, especially for those data sets that are close to being lognormal, as the lognormal UCL equation (Gilbert, 1987) generally overestimates the UCL, compared with the alternative bootstrap method. If a data set passed both the normal and lognormal distribution tests, the distribution with the best fit (i.e., distribution with the value that is closest to the critical value) is selected.

The UCL is calculated for a normal distribution as follows (USEPA, 1992b):

$$UCL = \bar{x} + t_{1-\alpha,n-1}\, x\, (s/\sqrt{n})$$

where:

$\bar{x}$ = sample arithmetic mean
t = critical value for student's t distribution
$1-\alpha$ = 0.05 (95 percent confidence limit for a one-tailed test)
n = number of samples in the set
s = sample standard deviation.

The UCL is calculated for a lognormal distribution as follows (Gilbert, 1987):

$$UCL = e^{\left(\bar{y} + (0.5 \bullet s_y^2) + \left[H_{0.95} \bullet \frac{s_y}{(n-1)^{0.5}}\right]\right)}$$

where:

$\bar{y}$ = 3y/n=sample arithmetic mean of the log-transformed data, y = ln x
s_y = sample standard deviation of the log-transformed data
n = number of samples in the data set
$H_{0.95}$ = value for computing the one-sided 95 percent UCL on a lognormal mean from standard statistical tables (Land, 1975).

A nonparametric confidence limit is used when the data set fits neither a normal or a lognormal distribution. The "bootstrap" method (Efron, 1981), a nonparametric method recommended by USEPA for censored data (USEPA, 2002a), was used to calculate 95% UCLs on the arithmetic means for these COPC data. This method, which estimates the UCL by simulation, is a computer-based replacement method for assigning measures of accuracy to statistical estimates. This method does not require assumptions regarding the statistical distribution of the underlying population (Efron, 1981). Bootstrap 95% UCLs were calculated as follows (Efron, 1981; Efron and Tibshirani, 1993):

1. The data set was randomly resampled with replacement;
2. The arithmetic mean of the resampled data set was estimated;
3. Based on guidance from USEPA (2002a), “thousands” of iterations are recommended for the bootstrap method. Therefore, Steps 1 and 2 were performed 5,000 times and a new data set of 5,000 resampled means was created; and,
4. The 95th percentile of the resampled mean data set created during Step 3 was selected. Per Efron and Tibshirani (1993), the 95th percentile of the resampled mean data set is a good approximation to the 95% UCL on the mean of the original data set.

6.2.3 Quantification of Dose Due to Chemical Exposures

This section describes the development of the exposure estimates (chemical doses) that serve as the basis of the risk estimates in *Section 6.4*. To estimate doses, EPCs for each COPC are combined with information describing the extent, frequency, and duration of exposure for each potential receptor of concern. This section presents an overview of the approaches and equations used in quantifying exposures and specific details relevant to each selected exposure pathway. The approaches used to quantify exposures are consistent with guidance provided by USEPA (1989; 1991a; 1992b,c,d, 2001a,b).

Methodology for Deriving Dose Estimates. For the exposure pathways that involve ingestion or dermal contact, quantification of exposure involves the estimation of an average daily dose (ADD), expressed in units of mg chemical/kg body weight per day (mg/kg-day). Dose can be defined as an exposure rate to a chemical assessed over an exposure period per unit body weight, and is calculated similarly for ingestion and dermal absorption pathways. There are, however, significant differences in the meaning and terms used to describe doses for the ingestion pathways as compared to the dermal absorption pathways. For the ingestion exposure pathways, the doses calculated in this assessment are referred to as "potential doses." The potential dose is

the amount of chemical ingested and available for uptake in the body, and is analogous to the administered dose in a dose-response toxicity experiment. For the dermal absorption pathways, the estimated dose is referred to as an "internal dose," and reflects the amount of chemical that has been absorbed into the body and is available for interaction with biologically important tissues.

ADDs are estimated differently for chemicals exhibiting noncarcinogenic and carcinogenic effects, because different toxicity criteria are available for carcinogenic effects and noncarcinogenic effects of chemicals (see *Section 6.3,* Human Health Toxicity Assessment). ADDs for noncarcinogens are averaged over the duration of exposure and, following USEPA (2001a) guidance, are given the acronym ADD for average daily doses. ADDs for carcinogens are averaged over a lifetime, and are given the acronym LADD for lifetime average daily doses.

The ADDs and LADDs are estimated using EPCs of chemicals together with exposure parameters that specifically describe the exposure pathway. ADDs and LADDs for each pathway were derived by combining the selected EPC (based on the maximum or on the 95% UCL on the mean concentration) of each chemical with reasonable maximum values describing the extent, frequency, and duration of exposure (USEPA, 1989; 1992d, 2001a).

The following sections present the equations and exposure parameters used in the HHRA to estimate potential doses ($ADDs_{pot}$ and $LADDs_{pot}$) for ingestion exposures, internal doses ($ADDs_{int}$ and $LADDs_{int}$) for dermal absorption exposures, and ($ADDs_{pot}$ and $LADDs_{pot}$) for inhalation exposures. It was assumed that the chemical concentrations in the media evaluated would remain constant over the exposure period.

The particulate emission factor (PEF) used to calculate the inhalation ADDs and LADDs was calculated based on an equation provided by USEPA (1996a), and is shown below. It should be noted that one of the inputs for calculating the PEF is the Q/C value, which represents both local climatic conditions and the size of the contaminated area. Q/C values are provided by USEPA (1996a) for 29 different cities in the United States and for contaminated areas ranging from 0.5 to 30 acres. For this HHRA, Q/C value representing climatic conditions for Zone VII, Huntington, WV was selected. A site-specific PEF value was calculated to account for the approximate size of the site. Based on a 1-acre site, a Q/C value of 47.24 was selected to represent the Building 4343 study area.

The variable for vegetative cover used to calculate the PEF accounts for the percentage of ground cover (e.g., pavement, gravel, or vegetation) that potentially inhibits the release of VOCs and particulate matter from soil into ambient air. Although the majority of the site is currently covered, the fraction of the vegetative cover was conservatively assumed to be 50 percent to allow for potential changes to site conditions in the future. USEPA's default value was used to represent the mean annual wind speed [4.69 meters/second (m/s)].

Using the following equation and the assumptions described above, a PEF of 6.85 x 10^8 m^3/kg was calculated for Building 4343.

$$PEF = \frac{Q}{C} * \frac{3{,}600 \frac{\text{sec}}{hr}}{0.036 * (1 - V) * \left(\frac{U_m}{U_t}\right)^3 * F(x)}$$

where:

PEF = particulate emission factor (m^3/kg)

$\frac{Q}{C}$ = inverse of the mean concentration at the center of a 1-acre source (equal to 47.24 $g/m^2 \cdot sec$ per kg/m^3) for Climatic Zone VII, Huntington, WV (USEPA, 1996a)

V = fraction of vegetative cover (assumed to be 50 percent, default)

U_m = mean annual windspeed (4.69 m/sec, default)

U_t = equivalent threshold value of windspeed at 7 m (11.32 m/sec, default)

F(x) = function dependent on Um/Ut derived using Cowherd et al. (as cited in USEPA, 1996a)

Current and Future Maintenance Worker Dose Equations and Exposure Parameters for Soil. The potential chemical doses for current and future maintenance worker exposures to surface soil and total soil at Building 4343 were estimated using the equations and exposure parameters presented below. The EPCs used to estimate potential chemical doses for each evaluated medium and data grouping were presented in *Section 6.2.2*, while the calculated LADDs for carcinogenic effects and ADDs for noncarcinogenic effects are presented in the corresponding tables for workers in the *Section 6.4*.

Incidental Ingestion of Soil by Maintenance Workers. The exposure for incidental ingestion of COPCs in soil by workers was calculated using the equation and the exposure parameters presented in **Appendix E-1, Tables E-5 and E-6**. Where relevant, standard adult parameters were used to characterize worker exposures, because most workers are adults (> 18 years of age).

Workers were assumed to be exposed to soil 50 days/year, based on the assumption that maintenance/inspection activities are conducted 1 day/week based on a 5-day work week for 50 weeks/year (workers were assumed to spend 2 weeks a year on vacation/holiday). Duration of exposure for workers was assumed to be 25 years, a USEPA (1991a) upper-bound default estimate of the time spent working in one location. The body weight value used for workers was 70 kg, the standard USEPA (1991a) default value for adult body weight. An averaging time of 70 years was used for carcinogenic COPCs, while 25 years was used for noncarcinogenic COPCs.

The daily soil ingestion rate for workers was assumed to be 100 mg/day, a standard USEPA (2001b) default value for exposure to adults in the workplace. It was conservatively assumed that soil ingested during the workday by workers would originate in the sampled areas; however, most maintenance workers would likely visit other portions of the Installation. Furthermore, it was assumed that the chemical would be totally available for intake into the body rather than bound to the soil.

Dermal Absorption of Chemicals in Soil by Maintenance Workers. The internal dose due to dermal absorption of COPCs in soil by workers was estimated using the equation and the exposure parameters presented in **Appendix E-1, Tables E-5 and E-6**. The parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used for estimating the ingestion of soil by a worker.

Parameters that are specific to the dermal absorption exposure scenario include the area of exposed skin, the amount of soil adhering to the skin, and amount of chemical absorbed through the skin from soil. It was assumed that a worker's head, hands and forearms would be exposed to soil, based on the likelihood that workers at the site will wear long pants but may wear short sleeve shirts. Using data from USEPA (1997c), and averaging across gender and age, it was

estimated that the exposed skin surface area for workers would be 3,300 cm^2. The soil-to-skin adherence factor was assumed to be 0.2 mg/cm^2-event, based on 50^{th} percentile values for similar activities (USEPA, 1997c; 2001b).

The amount of chemical in soil absorbed through the skin must be estimated in order to calculate dermal absorption doses. For a chemical to be absorbed through the skin from soil, it must be released from the soil matrix, pass through the layers of the skin, and enter into the systemic circulation. This series of events is dependent on a number of factors including the characteristics of the chemical, the concentration in the applied dose, the site of exposure, inter-individual variability, and characteristics of soil (e.g., particle size and organic carbon content). Data regarding the amount of specific chemicals that may be absorbed through the skin under conditions normally encountered in the environment (and assumed to occur for this assessment) are lacking. While a number of approaches have been developed to estimate absorption of compounds from the soil matrix, the resulting dose estimates are highly uncertain (USEPA, 1992d, 2001a). Chemical-specific dermal absorption factors were used to estimate absorption of COPCs from soil (USEPA, 2001a). If chemical-specific information was not available, class-specific dermal absorption values were applied (USEPA, 1995b, 2003c). These factors include: arsenic (3.2 percent), cadmium (0.1 percent), other inorganics (1 percent), and PCBs (14 percent).

Inhalation of Particulates from Soil by Maintenance Workers. The exposure for inhalation of COPCs in soil by maintenance workers was calculated using the equation and the exposure parameters presented in **Appendix E-1, Tables E-7 and E-8**. The parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used for estimating the ingestion of soil by a maintenance worker.

The inhalation rate of 2.5 m^3 per hour for maintenance workers was derived by dividing the adult daily rate of 20 m^3/day (USEPA, 1991a) by an 10-hour workday. The exposure time is 8 hours per day. It was conservatively assumed that soil inhaled during the visit would originate in the sampled areas; however, it is unlikely that a worker would spend the entire day at just one location on the Installation every day.

Future Excavation Worker Dose Equations and Exposure Parameters for Soil. The potential chemical doses for future excavation worker exposures to total soil at Building 4343 were estimated using the equations and exposure parameters presented below. The EPCs used to estimate potential chemical doses for each evaluated medium and data grouping were presented in *Section 6.2.2*, while the calculated LADDs for carcinogenic effects and ADDs for noncarcinogenic effects are presented in the corresponding tables in the Risk Characterization section (*Section 6.4*).

Incidental Ingestion of Soil by Excavation Workers. The exposure for incidental ingestion of COPCs in soil by excavation workers was calculated using the equation and the exposure parameters presented in **Appendix E-1, Table E-6**. Excavation workers were assumed to be exposed to soil 250 days/year, a standard USEPA (2001b) default assumption assuming a 5-day work week for 50 weeks/year (workers were assumed to spend 2 weeks a year on vacation). Duration of exposure for excavation workers was assumed to be 1 year, a standard USEPA default (2001b). The body weight value used for excavation workers was 70 kg, the standard USEPA (1991a) default value for adult body weight. An averaging time of 70 years was used for carcinogenic COPCs, while 1 year was used for noncarcinogenic COPCs.

The daily soil ingestion rate for excavation workers was assumed to be 330 mg/day, a standard USEPA (2001b) default value for exposure to construction workers. It was conservatively assumed that soil ingested during the workday by workers would originate in the sampled areas. Furthermore, it was assumed that the chemical would be totally available for intake into the body rather than bound to the soil.

Dermal Absorption of Chemicals in Soil by Excavation Workers. The internal dose due to dermal absorption of COPCs in total soil by excavation workers was estimated using the equation and the exposure parameters presented in **Appendix E-1, Table E-6**. The parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used for estimating the ingestion of soil by an excavation worker.

Parameters that are specific to the dermal absorption exposure scenario include the area of exposed skin, the amount of soil adhering to the skin, and the amount of chemical absorbed through the skin from soil. It was assumed that an excavation worker's head, hands, and forearms would be exposed to soil, based on the likelihood that workers at the site will wear long pants but may wear short sleeve shirts. Using data from USEPA (USEPA Tables 6-2 and 6-3; USEPA, 1997c), and averaging 50^{th} percentile values across gender and age, it was estimated that the exposed skin surface area for excavation workers would be 3,300 cm^2. The soil-to-skin adherence factor was assumed to be 0.3 mg/cm^2-event, based on 50^{th} percentile values for similar activities (USEPA, 2001b).

The amount of chemical in soil absorbed through the skin must be estimated in order to calculate dermal absorption doses. The estimation of absorbed dose is described in the previous section for maintenance worker exposures. Dermal absorption factors (USEPA, 1995b; 2001a; 2003c) were used to estimate absorption of COPCs from soil.

Inhalation of Particulates from Soil by Excavation Workers. The exposure for inhalation of COPCs in total soil by excavation workers was calculated using the equation and the exposure parameters presented in **Appendix E-1, Table E-8**. The parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used for estimating the ingestion of soil by an excavation worker.

The inhalation rate of 2.5 m^3 per hour for excavation workers was derived by dividing the adult daily rate of 20 m^3/day (USEPA, 1991a) by an 10-hour workday. The exposure time is 8 hours per day. It was conservatively assumed that soil inhaled during the visit would originate in the sampled areas.

Future Adult Resident Dose Equations and Exposure Parameters for Soil. The potential chemical doses for future hypothetical adult resident exposures to total soil at Building 4343 were estimated using the equations and exposure parameters presented below. The EPCs used to estimate potential chemical doses for each evaluated medium and data grouping were presented in *Section 6.2.2*, while the calculated LADDs for carcinogenic effects and ADDs for noncarcinogenic effects are presented in the corresponding tables for residents in the Risk Characterization section (*Section 6.4*).

Incidental Ingestion of Soil by Adult Residents. The exposure for incidental ingestion of COPCs in total soil by adult residents was calculated using the equation and the exposure parameters presented in **Appendix E-1, Table E-6**. Standard parameters were used to characterize adult exposures (> 18 years of age).

Adult residents were assumed to be exposed to surface soil 350 days/year, a standard USEPA (1991a) default assumption assuming a 7-day week for 50 weeks/year (residents were assumed to spend 2 weeks a year on vacation). Duration of exposure for residents was assumed to be 30 years, a USEPA (1991a) upper-bound default estimate of the time spent residing in one location. The body weight value used for adult residents was 70 kg, the standard USEPA (1991a) default value for adult body weight. An averaging time of 70 years was used for carcinogenic COPCs, while 30 years was used for noncarcinogenic COPCs.

The daily soil ingestion rate for adult residents was assumed to be 100 mg/day, a standard USEPA (1991a) default value for exposure to soil for the residential scenario. It was conservatively assumed that soil ingested during time at home by residents would originate in the sampled areas. Furthermore, it was assumed that the chemical would be totally available for intake into the body rather than bound to the soil.

Dermal Absorption of Chemicals in Soil by Adult Residents. The internal dose due to dermal absorption of COPCs in total soil by adult residents was estimated using the equation and the exposure parameters presented in **Appendix E-1, Table E-6**. The parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used for estimating the ingestion of soil by an adult resident.

Parameters that are specific to the dermal absorption exposure scenario include the area of exposed skin, the amount of soil adhering to the skin, and the amount of chemical absorbed through the skin from soil. It was assumed that a resident's head, hands, arms, and lower legs would be exposed to soil. Using data from USEPA (Tables 6-2 and 6-3; USEPA, 1997c), and averaging 50th percentile values across gender and age, it was estimated that the exposed skin surface area for adult residents would be 5,700 cm^2. The soil-to-skin adherence factor was assumed to be 0.07 mg/cm^2-event, based on 50th percentile values for similar activities (USEPA, 1997c; 2001a).

The amount of chemical in soil absorbed through the skin must be estimated in order to calculate dermal absorption doses. The estimation of absorbed dose is described in the previous section for maintenance worker exposures. Dermal absorption factors (USEPA, 1995b; 2001a; 2003c) were used to estimate absorption of COPCs from soil.

Inhalation of Particulates from Soil by Adult Residents. The exposure for inhalation of COPCs in soil by adult residents was calculated using the equation and the exposure parameters presented in **Appendix E-1, Table E-8**. The parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used for estimating the inhalation rate of 0.83 m^3 per hour for adult residents was derived by dividing the adult daily rate of 20 m^3/day (USEPA, 1991a) by 24 hours per day. The exposure time is 1 hour per day based on the average time an adult spends outside (1.5 hours/day; USEPA, 1997c) with the exception of the three coldest months of the year. It was conservatively assumed that soil inhaled at the residence would originate in the sampled areas.

Future Child Resident Dose Equations and Exposure Parameters for Soil. The potential chemical doses for future hypothetical child resident exposures to soil at Building 4343 were estimated using the equations and exposure parameters presented below. The EPCs used to estimate potential chemical doses for each evaluated medium and data grouping were presented in *Section 6.2.2*, while the calculated LADDs for carcinogenic effects and ADDs for noncarcinogenic effects are presented in the corresponding tables for residents in *Section 6.4*.

Incidental Ingestion of Soil by Child Residents. The exposure for incidental ingestion of COPCs in soil by child residents was calculated using the equation and the exposure parameters presented in **Appendix E-1, Table E-6**. Standard parameters were used to characterize exposures by children of 6 years of age or less.

Child residents were assumed to be exposed to surface soil 350 days/year, a standard USEPA (1991a) default assumption assuming a 7-day week for 50 weeks/year (residents were assumed to spend 2 weeks a year on vacation). Duration of exposure for children was assumed to be 6 years (USEPA, 1991a). The body weight value used for child residents was 15 kg, the standard USEPA (1991a) default value for a child's body weight averaged over 0 to 6 years of age. An averaging time of 70 years was used for carcinogenic COPCs, while 6 years was used for noncarcinogenic COPCs.

The daily soil ingestion rate for child residents was assumed to be 200 mg/day, a standard USEPA (1991a) default value for exposure to soil for the children of 6 years of age and under. It was conservatively assumed that soil ingested during time at home by child residents would originate in the sampled areas. Furthermore, it was assumed that the chemical would be totally available for intake into the body rather than bound to the soil.

Dermal Absorption of Chemicals in Soil by Child Residents. The internal dose due to dermal absorption of COPCs in soil by child residents was estimated using the equation and the exposure parameters presented in **Appendix E-1, Table E-6**. The parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used for estimating the ingestion of soil by a child resident.

Parameters that are specific to the dermal absorption exposure scenario include the area of exposed skin, the amount of soil adhering to the skin, and the amount of chemical absorbed through the skin from soil. It was assumed that a child's head, hands, forearms, lower legs, and feet would be exposed to soil. Using data from USEPA (USEPA Tables 6-6, 6-7, 6-8; USEPA, 1997c), and averaging 50th percentile values across gender and age, it was estimated that the exposed skin surface area for child residents would be 2,800 cm^2. The soil-to-skin adherence factor was assumed to be 0.2 mg/cm^2-event, based on 50th percentile values for similar activities (USEPA, 1997c; 2001b).

The amount of chemical in soil absorbed through the skin must be estimated in order to calculate dermal absorption doses. The estimation of absorbed dose is described in the previous section for maintenance worker exposures. Dermal absorption factors (USEPA, 1995b; 2001a; 2003c) were used to estimate absorption of COPCs from soil.

Inhalation of Particulates from Soil by Child Residents. The exposure for inhalation of COPCs in soil by child residents was calculated using the equation and the exposure parameters presented in **Appendix E-1, Table E-8**. The parameters describing the frequency of exposure, duration of exposure, body weight, and averaging time are identical to those used for estimating the ingestion of soil by a child resident.

The inhalation rate of 1 m^3 per hour for child residents was based on the recommended value for light activities (USEPA Table 5-23; USEPA, 1997c). The exposure time is 1 hour per day. It was assumed that children under the age of 6 years year old are likely to be accompanied or supervised by an adult during their time spent outdoors. Therefore, the exposure time was

assumed to be equivalent to that of the adult resident. It was conservatively assumed that soil inhaled at the residence would originate in the sampled areas.

6.3 Human Health Toxicity Assessment

The general methodology for the classification of health effects and the development of health effects criteria is described in *Section 6.3* to provide the analytical framework for the characterization of human health risks. In *Section 6.3.2*, the health effects criteria, or toxicity values, used to derive estimates of risk are presented. These values are combined with dose information for each complete exposure pathway quantitatively evaluated to predict potential risks associated with exposures to COPCs in environmental media at Building 4343 (*Section 6.4*).

The methodology used for classifying health effects from exposure to chemicals is recommended by USEPA (1986a,b; 1989; 1997c; 2003b). The health effects analysis considers chronic (long-term) exposures. Using the following hierarchy (USEPA, 2003d), the chronic toxicity criteria were obtained from:

- Tier 1 – Integrated Risk Information System (IRIS) (USEPA, 2003b).
- 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 (STSC).
- Tier 3 – Other Toxicity Values – including additional USEPA and non-USEPA sources of toxicity information. This tier includes the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997b).

6.3.1 Health Effects Classification and Criteria Development

According to USEPA's science policy, there are two primary approaches to developing toxicity values or health criteria. The non-threshold approach is based on USEPA's scientific policy position that a small number of molecular events can evoke changes in a single cell, or a small number of cells. This is described as a non-threshold initiator mechanism, because there is essentially no level of exposure (i.e., a threshold) to a constituent that will not result in some finite possibility of causing an adverse effect. Another assumption stemming from USEPA's science policy is that the dose-response curve is linear at low doses. For most carcinogens, toxicity values are based on the non-threshold approach.

The threshold approach is based on the assumption that organisms have repair and detoxification capabilities that must be exceeded by some critical concentration (threshold) before the adverse effect is manifested. For example, an organ can have a large number of cells performing the same or similar functions that must be significantly depleted before the effect on the organ is realized. This threshold view holds that a range of exposures from just above zero to some finite value can be tolerated by the organism without an appreciable risk of adverse effects. Toxicity values for noncarcinogenic effects are based on the threshold approach. Furthermore, as additional information regarding the mechanisms of toxicity becomes available, the threshold approach may also apply to some carcinogens (e.g., chloroform).

Cancer Slope Factors. For carcinogens, USEPA estimates the excess lifetime cancer risks associated with various levels of exposure by developing cancer slope factors (CSFs) and unit risks. CSFs are expressed in terms of reciprocal dose, as units of (mg chemical/kg body weight-

day)$^{-1}$, which describes the upper-bound increase in an individual's risk of developing cancer over a 70-year lifetime per unit of exposure. Unit risks are expressed either as a reciprocal air concentration, in units of $(\mu g/m^3)^{-1}$, or as a reciprocal drinking water concentration, in units of $(\mu g/L)^{-1}$. Similarly, they are defined as the probability of an individual developing cancer over a 70-year lifetime as a result of exposure to one unit of concentration in air or water. Because regulatory efforts are geared to be protective of public health, including even the most sensitive members of the population, the CSFs are derived using conservative assumptions.

CSFs and unit risks are derived from the results of human epidemiological studies or chronic animal bioassays. The animal studies usually must be conducted using relatively high doses to detect possible adverse effects. Because humans are expected to be exposed to doses lower than those used in the animal studies, the potential cancer risks at lower doses are estimated by using mathematical models. The data from animal studies are typically fitted to the linearized multistage model to obtain a dose-response relationship. In general, after the data are fit to the dose-response model, the 95 percent UCL of the slope of the resulting dose-response relationship at low doses is calculated. This upper-bound limit is subjected to various adjustments, and an interspecies scaling factor is applied to derive the slope factor or unit risk for humans. Thus, the actual risks associated with a given intake of a potential carcinogen quantitatively evaluated based on animal data are generally regarded as not likely to exceed the risks estimated using these CSFs or unit risks, and they may be as low as zero (USEPA, 1986a). Dose-response data derived from human epidemiological studies are fitted to dose-time-response curves. These models provide rough, but plausible, estimates of the upper limits on lifetime risk. CSFs and unit risks based on human epidemiological data are derived using conservative assumptions and, as such, they too are unlikely to underestimate risks for a given level of exposure.

Weight-of-evidence categories represent an assessment of the amount and quality of the data, which support the finding that specific chemicals and elements can cause cancer in humans. Although USEPA's guidelines for carcinogen risk assessment (USEPA, 1996b; 2003e) proposes a weight-of-evidence narrative, IRIS currently uses the original alphanumeric classification. Under the existing guidelines (USEPA, 1986a), chemicals are classified as either Group A, Group B1, Group B2, Group C, Group D, or Group E. Group A includes those substances for which high-quality studies have demonstrated a relationship between the exposure to the substance in question and the development of cancer in human populations. Groups B1, B2, and C represent chemicals with limited (B1) or insufficient (B2) human evidence of carcinogenicity, and sufficient (B1, B2) or insufficient (C) animal data. Group D substances are those for which there is insufficient or no evidence of carcinogenicity in humans or animals, while Group E substances are those for which no evidence of carcinogenicity is available in adequate human or animal studies.

Reference Doses and Reference Concentrations. Health effects criteria for chemicals exhibiting noncarcinogenic effects are generally developed using verified risk reference doses (RfDs) and reference concentrations (RfCs). These are developed by USEPA and listed in IRIS (USEPA, 2003b), or can be obtained from HEAST (USEPA, 1997b) and supplements. The RfD is expressed in units of dose (mg chemical/kg body weight-day) and are usually derived either from human studies involving workplace exposures or from animal studies. The RfDs are estimates (with uncertainty spanning perhaps an order of magnitude) of the daily exposure to the human population (including sensitive subpopulations) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The RfD is used as a reference point for gauging the

potential effects of exposures. Usually, exposures (as chemical intakes or doses) that are less than the RfD are not likely to be associated with adverse health effects. As the frequency and/or magnitude of the exposures exceeding the RfD increase, the probability of adverse effects in a human population increases.

RfDs are developed for both chronic and subchronic exposures. Chronic RfDs are presented in IRIS or HEAST and are intended for use in evaluating exposures of durations greater than seven years. Subchronic RfDs are developed by USEPA's NCEA and are used to characterize the potential for the occurrence of noncarcinogenic effects associated with short-term exposures [two weeks to seven years as defined by USEPA (1989)]. The subchronic RfDs are developed similarly to chronic RfDs, and are typically equal to chronic RfDs or are 1 order of magnitude greater (less stringent). The subchronic RfDs are presented in HEAST, but they are no longer being reviewed and updated in the same manner as IRIS. Because there is greater uncertainty associated with the subchronic RfDs, chronic RfDs have been used in this HHRA.

The RfDs are derived using uncertainty factors that reflect scientific judgment regarding the various types of data used to estimate the RfD. RfDs are typically estimated from no observable adverse effect levels (NOAELs) or lowest observable adverse effect levels (LOAELs) in human or animal studies. Uncertainty factors, generally 10-fold factors, are intended to account for:

- The variation in sensitivity among members of the human population;
- The uncertainty in extrapolating animal data to the case of humans;
- The uncertainty in extrapolating from data obtained in a study that is less-than-lifetime exposure;
- The uncertainty in using LOAEL data, when necessary, rather than NOAEL data; and,
- The inability of a single study to adequately address every possible adverse outcome in humans.

To derive RfDs, NOAELs or LOAELs are divided by one or more uncertainty factors, as appropriate. When taken together, these uncertainty factors may confer an extra margin of safety of up to a factor of 10,000 below a LOAEL. In some cases, modifying factors are also applied to RfDs to take into account other uncertainties in the toxicity database and reflect the professional judgment of those reviewing the database. The net result is that RfDs are generally considered to provide a conservative estimate of the likelihood of adverse noncarcinogenic effects.

6.3.2 Health Effects Criteria for COPCs

Health effects criteria for chronic exposures to COPCs via the oral route of exposure are presented in **Appendix E-1, Tables E-9 and E-10**. Health effects criteria for chronic exposures to the COPCs in soil via the inhalation of particulate matter are presented in **Appendix E-1, Tables E-11 and E-12**. The following chemical-specific guidance was also used.

Chromium. The toxic effects associated with chromium are dependent upon its valence state (USEPA, 1998b). Two common forms of chromium are trivalent chromium (chromium III) and hexavalent chromium (chromium VI). Chromium III is the predominant form of chromium in nature and is the less toxic of the two forms. Hexavalent chromium is the more toxic form of chromium and is considered to be a Class A carcinogen via the route of inhalation. The speciation of hexavalent chromium (Cr VI) is not routinely performed during a sampling

program due to the very short holding time and the unique stability issues associated with hexavalent chromium (i.e., it tends to change valence states very easily after sample collection). Unless there is convincing evidence that hexavalent chromium may be present at a site (such as its for control of scale in non-contact cooling water piping for a power plant or a chromium plating operation), it is generally not included in an analytical program. For the Building 4343 site, hexavalent chromium analyses were not performed for the environmental media samples.

It was assumed that the majority of the chromium that was detected at the site would be in the trivalent form. Hexavalent chromium is relatively unstable in the environment and is typically converted to trivalent chromium. As stated in Water-Related Environmental Fate of 129 Priority Pollutants (USEPA, 1979), hexavalent chromium or Cr(VI) is a moderately strong oxidizing agent and reacts with reducing materials to form trivalent chromium or Cr(III). Chemical speciation is an important fate process for chromium and in aquatic environments (such as the process water discharge at Building 4343). Cr(VI), if present, would be expected to remain in a soluble form, while trivalent chromium would be expected to hydrolyze and precipitate as $Cr(OH)^3$. Cr(III) the most stable form under reducing conditions normally found in natural waters and sediments, and when in solution at pH greater than 5, quickly precipitates due to formation of the insoluble hydroxide or oxide.

Cr (III) is the stable form of chromium in soil (FRTR, 2002). Cr (III) hydroxy compounds precipitate at pH 4.5 and complete precipitation of the hydroxy species occurs at pH 5.5. In contrast to Cr (VI), Cr (III) is relatively immobile in soil. Chromium concentrations in soil at Building 4343 were evaluated with respect to pH at the site **(Appendix E-2, Plot 1)**. Soil at Building 4343 had an average pH of 5.8, which would favor precipitation.

Because of its anionic nature, Cr (VI) associates with soil surfaces at positively charged exchange sites (FRTR, 2002). This association decreases with increasing soil pH. Regardless of pH and redox potential, most Cr(VI) in soil is reduced to Cr(III). Soil organic matter and iron (Fe II) minerals donate electrons in this reaction. The reduction reaction in the presence of organic matter proceeds at a slow rate under normal environmental pH and temperatures, but the rate of reaction increases with decreasing soil pH.

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

Chromium concentrations in soil at Building 4343 were also evaluated with respect to organic matter at the site. Total chromium (mg/kg) was plotted against organic matter (mg/kg) **(Appendix E-2, Plot 2)**. Increasing chromium concentrations are associated with increasing levels of organic matter. These results would suggest that elevated chromium at the site might be due to the organic matter available to reduce Cr(VI) to Cr(III). Even if trace amounts of Cr(VI) were present at the site, the environmental conditions at RFAAP, including typical precipitation events over the years, would tend to favor the conversion of this form of chromium to the more stable (less toxic) trivalent state. For these reasons, it was assumed that toxicity associated with chromium would be most accurately represented by the use of chromium III toxicity data.

***Iron*.** In accordance with the SSP for RFAAP (USEPA, 2001c), a "margin of exposure" evaluation was performed in cases where iron concentrations in soil or water resulted in an HQ greater than 0.5. Hazards associated with exposures to iron were characterized by comparing the estimated iron intake with the RDA and concentrations known to cause adverse effects in children (USEPA, 1996f).

***Lead*.** Quantitative oral toxicity criteria were available from IRIS (USEPA, 2003b), HEAST (USEPA, 1997b), or USEPA's NCEA for the majority of the COPCs, with the exception of lead, which was selected as a COPC in surface and subsurface soil at Building 4343. An interim approach to assessing risks associated with adult exposures to lead was developed by USEPA's Technical Review Workgroup for Lead (USEPA, 2003f). This methodology is a variation of the IEUBK Model used to evaluate lead exposures to children. The adult lead model is used to evaluate risks associated with nonresidential adult exposures to lead in soil. The model focuses on estimating fetal blood concentrations in women exposed to lead in soil (USEPA, 2003f). It was used in this HHRA to be protective of potentially sensitive receptors within an industrial or commercial worker population. For the purpose of this HHRA, it was assumed that the worker would be potentially exposed to surface or total soil at Building 4343. Because the lead model is a probabilistic model, USEPA default parameters are based on central tendency (i.e., average) values (USEPA, 2003f). Therefore, the arithmetic means for surface and total soil served as input values for the soil concentrations.

Because exposure parameters have not been developed for intermittent occupational exposures, such as maintenance work, the default soil ingestion rate of 50 mg/day and an exposure frequency of 219 days/year were assumed for the maintenance worker. The geometric standard deviation (GSD) is a measure of the inter-individual variability in blood lead concentrations in a population whose members are exposed to the same nonresidential environmental lead levels. This value reflects the homogeneity or heterogeneity of the exposed population with respect to socioeconomic, ethnic, and geographic factors. A GSD of 2.2 was used as the mid-range value of updated GSD values (2.1 to 2.3) from the *Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III)* (USEPA, 2002c). Although the worker population at RFAAP would be expected to be relatively homogeneous, this value accounts for potential differences in future worker populations. The baseline blood lead concentration is intended to represent the best estimate of a reasonable central value of blood lead concentration in women of child-bearing age who are not exposed to lead-contaminated nonresidential soil or dust at the site (USEPA, 2003f). In this analysis, geometric means are used for this purpose. A baseline blood lead concentration of 1.6

µg/dl was used as the mid-range value of updated values (1.5 to 1.7 µg/dl) from NHANES III (USEPA, 2002c).

USEPA has provided additional guidance regarding exposure parameters for the excavation workers (USEPA, 2003g). The soil ingestion rate of 100 mg/day was used as a reasonable value for workers with contact-intense exposures to soil. An exposure frequency of 250 days/year was assumed because the excavation worker would be expected to have full-time soil exposures during the entire period of exposure (i.e., one year). As described the maintenance worker, a GSD of 2.2 was used as the mid-range value of updated GSD values and a baseline blood lead concentration 1.6 µg/dl was used as the mid-range value of updated values (1.5 to 1.7 µg/dl) from NHANES III (USEPA, 2002c).

Spreadsheets for the Adult Lead Model (USEPA, 2003h) were used to calculate blood lead concentrations for surface and total soil for the maintenance worker and total soil for the excavation worker. The input parameters are presented in **Appendix E-1, Tables E-13a, E-14a, and E-15a**, respectively. The spreadsheets are provided as **Appendix E-1, Tables E-13b, E-14b, and E-15b** and discussed as part of the risk characterization in *Section 6.4*. The model results are expressed as the predicted geometric mean blood lead level and the percent of the population potentially experiencing concentrations above 10 µg/dl (below which adverse manifestations are not expected).

The potential risks associated with residential exposures to lead are addressed using the IEUBK Lead Model for Windows®, Version 1.0, Build 253 (USEPA, 1994b; 2002b; 2003i). 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 arithmetic mean of the lead concentration in total soil and an assumed lead concentration in groundwater (15 µg/L) were used in conjunction with the default input parameters to represent site-specific exposures to lead. The predicted geometric mean blood lead level and the percent of the population potentially experiencing concentrations above 10 µg/dl (below which adverse manifestations are not expected) are provided in *Section 6.4* and **Appendix E-1, Table E-16.** Percentages below 5 percent are considered to be protective of human health. The corresponding input parameters and the distribution probability plot from the model are included with the table.

PCBs. USEPA has developed guidance for evaluating PCBs in environmental media (USEPA, 1996c). The cancer potency of PCB mixtures is assessed using a tiered approach that depends upon the information available. Rather than defaulting to a single dose-response factor, upper-bound slope factors have been described by a range of estimates. The first (default) tier is invoked when information on the mixture of interest is limited. The upper reference point (i.e., slope factor) of 2 per mg/kg-day is appropriate for food chain exposure, sediment or soil ingestion, and dust or aerosol inhalation; these are exposure pathways for which environmental processes are likely to increase risk. Because some of these pathways apply at Building 4343, the upper reference point for the first tier was used in this HHRA.

6.3.3 Adjustment for Dermal Absorption

Toxicity criteria have not been developed by USEPA specifically for the dermal absorption route of exposure; instead, oral health effects criteria are adjusted to assess this pathway. In order to

have a meaningful comparison between the dermal absorption dose estimates, which represent internal (or absorbed) doses, and oral toxicity criteria, which typically represent potential (or administered) doses, toxicity criteria are modified to represent absorbed doses. The method for modifying toxicity criteria involves determination of an absolute oral absorption factor for each chemical and use of this value to increase the chemical's CSF or to decrease the chemical's RfD, as shown in the following equations:

(CSF) / (Absolute oral absorption factor) = Adjusted Dermal CSF
(RfD) x (Absolute oral absorption factor) = Adjusted Dermal RfD

The absolute oral absorption factors that are applied should reflect the specific conditions under which the toxicological study was conducted (e.g., method of administration such as gavage, water or diet, and vehicle of administration such as solvent or solution). The absolute oral absorption factors and adjusted toxicity criteria for the COPCs used when evaluating dermal absorption are also presented in **Appendix E-1, Tables E-9 and E-10**. The adjusted CSFs and RfDs presented in these tables were used to evaluate potential risks associated with dermal absorption exposures.

6.4 Human Health Risk Characterization

In this section, the potential human health cancer risks and noncancer hazards associated with selected human exposure pathways are calculated and detailed results are provided in **Appendix E-1, Tables E-17 through E-26**. To quantitatively assess risks at Building 4343, the average daily doses (LADDs and ADDs) calculated in the exposure section are combined with the health effects criteria presented in the toxicity section. USEPA has developed guidance for assessing the potential risks to individuals from exposure to carcinogenic and noncarcinogenic chemicals, and uses separate methodologies for estimating the risks from these two different classes of compounds.

For exposures to potential carcinogens, the individual upper-bound excess lifetime cancer risk was calculated by multiplying the estimated LADD by the upper-bound CSF. Upper-bound is a term used by USEPA to describe CSFs, meaning that actual risks are unlikely to be higher than the risks predicted using the upper-bound CSFs. Using this approach, a risk level of 1×10^{-6}, for example, represents an upper-bound increase in the lifetime probability of 1 in 1,000,000 that an individual could develop cancer as a result of exposure.

The approach of calculating carcinogenic risks by multiplying the LADD by the CSF assumes that the increased risk of cancer resulting from exposure to a constituent is linearly proportional to the amount of chemical intake averaged over a lifetime. According to USEPA (1989) risk assessment guidance, this approach is appropriate when the estimated carcinogenic risks calculated are less than 10^{-2} (i.e., one excess cancer case per 100 people exposed). If the estimated risks are above 10^{-2}, the assumption of linearity is not valid. In such cases, the carcinogenic risks should be calculated using the following equation, per USEPA risk assessment guidance (USEPA, 1989):

$$\text{Risk} = 1 - e^{(-\text{LADD} * \text{CSF})}$$

It is important to note that although the upper-bound cancer risk estimates provide plausible estimates of the upper limits of risk, the actual risk could be considerably lower.

In order to assess the upper-bound individual excess lifetime cancer risks associated with simultaneous exposure to COPCs, the risks derived from the individual chemicals were summed within each exposure pathway. This approach is consistent with the USEPA's guidelines for evaluating the toxic effects of chemical mixtures (USEPA, 1986b; 1989).

Potential adverse health effects for noncarcinogens were calculated by means of an HI technique as recommended by USEPA (1989). The ratio of the ADD to the reference dose (ADD:RfD) was derived for each chemical. Values of these ratios, called hazard quotients (HQs), which are greater than 1 are indicative of the potential for adverse health effects. The effects from simultaneous exposures to COPCs were computed by summing the individual ratios (HQs) within each exposure pathway. This sum, known as the HI, serves the same function for the mixture as the HQ does for the individual compound. In general, HIs that are less than 1 are not likely to be associated with health risks and are, therefore, less likely to be of regulatory concern than HIs greater than 1. If an HI is greater than 1, the COPCs are subdivided into categories based on target organ affected by exposure (e.g., liver, kidney) in accordance with USEPA (1989) guidance. HIs are then recalculated for these categories to better identify whether noncarcinogenic effects to specific target organs or endpoints might occur.

The upper-bound excess lifetime cancer risks derived in this report can be compared to USEPA's target risk range for health protectiveness at Superfund sites of 1×10^{-6} to 1×10^{-4} (USEPA, 1990). In addition, USEPA's Office of Solid Waste and Emergency Response (USEPA, 1991b) has issued a directive clarifying the role of HHRA in the Superfund process. The directive states that, where the cumulative carcinogenic site risk to an individual based on RME for both current and future land use is less than 1×10^{-4}, and the noncarcinogenic HI is less than 1, action generally is not warranted unless there could be adverse environmental effects.

6.4.1 Risk Estimates for Maintenance Workers under Current Land-Use Conditions at Building 4343

A summary of the upper-bound excess lifetime cancer risks and HIs associated with maintenance worker exposures to surface soil at Building 4343 under current land-use conditions are provided in **Appendix E-1, Table E-27**. For each exposure pathway evaluated, the predominant chemicals contributing to total upper-bound excess lifetime cancer risks above 1×10^{-6} or HIs above 1 are identified in the text below. Because maintenance workers may be exposed at one time by a combination of pathways (e.g., incidental ingestion and dermal absorption), the cumulative pathway risks for plausible multiple pathway exposures are also provided in **Appendix E-1, Table E-27** and discussed below.

Surface Soil. The total upper-bound excess lifetime cancer risk associated with exposures to COPCs in surface soil was estimated to be (3.1×10^{-6}) for inhalation. The primary contributor was cadmium. This value is within the target risk range of $1x10^{-6}$ to $1x10^{-4}$. The HIs associated with exposures to noncarcinogenic COPCs in surface soil by a maintenance worker were 6.1, primarily due to cadmium.

Lead was also evaluated as a COPC in surface soil at Building 4343. Because there is no toxicity value for lead, an HQ for noncarcinogenic effects was not calculated for lead. Per USEPA guidance (USEPA, 2002c; 2003f), site-specific lead exposures were evaluated for worker exposures using the Adult Lead Model. This calculation was based on the site-specific arithmetic mean concentration of lead detected in surface soil (77 mg/kg). Because there are no site-specific groundwater data available for Building 4343, it was assumed that water would be

obtained from alternate water supply and the maximum concentration would be no greater than the action level for groundwater (15 µg/L; USEPA, 1996d). The corresponding input parameters are provided in **Appendix E-1, Table E-13a**. The results of the model are presented in **Table E-13b**. The input value of 77 mg/kg in soil results in 0.9 percent of receptors above a geometric mean blood lead level of 1.7 µg/dl. This value is below the blood lead goal of no more than 5 percent of children (fetuses of exposed women) exceeding 10 µg/dl blood lead, which is considered to be protective of human health by USEPA (1994b).

Cumulative Risk and Hazard. The potential cumulative risk for maintenance workers exposed to surface soil at Building 4343 under current land-use conditions was $3.2x10^{-6}$, which is within the USEPA's target risk range of 1×10^{-6} to 1×10^{-4} for health protectiveness at Superfund sites (USEPA, 1990). The potential cumulative HI for maintenance workers was 6.1, primarily due to cadmium. When recalculated by target organ, the kidney HI (6.0) exceeded 1.

Because there is no toxicity value to lead, an HQ was not calculated for lead. Therefore, no HQ was available for inclusion in the cumulative HI calculation. The results of the Adult Lead Model are described in the previous section. These results indicate that lead concentrations at Building 4343 are below the criterion for blood lead levels in exposed populations.

6.4.2 Risk Estimates for Maintenance Workers under Future Land-Use Conditions at Building 4343

A summary of the upper-bound excess lifetime cancer risks and HIs associated with maintenance worker exposures to surface soil at Building 4343 under current and future land-use conditions are provided in **Appendix E-1, Table E-28**. (It should be noted that future exposures to surface soil are assumed to be identical to those under current land-use conditions.) For each exposure pathway evaluated, the predominant chemicals contributing to total upper-bound excess lifetime cancer risks above 1×10^{-6} or HIs above 1 are identified in the text below. Because maintenance workers may be exposed at one time by a combination of pathways (e.g., incidental ingestion and dermal absorption), the cumulative pathway risks for plausible multiple pathway exposures are also provided in **Appendix E-1, Table E-28** and discussed below.

Surface Soil. The total upper-bound excess lifetime cancer risks and HIs associated with COPCs in surface soil are assumed to be the same as those under current land-use conditions.

Total Soil. The total upper-bound excess lifetime cancer risks associated with exposures to COPCs in total soil were less than the target risk range of $1x10^{-6}$ to $1x10^{-4}$. The HIs associated with exposures to noncarcinogenic COPCs in total soil by a maintenance worker were less than 1.

Lead was also evaluated as a COPC in total soil at Building 4343. Because there is no toxicity value for lead, an HQ for noncarcinogenic effects was not calculated for lead. Per USEPA guidance (USEPA, 2002c; 2003f), site-specific lead exposures were evaluated for worker exposures using the Adult Lead Model. This calculation was based on the site-specific arithmetic mean concentration of lead detected in total soil (46 mg/kg). Because there are no site-specific groundwater data available for Building 4343, it was assumed that water would be obtained from alternate water supply and the maximum concentration would be no greater than the action level for groundwater (15 µg/L; USEPA, 1996d). The corresponding input parameters are provided in **Appendix E-1, Table E-14a**. The results of the model are presented in **Appendix E-1, Table E-14b**. The input value of 46 mg/kg in soil results in 0.8 percent of

receptors above a geometric mean blood lead level of 1.7 μg/dl. This value is below the blood lead goal of no more than 5 percent of children (fetuses of exposed women) exceeding 10 μg/dl blood lead, which is considered to be protective of human health by USEPA (1994b).

Cumulative Risk and Hazard. Because surface soil represents the more highly contaminated portion of soil, cumulative risk and hazard estimates are conservatively based on this soil data grouping. The potential cumulative risk for maintenance workers exposed to surface soil at Building 4343 under future land-use conditions was $3.1x10^{-6}$, which is within the USEPA's target risk range of 1×10^{-6} to 1×10^{-4} for health protectiveness at Superfund sites (USEPA, 1990). The potential cumulative HI for maintenance workers was 6.1, primarily due to cadmium. When recalculated by target organ, the kidney HI (6.0) exceeded 1.

Because there is no toxicity value to lead, an HQ was not calculated for lead. Therefore, no HQ was available for inclusion in the cumulative HI calculation. The results of the Adult Lead Model are described in the previous section. These results indicate that lead concentrations at Building 4343 are below the criterion for blood lead levels in exposed populations.

6.4.3 Risk Estimates for Excavation Worker under Future Land-use Conditions at Building 4343

A summary of the upper-bound excess lifetime cancer risks and HIs associated with excavation worker exposures to total soil at Building 4343 under future land-use conditions is provided in **Appendix E-1, Table E-29**. For each exposure pathway evaluated, the predominant chemicals contributing to total upper-bound excess lifetime cancer risks above 1×10^{-6} or HIs above 1 are identified in the text below. Because excavation workers may be exposed at one time by a combination of pathways (e.g., incidental ingestion and dermal absorption), the cumulative pathway risks for plausible multiple pathway exposures are also provided in **Appendix E-1, Table E-29** and discussed below.

Total Soil. The total upper-bound excess lifetime cancer risks associated with exposures to COPCs in total soil were less than the target risk range of $1x10^{-6}$ to $1x10^{-4}$. The HIs associated with exposures to noncarcinogenic COPCs in total soil by an excavation worker exceeded 1 for the ingestion (HI = 3.5) pathway, primarily due to cadmium.

Lead was also evaluated as a COPC in total soil at Building 4343. Because there is no toxicity value for lead, an HQ for noncarcinogenic effects was not calculated for lead. Per USEPA guidance (USEPA, 2002c; 2003f), site-specific lead exposures were evaluated for worker exposures using the Adult Lead Model. This calculation was based on the site-specific arithmetic mean concentration of lead detected in total soil (46 mg/kg). Because there are no site-specific groundwater data available for Building 4343, it was assumed that water would be obtained from alternate water supply and the maximum concentration would be no greater than the action level for groundwater (15 μg/L; USEPA, 1996d). The corresponding input parameters are provided in **Appendix E-1, Table E-15a**. The results of the model are presented in **Appendix E-1, Table E-15b**. The input value of 46 mg/kg in soil results in 1.0 percent of receptors above a geometric mean blood lead level of 1.8 μg/dl. This value is below the blood lead goal of no more than 5 percent of children (fetuses of exposed women) exceeding 10 μg/dl blood lead, which is considered to be protective of human health by USEPA (1994b).

Cumulative Risk and Hazard. The potential cumulative risk for excavation workers exposed to total soil at Building 4343 under future land-use conditions was $4.1x10^{-8}$, which is below the

USEPA's target risk range of 1×10^{-6} to 1×10^{-4} for health protectiveness at Superfund sites (USEPA, 1990). The potential cumulative HI for excavation workers was 4.0, primarily due to cadmium. When recalculated by target organ, the kidney HI (3.3) exceeded 1.

Because there is no toxicity value to lead, an HQ was not calculated for lead. Therefore, no HQ was available for inclusion in the cumulative hazard index calculation. The results of the Adult Lead Model are described in the previous section. These results indicate that lead concentrations at Building 4343 are below the criterion for blood lead levels in exposed populations.

6.4.4 Risk Estimates for Adult Residents under Future Land-Use Conditions at Building 4343

A summary of the upper-bound excess lifetime cancer risks and HIs associated with adult resident exposures to total soil at Building 4343 under future land-use conditions is provided in **Appendix E-1, Table E-30**. For each exposure pathway evaluated, the predominant chemicals contributing to total upper-bound excess lifetime cancer risks above 1×10^{-6} or HIs above 1 are identified in the text below. Because residents may be exposed at one time by a combination of pathways (e.g., incidental ingestion and dermal absorption), the cumulative pathway risks for plausible multiple pathway exposures are also provided in **Appendix E-1, Table E-30** and discussed below.

Total Soil. The total upper-bound excess lifetime cancer risks associated with exposures to COPCs in total soil were less than the target risk range of $1x10^{-6}$ to $1x10^{-4}$. The HI associated with exposures to noncarcinogenic COPCs in total soil by an adult resident exceeded 1 for ingestion (HI = 1.5), primarily due to cadmium.

Lead was also evaluated as a COPC in total soil at Building 4343. Because there is no toxicity value for lead, an HQ for noncarcinogenic effects was not calculated for lead. Per USEPA guidance (USEPA, 1992e; 1994a; 1994b; 2002b), site-specific lead exposures were evaluated for residential exposures using the IEUBK model. This calculation was based on the site-specific arithmetic mean concentration of lead detected in total soil (46 mg/kg). Because there are no site-specific groundwater data available for Building 4343, it was assumed that water would be obtained from alternate water supply and the maximum concentration would be no greater than the action level for groundwater (15 µg/L; USEPA, 1996d). The results of the model are presented in **Appendix E-1, Table E-16**. The corresponding input parameters and distribution probability plot are also provided with the table. The predicted geometric mean blood lead level for the young child was 2.9 µg/dl, with 0.4 percent of the population potentially experiencing concentrations above 10 µg/dl, below which adverse manifestations are not expected. These results indicate that if the site were to be developed for residential use in the future, the percent of the exposed population with a blood lead level exceeding 10 µg/dl (1.0 percent) would be below the 5 percent level of exceedance considered to be protective of human health by USEPA.

Cumulative Risk and Hazard. The potential cumulative risk for adult residents exposed to total soil at Building 4343 under future land-use conditions was $2.9x10^{-7}$, which is below the USEPA's target risk range of 1×10^{-6} to 1×10^{-4} for health protectiveness at Superfund sites (USEPA, 1990). The potential cumulative HI for adult base residents was equal to 1.7, primarily due to cadmium. When recalculated by target organ, the kidney HI (1.4) exceeded 1.

Because there is no toxicity value for lead, an HQ was not calculated for lead. Therefore, no HQ was available for inclusion in the cumulative HI calculation. However, the results of the IEUBK

model are described in the previous section. These results indicate that lead concentrations at Building 4343 are below the criterion for blood lead levels in exposed populations.

6.4.5 Risk Estimates for Child Resident under Future Land-use Conditions at Building 4343

A summary of the upper-bound excess lifetime cancer risks and HIs associated with child resident exposures to total soil at Building 4343 under future land-use conditions is provided in **Appendix E-1, Table E-31**. For each exposure pathway evaluated, the predominant chemicals contributing to total upper-bound excess lifetime cancer risks above 1×10^{-6} or HIs above 1 are identified in the text below. Because residents may be exposed at one time by a combination of pathways (e.g., incidental ingestion and dermal absorption), the cumulative pathway risks for plausible multiple pathway exposures are also provided in **Appendix E-1, Table E-31** and discussed below.

Total Soil. The total upper-bound excess lifetime cancer risks associated with exposures to COPCs in total soil were less than the target risk range of $1x10^{-6}$ to $1x10^{-4}$. The HIs associated with exposures to noncarcinogenic COPCs in surface soil by a child resident exceeded 1 for the ingestion pathway (HI = 13.8), primarily due to cadmium and iron, and for the dermal pathway (HI = 1.6), primarily due to cadmium.

As described in *Section 6.3.2*, a margin of exposure evaluation was performed because the HI for iron (1.7) exceeded a value of 0.5. The calculated intake of iron was 0.5 mg/kg-day via the route of ingestion. This value was compared to amounts that are associated with a recommended daily allowance (RDA) of 10 mg/day (0.36 to 1.11 mg/kg-day) for children from 6 months to 10 years of age (USEPA, 1996f). Therefore, the intake calculated for total soil at Building 4343 is within the allowable range.

Lead was also evaluated as a COPC in total soil at Building 4343. Because there is no toxicity value for lead, an HQ for noncarcinogenic effects was not calculated for lead. Per USEPA guidance (USEPA, 1992e; 1994a; 1994b; 2002b), site-specific lead exposures were evaluated for residential exposures using the IEUBK model. This calculation was based on the site-specific arithmetic mean concentration of lead detected in total soil (46 mg/kg). Because there are no site-specific groundwater data available for Building 4343, it was assumed that water would be obtained from alternate water supply and the maximum concentration would be no greater than the action level for groundwater (15 µg/L; USEPA, 1996d). The results of the model are presented in **Appendix E-1, Table E-16**. The corresponding input parameters and distribution probability plot are also provided with the table. The predicted geometric mean blood lead level for the young child was 2.9 µg/dl, with 0.4 percent of the population potentially experiencing concentrations above 10 µg/dl, below which adverse manifestations are not expected. These results indicate that if the site were to be developed for residential use in the future, the percent of the exposed population with a blood lead level exceeding 10 µg/dl (1.0 percent) would be below the 5 percent level of exceedance considered to be protective of human health by USEPA.

Cumulative Risk and Hazard. The potential cumulative risk for child residents exposed to total soil at Building 4343 under future land-use conditions was $4.6x10^{-7}$, which is below the USEPA's target risk range of 1×10^{-6} to 1×10^{-4} for health protectiveness at Superfund sites (USEPA, 1990). The potential cumulative HI for child base residents was equal to 15.5, primarily due to cadmium and iron. When recalculated by target organ, the following HIs exceeded 1: kidney (12.8), Blood/Blood Chemistry (1.9), GI irritation (1.7), and liver (1.8).

As described in the above section, a margin of exposure evaluation was performed because the HI for iron (1.7) exceeded a value of 0.5. However, the intake calculated for total soil at Building 4343 is within the allowable range.

Because there is no toxicity value for lead, an HQ was not calculated for lead. Therefore, no HQ was available for inclusion in the cumulative HI calculation. However, the results of the IEUBK model are described in the previous section. These results indicate that lead concentrations at Building 4343 are below the criterion for blood lead levels in exposed populations.

6.4.6 Summary of Predominant COPCs at Building 4343

This section summarizes the predominant COPCs associated with potential risks and hazards at Building 4343. For the purposes of the HHRA, predominant COPCs are defined as chemicals contributing to exposure route total cancer risks (i.e., based on the sum of every route evaluated) greater than or equal to 1×10^{-6} or exposure route total HIs greater than or equal to one. The predominant COPCs are summarized by receptor, media, and exposure route, in **Appendix E-1, Tables E-32 through E-36**. The predominant COPCs are discussed according to exposure medium in the text below.

Surface Soil at Building 4343. As shown in **Appendix E-1, Tables E-32 and E-33,** the predominant COPC representing cancer risk for surface soil at Building 4343 is cadmium. The total cancer risk estimates for surface soil exposure were within the USEPA target risk range for health protectiveness. The HI for surface soil exceeded 1, due to cadmium. On the basis of a separate evaluation of lead, it was found that site concentrations were below the health protective criterion for lead.

Total Soil at Building 4343. As shown in **Appendix E-1, Tables E-33 through E-36**, there are no predominant COPCs representing cancer risk for total soil at Building 4343. The total cancer risk estimate for total soil exposures were below the USEPA target risk range for health protectiveness. The total HIs for total soil at Building 4343 exceeded 1. The predominant COPCs representing noncancer hazard are cadmium and iron. Based on a margin of exposure evaluation for iron, however, the intake calculated for total soil at Building 4343 is within the allowable range. On the basis of a separate evaluation of lead, it was found that site concentrations are below the health protective criterion for lead.

6.5 Uncertainties in the HHRA

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 chemicals at Building 4343.

Consideration of the uncertainty attached to various aspects of the risk assessment process allows one to better interpret the risk assessment results and understand 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.

Environmental Sampling and Analysis. 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 reported detection limit, but still included in data analysis, and with those chemicals qualified with the letter J, indicating that the concentrations are estimated. Another issue involves the amount of blank-related (i.e., B-qualified) data in the data set. These data were retained in the HHRA and treated as concentrations equal to ½ the SQL. The effects of using data with these uncertainties may over- or underestimate risks.

The data set for each medium represented a compilation of several subsets. These subsets consisted of samples that were collected at various times under different investigations and analyzed by different laboratories. Combining these data involves some uncertainty in the risk assessment. The degree of potential overestimation or underestimation is not known. However, several measures were taken to minimize this uncertainty, which included using validated data, ensuring that chemical names in the file were comparable, and reviewing data qualifiers.

Selection of Chemicals for Evaluation. A comparison of maximum detected chemical concentrations to USEPA Region III RBCs was conducted for each medium. Chemicals whose maximum concentrations were below their respective RBCs were not carried through the assessment. It is unlikely that this risk-based screening would have excluded chemicals that would be of concern, based on the conservative exposure assumptions and conservatively derived toxicity criteria that are the basis of the RBCs. Although following this methodology does not provide a quantitative risk estimate for every chemical, it focuses the assessment on the chemicals accounting for the greatest risks (i.e., chemicals whose maximum concentrations exceed their respective RBCs), and the overall cumulative risk estimates would not be expected to be significantly (if at all) greater.

Toxicological Data. The assessment of risks relied 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, 1986a): "There are major uncertainties in extrapolating both from animals to humans and from high to low doses. There are important species differences in uptake, metabolism, and organ distribution of carcinogens, as well as species and strain differences in target site susceptibility. Human populations are variable with respect to genetic constitution, diet, occupational and home environment, activity patterns and other cultural factors."

These uncertainties are compensated for by using upper-bound 95% UCLs for CSFs for carcinogens, and safety factors for RfDs for noncarcinogens. 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.

Lead was not included in the quantitative risk estimates because a dose-response toxicity value is not available for this chemical. Lead was selected as a COPC in surface and total soil at Building 4343. Adult exposures to lead were evaluated by using a model developed by USEPA's Technical Review Workgroup for Lead to calculate blood lead concentrations for non-residential adults (USEPA, 2003f,g,h). Residential exposures to lead were evaluated using the IEUBK model (USEPA, 1994b; 2002c; 2003i). Because the non-carcinogenic effects from lead are evaluated separately, these effects are not represented in the cumulative HI.

The Adult Lead Model was used to evaluate exposures of workers to lead in surface soil and total soil (USEPA, 2003f), as discussed in *Section 6.3.2*. Because the Adult Lead Model is a probabilistic model, the default parameters are based on central tendency values. For example, the incidental ingestion rate for soil that is assumed for the model is 50 mg/day, whereas an incidental ingestion rate of 100 mg/day was used for the maintenance worker. Another area of uncertainty, however, is the exposure frequency. The exposure frequency for the Adult Lead Model is 219 days/year, while the exposure frequency for the maintenance worker is 50 days/year. According to the guidance for the Adult Lead Model (USEPA, 2003f), infrequent exposures (i.e., less than 1 day per week) over a minimum duration of 90 days would be expected to produce oscillations in blood lead concentrations associated with the absorption and subsequent clearance of lead from the blood between each exposure event. The exposure parameters for the excavation worker also differed from the parameters used in the Adult Lead Model. The incidental ingestion rate for the excavation worker was 330 mg/day. However, the suggested default value for exposure to an excavation worker via incidental ingestion is 100 mg/day (USEPA, 2003g).

For dermal absorption exposure pathways, the absence of dermal toxicity criteria necessitated the use of oral toxicity data. In order to calculate risk estimates for the dermal absorption pathway, absorbed dermal absorption doses were combined with oral toxicity values. As described 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 for which sufficient information is lacking, a default oral absorption factor of 1.0 was used. The risk estimates for the dermal absorption pathways may be over- or underestimated depending on how closely the values used in the HHRA reflect the difference between the oral and dermal routes.

For chemicals without IRIS toxicity criteria, provisional toxicity criteria (i.e., PPRTVs) were used if available **(Appendix E-1, Tables E-9 through E-12)**. The PPRTVs present a source of uncertainty because USEPA has evaluated the compound, but consensus has not been established on the toxicity criteria. For this assessment, use of provisional toxicity criteria was preferable to not evaluating the chemical in order to limit data gaps. However, because the toxicity criteria have not been formally accepted by USEPA, there is uncertainty with these values and, therefore, with the risks calculated using these toxicity criteria. Another source of uncertainty are values obtained from HEAST. These values have not been updated since 1997.

For some chemicals (e.g., lead), there were no toxicity criteria available **(Appendix E-1, Tables E-9 through E-12)**. Although lack of published toxicity data could result in an underestimation of risk, this uncertainty is likely to be balanced by the conservative nature of the verified toxicity values that were available for use.

Exposure Assessment. The primary areas of uncertainty affecting exposure parameter estimation involve the assumptions regarding exposure pathways, the estimation of EPCs, and the parameters used to estimate chemical doses. The uncertainties associated with these various sources are discussed below.

An underlying assumption in the HHRA is that individuals at the site would engage in certain activities that would result in exposures via each selected pathway. For example, it was assumed that receptors would engage in regular activities under current and future land-use conditions that would result in exposures to COPCs. This assumption is conservative, in that it is more likely that the activity patterns assumed to occur in this analysis would likely occur occasionally, if at all.

Chemical results from two Building 4343 sump samples were not included in the HHRA (*Section 6.1.3.1*) because no current exposure is expected to these sumps. Given that the sumps will be removed, there are no future exposures anticipated. To address the uncertainty of not including these results in the HHRA, the following comparison is presented. The EPCs based on the exclusion of the sump sample results from the surface soil and total soil data sets (as used in the current HHRA) are compared to the EPCs based on the inclusion of the sump sample results **(Tables 6-5 and 6-6**, respectively).

Table 6-5
Comparison of Exposure Point Concentrations - Surface Soil

Constituent	EPC Without Sump Samples (mg/kg)	EPC with Sump Samples (mg/kg)
Aluminum	16,100	15,400
Antimony	3.9	16.2
Barium	Not a COPC	188
Cadmium	24,300	24,300
Chromium	223	840
Copper	85.0	250
Iron	34,200	37,700
Lead	133	327
Manganese	375	408
Vanadium	69.4	67.7
Zinc	Not a COPC	432
Aroclor-1254	0.344	0.344

This comparison demonstrates that for the driver of most concern (i.e., cadmium), the EPC for surface soil does not change. For most of the other COPCs, however, EPCs do increase with the inclusion of the two sump samples. The change in EPC could not be assessed for two constituents (barium and zinc) as these constituents were not selected as COPCs in the HHRA and therefore, were not carried through the HHRA.

Table 6-6
Comparison of Exposure Point Concentrations - Total Soil

Constituent	EPC Without Sump Samples (mg/kg)	EPC with Sump Samples (mg/kg)
Aluminum	21,400	20,800
Antimony	1.98	7.72
Barium	Not a COPC	125
Cadmium	903	1,090
Chromium	124	407
Copper	48.7	126
Iron	38,900	40,000
Lead	70.7	161
Thallium	0.561	0.555
Vanadium	98.4	96.1
Zinc	Not a COPC	216
Aroclor-1254	0.137	0.136

Had the two sump samples been included in the HHRA, the conclusions would not have changed. The cancer risk estimates for the total soil for both the maintenance worker and the excavation worker would have been below the target risk range of $1x10^{-6}$ to $1x10^{-4}$. The HIs would have exceeded 1, primarily due to cadmium.

With respect to determining EPCs, one assumption was that the concentrations of chemicals in the media evaluated would remain constant over time. Depending on the properties of the chemical and the media in which it was detected, this assumption could over-estimate risks, depending on the degree of chemical transport to other media.

When calculating EPCs from sampling data, one-half of the reported quantitation limit was used for non-detect samples in the calculation of the 95% UCL on the mean. An approach dealing with non-detected chemical concentrations is associated with some uncertainty, because chemicals that were not detected at the specified SQL may be absent from the medium or may be present at a concentration below the SQL. The uncertainty of the EPC will increase as the number of non-detects in a data set increases, and the uncertainty could result in either the over- or underestimation of EPCs.

The 95 percent UCL was used preferably as the EPC for each medium if at least 5 samples were available for a data grouping. If the 95 percent UCL exceeded the maximum detected value or if fewer than 5 samples were available for a data grouping, the maximum was conservatively used as a default for the EPC. Using a value that is based on one sampling location (i.e., the maximum) is associated with some uncertainty, and adds a great deal of conservatism to the assessment.

Another source of uncertainty is introduced by combining the data sets for surface and subsurface soil to represent total soil. While total risks for the future maintenance worker for total soil exposures are acceptable, there are cadmium hot spots in the mixture (e.g., in surface soil) that may have been diluted by combining the surface and subsurface soil data.

The parameter values used to describe the extent, frequency, and duration of exposure are associated with some uncertainty. Actual risks for certain individuals within an exposed population may vary from those predicted depending upon their actual intake rates (e.g., soil ingestion rates), nutritional status, or body weights. The exposure assumptions were selected to produce an upper-bound estimate of exposure in accordance with USEPA guidelines regarding evaluation of potential exposures at Superfund sites (e.g., exposures were assumed to occur for 25 years for workers). In addition, many USEPA (1991a) default exposure parameters are highly conservative and are based on risk management interpretations of limited data. An example is soil ingestion rates. 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 were assumed to be 100% bioavailable; this assumes that ingested chemicals present in a soil matrix are absorbed through the gastrointestinal tract, which is unlikely due to their affinity to the soil particles. Therefore, based on the conservative exposure assumptions used in the HHRA, exposures and estimated potential risks are likely to be overestimated for the ingestion of soil pathways.

Evaluation of the dermal absorption exposure pathway is affected by uncertainties in exposure parameters specific to dermal contact. For example, there is uncertainty associated with the exposed skin surface areas used, because the choice of exposed body parts could slightly over- or underestimate risks. More significant uncertainties are associated with the selection and use of dermal absorption factors. For this HHRA, the dermal absorption factors were based on USEPA Region III's technical guidance, *Assessing Dermal Exposure from Soil* (USEPA, 1995b) and *Updated Dermal Exposure Assessment Guidance* (USEPA, 2003c). The latter of these documents clarifies USEPA Region III's implementation of USEPA's interim draft document, *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E: Supplemental Guidance for Dermal Risk Assessment* (USEPA, 2001a). When comparing the USEPA Region III dermal absorption factors to values in the USEPA's RAGS, Part E, the values for the majority of the COPCs differed **(Table 6-7)**. For example, the default dermal absorption factor for inorganics is 1 percent (USEPA, 1995b; 2003c). However, USEPA's *RAGS, Part E* (USEPA 2001a), states that the speciation of the compound is critical to the dermal absorption of inorganics and there are too little data to extrapolate a reasonable default value. Very limited information is available on dermal absorption of chemicals from contacted soil under realistic environmental conditions. In fact, there are no actual human epidemiological data to support the hypothesis that absorption of soil-bound compounds under realistic exposure conditions is a complete route of exposure. For example, the Public Health Statements from the Agency for Toxic Substances and Disease Registry's (ATSDR's) indicates that cadmium is not known to result in human health effects because virtually no cadmium 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) (ATSDR, 1999). Therefore, the impact of using the dermal absorption factors to evaluate dermal absorption exposures is not known.

6.6 HHRA Summary

This HHRA was performed to evaluate the potential human health effects associated with chemical contamination from past operations at Building 4343. For the purposes of the HHRA, surface soil and total soil were evaluated.

Table 6-7
Dermal Absorption Factors

COPC	USEPA Region III Dermal Absorption Factor[a,b]	USEPA RAGS Part E Dermal Absorption Factor[c]
Polychlorinated Biphenyls (PCBs)	0.14[c]	0.14
Aluminum	0.01	d
Antimony	0.01	d
Cadmium	0.001	0.001
Chromium III	0.01	d
Copper	0.01	d
Iron	0.01	d
Lead	0.01	d
Manganese	0.01	d
Thallium	0.01	d
Vanadium	0.01	d

a) Assessing Dermal Exposure from Soil. Hazardous Waste Management Division. Office of Superfund Programs. USEPA Region III, Philadelphia, PA. (USEPA, 1995b)
b) Updated Dermal Exposure Assessment Guidance. Mid-Atlantic Hazardous Site Cleanup. Office of Superfund Programs. USEPA Region III, Philadelphia, PA. June. (USEPA, 2003c)
c) Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Interim. (USEPA, 2001a)
d) No default value is given.

The HHRA was performed for both current and future land-use conditions. Under current land-use conditions, maintenance worker exposures to surface soil were evaluated. Although exposures to trespassers were considered, it is unlikely that a trespasser would have access to Building 4343 due to security at the Installation. However, the maintenance worker scenario would be similar to the limited exposure that a trespasser could experience at the site and would be protective of the trespasser.

Under future conditions, maintenance worker exposures to surface soil and maintenance worker and excavation worker exposures to total soil were evaluated. Exposures to surface soil by a maintenance worker were assumed to be the same under future land-use conditions as those under current land-use conditions. In addition, adult resident and child resident exposures to total soil were evaluated under future conditions.

Upper-bound excess lifetime cancer risks and non-cancer HIs were estimated for the exposure pathways and data groupings described above. Estimations of non-cancer HIs and excess lifetime cancer risks and non-cancer HIs for maintenance worker, excavation worker, resident adult, and resident child exposures evaluated in the HHRA are presented in **Appendix E-1, Tables E-17 through E-26**. Summaries of upper-bound excess lifetime cancer risks and non-cancer HIs for exposures evaluated in the HHRA are presented in **Appendix E-1, Tables E-27 through E-31**; the predominant exposure pathways and COPCs are shown in **Appendix E-1, Tables E-32 through E-36**. These results are summarized for each receptor group.

Maintenance Worker. For the current and future maintenance worker exposures at Building 4343, the risk characterization results showed total cancer risk associated with surface soil was within the target risk range. The total HI for the maintenance worker's exposure to surface soil exceeded 1, due to cadmium.

For the future maintenance worker exposures at Building 4343, the risk characterization results showed total cancer risk associated with total soil was below the target risk range. The total HI is less than 1.

Excavation Worker. For the future excavation worker, the risk characterization results showed total cancer risk associated with total soil was below the target risk range. The total HI exceeded 1, primarily due to cadmium.

Adult Resident. For the future adult resident, the risk characterization results showed total cancer risks associated with total soil were below the target risk range. The total HI was greater than 1, primarily due to cadmium.

Child Resident. For the future child resident, the risk characterization results showed total cancer risks associated with total soil were below the target risk range. The total HI was greater than 1, primarily due to cadmium and iron. Based on a margin of exposure evaluation for iron, however, the intake calculated for total soil at Building 4343 is within the allowable range.

7.0 ECOLOGICAL RISK ASSESSMENT

A SLERA was performed to provide an estimate of current and future ecological risk associated with potential hazardous substance releases at Building 4343. The results of the SLERA contribute to the overall characterization of the site and the scientific/management decision point (SMDP) reached from the 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; or,
- The information collected and presented indicates that a more thorough assessment is warranted.

The SLERA has been performed following the *RFAAP Final Master Work Plan* (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: Process for Designing and Conducting Ecological Risk Assessments* (USEPA, 1997d). Steps 1, 2, and 3a have been completed as part of the SLERA. The addition of Step 3a focuses the outcome of the SLERA, streamlines the review process, and allows one document to function as the initial forum for ecological risk management decision making at Building 4343.

The primary objective of the SLERA 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. This objective is met by characterizing the ecological communities in the vicinity of Building 4343, assessing the particular hazardous substances being released, identifying pathways for receptor exposure, and estimating the magnitude and likelihood of potential risk to identified receptors. The SLERA addresses 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 Building 4343.

Concentrations of chemicals have been measured in relevant environmental media including soil. No groundwater data have been collected in association with Building 4343 [as groundwater is being assessed under MWP Addendum 009, "Horseshoe Area Groundwater Study" (IT, 2002b)], however, groundwater data are irrelevant for this site as groundwater does not discharge to the surface in the vicinity of the Building 4343 and there is no potential exposure for ecological receptors to groundwater. Although area-wide groundwater does ultimately discharge to the New River, groundwater is being assessed as a separate operable unit. Using available concentration data, a SLERA has been performed by following Steps 1 and 2 of USEPA (1997), where 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: Site Characterization (*Section 7.1*); Identification of Chemicals of Potential Ecological Concern (COPECs) and Concentration Statistics (*Section 7.2*); Identification of Exposure Pathways and Potential Receptors for Analysis (Section 7.3); Identification of Assessment and Measurement Endpoints (*Section 7.4*); Exposure Estimation

and Risk Characterization (*Section 7.5*); Uncertainty Analysis (*Section 7.6*); and, Results and Conclusions (*Section 7.7*).

7.1 Site Characterization

This site characterization section includes a general discussion of Building 4343 itself, vegetative communities, a species inventory, and a discussion on threatened and endangered species.

Building 4343, the Former Cadmium Plating Facility, is situated in the Horseshoe Area. Building 4343 was originally designated as the Fire Water Pump House. The building was used to house a 5-inch, one-stage, 500-gallon/minute gasoline-powered pump. A 550-gallon UST, located approximately 40 ft south of the building, was used to store the pump fuel. In 1956, the building was converted to conduct cadmium plating operations in support of the NIKE missile program. Conversion activities included the installation of a drying cabinet, cadmium plating baths, an exterior lead catch tank, and an exhaust system. In 1998, the 550-gallon UST used to store the pump fuel was removed **(Appendix G-1)**.

7.1.1 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 habit 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; and,
- water.

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

An earlier comprehensive inventory of the mammals, birds, reptiles, aquatic invertebrates, trees, and plants found on the Installation, and of fish inhabiting the New River where it flows through the Installation, was conducted in 1976 during the RFAAP Installation Assessment (USATHAMA, 1976). Information from that assessment was summarized in previous documents (Dames & 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. However, indications are that some species, including ruffed grouse and upland plovers, have decreased in number or have disappeared from RFAAP. Foxes, which were once trapped to prevent rabies outbreaks (the last trapping program for foxes was conducted in 1966), were reintroduced to RFAAP as a control for groundhogs. Deer are common at RFAAP and bow hunting has been allowed at the facility since 1991. Migratory waterfowl are found throughout the spring and winter near the New River because the Installation is on the Atlantic Flyway. Federally protected black vultures are present at RFAAP during certain times of the year. Between 1,500 and 3,000 of these migratory birds nest in thickets on the facility (Washington Post, 1995).

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

- Plant species - six endangered, three threatened;
- Mollusk species - one endangered, one threatened;
- Insect species - one endangered, four threatened;
- Bird species - three endangered; and,
- 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.

According to the RFAAP Installation Assessment (USATHAMA, 1976), timber harvesting occurred at RFAAP in the past. The most recent harvest was conducted in 1987. 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). In 1964, 922 acres of the Horseshoe Area were reforested. No reforestation has occurred in the Main Manufacturing Area.

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

Table 7-1
Ecoregions of RFAAP

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

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

The Building 4343 study area, limited to 0.94 acres in size (as defined by the approximate area of soil samples collected at the site), is situated on the top of a small hill. The area surrounding the building is mowed grass at an elevation of approximately 1,830 ft msl. The area is mowed on an infrequent basis to eliminate woody plants. Surface water runoff flows to the north to an east-west trending storm water drainage ditch that grades to approximately 1,810 ft msl.

Based on site reconnaissance performed by an ecologist in June 2002, a photographic record was prepared **(Appendix F-1)**. An aerial photograph of the surrounding land use is presented in **Appendix F-1, Photo 3**. Prior to arrival at the site, 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 the site. 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 site 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.

7.1.2 Surface Water

If present, surface water would drain north to the east-west trending storm water drainage ditch. However, there is no surface water or aquatic habitat at the site. The drainage ditches are ephemerally influenced by rain events.

7.1.3 Wetlands

According to the information presented in the Virginia Department of Game and Inland Fisheries (1999) Installation-Wide Biological Survey, and confirmed during the site reconnaissance, there are no designated wetlands at Building 4343.

7.1.4 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 during the site reconnaissance trip. As shown in **Appendix F-1, Photos 1 through 8**, the area is primarily maintained grass. Some areas of bare soil exist along the north-south trending ditch and within the alluvial fan at the base of the hill where the ditch merges with the east-west trending storm water drainage ditch.

These habitat types 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, resting, and loafing activities, depending on the season. The bare soil areas themselves would not be expected to provide suitable habitat for most species of wildlife.

Based on information from the Virginia Department of Game and Inland Fisheries (1999) Installation-Wide Biological Survey, and confirmed during the site reconnaissance, 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. Trees or shrubs may be present individually or in small groups, but a canopy is lacking. At Building 4343, there are no trees or shrubs present. Where shrub invasion has progressed to form larger patches (as in other areas near Building 4343), a shrubland subtype is recognizable. Old fields, in most cases, are dominated by native, warm-season species with a wide variety of other grasses, sedges, and herbs mixed in. The two dominants are little bluestem (*Schizachyrium scoparium*) and broomsedge (*Andropogon virginicus*) with others such as *Tridens flavus, Panicum oligosanthes, Panicum anceps, Eragrostis spectabilis, Setaria glauca, Sorghastrum nutans,* and *Paspalum* being frequent. Much of the old field community is mowed (on an infrequent basis) to help keep woody 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.*

The grassed area adjacent to Building 4343 is similar to the grassland communities at RFAAP that 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).

During the site reconnaissance, the study area was examined for vegetative stress, including looking for plants displaying stunted growth, poor foliage growth, tissue discoloration, and a loss of leaf coverage. Vegetative stress attributable to chemicals was not observed. A few locations were devoid of vegetation; however, these areas occurred in locations of wet weather flow or within sediment depositional areas (e.g., the alluvial fan) (see bare soil areas in **Appendix F-1, Photos 6 and 8**).

7.1.5 Species Inventory

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

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

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

7.1.6 Threatened, Rare and Endangered Species Information

Threatened, rare, or endangered species found within the grassland community type at RFAAP included those presented in **Table 7-3** (Virginia Department of Game and Inland Fisheries [1999] Installation-Wide Biological Survey).

None of these species were observed during the site reconnaissance; however, their occurrence is possible given the existing habitat type. Although a unique community type (the calcareous fen) exists within the RFAAP grassland community type, it is not found at or near Building 4343.

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

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

7.2 Identification of Chemicals of Potential Ecological Concern and Concentration Statistics

A list of surface soil samples used in the SLERA is presented in **Table 7-4**. It should be noted that data from two sump samples (both under metal grates, with one located within Building 4343 and one located just outside the building) have not been included, as ecological exposure to chemical constituents in these sumps is highly unlikely.

Table 7-4
Surface Soil Samples Used in the Building 4343 SLERA

B43SS01	B43SSB14
B43SS02	B43SSB15
B43SS03	B43SSB16
B43SSB4	B43SSB17
B43SSB5	B43SSB18
B43SSB6	B43SSB28
B43SSB7	B43SSD1
B43SSB8	B43SSD2
B43SSB9	B43SSD3
B43SSB10	B43SSD4
B43SSB11	B43SSD4D
B43SSB12	B43SSD5
B43SSB13	B43SSD6
B43SB34A	B43SB35A

Note: sample identifications that end in "D" are sample duplicates.

The uncertainties of excluding these sump sample data are discussed in the Uncertainty Analysis section (*Section 7.6*). From the chemical results of samples on the list in **Table 7-4**, a subset of the chemicals detected have data of good quality and are not a result of non-site sources. Examples of screening criteria that have been used include the following: analytical detection limit **(Tables 7-5 and 7-6)**; and comparison with risk-based ecotoxicity screening values [based on Biological Technical Assistance Group (BTAG) Screening Levels **(Table 7-5)** and other screening levels appropriate for food-chain exposure, based on information presented in **Table 7-7**]. The COPEC selection process is described in more detail in the following subsections. A discussion of nondetected constituent concentrations compared with ecotoxicity screening values is presented in the Uncertainty Analysis section (*Section 7.6*).

7.2.1 Data Organization

The data for each chemical have been sorted by medium. To assess potential ecological impacts, soil from 0-2 ft bgs have been considered. The 0-2 ft depth interval was selected for three primary reasons: (1) to maintain consistency with other RFAAP ecological risk assessment documents that used 0-2 ft, or a similar depth interval (e.g., *Ecological Risk Assessment Approach*, IT, 1998; *Screening Ecological Risk Assessment*, IT, 1999); (2) to address the most important ecological soil depth exposure interval, as soil depths below two feet would be infrequently contacted; and, (3) to focus on the soil depth interval expected to have the highest COPEC concentrations, as discharges at Building 4343 were surficial. Although some burrowing wildlife (e.g., the red fox) may actually burrow to depths greater than two feet, 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 have not been included in the risk assessment, although nondetect constituents are discussed in the Uncertainty Analysis section (*Section 7.6*). Available background data exist for soil, as summarized in the Site Screening Process (USEPA, 2001c), and these data are used in the Risk Characterization (*Section 7.5.3*) to screen out COPECs considered to be background related (*Section 7.2.4*).

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 are from USEPA (1989) and are discussed in *Section 6.1.1*, along with other data issues. Besides taking into account the ecological depth of interest, the methodology for data summary was identical between the SLERA and the HHRA (*Section 6.0*).

7.2.2 Descriptive Statistical Calculations

Because of the uncertainty associated with characterizing contamination in environmental media, the 95 percent UCL of the mean has been estimated for chemicals selected as COPECs **(Table 7-8)**. The calculation of EPCs follows the same procedure used for the HHRA (*Section 6.2.2*).

7.2.3 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.

Table 7-5
Occurence, Distribution, and Selection of COPECs at Building 4343 for Direct Contact

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

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Screening Toxicity Value (2)	COPEC Flag (Y/N)	Rationale for Selection or Deletion (3)
Surface Soil	7429-90-5	Aluminum	552	25100	mg/kg	B43SSB10	25/25	N/A	25100	1	N	pH
0-2 ft.	7440-36-0	Antimony	41.2J	41.2	mg/kg	B43SSD1	1/25	0.2000-5.3000	41.2	0.48	Y	ASL
	7440-38-2	Arsenic	2.05	4.97	mg/kg	B43SS01	4/25	1.4000-5.6000	4.97	328	N	BSL
	7440-39-3	Barium	26.7	242	mg/kg	B43SSD1	25/25	N/A	242	440	N	BSL
	7440-41-7	Beryllium	0.22K	0.57	mg/kg	B43SS02	5/25	0.1000-1.1000	0.57	0.02	Y	ASL
	7440-43-9	Cadmium	0.5J	24300	mg/kg	B43SSD1	23/25	0.1200-0.1300	24300	2.5	Y	ASL
	7440-70-2	Calcium	270J	91000	mg/kg	B43SSB11	25/25	N/A	91000	NVA	N	NUT
	7440-47-3	Chromium	4.2	1820	mg/kg	B43SSD1	25/25	N/A	1820	0.0075	Y	ASL
	7440-48-4	Cobalt	2.2K	19.8	mg/kg	B43SSB18	23/24	0.1300-0.1300	19.8	100	N	BSL
	7440-50-8	Copper	8.6	677	mg/kg	B43SSD1	25/25	N/A	677	15	Y	ASL
	7439-89-6	Iron	2340	51400	mg/kg	B43SSB10	25/25	N/A	51400	12	Y	ASL
	7439-92-1	Lead	3.1	1410	mg/kg	B43SSD1	25/25	N/A	1410	0.01	Y	ASL
	7439-95-4	Magnesium	240J	19400	mg/kg	B43SS01	25/25	N/A	19400	4,400	Y	ASL
	7439-96-5	Manganese	70.5	642	mg/kg	B43SSB18	25/25	N/A	642	330	Y	ASL
	7439-97-6	Mercury (Inorganic)	0.025L	0.53	mg/kg	B43SSB9	7/25	0.1000-0.1300	0.53	0.058	Y	ASL
	7440-02-0	Nickel	2.9J	32.6	mg/kg	B43SSD1	24/25	0.1000-0.1000	32.6	2	Y	ASL
	7440-09-7	Potassium	285.5J	2050	mg/kg	B43SSB18	25/25	N/A	2050	NVA	N	NUT
	7782-49-2	Selenium	0.6	1.1	mg/kg	B43SSB11	2/25	0.4700-1.1700	1.1	1.8	N	BSL
	7440-22-4	Silver	0.87J	36	mg/kg	B43SSD1	2/25	0.1000-0.7300	36	0.0000098	Y	ASL
	7440-23-5	Sodium	39.1	138	mg/kg	B43SSB4	5/25	8.5000-443.0000	138	NVA	N	NUT
	7440-28-0	Thallium	0.09J	0.18	mg/kg	B43SS01	3/25	0.7200-0.9200	0.18	0.001	Y	ASL
	57-12-5	Total Cyanide	14.1	14.8	mg/kg	B43SSB5	2/17	0.2000-0.2600	14.8	0.005	Y	ASL
	7440-62-2	Vanadium	5.7K	108	mg/kg	B43SSB10	25/25	N/A	108	0.5	Y	ASL
	7440-66-6	Zinc	19.1	1780	mg/kg	B43SSD1	24/24	N/A	1780	10	Y	ASL
	7440-44-0	Total Organic Carbon	3950	6160	mg/kg	B43SSD5	3/3	N/A	6160	NVA	N	PHYS
	72-54-8	4,4'-DDD	0.000479J	0.00057J	mg/kg	B43SB34A	2/2	N/A	0.00057	0.1	N	BSL
	50-29-3	4,4'-DDT	0.0153	0.0218	mg/kg	B43SB35A	2/2	N/A	0.0218	0.1	N	BSL
	33213-65-9	Endosulfan II	0.00226	0.00246	mg/kg	B43SB35A	2/2	N/A	0.00246	NVA	Y	TX
	72-20-8	Endrin	0.000498J	0.000498J	mg/kg	B43SB34A	1/2	0.0007-0.0007	0.000498	0.1	N	BSL
	7421-93-4	Endrin aldehyde	0.00289J	0.00289J	mg/kg	B43SB35A	1/2	0.0007-0.0007	0.00289	NVA	Y	TX
	72-43-5	Methoxychlor	0.00197	0.00197	mg/kg	B43SB34A	1/2	0.0007-0.0007	0.00197	0.1	N	BSL
	11097-69-1	Aroclor 1254	0.0212J	0.344	mg/kg	B43SB35A	4/4	N/A	0.344	0.1	Y	ASL
	91-57-6	2-Methylnaphthalene	0.011	0.011	mg/kg	B43SB35A	1/1	N/A	0.011	NVA	Y	TX
	208-96-8	Acenaphthylene	0.00077J	0.0069	mg/kg	B43SB35A	2/2	N/A	0.0069	0.1	N	BSL
	120-12-7	Anthracene	0.0034	0.0034	mg/kg	B43SB35A	1/2	0.0019-0.0019	0.0034	0.1	N	BSL
	56-55-3	Benzo(a)anthracene	0.0031	0.0087	mg/kg	B43SB35A	2/2	N/A	0.0087	0.1	N	BSL
	50-32-8	Benzo(a)pyrene	0.0031	0.0074	mg/kg	B43SB35A	2/2	N/A	0.0074	0.1	N	BSL
	205-99-2	Benzo(b)fluoranthene	0.0076	0.027	mg/kg	B43SB35A	2/2	N/A	0.027	0.1	N	BSL
	191-24-2	Benzo(g,h,i)perylene	0.0033	0.0065	mg/kg	B43SB35A	2/2	N/A	0.0065	0.1	N	BSL
	207-08-9	Benzo(k)fluoranthene	0.002	0.0081	mg/kg	B43SB35A	2/2	N/A	0.0081	0.1	N	BSL
	218-01-9	Chrysene	0.0073	0.016	mg/kg	B43SB35A	2/2	N/A	0.016	0.1	N	BSL
	53-70-3	Dibenz(a,h)anthracene	0.0008J	0.0019J	mg/kg	B43SB35A	2/2	N/A	0.0019	0.1	N	BSL
	206-44-0	Fluoranthene	0.0093	0.015	mg/kg	B43SB35A	2/2	N/A	0.015	0.1	N	BSL

Table 7-5
Occurence, Distribution, and Selection of COPECs at Building 4343 for Direct Contact

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

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Screening Toxicity Value (2)	COPEC Flag (Y/N)	Rationale for Selection or Deletion (3)
	86-73-7	Fluorene	0.0047	0.0047	mg/kg	B43SB35A	1/2	0.0019-0.0019	0.0047	0.1	N	BSL
	193-39-5	Indeno(1,2,3-cd)pyrene	0.0033	0.0084	mg/kg	B43SB35A	2/2	N/A	0.0084	0.1	N	BSL
	91-20-3	Naphthalene	0.011	0.011	mg/kg	B43SB35A	1/2	0.0027-0.0027	0.011	0.1	N	BSL
	85-01-8	Phenanthrene	0.0071	0.012	mg/kg	B43SB35A	2/2	N/A	0.012	0.1	N	BSL
	129-00-0	Pyrene	0.013J	0.02J	mg/kg	B43SB35A	2/2	N/A	0.02	0.1	N	BSL

(1) Maximum concentration used for screening.

(2) Screening toxicity values from BTAG (1995).

(3) Rationale Codes Selection Reason:
- Infrequent Detection but Associated Historically (HIST)
- Toxicity Information May Be Available (TX)
- Above Screening Levels (ASL)
- Elevated Detected Concentration (EDC)

Deletion Reason:
- Infrequent Detection (<= 5%, IFD)
- Below Screening Level (BSL)
- Nutrient (NUT)
- Soil pH > 5.5 (pH)
- Physical/Chemical (PHYS)

Definitions:
- N/A = Not Applicable or Not Available
- SQL = Sample Quantitation Limit
- COPEC = Chemical of Potential Ecological Concern
- J = Estimated Value
- K = Result May Be Biased High.
- NVA = No Value Available

Table 7-6
Occurrence, Distribution, and Selection of COPECs at Building 4343 for Food Chain Modeling

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

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Screening Toxicity Value (2)	COPEC Flag (Y/N)	Rationale for Selection or Deletion (3)
Surface Soil	7429-90-5	Aluminum	552	25100	mg/kg	B43SSB10	25/25	N/A	25100	NVA	No	NIBC,
0-2 ft.	7440-36-0	Antimony	41.2J	41.2	mg/kg	B43SSD1	1/25	0.2000-5.3000	41.2	5	Yes	ASL,
	7440-38-2	Arsenic	2.05	4.97	mg/kg	B43SS01	4/25	1.4000-5.6000	4.97	9.9	No	BSL,
	7440-39-3	Barium	26.7	242	mg/kg	B43SSD1	25/25	N/A	242	283	No	BSL,
	7440-41-7	Beryllium	0.22K	0.57	mg/kg	B43SS02	5/25	0.1000-1.1000	0.57	10	No	BSL,
	7440-43-9	Cadmium	0.5J	24300	mg/kg	B43SSD1	23/25	0.1200-0.1300	24300	4	Yes	ASL,
	7440-70-2	Calcium	270J	91000	mg/kg	B43SSB11	25/25	N/A	91000	NVA	No	NUT
	7440-47-3	Chromium	4.2	1820	mg/kg	B43SSD1	25/25	N/A	1820	0.4	Yes	ASL,
	7440-48-4	Cobalt	2.2K	19.8	mg/kg	B43SSB18	23/24	0.1300-0.1300	19.8	20	No	BSL,
	7440-50-8	Copper	8.6	677	mg/kg	B43SSD1	25/25	N/A	677	60	Yes	ASL,
	7439-89-6	Iron	2340	51400	mg/kg	B43SSB10	25/25	N/A	51400	NVA	Yes	TX
	7439-92-1	Lead	3.1	1410	mg/kg	B43SSD1	25/25	N/A	1410	40.5	Yes	ASL
	7439-95-4	Magnesium	240J	19400	mg/kg	B43SS01	25/25	N/A	19400	NVA	No	NUT
	7439-96-5	Manganese	70.5	642	mg/kg	B43SSB18	25/25	N/A	642	NVA	No	NIBC,
	7439-97-6	Mercury (Inorganic)	0.025L	0.53	mg/kg	B43SSB9	7/25	0.1000-0.1300	0.53	0.00051	Yes	ASL,
	7440-02-0	Nickel	2.9J	32.6	mg/kg	B43SSD1	24/25	0.1000-0.1000	32.6	30	Yes	ASL,
	7440-09-7	Potassium	285.5J	2050	mg/kg	B43SSB18	25/25	N/A	2050	NVA	No	NUT
	7782-49-2	Selenium	0.6	1.1	mg/kg	B43SSB11	2/25	0.4700-1.1700	1.1	0.21	Yes	ASL
	7440-22-4	Silver	0.87J	36	mg/kg	B43SSD1	2/25	0.1000-0.7300	36	2	Yes	ASL
	7440-23-5	Sodium	39.1	138	mg/kg	B43SSB4	5/25	8.5000-443.0000	138	NVA	No	NUT
	7440-28-0	Thallium	0.09J	0.18	mg/kg	B43SS01	3/25	0.7200-0.9200	0.18	1	No	BSL,
	57-12-5	Total Cyanide	14.1	14.8	mg/kg	B43SSB5	2/17	0.2000-0.2600	14.8	1.33	Yes	ASL
	7440-62-2	Vanadium	5.7K	108	mg/kg	B43SSB10	25/25	N/A	108	2	No	NIBC,
	7440-66-6	Zinc	19.1	1780	mg/kg	B43SSD1	24/24	N/A	1780	8.5	Yes	ASL
	7440-44-0	Total Organic Carbon	3950	6160	mg/kg	B43SSD5	3/3	N/A	6160	NVA	No	PHYS
	72-54-8	4,4'-DDD	0.000479J	0.00057J	mg/kg	B43SB34A	2/2	N/A	0.00057	0.75815	No	BSL,
	50-29-3	4,4'-DDT	0.0153	0.0218	mg/kg	B43SB35A	2/2	N/A	0.0218	0.0175	Yes	ASL
	33213-65-9	Endosulfan II	0.00226	0.00246	mg/kg	B43SB35A	2/2	N/A	0.00246	0.11927	No	BSL,
	72-20-8	Endrin	0.000498J	0.000498J	mg/kg	B43SB34A	1/2	0.0007-0.0007	0.000498	0.0101	No	BSL,
	7421-93-4	Endrin aldehyde	0.00289J	0.00289J	mg/kg	B43SB35A	1/2	0.0007-0.0007	0.00289	0.0105	No	BSL,
	72-43-5	Methoxychlor	0.00197	0.00197	mg/kg	B43SB34A	1/2	0.0007-0.0007	0.00197	0.01988	No	BSL,
	11097-69-1	Aroclor 1254	0.0212J	0.344	mg/kg	B43SB35A	4/4	N/A	0.344	0.371	No	BSL,
	91-57-6	2-Methylnaphthalene	0.011	0.011	mg/kg	B43SB35A	1/1	N/A	0.011	3.24	No	BSL,
	208-96-8	Acenaphthylene	0.00077J	0.0069	mg/kg	B43SB35A	2/2	N/A	0.0069	682	No	BSL,
	120-12-7	Anthracene	0.0034	0.0034	mg/kg	B43SB35A	1/2	0.0019-0.0019	0.0034	1480	No	BSL,
	56-55-3	Benzo(a)anthracene	0.0031	0.0087	mg/kg	B43SB35A	2/2	N/A	0.0087	5.21	No	BSL,
	50-32-8	Benzo(a)pyrene	0.0031	0.0074	mg/kg	B43SB35A	2/2	N/A	0.0074	1.52	No	BSL,
	205-99-2	Benzo(b)fluoranthene	0.0076	0.027	mg/kg	B43SB35A	2/2	N/A	0.027	59.8	No	BSL,
	191-24-2	Benzo(g,h,i)perylene	0.0033	0.0065	mg/kg	B43SB35A	2/2	N/A	0.0065	119	No	BSL,
	207-08-9	Benzo(k)fluoranthene	0.002	0.0081	mg/kg	B43SB35A	2/2	N/A	0.0081	148	No	BSL,
	218-01-9	Chrysene	0.0073	0.016	mg/kg	B43SB35A	2/2	N/A	0.016	4.73	No	BSL,
	53-70-3	Dibenz(a,h)anthracene	0.0008J	0.0019J	mg/kg	B43SB35A	2/2	N/A	0.0019	18.4	No	BSL,
	206-44-0	Fluoranthene	0.0093	0.015	mg/kg	B43SB35A	2/2	N/A	0.015	122	No	BSL,

Table 7-6
Occurrence, Distribution, and Selection of COPECs at Building 4343 for Food Chain Modeling

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

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Screening Toxicity Value (2)	COPEC Flag (Y/N)	Rationale for Selection or Deletion (3)
	86-73-7	Fluorene	0.0047	0.0047	mg/kg	B43SB35A	1/2	0.0019-0.0019	0.0047	122	No	BSL,
	193-39-5	Indeno(1,2,3-cd)pyrene	0.0033	0.0084	mg/kg	B43SB35A	2/2	N/A	0.0084	109	No	BSL,
	91-20-3	Naphthalene	0.011	0.011	mg/kg	B43SB35A	1/2	0.0027-0.0027	0.011	0.09939	No	BSL,
	85-01-8	Phenanthrene	0.0071	0.012	mg/kg	B43SB35A	2/2	N/A	0.012	45.7	No	BSL,
	129-00-0	Pyrene	0.013J	0.02J	mg/kg	B43SB35A	2/2	N/A	0.02	78.5	No	BSL,

(1) Maximum concentration used for screening.

(2) Screening toxicity values from USEPA SSLs (2000); Efroymson et al., PRGs (1997); and USEPA Region V EDQLs (1999). See text for derivation.

(3) Rationale Codes Selection Reason:
- Infrequent Detection but Associated Historically (HIST)
- Toxicity Information May Be Available (TX)
- Above Screening Levels (ASL)
- Elevated Detected Concentration (EDC)

Deletion Reason:
- Infrequent Detection (<= 5%, IFD)
- Not Important Bioaccumulative Constituent (NIBC), per USEPA (2000)
- Below Screening Level (BSL)
- Nutrient (NUT)
- Soil pH > 5.5 (pH)
- Physical/Chemical (PHYS)

Definitions:
- N/A = Not Applicable or Not Available
- SQL = Sample Quantitation Limit
- COPEC = Chemical of Potential Ecological Concern
- J = Estimated Value
- K = Result May Be Biased High.
- NVA = No Value Available

Table 7-7
Selection of Building 4343 Ecological Screening Toxicity Values For Food Chain Modeling

Parameter *(only detected constituents listed)*	**Ecological Soil Screening Levels[a] (mg/kg)**	**Ecological Preliminary Remediation Goals[b] (mg/kg)**	**Ecological Data Quality Levels[c] (mg/kg)**	**Selected Ecological Screening Toxicity Value[d] (mg/kg)**
Aluminum	NVA[e]	NVA	NVA	NVA
Antimony	$21_{(mammal)}$	$5_{(plant)}$	0.1423	5
Arsenic	$37_{(plant)}$	$9.9_{(mammal, plant)}$	5.7	9.9
Barium	NVA	283	1.04	283
Beryllium	NVA	10	1.06	10
Cadmium	$29_{(plant)}$	$4_{(plant, bird)}$	0.00222	4
Calcium	NVA	NVA	NVA	Nutrient
Chromium	$5_{(plant)}$	$0.4_{(earthworm)}$	0.4	0.4
Cobalt	$32_{(bird)}$	$20_{(plant)}$	0.14033	20
Copper	$61_{(earthworm)}$	$60_{(earthworm)}$	0.3132	60
Iron	NVA	NVA	NVA	NVA
Lead	NVA	40.5	0.05373	40.5
Magnesium	NVA	NVA	NVA	Nutrient
Manganese	NVA	NVA	NVA	NVA
Mercury (Inorganic)	NVA	0.00051	0.1	0.00051
Nickel	NVA	30	13.6	30
Potassium	NVA	NVA	NVA	Nutrient
Selenium	NVA	0.21	0.02765	0.21
Silver	NVA	2	4.04	2
Sodium	NVA	NVA	NVA	Nutrient
Thallium	NVA	1	0.05692	1
Total Cyanide	NVA	NVA	1.33	1.33
Vanadium	NVA	2	1.59	2
Zinc	$120_{(earthworm)}$	$8.5_{(bird)}$	6.62	8.5
4,4'-DDD	NVA	NVA	0.75815	0.75815
4,4'-DDT	NVA	NVA	0.0175	0.0175
Endosulfan II	NVA	NVA	0.11927	0.11927
Endrin	NVA	NVA	0.0101	0.0101
Endrin Aldehyde	NVA	NVA	0.0105	0.0105
Methoxychlor	NVA	NVA	0.01988	0.01988
Aroclor 1254	NVA	0.371	0.000332	0.371
2-Methylnaphthalene	NVA	NVA	3.24	3.24
Acenaphthylene	NVA	NVA	682	682
Anthracene	NVA	NVA	1480	1480
Benzo(a)anthracene	NVA	NVA	5.21	5.21
Benzo(a)pyrene	NVA	NVA	1.52	1.52
Benzo(b)fluoranthene	NVA	NVA	59.8	59.8
Benzo(g,h,i)perylene	NVA	NVA	119	119
Benzo(k)fluoranthene	NVA	NVA	148	148
Chrysene	NVA	NVA	4.73	4.73
Dibenz(a,h)anthracene	NVA	NVA	18.4	18.4
Fluoranthene	NVA	NVA	122	122
Fluorene	NVA	NVA	122	122
Indeno(1,2,3-cd)pyrene	NVA	NVA	109	109
Naphthalene	NVA	NVA	0.09939	0.09939
Phenanthrene	NVA	NVA	45.7	45.7
Pyrene	NVA	NVA	78.5	78.5

a Ecological Soil Screening Level Guidance, USEPA, July 2000, Draft.

b Preliminary Remediation Goals for Ecological Endpoints, R. A. Efroymson, et. al., August 1997.

c Ecological Data Quality Levels, USEPA Region 5, October 1999.

d The following hierarchy was utilized to select the final Ecological Screening Toxicity Values for this assessment:

1. The lower value of either the Ecological Soil Screening Level Guidance or the Preliminary Remediation Goals for Ecological Endpoints.
2. Ecological Data Quality Levels, USEPA Region 5

e NVA = No Value Available

Table 7-8
Exposure Point Concentration Summary for Building 4343 Ecological Receptors
Reasonable Maximum Exposure

Scenario Timeframe: CURRENT/FUTURE
Medium: SOIL
Exposure Medium: SOIL

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
SURFACE SOIL (0-2 FEET)	2-Methylnaphthalene	mg/kg	1.10E-02	N/A	1.10E-02	1.10E-02	mg/kg	Max	W-Test(3)
	4,4'-DDT	mg/kg	1.86E-02	N/A	2.18E-02	2.18E-02	mg/kg	Max	W-Test(3)
	Antimony	mg/kg	2.25E+00	3.89E+00 (NP)	4.12E+01	3.89E+00	mg/kg	95%UCL-Bst	W-Test(1)
	Aroclor-1254	mg/kg	1.12E-01	3.45E+01 (T)	3.44E-01	3.44E-01	mg/kg	Max	W-Test(3)
	Beryllium	mg/kg	1.81E-01	2.41E-01 (NP)	5.70E-01	2.41E-01	mg/kg	95%UCL-Bst	W-Test(1)
	Cadmium	mg/kg	1.08E+03	5.17E+04 (T)	2.43E+04	2.43E+04	mg/kg	Max	W-Test(5)
	Chromium	mg/kg	1.45E+02	2.23E+02 (T)	1.82E+03	2.23E+02	mg/kg	95%UCL-T	W-Test(2)
	Copper	mg/kg	5.79E+01	8.50E+01 (NP)	6.77E+02	8.50E+01	mg/kg	95%UCL-Bst	W-Test(1)
	Cyanide	mg/kg	1.81E+00	3.44E+00 (NP)	1.48E+01	3.44E+00	mg/kg	95%UCL-Bst	W-Test(1)
	Endosulfan II	mg/kg	2.36E-03	N/A	2.46E-03	2.46E-03	mg/kg	Max	W-Test(3)
	Endrin aldehyde	mg/kg	1.63E-03	N/A	2.89E-03	2.89E-03	mg/kg	Max	W-Test(3)
	Iron	mg/kg	2.99E+04	3.42E+04 (N)	5.14E+04	3.42E+04	mg/kg	95%UCL-N	W-Test(4)
	Lead	mg/kg	7.72E+01	1.33E+02 (NP)	1.41E+03	1.33E+02	mg/kg	95%UCL-Bst	W-Test(1)
	Magnesium	mg/kg	2.74E+03	5.32E+03 (T)	1.94E+04	5.32E+03	mg/kg	95%UCL-T	W-Test(2)
	Manganese	mg/kg	2.70E+02	3.75E+02 (T)	6.42E+02	3.75E+02	mg/kg	95%UCL-T	W-Test(2)
	Mercury	mg/kg	1.00E-01	1.26E-01 (NP)	5.30E-01	1.26E-01	mg/kg	95%UCL-Bst	W-Test(1)
	Nickel	mg/kg	9.47E+00	1.16E+01 (NP)	3.26E+01	1.16E+01	mg/kg	95%UCL-Bst	W-Test(1)
	Selenium	mg/kg	3.44E-01	4.29E-01 (NP)	1.10E+00	4.29E-01	mg/kg	95%UCL-Bst	W-Test(1)
	Silver	mg/kg	1.64E+00	3.08E+00 (NP)	3.60E+01	3.08E+00	mg/kg	95%UCL-Bst	W-Test(1)
	Thallium	mg/kg	3.92E-01	4.78E-01 (NP)	1.80E-01	1.80E-01	mg/kg	Max	W-Test(5)
	Vanadium	mg/kg	5.97E+01	6.94E+01 (N)	1.08E+02	6.94E+01	mg/kg	95%UCL-N	W-Test(4)
	Zinc	mg/kg	1.16E+02	1.89E+02 (NP)	1.78E+03	1.89E+02	mg/kg	95%UCL-Bst	W-Test(1)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N), 95% UCL based on bootstrap statistic (95% UCL-Bst).
N/A - Not Applicable; Not Available
Distributions: Normal (N); Lognormal/Transformed (T); Undefined/Nonparametric (NP).
Test(1) The data were determined to be neither normally or lognormally distributed using Shapiro-Wilks (sample size<=50) or the Shapiro-Francia Calculation (sample size > 50), and the bootstrap statistic used.
Test(2) The data were determined to be lognormally distributed using Shapiro-Wilks (sample size<=50) or the Shapiro-Francia Calculation (sample size > 50).
Test(3) The 95% UCL was not calculated due to limited number of samples (n<=5); therefore, the maximum detect was used as the EPC.
Test(4) The data were determined to be normally distributed using Shapiro-Wilks Shapiro-Wilks (sample size<=50) or the Shapiro-Francia Calculation (sample size > 50).
Test(5) The 95% UCL exceeds the maximum detected concentration; therefore, the maximum detect was used as the EPC.

7.2.4 Natural Site Constituents (Background and Essential Nutrients)

Chemical concentrations are compared to facility-wide background concentrations as an indication of whether a chemical is present from site-related activity or as natural background (as discussed in *Section 2.4*). This comparison, performed as part of the Risk Characterization (*Section 7.5.3*) is generally valid for inorganic chemicals, but not for organic chemicals, because inorganic chemicals are naturally occurring and most organic chemicals are not. The 95% UTL **(Table 2-2)** was used as one of the background comparison statistics.

Chemicals with maximum detected concentrations (MDCs) less than the background UTL and shown not to be statistically different based on appropriate population statistics are eliminated from further consideration in the Risk Characterization (*Section 7.5.3*). If the MDC exceeds the UTL, or the populations are shown to be statistically different, the chemical is retained as a COPEC. In general, UTLs were calculated as discussed in *Section 2.4* and population statistics were performed as discussed in *Section 6.1.2.3*.

As recommended in both the Site Screening Process (USEPA, 2001c) and the Final Master Work Plan (URS, 2003) the essential nutrients calcium, magnesium, potassium and sodium were eliminated as COPECs. The elimination of essential nutrients was the same for the SLERA and the HHRA (*Section 6.1.2.2*).

7.2.5 Comparison to Risk-Based Screening Ecotoxicity Values

A comparison was performed between MDCs of chemicals in sampled media and risk-based ecotoxicity screening values for ecological endpoints. Chemicals that exceeded the screening values, or for which no screening values are available, have been retained as COPECs. The following screening values, or screening value hierarchy (as noted) have been used to select soil COPECs for (1) direct contact exposure and (2) food chain exposure:

For Direct Contact Exposure

(1) the lower of the flora and fauna BTAG Screening Values (USEPA, 1995d)

For Food Chain Exposure

(1) the lower of *Ecological Soil Screening Levels* (USEPA, 2000c) and *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson et al., 1997); and,

(2) *Ecological Data Quality Levels* (EDQLs; USEPA, 1999b).

The results of the COPEC screenings are presented in **Tables 7-5 and 7-6**. COPECs were selected for further consideration in the SLERA if the MDC exceeded the available screening value. If no screening value was available, the constituent was carried forward for consideration in the SLERA, unless it is an essential nutrient, or site-specific information exists to eliminate it from further consideration (see following discussion). Note: **Table 7-7** presents a compilation of the screening toxicity values for soil food chain exposure, and shows the final values that are used in the screening assessment to select COPECs for the food chain pathway.

Aluminum was not selected as a COPEC for direct contact exposure, as USEPA (2000c) recommends that this metal be identified as a COPEC for those sites with soil with a pH less than 5.5. The technical basis for this rationale is that soluble and toxic forms of aluminum are present in soil under soil pH values of less than 5.5. Of the 20 surface soil samples from Building 4343 that had pH measured, three were below a pH of 5.5 (e.g., 5.03, 5.20, and 5.35). The average surface soil pH was 5.8. The average pH was calculated using the arithmetic mean of the inverse

$\log_{10}$ of the negative pH values. This conservative approach of calculating the mean appropriately accounts for the larger influence of lower pH values on the mean, as pH 5 is 10 times more acidic than pH 6, etc. Potential toxicity associated with aluminum at the three soil locations with a pH less than 5.5 is discussed in the Uncertainty Analysis (*Section 7.6*).

7.2.6 Summary of COPEC Selection

Tables 7-5 and 7-6 have been prepared for constituent concentrations in soil, with the following information:

- CAS number;
- Chemical name;
- Range of detected concentrations, and associated qualifiers;
- Concentration units;
- Location of maximum detected concentration;
- Frequency of detection;
- Range of detection limits;
- Concentration used for screening (i.e., maximum);
- Risk-based screening criterion, if available (BTAG screening values for direct contact exposure and from **Table 7-7** for food chain exposure);
- COPEC selection conclusion: YES or NO; and,
- Rationale for selection or rejection of the COPEC.

Footnotes in the tables provide the rationale for selecting or rejecting a chemical as a COPEC. An evaluation of the constituents that were eliminated from further consideration was performed to assess whether constituents should be reinstated as COPECs due to other considerations. Examples of these exceptions include: chemicals known to have been used on-site historically and detected chemicals with detection limits greater than the screening values. Based on this evaluation, no additional COPECs are recommended.

Twenty COPECs (four organics and 16 inorganics) have been selected for surface soil for direct contact exposure (**Table 7-5**). Chemicals not eliminated using the screening procedures previously presented are considered final COPECs and have been quantitatively evaluated in this SLERA for direct contact.

Thirteen COPECs (one organic and 12 inorganics) have been selected for surface soil for food chain exposure (**Table 7-6**). Chemicals not eliminated using the screening procedures previously presented are considered final COPECs and have been quantitatively evaluated in this SLERA for food chain exposure. It should be noted that some COPECs were not selected if they are considered to be Not Important Bioaccumulative Constituents (NIBC), per Table 4.2 in *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment – Status and Needs* (USEPA, 2000d).

Table 7-8 presents EPCs for these COPECs, based on the statistical procedures discussed in *Section 7.2.2*. Arithmetic mean concentrations are also presented for informational purposes.

7.3 Identification of Exposure Pathways and Potential Receptors for Analysis

RFAAP terrestrial wildlife may be exposed to COPECs by several pathways, including: (1) the ingestion of impacted soil, sediment, surface water, or food while foraging; (2) dermal absorption of chemicals from soil, sediment, or surface water; and, (3) inhalation of chemicals that have been wind-eroded from soil or have volatilized from soil or water. Among these potential exposure pathways, the greatest potential for exposure to chemicals is likely to result from the ingestion of chemicals in food and surface water. The incidental ingestion of impacted soil or sediment (while foraging) is a less important exposure route. The ingestion of food, soil, sediment, and surface water, however, are viable exposure pathways and were considered in this SLERA, if relevant. As surface water and sediment are not associated with Building 4343, exposures to these media were not included, nor are aquatic receptors identified for the site. 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.

The appropriate assessment receptors have been selected for evaluation during the SLERA. In order to narrow the exposure characterization portion of the SLERA on species or components that are the most likely to be affected, given the toxicological and mobility characteristics of the COPECs, and on those COPECs that, if affected, are most likely to produce greater effects in the on-site ecosystem, the SLERA has 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 (water fowl and fish), aquatic invertebrates, and wetland/terrestrial mammals. Species presence was assessed during a literature review and during the site reconnaissance (*Section 7.1*) 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).
- The assessment receptor may be listed as rare, threatened, or endangered (RTE) by a governmental organization; or the receptor will consist of critical habitat for RTE species. Based on the availability of species-specific data, an RTE surrogate species may be selected.

Additional criteria for selection of assessment receptors were used to identify species that offer the most favorable combination of characteristics for assessing the implications of on-site contaminants. These criteria included: (1) limited home range; (2) role in local nonhuman food chains; (3) potential high abundance and wide distribution; (4) sufficient toxicological information available in the literature for comparative and interpretive purposes; (5) sensitivity to COPECs; (6) relatively high likelihood of occurrence on-site following remediation (if required);

(7) suitability for long-term monitoring; (8) importance to the stability of the ecological food chain or biotic community of concern; and, (9) relatively high likelihood that they will be present or that habitats present could support the species.

It is important that sufficient toxicological information is available in the literature on the receptor species, or that a closely related species may be selected. While the ecological communities have species with many desirable characteristics for use as receptor species, not every species has been used extensively for toxicological testing.

7.3.1 Terrestrial Receptors

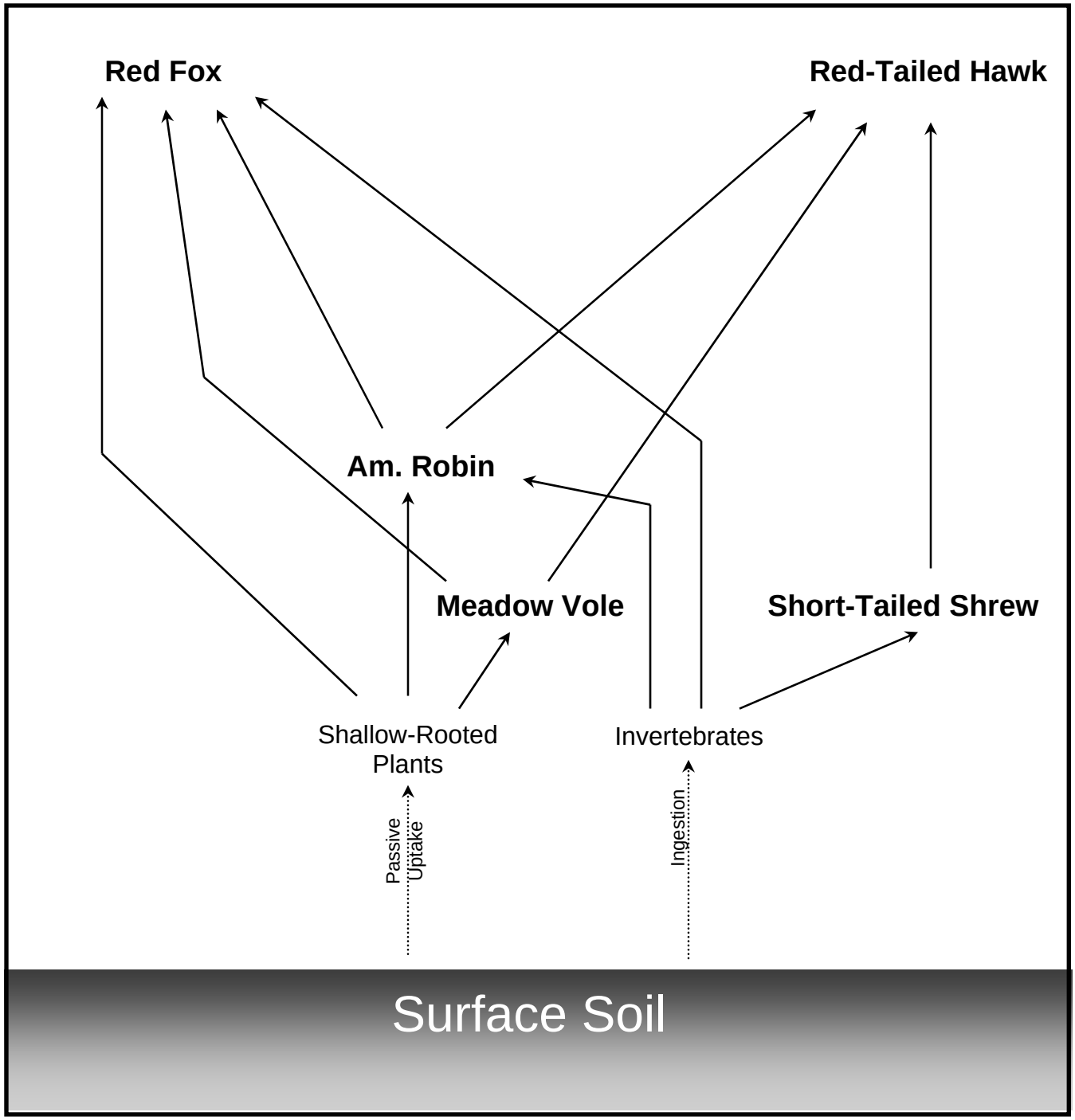
Five representative receptor species that are expected or possible in the area of Building 4343 (*Section 7.1*) were selected as indicator species for the potential effects of COPECs. These indicator species represent two classes of vertebrate wildlife (mammals and birds) and a range of both body size 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 (*Section 7.1.4*). 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 (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. The selected terrestrial receptor species have a potential high abundance and wide distribution at the site; also, sufficient toxicological information (with the exception of some bird species) is available in the literature for comparative and interpretive purposes. In addition, the selected species are likely to occur after site remediation (if risk management decisions require it). Every species is 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, 1993a).

Larger mammal species were generally not selected as sensitive receptors due to their large home ranges; however, the far-ranging red-tailed hawk and red fox were retained due to their unique role as top predators in the food chain. Smaller birds were generally not included because most are migratory. The potential risk to species with larger home ranges and migratory avian species are generally included within the predicted risks to the selected terrestrial indicator receptors. 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, 1993a). It is likely to have a relatively high rate of incidental soil ingestion given that it is sometimes coprophagous (consumes its own feces for secondary nutrient adsorption) and builds runways and burrows in the soil. 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

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



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, 1993a).

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 shrew is the largest found in North America. It is solid gray above and below, with a short tail, and 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 vertebrates, and sometimes young mice (Whitaker, 1995). Mean population densities range from 5.7, in the winter, to 28 per acre in the summer (USEPA, 1993a). 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 this SLERA **(Appendix F-2, Table F-1)**. Longevity is typically around 20 months (USEPA, 1993a), with 5 to 8 young born to each of 2 to 3 litters (Burt and Grossenheider, 1980).

American Robin. The American robin is an omnivore that feeds on both plants (primarily fruit) and terrestrial invertebrates including earthworms. The robin occurs throughout most of the continental United States and Canada during the breeding season and winters in the southern half of the United States and Mexico and Central America. They live in a variety of habitats, including woodlands, wetlands, suburbs and parks. Robins are likely to forage throughout RFAAP and are present year-round. Most robins build nests of mud and vegetation on the ground or in the crotches of trees or shrubs. Robins forage primarily on the ground and in low vegetation by probing and gleaning. They are approximately 25 centimeters in size, have a body weight range of 63 to 103 grams, and an average home range of 1.2 acres (USEPA, 1993a). The average longevity of a robin that survives to its first January is from 1.3 to 1.4 years (USEPA, 1993a).

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 (1993a) 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 (1993a) reports an average body weight of 1,134 grams. More northerly populations are migratory, while the more southerly are year-round residents. They typically mate for life or until one of the pair dies, with pairs clinging to territories year after year (Austing, 1964).

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, 1993a). Red fox incur high mortality rates as a result of shooting, trapping, disease, and accidents. 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. The CSEM has been used as a tool for judging the appropriateness and usefulness of the selected measurement endpoints in evaluating the assessment endpoints, and for identifying sources of uncertainty in the exposure characterization.

7.4 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 SLERA. Key aspects of ecological protection are presented as policy goals. These are general goals established by legislation or agency policy that are based on societal concern for the protection of certain environmental resources. For example, environmental protection is mandated by a variety of legislation and government agency policies (e.g., CERCLA, National Environmental Policy Act). Other legislation includes the Endangered Species Act 16 U.S.C. 1531-1544 (1993, as amended) and the Migratory Bird Treaty Act 16 U.S.C. 703-711 (1993, as amended). To assess whether these protection goals are met at the site, assessment and measurement endpoints have been formulated to define the specific ecological values to be protected and to define the degree to which each may be protected.

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

Given the diversity of the biological world and the multiple values placed on it by society, there is no universally applicable list of assessment endpoints. Suggested criteria that may be considered in selecting assessment endpoints suitable for a specific ecological risk assessment are: (1) ecological relevance; (2) susceptibility to the contaminant(s); (3) accessibility to prediction and/or measurement; and, (4) definable in clear, operational terms (Suter, 1993). Selected assessment endpoints should reflect environmental values that are protected by law, are critical resources, or have relevance to ecological functions that may be impaired. Both the entity and attribute are identified for each assessment endpoint.

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. Information gained during the site reconnaissance was used to assist in the selection of assessment and measurement endpoints. These endpoints, formal expressions of the environmental values to be protected (Suter, 1993), have been used to focus the goals of the SLERA.

Measurement endpoints for this SLERA are based on toxicity values from the available literature and not statistical summaries of actual field or laboratory observations or measurements. 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. COPECs for those receptors and endpoints have been identified by drawing on the scientific literature to obtain information regarding potential toxic effects of site chemicals to site species. This process ensures that a conservative approach is taken in selecting endpoints and evaluating receptors that are likely to be adversely affected by the potentially most toxic chemicals at Building 4343.

7.4.1 Assessment Endpoints

Ecological Risk Assessment Guidance for Superfund (ERAGS) (USEPA, 1997d) states: "For the screening-level ecological risk assessment, assessment endpoints are 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 Building 4343 are stated as the protection of long-term survival and reproductive capabilities for populations of herbivorous, insectivorous, and carnivorous mammals, and omnivorous and carnivorous birds. The corresponding null hypothesis (H_o) for each of the assessment endpoints is stated as: the presence of site contaminants within soil, vegetation, and prey will have no effect on the survival or reproductive capabilities of populations of herbivorous, insectivorous, and carnivorous mammals, and omnivorous and carnivorous birds.

Assessment receptor species were selected based on the likelihood of finding the species at Building 4343. Historical information, the site reconnaissance, and the availability of toxicological data were used to select terrestrial receptor species. These receptors species are depicted in the food web model **(Figure 7-1)**. Food web models are simplified versions of the possible movement of contaminants through the food chain present or potentially present. Due to lack of data for every possible species, key species have been selected to represent broad classes, or guilds.

The food web CSEM was developed to illustrate how the selected terrestrial species are ecologically linked within food webs. One species was used to represent each of the major trophic levels and habitats. The decision was made not to complicate the food web models with detailed species selection at the base of the food web (i.e., specific terrestrial invertebrates). Thus, generic terrestrial invertebrates were used to represent the bottom of the food chain. For terrestrial invertebrates and plants, partitioning coefficients and simple empirical uptake models were employed to estimate COPEC concentrations within tissues (*Section 7.5*). These tissue concentrations were then used as input values for exposure to higher trophic level receptors

through the dietary route of exposure. Brief life-history descriptions for the selected receptor species are provided in *Section 7.3.1*.

Trophic levels may be exposed to COPECs, either by direct exposure to contaminated abiotic media or through ingestion of lower trophic level food items. Primary producers (plants) absorb COPECs (as well as nutrients) from soil and/or water. In terrestrial species bioconcentration occurs in plants and invertebrates, and higher food chain receptors bioaccumulate COPECs through the ingestion of food items.

7.4.2 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. Examples of typical measurement endpoints include mortality, growth or reproduction in toxicity tests; individual abundance; species diversity; and the presence or absence of indicator data in field surveys of existing impacts (USEPA, 1997d).

For assessments, measurable responses to stressors may include LOAELs, NOAELs, LC50s (lethal concentration to 50 percent of the test population), LD50s (lethal dose to 50 percent of the test population), collectively termed toxicity endpoint values (see *Section 7.5* for further explanation). The most appropriate measurement endpoint(s) were chosen based on exposure pathways as well as ecotoxicity of the contaminant.

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.

7.5 Exposure Estimation and Risk Characterization

This section includes a discussion of how COPEC exposures were quantified (*Section 7.5.1*), how COPEC effects were assessed (*Section 7.5.2*), and a presentation of the resultant risk characterization (*Section 7.5.3*) that combines both exposure and effects.

7.5.1 Exposure Analysis

An estimate of the nature, extent, and magnitude of potential exposure of assessment receptors to COPECs that are present at or migrating from the site was developed, considering both current and reasonably plausible future use scenarios. Exposure characterization is critical in further evaluating the risk of compounds identified as COPECs during the selection process (*Section 7.2*). The exposure assessment was conducted by linking the magnitude (concentration) and distribution (locations) of the constituents detected in the media sampled during the investigation, evaluating pathways by which chemicals may be transported through the environment, and identifying the points at which organisms found in the study area may contact contaminants.

An exposure analysis was performed, which combines the spatial and temporal distribution of the ecological receptors with those of the COPEC to evaluate exposure. The exposure analysis focuses on the chemical amounts that are assumed to be bioavailable, and the means by which the ecological receptors are exposed (e.g., exposure pathways). The focus of the analysis is dependent on the assessment receptors being evaluated as well as the assessment and measurement endpoints.

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. Examples of food web exposure include animals at higher trophic levels consuming plants or animals that bioaccumulate contaminants. 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. As discussed previously, no surface water or sediment was present within the drainage ditches, and exposure to these media are not considered. In addition, as discussed in *Section 7.3*, dermal contact and inhalation exposures are considered insignificant compared to other quantified routes of exposure.

Contamination of biota could result from exposure to one or more COPEC. Bioavailability is an important contaminant characteristic that influences the degree of chemical-receptor interaction. Bioavailable compounds are those that a receptor can take in from the environment. Bioavailability of a chemical is a function of several physical and chemical factors such as grain size and organic carbon content. Environmental conditions such as soil moisture, soil pH, and cation exchange capacities significantly influence whether potential soil contaminants remain chemically bound in the soil matrix or whether they can be chemically mobilized (in a bioavailable form) and released for plant absorption. Generally, neutral to alkaline soil (soil pH of 6.5 or greater) restrict the absorption of toxic metals, making pathway completion to plants difficult. As discussed in *Section 7.2*, the average pH in surface soil at Building 4343 is 5.8. For purposes of this SLERA, bioavailability is conservatively assumed to be 100 percent.

Exposure pathways consist of four primary components: source and mechanism of contaminant release, transport medium, potential receptors, and exposure route. A chemical may also be transferred between several intermediate media before reaching the potential receptor. These components have been addressed within this SLERA. If these components are not complete, then contaminants in those media do not constitute an environmental risk at that specific site. The major fate and transport properties associated with typical site contaminants directly affect a contaminant's behavior in each of the exposure pathway components.

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

The first step in estimating exposure rates for terrestrial wildlife involves the calculation of food ingestion (and drinking water intake) rates for site receptors. USEPA (1993a) includes a variety of exposure information for a number of avian and mammalian species. Information regarding feeding (and watering) rates, and dietary composition are available for many species, or may be estimated using allometric equations (Nagy, 1987). Data have also been gathered on incidental ingestion of soil, and are incorporated for the receptor species. This information is summarized in **Appendix F-2, Table F-1**. For this SLERA, 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 percent 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. Singular algorithms have been developed for soil to plant uptake and for animal bioaccumulation (transfer factors).

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 are a medium of concern at the site.

For the current SLERA, bioaccumulation factors (BAFs) and bioconcentration factors (BCFs) for soil-to-plants, soil-to-earthworms, and soil-to-small mammals and birds are presented in **Appendix F-2, Tables F-2, F-3, and F-4**, 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 the maximum 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-2)** are based on information from USEPA (2000c), Efroymson et al. (2001), Baes et al. (1984), and IAEA (1994). Tier 2 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, an upper-bound or median value is used. 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.

Soil-to-earthworm BAF/BCF values **(Appendix F-2, Table F-3)** are based on information from Sample et al. (1998a), Sample et al. (1999), USEPA (2000c), and Beyer (1990). Earthworms are used as a surrogate species to represent terrestrial invertebrates including insects. Tier 2 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, an upper-bound or mean 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.

For the organic COPEC at Building 4343 (4,4'-DDT), the following equation from USEPA (2000c) was used to estimate the BAF/BCF, along with the COPEC-specific Kow and site-specific fraction of organic carbon information:

$$BAF/BCF = \frac{10^{(\log Kow - 0.6)}}{Foc \times 10^{(0.983 \times \log Kow + 0.00028)}}$$

where:

Log Kow = log octanol-water partition coefficient (6.79 for 4,4'-DDT),
Foc = fraction of organic carbon (Building 4343 geometric mean = 0.0049, arithmetic mean = 0.00595).

For 4,4'-DDT, the Tier 1 BAF/BCF value was estimated using the geometric mean site F_{oc}; whereas, the Tier 2 BAF/BCF was estimated using the arithmetic mean site F_{oc}.

Soil-to-small mammal and small bird BAF/BCF values **(Appendix F-2, Table F-4)** are based on information from Sample et al. (1998b). Tier 2 values are based on available 90th percentile BAF/BCF values.

The estimated chemical intakes for each exposed receptor group under each exposure pathway and scenario are presented in the risk characterization spreadsheets referenced in *Section 7.5.3*. These intake estimates are combined with the COPEC toxicity values, discussed in the following section, to characterize potential ecological risk. The uncertainties associated with the estimation of chemical intake are discussed in *Section 7.6*.

For direct contact exposure for soil invertebrates to COPECs in surface soil, measured COPEC concentrations were simply compared with direct contact benchmarks appropriate for the soil invertebrate community.

7.5.2 Ecological Effects Characterization

The ecological effects characterization includes the selection of literature benchmark values and the development of reference toxicity values.

7.5.2.1 Selection of Literature Benchmark Values

Appropriate sources for literature benchmark values have been consulted, such as (1) Toxicological Benchmarks for Wildlife (Sample et al., 1996); Development of Toxicity Reference Values for Conducting Ecological Risk Assessments at Naval Facilities in California (Engineering Field Activity, West, 1998); Review of the Navy - USEPA Region IX BTAG Toxicity Reference Values for Wildlife (CH2M-Hill, 2000); and, (2) LD50 values from data bases such as the Registry of Toxic Effects Concentrations (RTEC) (extrapolated to chronic NOAEL or LOAEL values using recommended USACHPPM TG 254 (2000) uncertainty factors that follow Wentsel et al. [1996]). The level of effort has been limited to documents that

summarize the available ecotoxicological information and does not consist of a review of the primary toxicological literature (i.e., details of toxicity test conditions were not reviewed to assess validity of the tests performed).

7.5.2.2 Development of Toxicity Reference Values

Toxicity reference values (TRV) have been developed for the Building 4343 study area. 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 because 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 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 in the following paragraphs.

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 has been 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. As previously noted, where data are unavailable for the exposure of a receptor to a COPEC, data for a surrogate chemical have been gathered for use in the SLERA.

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 using safety factors recommended by USACHPPM TG 254 (2000), based on information specified in Ford et al. (1992) and in Wentsel et al. (1996) and summarized in the footnotes to **Appendix F-2, Tables F-5 and F-6** for NOAEL and LOAEL TRVs, respectively. Interclass toxicity extrapolations were not performed as physiological differences between classes are too great to be addressed with the use of simplistic safety factors. Separate uncertainty factors are 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-7** for the receptors used in this SLERA. 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 7.5.3*. Reference toxicity threshold value uncertainties are discussed in *Section 7.6*.

Exposure 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.

To assess direct contact exposure for terrestrial invertebrates, the following three sources were evaluated and used as appropriate:

- BTAG screening values for fauna (USEPA, 1995d);
- Screening toxicity values for earthworms from ORNL (1997); and
- Screening toxicity values for earthworms from Los Alamos National Laboratory (LANL) (2002).

7.5.3 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.

7.5.3.1 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 (*Section 7.1.4*), and no obvious signs of vegetative stress were noted. The overall health of the grassland community at the site was comparable to the grasslands in the surrounding area. As allowed in the RFAAP Final MWP (URS, 2003) that states that owing to the invasive and successive nature of plants communities, plants as receptors do not typically warrant a detailed examination of effects, therefore, plants were not quantitatively evaluated in this SLERA. As there were no unique or site-specific terrestrial plant issues discovered at Building 4343, a qualitative evaluation was deemed adequate. Given these reasons, and because of the disturbed nature of the site, risks to plants are not quantitatively evaluated; however, plants (and invertebrates) are included in the SLERA as media through which the wildlife receptors may be exposed indirectly to COPECs in the soil by means of the food chain.

7.5.3.2 Predictive Risk Estimation for Terrestrial Wildlife

The risk associated with Building 4343 has been estimated. 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 (Tannenbaum, 2001; Bartell, 1996).

The simple HQ ratios have been summed to provide conservative HI estimates for chemicals and exposure pathways for a given receptor. HQ summation is appropriate and scientifically defensible for a given receptor if HQs for those chemicals that have a similar mode of toxicological action. While individual contaminants may affect distinct target organs or systems within an organism, classes of chemicals may act in similar ways, thus being additive in effect. The summation of HQs into an HI was performed, in part, to assess whether or not individual COPEC HQs should be segregated based on dissimilar modes of toxicological action. However, as risk drivers resulted in HQs greater than approximately 10 to 100 (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 Building 4343 are presented in risk characterization tables **(Appendix F-2, Tables F-8 through F-17)** for the five selected receptor species. These summed EEQs (generally rounded to two significant figures) are presented in **Table 7-9**, along with the hazard driver (the COPEC contributing the majority of the total estimated EEQ) and the exposure pathway of concern (the pathway contributing the most to the total estimated EEQ).

Table 7-9
Wildlife EEQ Hazard Summary

Receptor	Tier 1[a]		Tier 2[b]	
	NOAEL-Based EEQ	LOAEL-Based EEQ	NOAEL-Based EEQ	LOAEL-Based EEQ
Meadow vole	1,300,000	130,000	640	66
Hazard Driver(s)[c]:	Cd (plant ingestion)		Cd (plant, soil ingestion)	
Short-tailed shrew	9,000,000	900,000	8,000	800
Hazard Driver(s)[c]:	Cd (earthworm ingestion)		Cd (earthworm ingestion)	
American robin	3,800,000	280,000	3,100	280
Hazard Driver(s)[c]:	Cd (earthworm, plant ingestion)		Cd, Cr, DDT (earthworm ingestion)	
Red-tailed hawk	620,000	45,000	13	0.9
Hazard Driver(s)[c]:	Cd (mammal, bird ingestion)		Cd (mammal ingestion)	
Red fox	1,500,000	150,000	14	1.4
Hazard Driver(s)[c]:	Cd (mammal, bird ingestion)		Cd (mammal ingestion)	

[a] Tier 1 = Max EEQ using max EPC, max BAF/BCF, max Intake Rates, min BW, and FHR =1.

[b] Tier 2 = EEQ using 95% EPC, non-max BAF/BCF, 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.

Table Notes:

EEQ = Ecological Effects Quotient.

LOAEL = Lowest Observed Adverse Effect Level

NOAEL = No Observed Adverse Effect Level

FHR = Fraction home range

BW = body weight.

BAF/BCF = Bioaccumulation Factor/Bioconcentration Factor.

EPC = exposure point concentration.

As shown, Tier 1 EEQs were considerably greater than 100 for the five receptor species, using either TRVs based on NOAEL or LOAEL values. The short-tailed shrew was predicted to be the

most impacted, followed by the American robin, the red fox, the meadow vole, and red-tailed hawk.

More realistic Tier 2 EEQs were also elevated. Those based on NOAEL TRVs, however, were considerably lower than the Tier 1 estimates. Tier 2 EEQs, based on LOAEL values, were 280 for the American robin, 800 for the short-tailed shrew, 66 for the meadow vole, 1.4 for the red fox, and less than 1 for the red-tailed hawk **(Table 7-9)**. Cadmium was the COPEC contributing the most to the total EEQ for each of the five wildlife receptors, while the robin was potentially impacted by concentrations of chromium and DDT, in addition to cadmium. Exposure pathways of most concern, based on the results of the food-chain modeling, were earthworm ingestion and plant ingestion. Incidental soil ingestion was also a significant contributor to the total estimated hazard for the meadow vole.

A potential reduction in wildlife food supply was evaluated using a direct contact toxicity evaluation for soil invertebrates (such as earthworms) exposed to COPECs in surface soil. The 20 COPECs identified from the direct contact exposure screen (**Table 7-5**) were evaluated for potential toxicity to the terrestrial soil invertebrate community. BTAG screening values for faunal toxicity were used, as well as earthworm toxicity benchmarks from ORNL and LANL (**Table 7-10**). The lowest relevant screening value was selected from the available screening values, as discussed in the footnotes to **Table 7-10**. Maximum detected concentrations were used to estimate a Tier 1 EEQ, and EPCs more appropriate for invertebrate populations (e.g., the 95% UCL concentration) were used to estimate a Tier 2 EEQ. Tier 1 EEQs ranged from 0.2 to 4,550, with both chromium and cadmium having EEQs above 1,000. If chromium is assumed to be in the trivalent form, and not hexavalent, the chromium EEQ drops from 4,550 to 57 (**Table 7-10**). Tier 2 EEQs ranged 0.1 to 1,215, with both chromium and cadmium having EEQs above 500. If chromium is assumed to be in the trivalent form, and not hexavalent, the chromium EEQ drops from 558 to 7 (**Table 7-10**). Based on the Tier 2 EEQ results, and assuming chromium is in the trivalent form (based on site-specific information), cadmium, chromium, and zinc are the direct contact COPECs in soil that are estimated to adversely impact the terrestrial invertebrate community, and therefore potentially reduce the food supply for higher trophic level wildlife such as the American robin and short-tailed shrew.

7.5.3.3 Background Metals Considerations

Based on the statistical evaluation of background metals data (*Section 7.2.4*), the following inorganics in surface soil may be considered background related: arsenic, barium, beryllium, cobalt, magnesium, and nickel. Therefore, none of the ecological risk drivers are considered background related, and no adjustment to the list of ecological risk drivers is needed for the CMS.

7.6 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

Table 7-10
Direct Contact Toxicity Evaluation for Building 4343 Surface Soil

Chemical (1)	Detection Frequency	Maximum Concentration (mg/kg)	95% UCL Concentration (mg/kg)	BTAG Screening Toxicity Value (2)	Comment on BTAG Value	ORNL Screening Toxicity Value (3)	Comment on ORNL Value	LANL Screening Toxicity Value (4)	Lowest Relevant Screening Value (5)	Tier 1 EEQ (6)	Tier 2 EEQ (7)
Antimony	1/25	41.2	3.89	NVA	-	NVA	-	NVA	NVA	-	-
Beryllium	5/25	0.57	0.24	NVA	-	NVA	-	NVA	NVA	-	-
Cadmium	23/25	24,300	24,300	NVA	-	20	-	10	20	1,215	1,215
Chromium	25/25	1,820	223	0.0075	For Bacteria	0.4	Cr^{VI}	1.4	0.4	4,550	558
Chromium	25/25	1,820	223			32	Cr^{III}	NVA	32	57	7
Copper	25/25	677	85	NVA	-	60	-	13	60	11	1
Iron	25/25	51,400	34,200	12	Rabbit LD-50	NVA	-	NVA	NVA	-	-
Lead	25/25	1,410	133	0.01	Quail impact	500	-	2000	500	3	0.3
Magnesium	25/25	19,400	5,320	4,400	No reference	NVA	-	NVA	NVA	-	-
Manganese	25/25	642	375	330	No reference	NVA	-	NVA	NVA	-	-
Mercury (Inorganic)	7/25	0.53	0.126	0.058	No reference	0.1	For organic and inorganic forms	0.05	0.1	5	1
Nickel	24/25	32.6	11.6	NVA	-	200	-	100	200	0.2	0.1
Silver	2/25	36	3.08	NVA	-	NVA	-	NVA	NVA	-	-
Thallium	3/25	0.18	0.18	NVA	-	NVA	-	NVA	NVA	-	-
Total Cyanide	2/17	14.8	3.44	0.005	For Amoeba	NVA	-	NVA	NVA	-	-
Vanadium	25/25	108	69.4	58	No reference	NVA	-	NVA	NVA	-	-
Zinc	24/24	1,780	189	NVA	-	100	-	350	100	17.8	2
Endosulfan II	2/2	0.00246	0.00246	NVA	-	NVA	-	NVA	NVA	-	-
Endrin aldehyde	1/2	0.00289	0.00289	NVA	-	NVA	-	NVA	NVA	-	-
Aroclor 1254	4/4	0.344	0.344	NVA	-	NVA	-	NVA	NVA	-	-
2-Methylnaphthalene	1/1	0.011	0.011	NVA	-	NVA	-	NVA	NVA	-	-

(1) COPECs from **Table 7-5**.

(2) Screening toxicity values for fauna from BTAG (1995).

(3) Screening toxicity values for earthworms from ORNL (1997).

(4) Screening toxicity values for earthworms from Los Alamos National Laboratory (2002), Environmental Restoration Project, Environmental Screening Levels, Release 1.5, Sept.

(5) the Lowest relevant screening value is the lowest value appropriate for the RFAAP Site:

Non referenced values are omitted

Bacteria and amoeba are deemed inappropriate receptor species

Rabbit and quail are omitted, as wildlife impacts are evaluated in the food chain model section of the SLERA.

As LANL values were developed for a desert environment, they are only used if no other appropriate values are available.

(6) Tier 1 ecological effect quotient (EEQ) is estimated by dividing the maximum soil concentration by lowest relevant direct contact screening value.

(7) Tier 2 EEQ is estimated by dividing the 95% UCL soil concentration by the lowest relevant direct contact screening value.

Notes:

NVA = No Value Available

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. Because 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. Species physiology, feeding patterns, and nesting behavior are poorly predictable; therefore, toxicity information derived from toxicity testing, field studies, or observation will have uncertainties associated with them. Laboratory studies conducted to obtain site-specific, measured information often suffer from poor relevance to the actual exposure and uptake conditions on site (i.e., bioavailability, exposure, assimilation, etc., are generally greater under laboratory conditions as compared to field conditions). 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. Finally, habitat- or site-specific species may be misidentified if, for example, the observational assessment results are based on one brief site reconnaissance.

Constituents that were entirely non-detect in the surface soil data set are evaluated in **Appendix F-2, Table F-18**. Many constituents were not detected in surface soil analytical samples. To evaluate the uncertainty associated with these constituents' detection limits, the maximum detection limit for each non-detect constituent in this medium was compared with a conservative ecological toxicity screening value. Ecological screening values were compiled as discussed in *Section 7.2.5*, and final screening values for food chain exposure are presented in **Appendix F-2, Table F-19**; whereas, BTAG screening values for direct contact exposure were the lower of the available flora and fauna values. For surface soil, 21 of the 130 non-detect constituents had maximum detection limits that exceeded one or the other screening criterion. This finding is not unexpected, given the conservative and numerically low screening values.

Three surface soil samples that had low pH concentrations (i.e., below 5.5) could potentially have toxic concentrations of aluminum, as aluminum has been shown to be both soluble and have toxic forms in soil with soil pH values of less than 5.5. The three low pH samples were B43SB34A, B43SSD2, and B43SSD3, with pH values of 5.03, 5.20, and 5.35, respectively. Concentrations of aluminum in these latter two samples were 9,970 and 7,380 mg/kg (sample B43SB34A was not analyzed for aluminum). The average aluminum surface soil concentration at Building 4343 was 14,000 mg/kg; therefore, the low pH samples where aluminum was analyzed did not have elevated aluminum concentrations, relative to the site as a whole, and enhanced aluminum toxicity is generally not expected in the low pH soil samples.

Chemical results from two Building 4343 sump samples were not included in the SLERA (*Section 7.2*) because no ecological exposure is expected to these sumps. To address the uncertainty of not including these results in the SLERA food chain model, as small receptors such as rodents might be able to gain limited access to these sumps either by passing through the metal grates or getting into the building itself, the following information in **Table 7-11** is

presented. This information includes EPCs excluding the sump sample results (as used in the current SLERA) as well as EPCs including the sump sample results.

This information demonstrates that for the ecological hazard driver of most concern for food chain exposure (i.e., cadmium), the EPC does not change. For other COPECs, however, EPCs do increase with the inclusion of the two sump samples in the surface soil database. The change in EPC could not be assessed for two constituents (arsenic and barium) as these constituents were not selected as COPECs in the initial screening assessment and were therefore not carried through the SLERA.

Table 7-11
Uncertainty Analysis of Not Including Sump Samples

Constituent	EPC Without Sump Samples (mg/kg)	EPC with Sump Samples (mg/kg)
Antimony	3.89	16.2
Arsenic	Not a COPEC	4.62
Barium	Not a COPEC	188
Cadmium	24,300	24,300
Chromium	223	840
Copper	85	246
Cyanide	3.44	17.4
Iron	34,200	37,700
Lead	133	327
Mercury	0.126	0.133
Nickel	11.6	16.2
Selenium	0.429	1.32
Silver	3.08	3.48
Zinc	189	432
4,4'-DDT	0.218	0.218

Specific information on the potential bioavailability of cadmium, the primary hazard driver at Building 4343, is presented is the following paragraph, extracted from *Guide for Incorporating Bioavailability Adjustments into Human Health and Ecological Risk Assessments at U.S. Navy and Marine Corps Facilities* (NFESC, 2000).

Cadmium in soil may be found in forms that range in solubility from sparingly (sulfides) to moderately (cadmium sulfate) to highly soluble (cadmium carbonate). The reference dose (for humans) for cadmium is based on effects of a soluble form of cadmium (cadmium chloride) on the kidney. Inorganic cadmium forms commonly present in soil induce chronic toxic effects after ingestion by the same mechanism. Consequently, inorganic cadmium compounds may be

considered together when assessing bioavailability. Oral absorption of cadmium in humans generally is reported to be very low (1 to 7 percent) (ATSDR, 1997a in NFESC, 2000).

Evidence that the bioavailability of cadmium in soil may be reduced compared to the bioavailability of soluble cadmium forms is available from a limited number of studies. Several studies have reported reduced oral bioavailability of a soluble cadmium form, cadmium chloride, mixed with soil (Griffin et al., 1990; Schilderman et al., 1997 in NFESC, 2000). For cadmium in weathered soil, data are available for soil from a single site (the site of a former zinc smelter) that has been evaluated in vivo in rats (Schoof and Freeman, 1995; PTI, 1994 in NFESC, 2000). A relative cadmium bioavailability estimate of 33 percent was obtained based on comparison of liver and kidney tissue concentrations in animals fed rodent chow mixed with soil, versus those fed rodent chow mixed with cadmium chloride. An in vitro study of this same soil yielded a higher value, which suggests that the in vitro method might overestimate the relative bioavailability of soil cadmium. Limited evidence is thus available that oral absorption of cadmium in soil is reduced compared to absorption of soluble cadmium.

The uncertainty analysis is presented in **Table 7-12** and lists some of the major assumptions made for the SLERA; 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]); and, 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, 1997d). 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 this SLERA. 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, prey species;
- Use of the maximum detected soil concentration when the 95% UCL EPC exceeds the maximum (e.g., cadmium);
- Inclusion of sample outliers in the estimation of EPCs for risk drivers; and,
- Use of the HQ method to estimate risks to populations or communities.

It should be emphasized that there are significant uncertainties associated with estimating COPEC concentrations in macroinvertebrates.

7.7 Results and Conclusions

The data, results, and conclusions of the SLERA are described in this section and conclusions are derived from the risk assessment, based on the responses to the assessment hypotheses and assessment endpoints. The wildlife EEQ results for food chain exposure are summarized in **Table 7-9** and direct contact EEQ results for terrestrial invertebrates, which may serve as a food source for wildlife, are summarized in **Table 7-10**. The food-chain assessment suggests potential adverse impacts to terrestrial wildlife, especially robins, shrews, and voles for potential exposure to the hazard driver (primarily cadmium) in surface soil (as well as DDT and chromium). The direct contact assessment Tier 2 results suggest a potential reduction in wildlife food supply, due primarily to cadmium and chromium in surface soil, as well as zinc.

Table 7-12
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 maximum detected concentration when 95% UCL, based on H-statistic equation, exceeds maximum (e.g., cadmium).	Overestimates Risk	Medium	Use bootstrap statistic to estimate 95% UCL for log normal data distributions.	Easy to implement, but may not be acceptable to Agency.
Assumption that soil depth interval of 0-2 ft is representative of surface soil	Overestimates Risk	Low to Medium	Resample to obtain additional samples 0-0.5 ft. for surface soil characterization	Moderately costly to implement.
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 other prey species.	Would be costly to implement.
Use of safety factors to convert LOAEL and LD_{50} toxicity data to NOAELs	Overestimates Risk	Medium	Obtain COPEC-specific NOAEL data	Would be costly to implement, unless data available in the literature.
Use of uncertainty factor of 8 to extrapolate TRVs between most species within the same class	Overestimates Risk	Medium	1) Assume TRVs similar for species in the same genus, family, or order; or 2) obtain species-specific NOAEL data	1) May not be accepted by Agency. 2) Would be very difficult to obtain species-specific NOAEL data.
Use of surrogate constituents to estimate toxicity for those COPECs without available toxicity data	Overestimates Risk	Low to Medium	Obtain COPEC-specific toxicity data	Would be very costly to obtain COPEC-specific toxicity data, unless available in the literature.
Use of hazard quotient method to estimate risks to populations or communities may be biased	Overestimates Risk	High	Perform population or community studies	Would be very costly to perform.

Based on uncertainties of toxicity, the fact that no wildlife RTE species have been confirmed at the Building 4343 study area, and the small size of the site (0.94 acres), remedial measures designed to address ecological concerns may not be warranted at this time for soil. The SMDP reached for this SLERA, however, in conjunction with the findings of the HHRA, is that the information collected and presented indicates that a more thorough assessment is warranted, in this case in the form of a CMS. As human health risks and/or hazards are unacceptable and chemical-specific human health preliminary remediation goals (PRGs) have been developed for the site (*Section 8.0*), these PRGs are evaluated to (1) decide if they are also protective of the environment; and/or (2) decide if they will reduce the estimated ecological hazards by a significant amount.

The assessment results may serve as the foci of discussions with risk managers and regulatory agencies concerning the potential need for additional assessment at Building 4343 to reduce the uncertainty in the estimate of ecological risk, as discussed in *Section 7.6*, if the no action alternative is selected in the CMS. It is very important to note that many conservative assumptions and modeling approaches were used in the SLERA assessment, and actual hazards to wildlife may be orders of magnitude lower than predicted herein.

8.0 DEVELOPMENT OF CORRECTIVE MEASURES OBJECTIVES

This section identifies the corrective measures objectives (CMOs) for the contaminants of interest (COIs) identified by the risk assessments, provides remediation volume estimates based on the CMOs and analytical results, and identifies applicable or relevant and appropriate requirements (ARARs) associated with the chemicals, environmental media, and potential actions associated with the remediation of site materials. CMOs are cleanup objectives that are developed during the RFI/CMS to protect human health and the environment. They consist of medium-specific goals for protecting human health and the environment. CMOs provide the basis for the identification, detailed analysis, and selection of corrective measures alternatives.

8.1 Summary of Chemicals of Interest

The HHRA (*Section 6.0*) identified one single COI (cadmium) under both an industrial and residential future-use scenario. The SLERA concluded that remedial measures to address ecological concerns are not warranted for soil. However, the residual risk to ecological receptors was calculated to evaluate whether remediation for human health concerns would be protective of the environment or significantly reduce ecological risks. Based on the results of the human health (*Section 6.0*) and ecological (*Section 7.0* and *Section 8.2.1*) risk evaluations, the COI selected for the Building 4343 RFI/CMS is cadmium.

8.2 Remedial Goals

Remedial goals (RGs) for soil associated with Building 4343 are calculated such that risks to human health are within the USEPA's acceptable range ($1x10^{-4}$ to $1x10^{-6}$ for carcinogens and an HI of 1.0 for non-carcinogens). These calculated values are then compared with the background values (95% UTLs) and the maximum of the two values is selected. The future land use identified for the Building 4343 study area is industrial. However, for comparison purposes in this RFI/CMS, remedial goals for both residential and industrial exposure scenarios were developed. **Table 8-1** summarizes the residential and industrial risk-based RGs for Building 4343 soil.

Table 8-1
Identification of Remedial Goals for Cadmium in Building 4343 Soil

Medium	Receptor	Calculated RG (HI=1.0)	Background (mg/kg)	Industrial RG (mg/kg)	Residential RG (mg/kg)
Industrial Scenarios					
Surface and Total Soil	Maintenance Worker	4,030	0.69	276	---
Surface and Total Soil	Industrial Worker	895	0.69		
Total Soil	Excavation Worker	276	0.69		
Residential Scenarios					
Total Soil	Adult Resident	629	0.69	---	70.3
Total Soil	Child Resident	70.3	0.69		

Details on the methodology used to calculate the remedial goals are presented in **Appendix H**.

8.2.1 Residual Ecological Hazards

As discussed in the SLERA (*Section 7.0*), ecological HQs estimated for metals and DDT in soil were found to be elevated. These estimates are associated with a considerable degree of uncertainty and are, by themselves, not appropriately definitive to recommend ecologically-

based CMOs. However, the SLERA suggests that proposed remediation based on human health-based CMOs for cadmium in soil be evaluated to assess whether the proposed action is either protective of the environment or significantly reduces ecological EEQs. This section integrates the ecological EEQs and the human health CMOs to provide a semi-quantitative assessment of the reduction in potential ecological hazard affected by human health risk-based remediation.

Table 8-2 presents estimated residual ecological hazards for chemicals found to be ecological "risk drivers" for at least one of the receptors evaluated for the respective environmental medium. The receptor with the highest (i.e., "critical") EEQ value from the SLERA is shown in the table. Estimated post-remediation residual concentrations are based on the EPC for samples in areas not proposed for remediation; revised EEQ values were simply scaled as described in the footnotes to the table. Using the estimated residual concentrations and the scaled EEQ estimation approach, the following reductions in EEQs based on LOAEL Tier 2 values are observed.

Building 4343 residual surface soil concentration using the industrial land-use scenario for human health cleanup – EEQ reductions range from a 0% reduction (mercury and DDT) to a reduction of 98.9% (cadmium). Scaled food-chain EEQs are approximately 9, 29, and 21 for cadmium effects on shrews, chromium effects on robins, and DDT effects on robins, respectively **(Table 8-2)**. Potential impacts to earthworms (that are representative of the soil invertebrate community at the site) are suggested by the scaled EEQs; however, the potential loss of earthworms as a food supply for the selected assessment endpoint receptors (the shrew and the robin) is less of a concern.

Building 4343 residual surface soil concentration using the residential land-use scenario for human health cleanup – EEQ reductions range from a 0% reduction (mercury) to a 99.9% reduction (cadmium). Scaled food-chain EEQs are approximately 0.6, 11, and 15 for cadmium effects on shrews, chromium effects on robins, and DDT effects on robins, respectively **(Table 8-2)**. Potential impacts to earthworms (that are representative of the soil invertebrate community at the site) are suggested by the scaled EEQs; however, the potential loss of earthworms as a food supply for the selected assessment endpoint receptors (the shrew and the robin) are less of a concern.

While some of the COPECs selected by the SLERA are still estimated to have potential EEQs greater than 1.0, this finding is not considered significant for the following reasons:

- The estimated ecological hazards in **Table 8-2** incorporate additional safety factors, such as the use of an 8-fold modifying factor to account for species-to-species extrapolation.
- HQs are not measures of the probability that a wildlife receptor will develop a toxicological endpoint of concern, such as mortality or reproductive impairment. Additionally, EEQs in excess of 1 do not necessarily indicate that even a single individual of a species will demonstrate the associated effect endpoint. Thus, EEQs of 1 or lower are not necessarily a requirement to demonstrate acceptable ecological impacts.
- Bioaccumulation of COPECs in the food chain was estimated using simple empirical models, and actual uptake is expected to be less than estimated. For example, uptake of chromium in earthworms from soil was estimated to be 3.2 fold but is likely much lower. Using a more realistic chromium uptake factor for earthworms would result in lower estimated exposures for earthworm-consuming wildlife, such as the robin, used in the SLERA.

Table 8-2
Ecological Implications of Human Health Soil RGs on Ecological Receptors

Chemical[a]	Human Health RG (mg/kg)	Expected Residual Conc.[b] (mg/kg)	Critical Ecological LOAEL EEQ (and receptor) [c]		EPC for Critical [d] Ecological Receptor (mg/kg)	Scaled [e] Ecological LOAEL EEQ Using Expected Residual Conc.	Estimated Reduction in Ecological Hazard (%)[f]
Industrial							
Cadmium	276	273	790	shrew	24,300	8.9	98.9%
Cadmium	276	273	1,215	earthworm	24,300	13.7	98.9%
Copper	-	34.7	1.4	earthworm	85	0.57	59.2%
Chromium	-	87.1	74	robin	223	28.9	60.9%
Chromium	-	87.1	7.0	earthworm	223	2.73	60.9%
Lead	-	26.9	0.27	earthworm	133	0.05	79.8%
Mercury	-	0.126 [g]	1.3	earthworm	0.126	1.3	0.0%
Zinc	-	43.4	1.9	earthworm	189	0.44	77.0%
4,4-DDT	-	0.0218	21.2	robin	0.0218	21.2	0.0%
Residential							
Cadmium	70.3	19.3	790	shrew	24,300	0.63	99.9%
Cadmium	70.3	19.3	1,215	earthworm	24,300	0.97	99.9%
Copper	-	22.1	1.4	earthworm	85	0.36	74.0%
Chromium	-	32.1	74	robin	223	10.7	85.6%
Chromium	-	32.1	7.0	earthworm	223	1.01	85.6%
Lead	-	19.3	0.27	earthworm	133	0.04	85.5%
Mercury	-	0.126 [g]	1.3	earthworm	0.126	1.3	0.0%
Zinc	-	43.2	1.9	earthworm	189	0.43	77.1%
4,4-DDT	-	0.0153	21.2	robin	0.0218	14.9	29.8%

[a] Chemicals shown are those having the highest ecological EEQ values in the RFI Screening Level Ecological Risk Assessment (SLERA) (*Section 7.0*). Human health COIs are bolded.

[b] Residual concentrations in surface soil were estimated by removing the soil samples from the ecological data base that are within the proposed excavation footprint and recalculating the 95% UCL exposure point concentration following the methodology used in the SLERA. Dilution from clean backfill was not considered in estimating residual concentrations.

[c] Value and corresponding receptor shown are for the highest Tier 2 EEQ value among receptors evaluated in the SLERA. For earthworms, trivalent chromium EEQ presented.

[d] Value shown is from the SLERA.

[e] Estimated using the following scaling relationship:

Scaled EEQ = Residual Conc. x (pre-remediation EEQ/pre-remediation EPC).

[f] Estimated as follows: (Critical Ecological LOAEL EEQ - Scaled Ecological LOAEL EEQ)/Critical Ecological LOAEL EEQ x 100%

[g] No change in residual concentration, as no mercury "hot spot" locations targeted for removal.

Notes:

COI = chemical of interest

EPC = exposure point concentration (original EPC used in SLERA for surface soil exposure)

SLERA = Screening Level Ecological Risk Assessment

EEQ = ecological effects quotient from SLERA.

LOAEL = lowest-observed-adverse-effect level

NA = not applicable

RG = remedial goal.

In conclusion, given the reasons presented above, the proposed human health CMOs in **Table 8-1** for either industrial or residential land use are expected to result in residual COPEC soil concentrations in surface soil that are protective of the environment. No additional ecological CMOs are needed because (1) there is limited ecological habitat at the site and (2) the habitat that is present is of generally low quality and is not expected to attract ecological receptors. The habitat is of low quality for wildlife because mowing of the grass and routine maintenance of the area limits the development of a diverse grassland/forbs community. Grasses at the site are predominantly limited to a few species, and the community lacks the variety of species that would develop in a natural undisturbed habitat that might include tall grasses, mid grasses, short grasses, and forbs such as composites and legumes. Grassy areas comprised of only a few species would not be expected to support a diverse wildlife community.

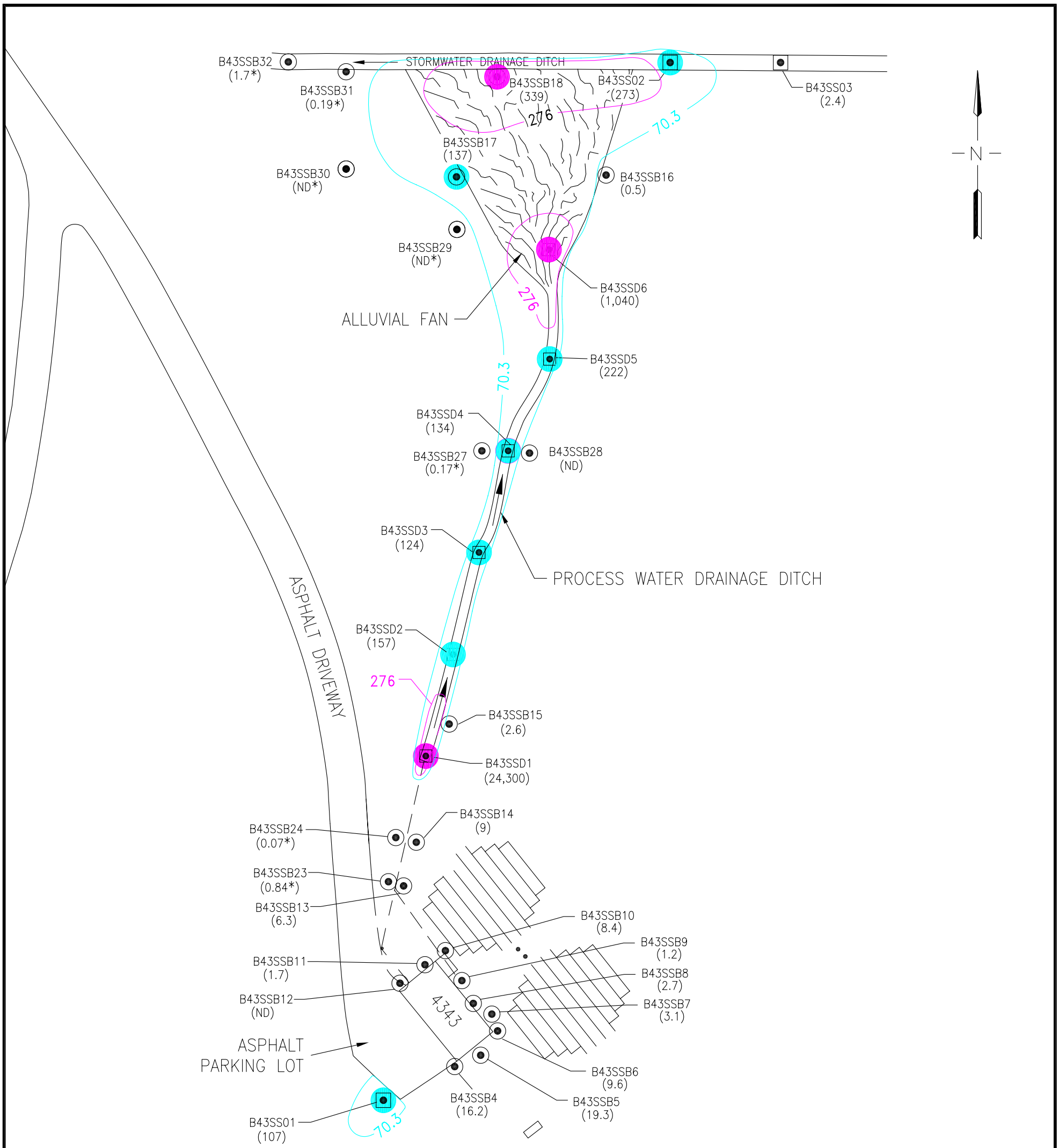
8.3 Site-Specific Corrective Measures Objectives

Impacted soil in the study area is currently not used or expected to be used in the future. However, site workers (maintenance and excavation workers) may come into contact with contaminated soil in the future. In addition, impacted soil in the study area is not migrating off-site to potential receptors; therefore, a corrective action objective has been established to reduce the contaminant concentrations in the study area with waste in place. Specifically, the corrective action objective for this RFI/CMS is to reduce contaminant concentrations in soil to levels that are protective of industrial workers at the site. However, the Army has evaluated the residential exposure pathways to assess what the remedial effort would be to obtain clean close out; therefore, a discussion of whether the proposed alternatives protect residential receptors is presented in the evaluation of alternatives. Clean close out has cost advantages over waste in place close out by eliminating long term costs and allow for tenant use. In addition, clean close out is the Army's primary goal for the Installation Restoration Program and its funding source the Environmental Restoration, Army account.

8.4 Area and Volume of Contamination

Based on the CMOs described in *Section 8.3*, the area and volume of contamination have been calculated. The results of the investigations of the Building 4343 soil indicate that cadmium is primarily present in surface soil at concentrations exceeding the Industrial RG (see **Figure 4-2**). However, there is one subsurface location (B43SB14) where cadmium was detected above the Residential RG. Although not defined during the field activities, the calculated areas of surface soil contamination (2,655 ft^2), presented as **Figure 8-1**, most likely define the limits of cadmium contamination. No cadmium was detected above the Industrial RG in subsurface soil samples. The depth of soil to be removed to reduce the cadmium concentration to less than the Industrial RG was assumed to be an average of 2 ft bgs. Based on the assumed area and depth of contamination, the total estimated volume of contaminated soil exceeding the Industrial RG is 197 yd^3.

The area and volume of contamination for clean close out (i.e., exceeding the Residential RG) was similarly calculated. The total area of surface soil and subsurface soil contamination, also presented on **Figures 8-1 and 8-2**, are estimated as 8,911 ft^2 and 148 ft^2, respectively. Assuming the average depth of contamination over this area is 2 ft bgs for areas where cadmium was detected in surface soil and 6 ft bgs for subsurface soil, the volume of contaminated soil exceeding the Residential RG is 693 yd^3.



LEGEND

- SURFACE SOIL SAMPLE LOCATION
- SOIL BORING LOCATION
- CADMIUM CONCENTRATION EXCEEDED THE CADMIUM INDUSTRIAL REMEDIAL GOAL (276 mg/kg)
- CADMIUM CONCENTRATION EXCEEDED THE CADMIUM RESIDENTIAL REMEDIAL GOAL (70.3 mg/kg)
- (0.19*) CADMIUM SOIL CONCENTRATION (mg/kg) BACK-CALCULATED FROM TCLP CONCENTRATION (ug/L)
- (2.6) CADMIUM SOIL CONCENTRATION (mg/kg)
- (ND) CADMIUM NOT DETECTED

- ESTIMATED AREA OF CADMIUM EXCEEDING INDUSTRIAL REMEDIAL GOAL (276 mg/kg)
- ESTIMATED AREA OF CADMIUM EXCEEDING RESIDENTIAL REMEDIAL GOAL (70.3 mg/kg)

NOTE: TCLP CONCENTRATIONS WERE BACK-CALCULATED TO SOIL CONCENTRATIONS USING SOIL SCREENING LEVEL IMPACT TO GROUNDWATER (USEPA, 1996).

0 20 40 80

SCALE IN FEET

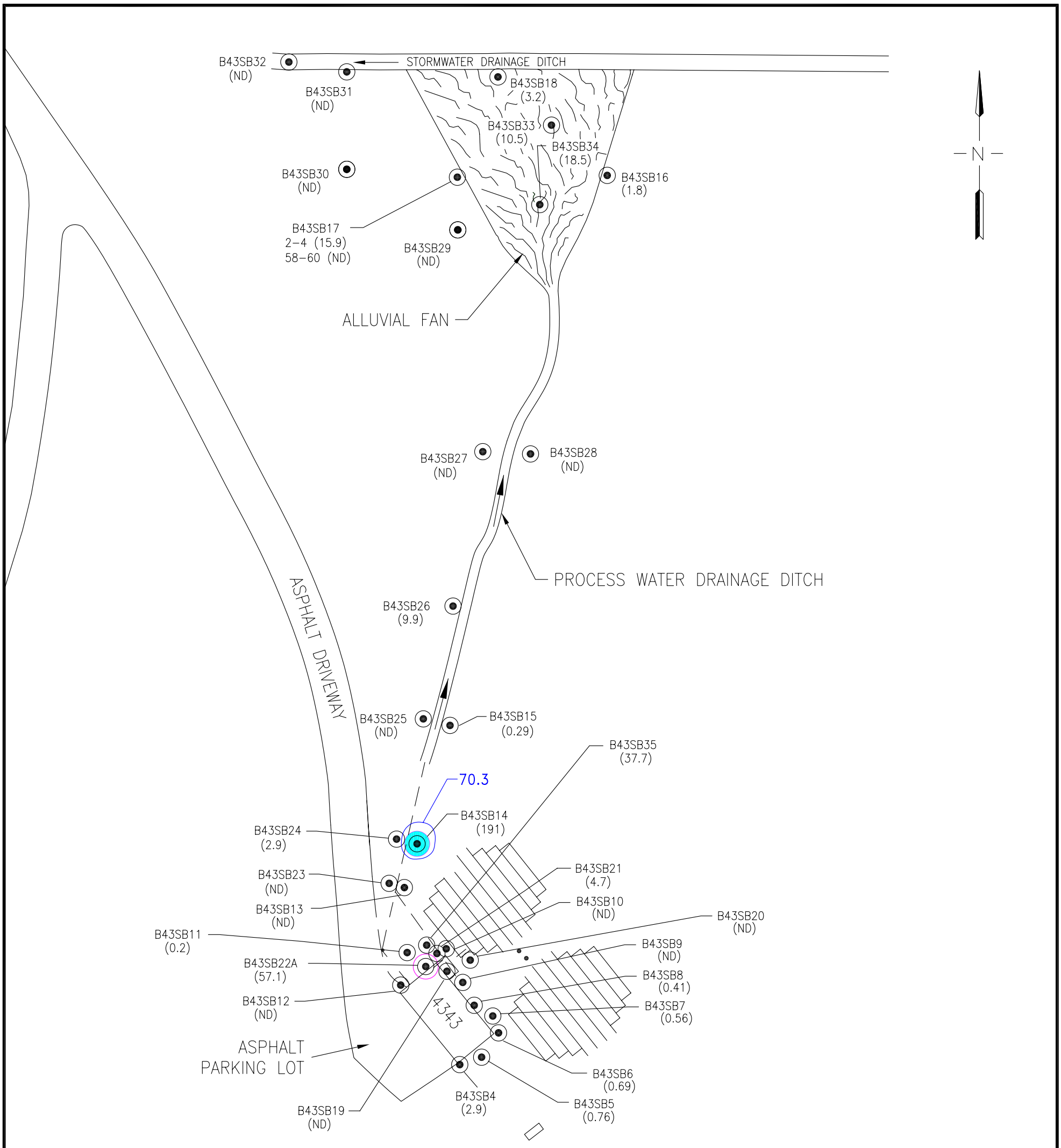
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RADFORD AAP

PREPARED BY: SHAW	TASK NO: 82987008400000
CHECKED BY: MT/GM	SHAW DWG NO: Fig8-1.dwg
DATE: REVISED FEB. 2004	

FIGURE 8-1

BUILDING 4343
CADMIUM
SURFACE SOIL
AREA OF CONTAMINATION



LEGEND

- SOIL BORING LOCATION
- CADMIUM CONCENTRATION EXCEEDED THE CADMIUM INDUSTRIAL REMEDIAL GOAL (276 mg/kg)
- CADMIUM CONCENTRATION EXCEEDED THE CADMIUM RESIDENTIAL REMEDIAL GOAL (70.3 mg/kg)
- (2.6) CADMIUM SOIL CONCENTRATION (mg/kg)
- (ND) CADMIUM NOT DETECTED
- ESTIMATED AREA OF CADMIUM EXCEEDING INDUSTRIAL REMEDIAL GOAL (276 mg/kg)
- ESTIMATED AREA OF CADMIUM EXCEEDING RESIDENTIAL REMEDIAL GOAL (70.3 mg/kg)

0 20 40 80

SCALE IN FEET

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RADFORD AAP

PREPARED BY: SHAW	TASK NO: 82987008400000
CHECKED BY: MT/GM	SHAW DWG NO: Fig8-2.dwg
DATE: REVISED FEB. 2004	

FIGURE 8-2

BUILDING 4343
CADMIUM
SUBSURFACE SOIL
AREA OF CONTAMINATION

9.0 CORRECTIVE MEASURES DEVELOPMENT

The following four corrective measure alternatives were developed to meet the CMOs described in *Section 8.0*:

- No Further Action;
- Excavation of Soil with Waste in Place, Off-site Disposal, Removal of Sumps, Demolition of Building 4343, and Land Use Controls;
- Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Demolition of Building 4343; and,
- Stabilization, Removal of Sumps, Demolition of Building 4343, and Land Use Controls.

9.1 Alternative One - No Further Action

The no further action alternative will be used as a baseline against which to measure the performance of other alternatives.

9.2 Alternative Two – Excavation of Soil with Waste in Place, Off-site Disposal, Removal of Sumps, Demolition of Building 4343, and Land Use Controls

This alternative involves excavation of soil containing cadmium concentrations exceeding the Industrial Risk-Based RG (see *Section 8.0*). The estimated area to be excavated is presented on **Figures 8-1 and 8-2**, as the area containing cadmium above the Industrial RG. Excavated materials will be shipped to an offsite landfill for disposal. Depending upon the waste characterization results (e.g., TCLP, RCRA waste characteristics), the materials will be transported offsite to either a hazardous waste or solid waste landfill. However, to be conservative, it was assumed that the materials present are hazardous and will be disposed in a RCRA Subtitle C Landfill.

The estimated volume of the materials to be excavated is 197 yd^3. The density of the waste material was assumed to be 1.4 tons/yd^3; therefore, the total quantity of waste material to be excavated will be approximately 276 tons. Conventional earthmoving equipment such as bulldozers, trackhoes, or other earthmoving equipment would be used for excavation of the waste material. Waste materials would be excavated and loaded directly into trucks for off-site transport and disposal. Trucks would be weighed and manifested prior to leaving the site.

Included in this alternative is the removal of two sumps (located within and just north of Building 4343), which have been identified as containing elevated levels of metals. The sumps will be removed along with the excavated soil and will be disposed at an appropriate disposal facility.

In addition, this alternative includes the presentation of costs associated with the demolition of Building 4343. While unacceptable risks to human health or the environment have not been identified for the building, potentially contaminated soil may be located beneath the building, therefore requiring its removal. Costs for these actions have been included for reference and scoping purposes.

This alternative entails leaving contaminant concentrations in-place at concentrations exceeding the Residential RG; therefore, clean close out will not be achieved and land use controls will be

required to prevent the property from being used for activities other than those associated with industrial reuse in the future. In addition, soil sampling will be performed every five years to demonstrate that conditions at the site have not changed.

The components of the excavation with waste in place, off-site disposal, removal of sumps, demolition of Building 4343, and land use controls alternative used for costing purposes are detailed below. The costs for this alternative are presented as **Table 9-1**.

Reporting/Design Work Plans. The contractor will prepare site-specific work plans prior to excavation activities that will include a QA planning component, health and safety component, Work Plan, and field procedures. The work plans will be reviewed and approved by the USACE, RFAAP, USEPA, and VDEQ prior to removal activities.

After the corrective measures have been completed and the final inspection approved by the USACE, RFAAP, USEPA, and VDEQ, a Corrective Measures Summary Report will be completed. Writing and compilation of the information for the report will occur throughout the duration of the remedial action. The report will include site drawings, sample data, copies of manifests, and a detailed narrative of the corrective measures. The completed Draft Corrective Measures Summary Report will be submitted to the USACE, RFAAP, and regulatory agencies for review and comment. Once regulatory agency comments have either been resolved or incorporated into the report, the Final Corrective Measures Summary Report will be issued.

Site Set-up. Site set-up for the excavation will consist of setting up a decontamination station, mobilization of equipment and personnel, and setting up staging areas. It should be noted that mobilization costs are included with the excavation costs in **Table 9-1**. The water needs of the process are for decontamination; therefore, water will be trucked to the site and stored in a 500-gallon tank. The cost elements for preparing the work zone are presented below.

- The equipment decontamination station will be constructed with material such as high-density polyethylene (HDPE) for containment purposes. This decontamination station should be bermed to ensure containment of decontamination liquids.
- A 500-gallon tank will be used throughout the duration of the corrective measure activities to store water for use in the decontamination station.

Contamination Delineation. The area to be excavated will be delineated prior to mobilization of the excavation personnel. Surface and subsurface soil sampling will be performed in order to delineate the area to be excavated. For the purpose of this study, it is assumed that one surface and two subsurface soil samples would be collected from a total of 20 locations (60 samples) and analyzed for cadmium. Details on sample locations, sample depths, etc. will be developed during the work planning phase.

Health and Safety. Health and safety measures will be taken to protect on-site workers during excavation activities. For cost estimating purposes, modified Level D PPE and decontamination equipment has been assumed. It was also assumed that a health and safety officer will be required on-site during corrective measures activities.

Table 9-1
Cost for Alternative Two: Excavation of Soil with Waste in Place, Off-site Disposal, Removal of Sumps, Demolition of Building 4343, and Land Use Controls (Page 1 of 2)

ITEM	UNITS	UNIT COST	NUMBER	TOTAL
CAPITAL COSTS[1]				
Reporting/Workplans				
Health and Safety Plan	Report	$10,000.00	1	$10,000.00
Quality Assurance Project Plan	Report	$10,000.00	1	$10,000.00
Work Plan	Report	$15,000.00	1	$15,000.00
O&M Sampling Plan	Report	$10,000.00	1	$10,000.00
Corrective Measures Summary Report	Report	$20,000.00	1	$20,000.00
Subtotal				**$65,000.00**
Land Use Controls				
Deed Restrictions	Lump Sum	$10,000.00	1	$10,000.00
Subtotal				**$10,000.00**
Site Set-Up				
500-gallon Storage Tank	Lump Sum	$500.00	1	$500.00
Decontamination Pad	Site	$1,500.00	1	$1,500.00
Subtotal				**$2,000.00**
Contamination Delineation				
Direct Push Rig (Geoprobe)	Day	$1,000.00	6	$6,000.00
Oversight (Geologist)	Hour	$50.00	60	$3,000.00
Per Diem	Day	$83.00	6	$498.00
Off-Site Laboratory (Cadmium, 72 hour TAT)	Sample	$105.00	60	$6,300.00
Subtotal				**$15,798.00**
Health and Safety				
Site Health and Safety Officer	Hour	$65.00	160	$10,400.00
H&S Monitoring Equipment	Day	$50.00	16	$800.00
Subtotal				**$11,200.00**
Excavation				
QC Personnel (1)	Hour	$70.00	160	$11,200.00
Project Chemist (1)	Hour	$60.00	30	$1,800.00
Field Supervisor (1)	Hour	$60.00	100	$6,000.00
Field Technician (2)	Hour	$37.50	200	$7,500.00
Equipment Operators (2)	Hour	$50.00	200	$10,000.00
Project Manager (1)	Hour	$82.50	40	$3,300.00
Level D PPE	Man-Day	$30.00	87	$2,610.00
Travel/Truck Rental	Day	$150.00	16	$2,400.00
Per Diem[3]	Day	$83.00	87	$7,221.00
D6 Bulldozer (includes mob/demob)	Month	$10,300.00	0.5	$5,150.00
3 CY Trackhoe (includes mob/demob)	Month	$8,130.00	0.5	$4,065.00
Roller - Vibratory Compactor (includes mob/demob)	Month	$3,166.00	0.5	$1,583.00
Water Truck (includes mob/demob)	Month	$1,740.00	0.5	$870.00
Subtotal				**$63,699.00**
Confirmational Sampling				
Off-Site Laboratory (Cadmium, 72 hour TAT)	Sample	$105.00	32	$3,360.00
Subtotal				**$3,360.00**
Sump Removal				
Supervisor	Hour	$60.00	20	$1,200.00
Laborers (2)	Hour	$37.50	40	$1,500.00
Hot Pressure Washer	Week	$500.00	2	$1,000.00
Jackhammer/Air Compressor	Week	$1,000.00	1	$1,000.00
Subtotal				**$4,700.00**
Waste Characterization				
Sump Materials Off-Site Lab Analytical \	Sample	$520.00	1	$520.00
Soil Off-Site Lab Analytical (TCLP metals, RCRA WC)	Sample	$520.00	11	$5,720.00
Decon Water Sample (RCRA Waste Characterization)	Sample	$1,410.00	1	$1,410.00
Subtotal				**$7,650.00**
Waste Transportation/Disposal				
Hazardous Waste Transportation/Disposal	Ton	$140.00	276	$38,640.00
Cement from Sumps	Ton	$50.00	9.2	$460.00
Subtotal				**$39,100.00**

Table 9-1
Cost for Alternative Two: Excavation of Soil with Waste in Place, Off-site Disposal, Removal of Sumps, Demolition of Building 4343, and Land Use Controls (Page 2 of 2)

ITEM	UNITS	UNIT COST	NUMBER	TOTAL
CAPITAL COSTS[1]				
Site Restoration				
Topsoil (6" lifts, off-site)[4]	CY	$10.00	591	$5,910.00
Seeding, Vegetative Cover	Acre	$3,528.00	0.5	$1,764.00
Survey Equipment/Team	Lump Sum	$1,500.00	1.0	$1,500.00
Groundwater Monitoring Wells (Labor, Equip, Materials)	Well	$20,000.00	3	$60,000.00
Subtotal				**$69,174.00**
Demolition of Building 4343				
QC Personnel (1)	Hour	$70.00	50	$3,500.00
Site Health and Safety Officer	Hour	$65.00	50	$3,250.00
Field Supervisor (1)	Hour	$60.00	50	$3,000.00
Laborers (2)	Hour	$37.50	100	$3,750.00
Equipment Operator (1)	Hour	$50.00	50	$2,500.00
Project Manager (1)	Hour	$82.50	10	$825.00
Per Diem	Day	$83.00	32	$2,656.00
Asbestos Survey	Lump Sum	$1,000.00	1	$1,000.00
Asbestos Abatement Plan	Lump Sum	$1,000.00	1	$1,000.00
Asbestos Abatement/Disposal	Linear Feet	$20.00	200	$4,000.00
Asbestos Removal Final Report	Lump Sum	$1,000.00	1	$1,000.00
D6 Bulldozer (includes mob/demob)	Month	$10,300.00	0.25	$2,575.00
3 CY Trackhoe w/Hammerjack Attach. (includes mob/demob)	Month	$8,750.00	0.25	$2,187.50
Roller - Vibratory Compactor (includes mob/demob)	Month	$3,166.00	0.25	$791.50
Water Truck (includes mob/demob)	Month	$1,740.00	0.25	$870.00
Non-Haz Disposal of Building Materials (Assume 80% Expansion)	Ton	$50.00	73	$3,646.30
Topsoil (6" lifts, off-site)	CY	$30.00	18	$535.24
Seeding, Vegetative Cover	Acre	$3,528.00	0.1	$1,764.00
Subtotal				**$38,850.54**
		SUBTOTAL		**$330,531.54**
		SUPERVISION AND ADMIN @ 8%		$26,442.52
		CONTINGENCY @ 30%		$99,159.46
TOTAL CAPITAL COSTS				**$456,133.53**
O&M COSTS				
5-Year Reporting/Workplans				
Work Plan	Report	$10,000.00	1	$10,000.00
Five-Year Sampling Summary Report	Report	$15,000.00	1	$15,000.00
Subtotal[5]				**$2,500.00**
5-Year Soil Sampling/Monitoring				
Geoprobe	Day	$1,000.00	3	$3,000.00
Oversight (Geologist)	Hour	$50.00	30	$1,500.00
Per Diem	Day	$83.00	3	$249.00
Off-Site Laboratory (Cadmium, 72 hour TAT)	Sample	$105.00	30	$3,150.00
Subtotal[5]				**$1,316.50**
Annual Groundwater Sampling				
Field Labor, Equipment, Reporting	Event	$8,000.00	1	$8,000.00
Off-Site Laboratory (Cadmium, 72 hour TAT)	Sample	$105.00	5	$525.00
Subtotal				**$8,525.00**
		SUBTOTAL (ANNUALLY)[5]		**$12,341.50**
		CONTINGENCY @ 30%		$3,702.45
		TOTAL ANNUAL O&M COSTS		**$16,043.95**
PRESENT WORTH (30 YEARS AT 5%)				**$702,768.36**

[1] Costs do not assume permit requirements

[2] The estimated length of time is as follows: mobilization 1 day, delineation 6 days, excavation 3 days, site restoration 2 days, confirmation 1 day, decon/demob 1 day, sump removal 2 days, Building 4343 demo 1 week

[3] Per diem costs for 10 days for field techs and equipment operators, 16 days for H&S and QC officer, 5 days for PM

[4] A factor of 3x was used to estimate the quantity of topsoil required to account for compression and volume to fill the process water drainage ditch.

[5] For O&M costs that occur once every five years, subtotal revised to indicate 1/5 costs.

Excavation. Excavation will be performed using conventional equipment. For cost estimating purposes, it was assumed that one excavator (trackhoe) will be used to excavate the contaminated area. It is assumed that the excavation will proceed at the rate of 90 tons per day (10-hour day). The estimated length of time for the excavation is 3 days. A water truck will be required on-site during excavation activities for dust suppression purposes. Oversight personnel assumed for this alternative include one QC Engineer, one field supervisor, two field technicians, and one project manager.

Confirmation Sampling. Confirmation sampling will be conducted concurrently with excavation and will document that the remaining soil meets established cleanup levels. Excavation will continue until CMOs have been met. It is estimated that 32 samples will be collected from the bottom and sides of the excavation area and sent to an off-site laboratory for cadmium analysis.

Removal of Sumps. Removal of the sumps will be performed using conventional equipment. The internal dimensions of the sumps are as follows:

- Interior sump: 18 in x 18 in x 7 in
- Exterior sump: 24 in x 18 in x 12 in

The sumps are constructed of concrete approximately 6 inches in thickness, for a total volume of 11.46 ft^3, or 0.4 yd^3 of concrete. It is assumed that 12 inches of soil from around the sidewalls and 24 inches of soil from below the bottom of the sumps will also be removed during the sump removal; therefore, an additional 4.6 yd^3 of soil will be removed. For cost estimating purposes, it was assumed that the sumps will be manually removed using a jackhammer and shovels by two laborers. Sludge material in the sumps will be removed and drummed separately from other disposal material. It is assumed that each sump can be removed in one day (10-hour day). Oversight personnel required for these activities are the same as those required for the soil removal.

Waste Characterization. For the purposes of this document, analysis for the following waste characteristics is assumed for composite samples collected from excavated soil prior to disposal. It is assumed that 11 composite soil samples (or one sample per 25 tons) and one composite sample from the sump materials will be compelted as part of this alternative. In addition, IDM will be sampled prior to disposal for RCRA waste characteristics.

Test	Media	Method		Price*
		Extraction	Analysis	
Corrosivity, pH, 3 day TAT	Solid	NA	SW-846 9045C	$20
Flash Pt. Ignitability, 3 day TAT	Solid	NA	SW-846 1030	$70
Reactivity, 3 day TAT	Solid	NA	SW-846 Chap 7.3	$180
TCLP Metals, 3 day TAT	Solid	SW-846 1311	SW-846 3010A/6010B/7470A	$250
Total Cost				$520

* Based on a laboratory quote from DataChem, July 2003.

In addition, the decontamination water will be analyzed for RCRA waste characteristics prior to disposal at the RFAAP wastewater treatment plant.

Description of Wastes. Corrective measure activities are expected to generate 276 tons of hazardous soil and 300 gallons of decontamination water.

Waste Disposal. Each waste type generated during this alternative will require a different disposal method. These include:

Waste Type	Disposal Method	Cost
Hazardous Soil	RCRA Subtitle C Landfill	$140/ton
Cement from Sumps	RCRA Subtitle D Landfill	$50/ton
Decontamination Water-Non-Hazardous	RFAAP Wastewater Treatment Facility	$0/gallon
Decontamination Water Hazardous	RCRA Part B Permitted Aqueous Treatment Facility	$0.70/gallon

Excavated soil is anticipated to be classified as hazardous waste, so will be disposed in a RCRA Subtitle C Landfill. It is assumed that the concrete removed from the sumps will be a non-hazardous waste, so it will be disposed in a RCRA Subtitle D Landfill. It is likely that the decontamination fluids will be characterized as non-hazardous waste. If the liquids are non-hazardous, they will be disposed in the RFAAP wastewater treatment plant at no cost to the Army.

Disposal Facility Selection. The contractor and Installation will select the final disposal facility for the waste based on several factors:

- Treatment, storage, and disposal facility (TSDF) capacity to accommodate incoming waste;
- Solicitation of bids using applicable Federal Acquisition Regulations (FARs);
- Verification of permits and insurance (at time of award); and,
- The disposal facility must meet the permit compliance requirements.

Waste Transportation and Disposal. Currently, it is proposed that excavated soil that is characterized as a hazardous waste will be transported to EQ Facilities in Michigan. Excavated soil that is characterized as a non-hazardous waste will be transported to Piedmont, Virginia utilizing Capital Environmental as the local broker. Liquid wastes that are characterized as hazardous will be transported to US Liquids in Detroit, MI. The cost for transportation of contaminated soil and liquids is included in the disposal costs listed above.

Site Restoration. Once the excavation is complete, approximately 6 inches of topsoil will be applied over the entire excavation area. In addition, the process water drainage ditch will be filled with soil to match the surrounding grade. Following this, the area will be graded to approximate the original grade. Erosion control measures will be implemented and excavation areas will be seeded. Upon completion of site restoration operations, the contractor will remove the temporary facilities from the area.

Demolition of Building 4343. Demolition of Building 4343 has been included in this RFI/CMS for reference/scoping purposes. Based on observations made during site visits, it is assumed that lead-based paints and asbestos are present in the building. It was estimated that approximately 200 linear feet of asbestos are present and will require abatement prior to demolition. Asbestos abatement activities considered in the cost estimate include completion of an asbestos survey, reporting, abatement, and disposal. Paint is present on the inside of Building 4343 (the outside is unpainted). In addition, soil from around Building 4343 will be removed during the demolition/excavation activities; therefore, additional costs associated with lead abatement were not considered. However, site workers will be made aware of the potential lead risks and health

and safety measures will be performed as required. Suppression of dust generation will also be performed during demolition of the building materials. Demolition will be performed using conventional equipment. The dimensions of the building are as follows: 34.1 ft x 16.3 ft x 8.5 ft (to lower edge of roof, 12.5 ft to upper edge of roof). The building is constructed of cinder blocks approximately 8 inches in thickness and has a poured concrete floor, approximately 8-inches thick. A bulldozer will be used to level the building and place the material into roll-off containers to be hauled off-site. A pneumatic hammer will then be used to breakup the floor and the pieces will be picked up with the thumb attachment on the arm of the trackhoe and placed into the roll-off container. The volume of materials in the building is estimated to be 40 yd^3. It was further estimated that an 80% increase in the volume would occur due to void space, for a total of 72 yd^3 of materials; therefore, it was assumed that the materials could be placed in six roll-off boxes for transport off-site. Following building demolition, confirmation samples will be collected from under the building to assess whether cadmium is present at concentrations exceeding the Industrial RG. It is assumed that no additional soil removal is required. It is further assumed that demolition/removal of the building can be performed in one week (five 10-hour days). A water truck will be required on-site during the building demolition and removal activities for dust suppression purposes. Oversight personnel required for these activities are the same as those required for the soil removal. Waste characterization samples will be collected from the waste to assess the appropriate disposal options for the debris. For cost estimating purposes, it was assumed that the demolition debris will be non-hazardous, so will be disposed at a RCRA Subtitle D Landfill. Following removal of the demolition debris, the area will be graded, six inches of topsoil and erosion control netting will be placed, and the area will be seeded.

Land Use Controls. Following completion of corrective measures actions, land use controls will be required because contaminant concentrations remain on-site at concentrations exceeding the levels for unrestricted reuse. The land use controls will be input into RFAAP's Installation Master Plan that will specify that use of the property for activities associated with unacceptable risks (e.g., residential) will not be permitted.

Operation and Maintenance Sampling/Reporting. Because wastes are left in place for this alternative, it was assumed that three new monitoring wells would be installed (one upgradient and two downgradient of the site) and analyzed annually for cadmium. One long-term monitoring work plan/sampling and analysis plan will be completed for the groundwater sampling effort. A data summary report would be completed for each sampling event. In addition, soil sampling will be performed once every five years. It was further assumed that the samples would be collected from those locations where cadmium was identified to be present at concentrations greater than the Residential RG and below the Industrial RG during the delineation effort. For the purpose of this study, it is assumed that one surface and two subsurface soil samples would be collected from a total of 10 locations (30 samples) and analyzed for cadmium. It was further assumed that work plans would be completed for each sampling event. A data summary report would be completed every five years summarizing the results of the groundwater and soil sampling efforts.

9.3 Alternative Three - Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Demolition of Building 4343

This alternative involves excavation of soil containing concentrations of COIs exceeding Residential RGs (see *Section 8.0*) to facilitate clean close out of the Building 4343 study area.

The estimated area to be excavated is presented on **Figures 8-1 and 8-2**, as the area containing cadmium above the Residential RG. Alternative Three includes the cost items discussed in Alternative Two (*Section 9.2*) above, with longer durations for the additional volume of soil to be excavated. However, as soil containing cadmium at concentrations exceeding the Residential RG will be removed, clean close out of the site will be achieved and land use controls and the five year sampling/reporting is not required.

The estimated volume of the materials to be excavated is 693 yd^3. The density of the waste material was assumed to be 1.4 tons/yd^3. Therefore, the total quantity of waste material to be excavated will be approximately 970 tons. Depending upon the waste characterization results (e.g., TCLP, RCRA waste characteristics), the materials will be transported off-site to either a hazardous waste or solid waste landfill. However, to be conservative, it was assumed that the materials present are hazardous and will be disposed in a RCRA Subtitle C Landfill.

The cost components for Alternative Three are discussed under Alternative Two (*Section 9.2*). The costs for this alternative are presented as **Table 9-2**.

9.4 Alternative Four –Stabilization, Removal of Sumps, Demolition of Building 4343, and Land Use Controls

This alternative includes treatment of the cadmium-contaminated soil using the stabilization technology. Chemical stabilization involves adding materials that will ensure that hazardous constituents are maintained in their least mobile or toxic form. For metals-contaminated soil, stabilization is typically performed by mixing the soil with a dry sorbent such as fly ash. However, due to the very low Universal Treatment Standard (UTS) promulgated by the USEPA for cadmium (0.11 mg/L), stabilization of cadmium-contaminated soil in this manner can be difficult and expensive. Therefore, it was assumed, for cost estimating purposes, that a chemical stabilization compound would be utilized. These compounds bind to the cadmium and permanently prevent leaching. Risks to human health and the environment are effectively reduced in the treated soil. These compounds have the added benefit of treatment without changing the soil's physical characteristics (i.e., the process is not solid block containment). A process flow diagram of the stabilization technology is presented as **Figure 9-1**.

The stabilization alternative reduces the risks to human health and the environment associated with cadmium. Cadmium still remains on-site, even in the treated regions; so residential reuse for treated areas is generally not acceptable. Therefore, this alternative proposes treatment of soil where cadmium exceeds the Industrial RG (see **Figures 8-1 and 8-2**). As contaminant concentrations remain in-place at concentrations exceeding the Residential RG, land use controls will be required to prevent the property from being used for activities other than those associated with industrial reuse in the future. In addition, soil sampling will be performed every five years to demonstrate that conditions at the site have not changed. The land use controls and operation and maintenance sampling/reporting requirements are the same as those detailed in the Alternative Two (*Section 9.2*) discussion. Also included in this alternative is the removal of two sumps (located within and just north of Building 4343), and demolition of Building 4343. Details of these activities are also presented in the Alternative Two (*Section 9.2*) discussion.

The stabilization components of Alternative Four used for costing purposes are detailed below. The costs for this alternative are presented as **Table 9-3**.

Table 9-2
Cost for Alternative Three: Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Demolition of Building 4343 (Page 1 of 2)

ITEM	UNITS	UNIT COST	NUMBER	TOTAL
CAPITAL COSTS[1]				
Reporting/Workplans				
Health and Safety Plan	Report	$10,000.00	1	$10,000.00
Quality Assurance Project Plan	Report	$10,000.00	1	$10,000.00
Work Plan	Report	$15,000.00	1	$15,000.00
Corrective Measures Summary Report	Report	$20,000.00	1	$20,000.00
Subtotal				**$55,000.00**
Site Set-Up				
500-gallon Storage Tank	Lump Sum	$500.00	1	$500.00
Decontamination Pad	Site	$1,500.00	1	$1,500.00
Subtotal				**$2,000.00**
Contamination Delineation				
Direct Push Rig (Geoprobe)	Day	$1,000.00	15	$15,000.00
Per Diem	Day	$83.00	6	$498.00
Oversight (Geologist)	Hour	$50.00	150	$7,500.00
Off-Site Laboratory (Cadmium, 72 hour TAT)	Sample	$105.00	150	$15,750.00
Subtotal				**$38,748.00**
Health and Safety				
Site Health and Safety Officer	Hour	$65.00	340	$22,100.00
H&S Monitoring Equipment	Day	$50.00	34	$1,700.00
Subtotal				**$23,800.00**
Excavation				
QC Personnel (1)	Hour	$70.00	340	$23,800.00
Project Chemist (1)	Hour	$60.00	60	$3,600.00
Field Supervisor (1)	Hour	$60.00	230	$13,800.00
Field Technician (2)	Hour	$37.50	460	$17,250.00
Equipment Operators (2)	Hour	$50.00	460	$23,000.00
Project Manager (1)	Hour	$82.50	80	$6,600.00
Level D PPE	Man-Day	$30.00	193	$5,790.00
Travel/Truck Rental	Day	$150.00	34	$5,100.00
Per Diem[3]	Day	$83.00	193	$16,019.00
D6 Bulldozer (includes mob/demob)	Month	$10,300.00	1	$10,300.00
3 CY Trackhoe (includes mob/demob)	Month	$8,130.00	1	$8,130.00
Roller - Vibratory Compactor (includes mob/demob)	Month	$3,166.00	1	$3,166.00
Water Truck (includes mob/demob)	Month	$1,740.00	1	$1,740.00
Subtotal				**$138,295.00**
Confirmational Sampling				
Off-Site Laboratory (Cadmium, 72 hour TAT)	Sample	$105.00	67	$7,035.00
Subtotal				**$7,035.00**
Sump Removal				
Supervisor	Hour	$60.00	20	$1,200.00
Laborers (2)	Hour	$37.50	40	$1,500.00
Hot Pressure Washer	Week	$500.00	2	$1,000.00
Jackhammer/Air Compressor	Week	$1,000.00	1	$1,000.00
Subtotal				**$4,700.00**
Waste Characterization				
Sump Materials Off-Site Lab Analytical (TCLP metals, RCRA WC)	Sample	$520.00	1	$520.00
Soil Off-Site Lab Analytical (TCLP metals, RCRA WC)	Sample	$520.00	24	$12,480.00
Decon Water Sample (RCRA Waste Characterization)	Sample	$1,410.00	1	$1,410.00
Subtotal				**$13,890.00**
Waste Transportation/Disposal				
Hazardous Waste Transportation/Disposal	Ton	$140.00	970	$135,800.00
Cement from Sumps	Ton	$50.00	9.2	$460.00
Subtotal				**$136,260.00**

Table 9-2
Cost for Alternative Three: Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Demolition of Building 4343 (Page 2 of 2)

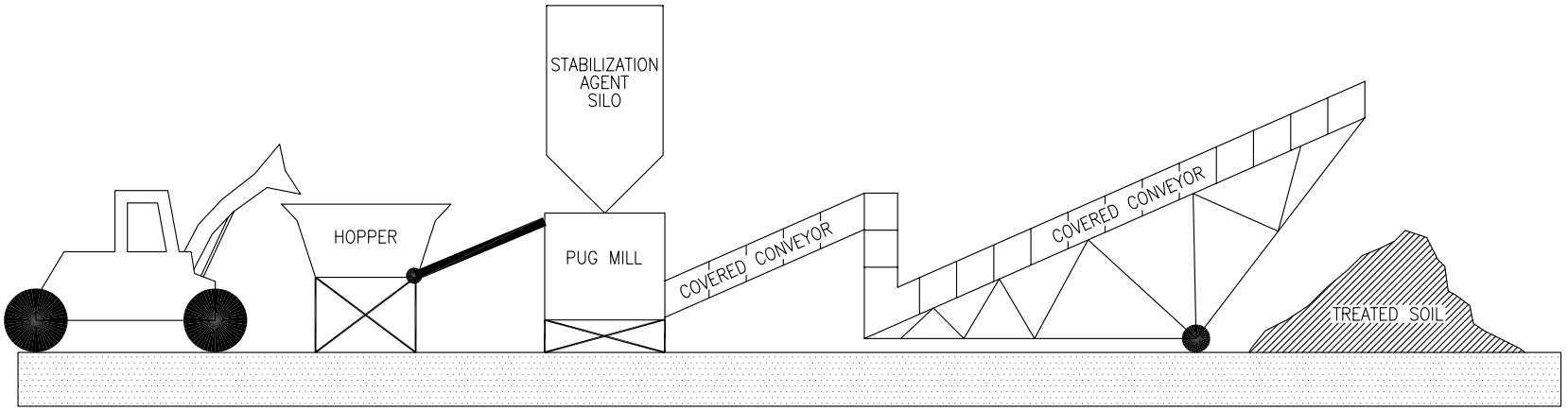
ITEM	UNITS	UNIT COST	NUMBER	TOTAL
CAPITAL COSTS[1]				
Site Restoration				
Topsoil (6" lifts, off-site)[4]	CY	$10.00	1386	$13,860.00
Seeding, Vegetative Cover	Acre	$3,528.00	0.5	$1,764.00
Survey Equipment/Team	Lump Sum	$1,500.00	1.0	$1,500.00
Subtotal				**$17,124.00**
Demolition of Building 4343				
QC Personnel (1)	Hour	$70.00	50	$3,500.00
Site Health and Safety Officer	Hour	$65.00	50	$3,250.00
Field Supervisor (1)	Hour	$60.00	50	$3,000.00
Laborers (2)	Hour	$37.50	100	$3,750.00
Equipment Operator (1)	Hour	$50.00	50	$2,500.00
Project Manager (1)	Hour	$82.50	10	$825.00
Per Diem	Day	$83.00	32	$2,656.00
Asbestos Survey	Lump Sum	$1,000.00	1	$1,000.00
Asbestos Abatement Plan	Lump Sum	$1,000.00	1	$1,000.00
Asbestos Abatement/Disposal	Linear Feet	$20.00	200	$4,000.00
Asbestos Removal Final Report	Lump Sum	$1,000.00	1	$1,000.00
D6 Bulldozer (includes mob/demob)	Month	$10,300.00	0.25	$2,575.00
3 CY Trackhoe w/Hammerjack Attachment (includes mob/demob)	Month	$8,750.00	0.25	$2,187.50
Roller - Vibratory Compactor (includes mob/demob)	Month	$3,166.00	0.25	$791.50
Water Truck (includes mob/demob)	Month	$1,740.00	0.25	$870.00
Non-Haz Disposal of Building Materials (Assume 80% Expansion)	Ton	$50.00	73	$3,646.30
Topsoil (6" lifts, off-site)	CY	$30.00	18	$535.24
Seeding, Vegetative Cover	Acre	$3,528.00	0.1	$1,764.00
Subtotal				**$38,850.54**
		SUBTOTAL		**$475,702.54**
		SUPERVISION AND ADMIN @ 8%		$38,056.20
		CONTINGENCY @ 30%		$142,710.76
TOTAL CAPITAL COSTS				**$656,469.51**
O&M COSTS				
None				
		SUBTOTAL (ANNUALLY)		**$0.00**
		CONTINGENCY @ 30%		$0.00
		TOTAL ANNUAL O&M COSTS		**$0.00**
PRESENT WORTH (30 YEARS AT 5%)				**$656,469.51**

[1] Costs do not assume permit requirements

[2] The estimated length of time is as follows: mobilization 1 day, delineation 15 days, excavation 11 days, site restoration 3 days, confirmation 1 day, decon/demob 1 day, sump removal 2 days, Building 4343 demo 1 week

[3] Per diem costs for 23 days for field techs and equipment operators, 34 days for H&S and QC officer, 10 days for PM

[4] A factor of 2x was used to estimate the quantity of topsoil required to account for compression and volume to fill the process water drainage ditch.



RADFORD AAP

FIGURE 9-1

PREPARED BY: SHAW	TASK NO: 82987008400000
CHECKED BY: GM	SHAW DWG NO: FIG9-1.dwg
DATE: REVISED JULY 2003	

STABILIZATION PROCESS FLOW DRAWING

Table 9-3
Cost for Alternative Four: Stabilization, Removal of Sumps, Demolition of Building 4343, and Land Use Controls (Page 1 of 3)

ITEM	UNITS	UNIT COST	NUMBER	TOTAL
CAPITAL COSTS[1]				
Reporting/Workplans				
Health and Safety Plan	Report	$10,000.00	1	$10,000.00
Quality Assurance Project Plan	Report	$10,000.00	1	$10,000.00
Work Plan	Report	$15,000.00	1	$15,000.00
O&M Sampling Plan	Report	$10,000	1	$10,000
Application for Modification to RFAAP Permit	Report	$2,000.00	1	$2,000.00
Corrective Measures Summary Report	Report	$20,000.00	1	$20,000.00
Subtotal				**$67,000.00**
Land Use Controls				
Deed Restrictions	Lump Sum	$10,000.00	1	$10,000.00
Subtotal				**$10,000.00**
Site Set-Up				
5,000 Gallon Frac Tank	Month	$1,000.00	1	$1,000.00
Stockpiling Pads (2)	Site	$1,500.00	2	$3,000.00
Decontamination Pad	Site	$1,500.00	1	$1,500.00
Subtotal				**$5,500.00**
Sump Removal				
Supervisor	Hour	$60.00	20	$1,200.00
Laborers (2)	Hour	$37.50	40	$1,500.00
Hot Pressure Washer	Week	$500.00	2	$1,000.00
Jackhammer/Air Compressor	Week	$1,000.00	1	$1,000.00
Subtotal				**$4,700.00**
Contamination Delineation				
Direct Push Rig (Geoprobe)	Day	$1,000.00	6	$6,000.00
Oversight (Geologist)	Hour	$50.00	60	$3,000.00
Per Diem	Day	$83.00	6	$498.00
Off-Site Laboratory (Cadmium, 72 hour TAT)	Sample	$105.00	60	$6,300.00
Subtotal				**$15,798.00**
Health and Safety				
Site Health and Safety Officer	Hour	$65.00	260	$16,900.00
H&S Monitoring Equipment	Day	$50.00	26	$1,300.00
Subtotal				**$18,200.00**
Excavation				
QC Personnel (1)	Hour	$70.00	260	$18,200.00
Project Chemist (1)	Hour	$60.00	80	$4,800.00
Field Supervisor (1)	Hour	$60.00	200	$12,000.00
Field Technician (2)	Hour	$37.50	400	$15,000.00
Equipment Operators (2)	Hour	$50.00	400	$20,000.00
Project Manager (1)	Hour	$82.50	60	$4,950.00
Level D PPE	Man-Day	$30.00	162	$4,860.00
Travel/Truck Rental	Day	$150.00	26	$3,900.00
Per Diem[3]	Day	$83.00	162	$13,446.00
D6 Bulldozer (includes mob/demob)	Month	$10,300.00	1.5	$15,450.00
3 CY Trackhoe (includes mob/demob)	Month	$8,130.00	1.5	$12,195.00
Roller - Vibratory Compactor (includes mob/demob)	Month	$3,166.00	1.5	$4,749.00
Water Truck (includes mob/demob)	Month	$1,740.00	1.5	$2,610.00
Subtotal				**$132,160.00**
Stabilization of Cadmium Contaminated Soil				
Soil Pre-Testing	Lump Sum	$2,000.00	1	$2,000.00
Purchase of Stabilization Agent	Ton	$450.00	17	$7,650.00
Transportation of Stabilization Agent	Ton	$140.00	17	$2,380.00
Rubber-Tired Front-End Loader	Month	$4,000.00	1	$4,000.00
Vibrating Screen/Conveyor	Day	$185.00	30	$5,550.00
Silo (Reagent)	Day	$68.00	30	$2,040.00

Table 9-3
Cost for Alternative Four: Stabilization, Removal of Sumps, Demolition of Building 4343, and Land Use Controls (Page 2 of 3)

ITEM	UNITS	UNIT COST	NUMBER	TOTAL
CAPITAL COSTS				
Pugmill	Day	$202.00	30	$6,060.00
Pugmill Operator	Hour	$50.00	150	$7,500.00
Per Diem for Pugmill Operator	Day	$83.00	10	$830.00
Subtotal				**$38,010.00**
Post-Treatment Sampling				
Off-Site Lab Analytical (TCLP metals, RCRA Waste Characterization)	Sample	$520.00	11	$5,720.00
Decon Water Sample (RCRA Waste Characterization)	Sample	$1,410.00	1	$1,410.00
Off-Site Laboratory (Cadmium, 72 hour TAT)	Sample	$105.00	20	$2,100.00
Subtotal				**$9,230.00**
Waste Characterization				
Off-Site Lab Analytical (TCLP metals, RCRA WC)	Sample	$520.00	1	$520.00
Decon Water Sample (RCRA Waste Characterization)	Sample	$1,410.00	1	$1,410.00
Subtotal				**$1,930.00**
Waste Transportation/Disposal				
Soil from Beneath Sumps Hazardous Waste T&D	Ton	$140.00	9.2	$1,288.00
Cement from Sumps	Ton	$50.00	9.2	$460.00
Subtotal				**$1,748.00**
Site Restoration				
Topsoil (6" lifts, off-site)	CY	$10.00	49	$491.67
Seeding, Vegetative Cover	Acre	$3,528.00	0.5	$1,764.00
Survey Equipment/Team	Lump Sum	$1,500.00	1.0	$1,500.00
Groundwater Monitoring Wells (Labor, Equip, Materials)	Well	$20,000.00	3	$60,000.00
Subtotal				**$63,755.67**
Demolition of Building 4343				
QC Personnel (1)	Hour	$70.00	50	$3,500.00
Site Health and Safety Officer	Hour	$65.00	50	$3,250.00
Field Supervisor (1)	Hour	$60.00	50	$3,000.00
Laborers (2)	Hour	$37.50	100	$3,750.00
Equipment Operator (1)	Hour	$50.00	50	$2,500.00
Project Manager (1)	Hour	$82.50	10	$825.00
Per Diem	Day	$83.00	32	$2,656.00
Asbestos Survey	Lump Sum	$1,000.00	1	$1,000.00
Asbestos Abatement Plan	Lump Sum	$1,000.00	1	$1,000.00
Asbestos Abatement/Disposal	Linear Feet	$20.00	200	$4,000.00
Asbestos Removal Final Report	Lump Sum	$1,000.00	1	$1,000.00
D6 Bulldozer (includes mob/demob)	Month	$10,300.00	0.25	$2,575.00
3 CY Trackhoe w/Hammerjack Attachment (includes mob/demob)	Month	$8,750.00	0.25	$2,187.50
Roller - Vibratory Compactor (includes mob/demob)	Month	$3,166.00	0.25	$791.50
Water Truck (includes mob/demob)	Month	$1,740.00	0.25	$870.00
Non-Haz Disposal of Building Materials (Assume 80% Expansion)	Ton	$50.00	73	$3,646.30
Topsoil (6" lifts, off-site)	CY	$30.00	18	$535.24
Seeding, Vegetative Cover	Acre	$3,528.00	0.1	$1,764.00
Subtotal				**$38,850.54**
		SUBTOTAL		**$406,882.21**
		SUPERVISION AND ADMIN @ 8%		$32,550.58
		CONTINGENCY @ 30%		$122,064.66
TOTAL CAPITAL COSTS				**$561,497.45**

Table 9-3
Cost for Alternative Four: Stabilization, Removal of Sumps, Demolition of Building 4343, and Land Use Controls (Page 3 of 3)

ITEM	UNITS	UNIT COST	NUMBER	TOTAL
O&M COSTS				
5-Year Reporting/Workplans				
Work Plan	Report	$10,000.00	1	$10,000.00
Five-Year Sampling Summary Report	Report	$15,000.00	1	$15,000.00
Subtotal[5]				**$2,500.00**
5-Year Soil Sampling/Monitoring				
Geoprobe	Day	$1,000.00	3	$3,000.00
Oversight (Geologist)	Hour	$50.00	30	$1,500.00
Per Diem	Day	$83.00	3	$249.00
Off-Site Laboratory (Cadmium, 72 hour TAT)	Sample	$105.00	30	$3,150.00
Subtotal[5]				**$1,316.50**
Annual Groundwater Sampling				
Field Labor, Equipment, Reporting	Event	$8,000.00	1	$8,000.00
Off-Site Laboratory (Cadmium, 72 hour TAT)	Sample	$105.00	5	$525.00
Subtotal				**$8,525.00**
		SUBTOTAL (ANNUALLY)[5]		**$12,341.50**
		CONTINGENCY @ 30%		$3,702.45
		TOTAL ANNUAL O&M COSTS		**$16,043.95**
PRESENT WORTH (30 YEARS AT 5%)				**$808,132.28**

Reporting/Design Work Plans. The contractor will prepare site-specific work plans prior to excavation/stabilization activities that will include a QA planning component, health and safety component, work plan, and field procedures. The work plans will be reviewed and approved by the USACE, RFAAP, USEPA, and VDEQ prior to removal activities. The estimated time for completion of these plans is four months. This includes incorporation of review comments and revisions.

This alternative entails performing remedial activities on-site. Therefore, the State and Federal regulations pertaining to Corrective Action Management Units (CAMUs) apply. Specifically, the regulations pertaining to Temporary Units (TUs) apply as the activities will be completed in under one year. The CAMU can be designated by a USEPA-initiated permit modification or by a request made by the site's waste management personnel according to procedures for an owner/operator-initiated Class 3 permit modification [40 CFR 264.552(g) and 40 CFR 270.42, Appendix I]. Therefore, costs associated with completion of the application for permit modification were also included.

After the remedial activities have been completed and the final inspection approved by the USACE, RFAAP, USEPA, and VDEQ, a Close Out Report will be completed. Writing and compilation of the information for the report will occur throughout the duration of the remedial action. The report will include site drawings, sample data, copies of manifests, and a detailed narrative of the remedial action. The completed Draft Close Out Report will be submitted to the USACE, RFAAP, and regulatory agencies for review and comment. Once regulatory agency comments have either been resolved or incorporated into the report, the Final Close Out Report will be issued.

Site Set-up. Site set-up will consist of setting up a decontamination station, mobilization of equipment and personnel, and setting up staging areas. It should be noted that mobilization costs are included with the excavation costs in **Table 9-3**. It is assumed that stabilization activities

will be performed in the parking area next to Building 4343, which has a large, flat open area for conducting treatment activities. Water will be required during the stabilization process to create a 50% moisture content to aid the mixing process and reduce dust generation. Therefore, water will be trucked to the site and stored in a 5,000-gallon tank. The treatment system does not have electrical needs, so electrical hookup is not required. Treatment will be conducted during daylight hours, so lighting is not required, as well. The cost elements for preparing the work zone are presented below.

- The equipment decontamination station will be constructed with material such as HDPE for containment purposes. This decontamination station should be bermed to ensure containment of decontamination liquids.
- A 5,000-gallon tank will be used throughout the duration of the removal activities to store water for use in the stabilization process and decontamination station.

Stabilization of Cadmium-Contaminated Soil. Stabilization will be performed on the areas where cadmium was detected above the Industrial RG. The compound used for the cost comparison analysis in this RFI/CMS is a propriety compound called Molecular Bonding System (MBS®). This compound has been demonstrated to be effective in a variety of conditions ranging from clays to sandy soil, so it should be effective for the soil present at Building 4343. To ensure this, soil from Building 4343 would be sent to the vendor and used to assess the appropriate ratio of soil:MBS® required to meet the UTS of 0.11 mg/L. Typically, 4-6% of the soil volume to be treated is required. Six percent was conservatively assumed to be required for cost estimating purposes. Therefore, the total quantity of MBS® required is approximately 17 tons. The soil requiring treatment would be excavated as described above and stockpiled in the parking lot area for Building 4343 on a lined, bermed containment area. Screening would then be performed to remove rocks larger than 2-inches in diameter to prevent damaging the pug mill system during treatment. Batches with a proper ratio of soil:MBS®:water would be added to the pug mill. Treated soil would be placed back into another lined, bermed area until the results of post-treatment sampling establish whether the UTS has been met. It is assumed that an average of approximately 30 tons of soil would be treated per day. Once treatment has been confirmed, soil would be placed back into the excavated area and site restoration activities would commence. It should be noted that placing remediation wastes into the CAMU does not constitute land disposal of hazardous waste [40 CFR 264.552(a)(l)]. Further, consolidating or placing remediation wastes into the CAMU does not create a hazardous waste management unit subject to minimum technology requirements (MTRs) [40 CFR 264.552(a)(2)]. Thus, remediation wastes generated at a site, can be consolidated in the CAMU, and remediation wastes can be moved between two or more CAMUs at the site without triggering Land Disposal Regulations (LDRs).

Post-Treatment Sampling. For the purposes of this RFI/CMS, one sample per 30 yd^3 of treated material (or 10 total samples,) plus one duplicate (11 total samples) for TCLP metals and RCRA waste characteristics were assumed to be required for composite samples collected from the stabilized soil. In addition, it was assumed that two samples for cadmium would be collected per day and analyzed at an off-site laboratory to assess the treatment efficiency.

Waste Disposal. Each waste type generated during this alternative will require a different disposal method. These include:

Waste Type	Disposal Method	Cost
Hazardous Soil from Beneath Sumps	RCRA Subtitle C Landfill	$140/ton
Cement from Sumps	RCRA Subtitle D Landfill	$50/ton
Decontamination Water-Non-Hazardous	RFAAP Wastewater Treatment Facility	$0/gallon
Decontamination Water Hazardous	RCRA Part B Permitted Aqueous Treatment Facility	$0.70/gallon

Excavated soil is anticipated to be classified as hazardous waste, so will be disposed in a RCRA Subtitle C Landfill. It is assumed that the concrete removed from the sumps is a non-hazardous waste, so it will be disposed in a RCRA Subtitle D Landfill. It is likely that the decontamination fluids will be characterized as non-hazardous waste. If the liquids are non-hazardous, they will be disposed in the RFAAP wastewater treatment plant at no cost to the Army.

Site Restoration. Once the stabilization process is complete, the treated soil will be placed back into the area from which it was removed and the area will be graded. Following this, approximately 6 inches of topsoil will be applied over the entire excavation area. Erosion control measures will be implemented and excavation areas will be seeded. Upon completion of site restoration operations, the contractor will remove the temporary facilities from the area.

10.0 DETAILED ANALYSIS OF CORRECTIVE ACTION ALTERNATIVES

10.1 Evaluation Criteria

The criteria used to evaluate each corrective action alternative include effectiveness, implementability, and cost, as described below.

10.1.1 Effectiveness of the Alternative

The effectiveness of an alternative was based on the ability of the alternative to address technical, human health, and ecological concerns. The effectiveness of each alternative is evaluated in this section based on the ability to:

- Meet the corrective action objective for the study area;
- Achieve remedial action goals for soil in a timely manner;
- Control the source of the release;
- Provide proven and reliable technologies; and,
- Reduce impacts to human health and the environment during corrective action implementation.

10.1.2 Implementability of the Alternative

Identified alternatives need to be readily available, easily constructed, and reliable. Evaluation is focused on:

- Ability to construct the technology; and,
- Availability of equipment, materials, and labor for construction.

10.1.3 Cost of the Alternative

Cost factors used to evaluate alternatives include costs associated with implementation of each corrective action alternative. Costs were included for project planning, project implementation reports, project administration, site restoration, and institutional controls. The cost for each alternative was developed based on a conceptual design for each alternative. These costs are present worth/equivalent cost (plus 50 percent to minus 30 percent). Actual cost of each alternative is dependent on the final scope, schedule, market conditions, and other variables. Development of the cost for each alternative included:

- Engineering level design of final remedy;
- Capital cost;
- Installation cost; and,
- Institutional controls costs (if applicable).

10.2 Effectiveness

10.2.1 Overall Protection of Human Health and the Environment

Alternative One does not meet this criterion as no measures are taken to prevent human or ecological contact with contaminated soil. For Alternatives Two, Three, and Four, soil-

containing contaminants at concentrations associated with unacceptable risks to human health will be removed from the areas under the anticipated industrial future use scenario. Alternative Three provides an additional level of protection for residential receptors. While this use scenario is not likely for Building 4343, it allows the site to be closed without use restrictions. In addition, as discussed in *Section 8.2.1*, the proposed human health CMOs in **Table 8-1** for either industrial or residential land use are expected to result in residual COPEC soil concentrations in surface soil that are protective of the environment. Therefore, protection of ecological receptors is also afforded by these alternatives.

10.2.2 Compliance with Federal, State, and Local Regulations

No reduction in contaminant concentrations is provided by Alternative One. Therefore, this alternative would not meet the Industrial RG. Alternatives Two, Three, and Four will meet the Industrial RG. In addition, Alternative Three will reduce contaminant concentrations to below the Residential RG, facilitating clean close out of the site. Each alternative will be designed to comply with applicable or relevant and appropriate Federal, State, and local regulations. Additional information regarding the alternatives' compliance with NEPA requirements is presented in **Appendix I**.

10.2.3 Long-term Effectiveness and Permanence

Alternative One does not provide long-term effectiveness or permanence because elevated cadmium concentrations will remain in place and no active controls will be taken to reduce exposure. For Alternative Two, cadmium concentrations present above the Industrial RG will be removed from the site, thereby providing long-term effectiveness and permanence. In addition, land use controls will be implemented under this alternative that will prevent the area from being used for activities associated with unacceptable risks. Alternative Three provides the highest level of protection, as it entails removal of soil containing cadmium concentrations above the Residential RG, thereby providing long-term effectiveness, regardless of the future use of the site. For Alternative Four, contaminated soil containing cadmium concentrations exceeding the Industrial RG will be stabilized *in-situ*. This is an irreversible process; therefore, this alternative provides long-term effectiveness and permanence under an industrial reuse scenario. In addition, land use controls will be implemented under this alternative that will prevent the area from being used for activities associated with unacceptable risks.

10.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

No actions are performed under Alternative One; therefore, no reduction in toxicity, mobility, or volume (TMV) is provided under this alternative. Alternatives Two and Three will not provide a reduction in the toxicity or volume of contamination as the cadmium is not destroyed, but is rather moved to a new location. However, a reduction in mobility will be provided as the cadmium will be placed in a RCRA landfill. For Alternative Four, the stabilization alternative, a reduction in toxicity and mobility is provided for the treated area (approximately 276 tons of treated soil). Addition of the stabilization compound will cause the cadmium present in the treated area to be non-bioavailable and immobile. However, the volume will not be affected, as the cadmium will still be present on-site.

10.2.5 Short-Term Effectiveness

There are no short-term risks associated with Alternative One, as no actions are implemented. Potential short-term risks to site workers, the environment, and the community can be reduced

for Alternatives Two, Three, and Four by the use of good construction practices, real-time air monitoring, standard dust-suppression techniques, and by following appropriate Department of Transportation (DOT) and Commonwealth of Virginia shipping requirements for transportation activities. The methodologies to safely perform these activities will be described in site-specific work plans and health and safety plans.

10.3 Implementability

10.3.1 Technical Feasibility

Alternative One is technically implementable, as no actions are to be implemented under this alternative. Alternatives Two, Three, and Four involve proven technologies for remediation of cadmium-contaminated soil.

10.3.2 Administrative Feasibility

Alternative One is administratively feasible, as no actions are to be implemented under this alternative. Administrative activities for Alternatives Two and Three are expected to be routine. Permitting will not be required for the activities described under Alternatives Two and Three. Alternative Four entails performing remedial activities on-site. Therefore, the State and Federal regulations pertaining to CAMUs apply. Specifically, the regulations pertaining to TUs apply, as the activities will be completed in under one year. The CAMU can be designated by an EPA-initiated permit modification or by a request made by the site's waste management personnel according to procedures for an owner/operator-initiated Class 3 permit modification [40 CFR 264.552(g) and 40 CFR 270.42, Appendix I]. It is assumed that incorporation of the CAMU into the RFAAP permit for Alterative Four is administratively feasible.

10.3.3 Availability of Services and Materials

Alternatives Two, Three, and Four involve full-scale technologies that can be readily implemented. Services and materials for the alternatives are readily available.

10.4 Cost

Costing assumptions are in the description of the alternatives in *Section 9.0*. The detailed cost estimates for Alternatives Two through Four are presented in **Tables 9-1 through 9-3**, respectively. Besides the No Action alternative (Alternative One), which has no associated cost, the least expensive alternative is Alternative Three – Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Demolition of Building 4343. Costs for each of the alternatives are summarized in **Table 10-1**.

Table 10-1
Summary of Costs
Building 4343 Corrective Measures Alternatives

Alternative Number	Capital Costs ($)	Operation and Maintenance Total ($)	Present Worth ($)
1 – No Further Action	$0	$0	$0
2 – Excavation of Soil with Waste in Place, Off-site Disposal, Removal of Sumps, Demolition of Building 4343, and Land Use Controls	$456,000	$16,000	$702,000
3 – Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Demolition of Building 4343	$656,000	$0	$656,000
4 – Stabilization, Removal of Sumps, Demolition of Building 4343, and Land Use Controls	$561,000	$16,000	$808,000

11.0 RANKING OF CORRECTIVE MEASURES ALTERNATIVES

The four corrective measures alternatives presented in *Section 9.0* and evaluated in *Section 10.0* are assessed in this section using a numerical ranking system. The alternatives are ranked according to the criteria discussed in *Section 10.0* that include effectiveness, implementability, and cost. Each selection criterion for each alternative was ranked 1 through 5. A score of 5 indicates the most favorable alternative. A score of 1 indicates the least favorable alternative.

In addition, the criteria were weighted based on importance. Effectiveness was given a weight factor of 3, because the primary purpose of the selected action is to be protective of human health and the environment. Implementability was given a weight factor of 2. Costs were given a weight factor of 1, because this criterion was considered the least import for selection of an alternative. The ranking for the five corrective action alternatives is provided in **Table 11-1**.

Based on the ranking, Alternative Three, Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Demolition of Building 4343, is the selected corrective measure alternative for Building 4343.

Table 11-1
Ranking Assessment of Corrective Measures Alternatives

Alternative	Effectiveness	Implementability	Cost	Total Score
Alternative 1 – No Further Action	Not effective in preventing unacceptable risks to human health or the environment as contaminant concentrations above the Industrial RG remain. 3 3X 1	This alternative does not entail activities to be implemented. Therefore, an assessment of implementability is not applicable. 10 2X 5	$0 5 1X 5	18
Alternative 2 – Excavation of Soil with Waste in Place, Off-site Disposal, Removal of Sumps, Demolition of Building 4343, and Land Use Controls	Contaminant concentrations above the Industrial RG would be removed from the site. Therefore, this alternative is effective in reducing the risks to within acceptable levels. 9 3X 3	Relatively simple to implement. Uses commercially-available processes from readily available sources. Administrative implementability expected to be achieved. 10 2X 5	$702,000 3 1X 3	23
Alternative 3 – Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Demolition of Building 4343	Contaminant concentrations above the Residential RG would be removed from the site facilitating clean close out. Therefore, this alternative is effective in reducing the risks to within acceptable levels. Provides an additional level of protection for residential users. 15 3X 5	Relatively simple to implement. Uses commercially-available processes from readily available sources. Administrative implementability expected to be achieved. 10 2X 5	$656,000 2 1X 4	29
Alternative 4 – Stabilization, Removal of Sumps, Demolition of Building 4343, and Land Use Controls	The stabilization technology will convert contaminants to a form that is not bioavailable, thereby reducing risks to human and ecological receptors. 9 3X 3	Relatively simple to implement. Uses commercially-available processes from readily available sources. Administrative implementability expected to be achieved. However, requires inclusion of CAMU into RFAAP permit. 8 2X 4	$808,000 2 1X 2	19

Ranking Value
1 – Least favorable → 5 – Most Favorable

Weight Factor
Effectiveness 3
Implementability 2
Cost 1

Note:
9 = Score
3 X 3 = weight factor X ranking value

12.0 SUBSTANTIATION/JUSTIFICATION OF FINAL REMEDY

The Building 4343 RFI/CMS identified one COI (cadmium) as being a potential concern to human health and the environment (see *Section 8.0*). The CMO for the Building 4343 study area is to reduce contaminant concentrations in soil to levels that are protective of industrial workers at the site. However, protection of residential receptors was also considered as alternatives that meet this more stringent objective facilitate clean close out of the site. This objective is considered protective of human health and the environment in the study area because unacceptable risks are not associated with the remaining contamination based on the current or anticipated future land use and contamination is not anticipated to migrate off-site. Four alternatives were developed and evaluated to select the best remedy for the site. These alternatives include:

- Alternative One: No Further Action;
- Alternative Two: Excavation of Soil with Waste in Place, Off-site Disposal, Removal of Sumps, Demolition of Building 4343, and Land Use Controls;
- Alternative Three: Excavation of Soil for Clean Close Out, Off-site Disposal, Removal of Sumps, and Demolition of Building 4343; and,
- Alternative Four: Stabilization, Removal of Sumps, Demolition of Building 4343, and Land Use Controls.

Alternatives Two, Three, and Four were found to achieve the CMO, however, Alternative Three restores the site for beneficial reuse (i.e., allows for tenant use) and eliminates long-term costs. Alternatives Two and Three both entail excavation and off-site disposal as the primary remediation process. Alternative Four utilizes stabilization to reduce risks associated with cadmium in soil.

Alternative Three was selected as the final alternative for Building 4343 because it is implementable and provides a greater level of protection to human health and the environment not provided by Alternatives Two and Four. Alternative Three facilitates clean close out and is cost effective. By achieving clean close out, Alternative Three accomplishes the Army's goal for the Installation Restoration Program and its funding source the Environmental Restoration, Army account. This alternative can be implemented in approximately one year. This time frame is considered an estimate and the actual time to complete the corrective measures will be impacted by site-specific conditions.

This alternative includes the following:

- Delineation of soil containing cadmium above the Residential RG;
- Excavation of the delineated area such that the remaining soil is below the Residential RG;
- Removal of the sumps (2) where elevated metals have been identified;
- Demolition of Building 4343;
- Transporation and off-site disposal of soil, sump material, and building debris; and,
- Site restoration activities.

Implementation of this alternative will reduce the concentrations of cadmium to below the Residential RG and facilitate clean close out of the site. In addition, implementation of this alternative meets the corrective action objective and is protective of human health and the environment.

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Appendix A
Quality Assurance/Quality Control

This Appendix Contains:

Appendix A-1 Analytical Services and Procedures
Appendix A-2 Quality Assurance/Quality Control Evaluation

Appendix A-1
Analytical Services and Procedures

ANALYTICAL SERVICES AND PROCEDURES

ANALYTICAL SERVICES

The analytical services for the field investigation program were provided by the following USACE-validated laboratories:

- DataChem Laboratories (DCL), Salt Lake City, UT. DCL used USEPA-SW846, 3rd ed., Test Methods for Evaluating Solid Waste, Update III (USEPA, 1996e) methodologies in providing analytical support for this project for every parameter except dioxins/furans, total petroleum hydrocarbons (TPH), grain size, and total organic halides (TOX). These parameters were subcontracted by DCL. DCL used Standard Methods for the Examination of Water and Wastewater, 18th Edition (APHA, 1992) for hardness and USEPA Methods for Chemical Analysis of Water and Wastes (MCAWW) (USEPA, 1983) for perchlorate and chemical oxygen demand (COD).
- Southwest Laboratory of Oklahoma, Inc. (SWOK), Broken Arrow, OK. SWOK used USEPA-SW846, 3rd ed., Test Methods for Evaluating Solid Waste, Update III (USEPA, 1996e) methodologies in providing analytical support for dioxins/furans.
- Mountain States Analytical, Inc. (MSAI), Salt Lake City, UT. MSAI used USEPA-SW846, 3rd ed., Test Methods for Evaluating Solid Waste, Update III (USEPA, 1996e) methodologies in providing analytical support for TOX and used USEPA's Office of Water methodology (USEPA, 1999c) in providing analytical support for TPH.
- Applied Geotechnical Engineering Consultants, Inc. (AGEC), Sandy, UT. AGEC used American Society for Testing and Materials (ASTM) (ASTM, 1991) in providing support for grain size analysis.

ANALYTICAL PROCEDURES

Analytical protocols used were in accordance with USEPA-approved methods for the analysis of environmental (i.e., organic, inorganic, and physical parameters) and waste characterization samples. The methodologies for environmental samples are summarized in **Table A-1** and for waste characterization samples in **Table A-2**. A brief discussion of the methodologies is presented in the following sections below.

Organics

Target compound list (TCL) VOCs, TCL SVOCs, TCL pesticides, TCL polychlorinated biphenyls (PCBs), herbicides, explosives, including nitroglycerin (NG) and pentaerythritol tetranitrate (PETN), polynuclear aromatic hydrocarbons (PAHs), dioxins/furans, and total petroleum hydrocarbons (TPH) were analyzed using USEPA-approved methodologies. The laboratory procedures and methodologies for organic compounds are summarized below.

TCL VOCs. Samples were analyzed for TCL VOCs using USEPA SW-846 Method 5030B/8260B for aqueous samples and USEPA SW-846 5035B/8260B for solid matrices using purge and trap technology. Soil samples were collected using an EnCore sampling device and subsequently sent to the laboratory for analysis. No sodium bisulfate was added to the soils due to the possibility of effervescence and ketone formation. An inert gas is bubbled through a mixture of reagent water and 5 gram soil sample or through a 25 mL aqueous sample contained in a specifically designed purging chamber at 40°C for solid and ambient temperature for water. The vapor was swept through a sorbent column where the purgeable compounds were trapped.

Table A-1
Summary of Analytical Methods for Environmental Samples

Parameter	Matrix	Analytical Method
TCL VOCs	Aqueous	USEPA SW-846 5030B/8260B
	Solid	USEPA SW-846 5035B/8260B
TCL SVOCs	Aqueous	USEPA SW-846 3510C/8270C
	Solid	USEPA SW-846 3550C/8270C
TCL Pesticides	Aqueous	USEPA SW-846 3510C/8081A
	Solid	USEPA SW-846 3550C/8081A
TCL PCBs	Aqueous	USEPA SW-846 3510C/8082
	Solid	USEPA SW-846 3550C/8082
Herbicides	Aqueous	USEPA SW-846 8151A
	Solid	USEPA SW-846 8151A
Explosives	Aqueous	USEPA SW-846 8330
	Solid	USEPA SW-846 8330
Nitroglycerin	Aqueous	USEPA SW-846 8332
	Solid	USEPA SW-846 8332
PETN	Aqueous	USEPA SW-846 8332
	Solid	USEPA SW-846 8332
Polynuclear Aromatic Hydrocarbons	Aqueous	USEPA SW-846 3510C/8270C SIM
	Solid	USEPA SW-846 3550C/8270C SIM
Total Petroleum Hydrocarbons	Solid	USEPA 1664
TAL Metals	Aqueous	USEPA SW-846 3015A/6010B; 3010(Mod.)/6020; and 7470A
	Solid	USEPA SW-846 3051A/6010B; ILM05.0 Draft/6020; 7471A
TAL Dissolved Metals	Aqueous	USEPA SW-846 3015A/6010B; 3010(Mod.)/6020; and 7470A
Dioxins/Furans	Aqueous	USEPA SW-846 8290
	Solid	USEPA SW-846 8290
Perchlorate	Aqueous	USEPA 314.0
pH	Solid	USEPA SW-846 9045C
Grain Size	Solid	ASTM Method D-422
Hardness	Aqueous	SM 2340B (Calc.)
Total Organic Carbon	Aqueous	USEPA SW-846 9060A
	Solid	USEPA Lloyd Kahn
Total Organic Halides	Aqueous	USEPA SW-846 9020B
Asbestos	Solid	USEPA 600/R-93/116

Table A-2
Summary of Analytical Methods for Waste Characterization Samples

Parameter	Matrix	Analytical Method
TCLP VOCs	Aqueous	USEPA SW-846 1311/5030B/8260B
	Solid	USEPA SW-846 1311/5030B//8260B
TCLP SVOCs	Aqueous	USEPA SW-846 1311/3510C/8270C
	Solid	USEPA SW-846 1311/3550C/8270C
TCLP Metals	Aqueous	USEPA SW-846 1311/3015A/6010B/7470A
	Solid	USEPA SW-846 1311/3015A/6010B/7471A
TCLP Pesticides	Aqueous	USEPA SW-846 1311/3510C/8081A
	Solid	USEPA SW-846 1311/3550C/8081A
TCL PCBs	Aqueous	USEPA SW-846 3510C/8082
	Solid	USEPA SW-846 3550C/8082
Chemical Oxygen Demand	Aqueous	USEPA 410.4
Corrosivity as pH	Aqueous	USEPA SW-846 9040B
	Solid	USEPA SW-846 9045C
Reactive Cyanide	Aqueous	USEPA SW-846 Chapter 7.3.3
	Solid	USEPA SW-846 Chapter 7.3.3
Reactive Sulfide	Aqueous	USEPA SW-846 Chapter 7.3.4
	Solid	USEPA SW-846 Chapter 7.3.4
Ignitability	Aqueous	USEPA SW-846 1010
	Solid	USEPA SW-846 Chapter 7.1.2.2

After purging was completed for both solid and aqueous samples, the sorbent column was heated and backflushed with the inert gas to desorb the purgeable compounds onto a gas chromatograph programmed to separate the purgeable compounds, which are then detected with a mass spectrometer.

TCL SVOCs/PAHs. Samples were analyzed for TCL SVOCs/PAHs using USEPA SW-846 Method 8270C. The use of selective ion monitoring (SIM) using USEPA SW-846 Method 8270C SIM was employed for PAH analysis to achieve lower quantitation and detection limits in order to meet screening criteria. Solid samples were extracted using soxhlet according to USEPA SW-846 Method 3550C and aqueous samples were extracted using a continuous liquid-liquid extraction technique according to USEPA SW-846 Method 3510C. The extract was injected into a gas chromatograph programmed to separate the compounds, which are then detected with a mass spectrometer.

TCL Pesticides/PCBs. Samples were analyzed for TCL pesticides using USEPA SW-846 Method 8081A and for TCL PCBs using USEPA SW-846 Method 8082. Aqueous and solid samples were prepared for analysis using extraction techniques. Solid samples were extracted using soxhlet method USEPA SW-846 Method 3550C for samples. Aqueous samples were extracted using a continuous liquid-liquid extraction technique by USEPA SW-846 Method

3510C. The extract was injected onto a gas chromatography programmed to separate the compounds, which are then detected with an electronic capture device (ECD). Sulfur cleanups were employed to aid in the quantification based upon the matrix interferences. Sample concentrations were confirmed on dissimilar columns.

Herbicides. Samples were analyzed for herbicides according to USEPA SW-846 Method 8151A. Aqueous and solid samples were extracted with diethyl ether and then esterified with diazomethane. The derivatives are determined by gas chromatography with an electron capture detector (GC/ECD). The results were reported as acid equivalents. Sample concentrations were confirmed on dissimilar columns.

Explosives. Samples were analyzed for explosives using USEPA SW-846 Method 8330. Aqueous samples of low concentration were extracted by a salting-out extraction procedure with acetonitrile and sodium chloride. The small volume of acetonitrile that remained undissolved above the salt water was drawn off and transferred to a smaller volumetric flask. It was back extracted by vigorous stirring with a specific volume of salt water. After equilibration, the phases were allowed to separate and the small volume of acetonitrile residing in the narrow neck of the volumetric flask was removed. The concentrated extract was diluted with reagent grade water, and an aliquot is separated on a C-18 reverse phase column. The wavelength was set at 254 nanometers and confirmed on a cyanide reverse column. Solid samples were extracted using acetonitirile in an ultrasonic bath, then filtered and chromatographed similarly to aqueous samples. Sample concentrations were confirmed on dissimilar columns.

NG/PETN. Samples were analyzed for NG/PETN using USEPA SW-846 Method 8332. Solid samples were extracted with acetonitrile in an ultrasonic bath, then filtered and mixed with a calcium chloride solution. Aqueous samples were extracted according to USEPA SW-846 Method 8330, using a double salting-out procedure with acetonitrile. The extract is mixed with calcium chloride just prior to analysis. The concentration was quantified using an isocratic HPLC system equipped with a column heater and UV detector. Sample concentrations were confirmed on dissimilar columns.

Dioxins/furans. Samples were analyzed for dioxin/furans using USEPA SW-846 Method 8290. The analytical method used high-resolution gas chromatography and high-resolution mass spectrometry (HRGC/HRMS) on purified sample extracts. This method is specific for the analysis of 2,3,7,8-tetrachlorinated dibenzofuran (2,3,7,8-TCDD), substituted penta-, hexa-, hepta- and octachlorinated dibenzo-p-dioxins and substituted penta-, hexa-, hepta- and octachlorinated dibenzofurans in water and solid samples. The extracts were injected onto a high-resolution gas chromatograph programmed to separate the compounds, which are then detected with a high-resolution mass spectrometer as confirmation.

TPH. Samples were analyzed for solids for TPH-Hexane Extractable Material (HEM) using USEPA Method 1664. A representative portion of soil sample was acidified and chemically dried with acidified sodium sulfate. The HEM was extracted with n-hexane using a sonication method. The n-hexane is then filtered into a pre-weighed vessel and evaporated. The vessel was desiccated and weighed. The HEM was re-dissolved in n-hexane. Silica gel was added to the HEM, shaken, filtered, and evaporated for silica gel treated-HEM determination.

Inorganics

Target analyte list (TAL) metals, mercury, cyanide, and hardness were analyzed using USEPA SW-846 methodologies. Perchlorate was analyzed using USEPA MCAWW methodologies. The laboratory procedures for inorganic compounds are summarized below.

TAL Metals/Hardness. TAL metals and hardness were analyzed using a combination of the following methodologies: inductively coupled plasma (ICP), ICP/ mass spectroscopy (MS), and cold vapor atomic absorption (CVAA). Trace metals were analyzed using USEPA SW-846 Methods 3015A/6010B and 3010(Mod.)/6020 for aqueous samples and Methods ILM05.0 Draft/6020 and 3051A/6010B for solid samples. Total hardness was calculated from the calcium and magnesium concentrations using Standard Method 2340B. The ICP method involved the simultaneous or sequential multi-element determination of trace elements in solution. The basis of the method is the measurement of atomic emission by optical spectrometry. Samples were nebulized and the aerosol that was produced was transported to the plasma torch where excitation occurs. Characteristic atomic-line emission spectra are produced by a radio-frequency ICP. A background correction technique was utilized to compensate for variable background contribution for the determination of trace elements.

Mercury was analyzed using CVAA according to USEPA SW-846 Method 7470A for aqueous samples and Method 7471A for solid samples. A sample aliquot was initially digested with nitric acid to free combined mercury. The mercury was then reduced to its elemental state and aerated from the solution into a closed system. The mercury vapor was passed through a cell positioned in the path of the mercury light source and the measured abundance was proportional to the concentration of mercury in the sample.

Perchlorate. Perchlorate was analyzed using ion chromatographic method USEPA MCAWW Method 314.0 for aqueous samples. Perchlorate was measured by the peak height or area generated from the sample elution through an anion separator column with a conductivity detector.

Waste Characterization

Samples collected to characterize investigative-derived materials were analyzed for hazardous waste characteristics using USEPA-approved methodologies., including toxicity characteristic leachate procedure (TCLP) VOCs, TCLP SVOCs, TCLP metals, TCLP pesticides, TCL PCBs, chemical oxygen demand (COD), corrosivity as pH, reactive cyanide, reactive sulfide, and ignitability. The laboratory procedures and methodologies are summarized below.

TCLP Extraction. Soil samples collected for material characterization were extracted using the USEPA SW-846 Method 1311. The final liquid extract was separated from the solid material and combined with the initial liquid phase (if applicable). The sample TCLP extract was then treated as an aqueous sample for analysis for VOCs, SVOCs, pesticides, and metals.

Reactivity. Reactivity comprises of reactive sulfide and reactive cyanide. Reactive sulfide was analyzed in aqueous and solid samples using USEPA SW-846 Method Chapter 7.3.4. This procedure was a colorimetric determination. Sulfide reacted with dimethyl-p-phenylenediamine in the presence of ferric chloride to produce methylene blue. Reactive cyanide was analyzed in aqueous and solid samples using USEPA SW-846 Method Chapter 7.3.3.

Ignitability. Ignitability was analyzed using USEPA SW-846 Method 1010 for aqueous samples and USEPA SW-846 Method Chapter 7.1.2.2 for solid samples. A samples was heated at a slow, constant rate with continual stirring. A small flame was directed into the cup at regular intervals with simultaneous interruption of stirring. The flash point was the lowest temperature at which application of the test flame ignited the vapor above the sample.

Corrosivity as pH. Corrosivity as pH was analyzed using USEPA SW-846 Method 9040B for aqueous samples and Method 9045C for solid samples. A sample pH was directly measured electrometrically using either a glass electrode in combination with a reference potential or a

combination electrode. For solids, samples were mixed 1:1 with reagent water prior to measurement.

COD. COD was analyzed using USEPA MCAWW Method 410.4. A sample was heated under acidic conditions at a slow, constant rate in an oven or block digestor in the presence of dichromate at 150°C for two hours. The COD was measured at 600 nm spectrophotometrically.

Physical Analyses

Grain size. Grain size distribution was determined using ASTM Method D-422 for solid samples. A No. 200 sieve was used to separate particles larger than 75 micrometer (µm) from the soil, while the distribution of particles smaller than 75 µm was determined by a sedimentation process, using a hydrometer to secure the necessary data.

TOC. Samples were analyzed for TOC using the USEPA Kahn Method for solid samples. Samples were subjected to either a catalytic combustion or wet chemical oxidation to convert the organic carbon in the sample to carbon dioxide. The carbon dioxide formed was then measured directly by an infrared detector or converted to methane and measured by a flame ionization detector. The amount of carbon dioxide or methane produced was directly proportional to the concentration of carbonaceous material.

TOX. Aqueous samples were analyzed for TOX using USEPA SW-846 Method 9020B. Samples were passed through a conditioned column containing activated carbon, which adsorbs the organohalides. The activated carbon was then combusted to convert the organohalides to hydrogen halide, which was trapped and titrated electrolytically using a microcoulometric detector.

pH. Samples were analyzed for pH using USEPA SW-846 Method 9045C for solid samples. A sample pH was directly measured electrometrically using either a glass electrode in combination with a reference potential or a combination electrode. For solids, samples are mixed 1:1 with reagent water prior to measurement.

Asbestos. Samples were analyzed for asbestos using method USEPA 600/R-93/116. Samples were ground to insure homogeneity. A polarizing light microscope equipped with 10x and 16x objectives and a 10x eyepiece was used for the analysis. If present, asbestos identities were confirmed with the appropriate refractive index liquids applying dispersion staining techniques. The area percentages of asbestos and other fibrous constituents were estimated microscopically by a visual examination of the fibers with an aspect ratio of 3:1 or greater. For the purposes of the reports generated, fiberglass was defined as fibrous glass with parallel sides and mineral wool was defined as fibrous glass with nonparallel sides.

Appendix A-2
Quality Assurance/Quality Control Evaluation

QUALITY ASSURANCE/QUALITY CONTROL EVALUATION

An independent Quality Assurance Project Plan Addendum (QAPA) was developed as part of MWP Addendum 012 (IT, 2002a). The QAPA was implemented through the integration of well-defined quality control elements for activities associated with the task assignment. The quality control criteria defined for sampling and analysis activities were developed in conjunction with specifications contained in USACE EM200-1-3, *Requirements for the Preparation of Sampling and Analysis Plans*, (USACE, 2001) as well as the USACE Shell Guidance for Analytical Chemistry (USACE, 1998).

Table A-3 outlines the data quality indicators as to their definitions, project goals, sampling and analytical assessments. Data quality was assessed through the evaluation of sampling activities and field measurements associated with the chemical analytical data in order to assess the reliability of the chemical analyses and the accuracy and precision of information acquired from the laboratory.

Table A-3
RFI Data Quality Indicators

Data Quality Indicator	Definition	Goal	Sampling Assessment	Analytical Assessment
Precision	Quantitative measure of the variability of a group of measurements in comparison to the average value	Low relative percent difference	Duplicate samples	MS/MSD or sample duplicate
Accuracy	Bias in a measurement system	Low bias	Blank contamination	Analysis spike results
Representativeness	Degree to which the measured results accurately reflect the medium being sampled	100%	Holding times, blanks, associated documentation	Inferred from accuracy, precision, and completeness evaluation
Completeness	Percentage of measurements which are judged to be usable	98±2%	Records review	Data validation
Comparability	Qualitative parameter expressing the confidence with which one data set can be compared with another	High	Work plans, quality documents	Analytical methods
Sensitivity	Quantitative measure of the level of detection and quantitation.	High	Review of analytical method or procedures and instrumentation	Analysis of MDL studies and practical quantitation limits per analytical method and matrix

Review of Documentation

The following documentation was required by the field investigation program in order to provide a quality assessment of data collected during routine investigative activities:

- **Field Logbooks:** Hardback logbooks with numbered pages were used to log daily activities, and data collected during the course of field activities. Designated logbooks

were also used to record calibration records and equipment maintenance as they were performed. Entries into field logbooks were evaluated for completeness and accuracy.

- **Field Parameter Forms:** Documentation of collected samples was provided to the laboratory on parameter forms developed by Shaw specifically for USACE investigations. Field Parameter Forms were electronically generated based on information recorded in field logbooks and were completed at the time of shipment to be included with the Chain-of-Custody for every sample, including QC samples. The completed forms contained the required information for encoding chemical data into ERIS database.
- **Chain-of-Custody:** Samples were collected and relinquished under stringent Chain-of-Custody protocols as specified in the project QA plan. A review of the Chain-of-Custody identified transcription errors that were corrected by drawing a single line through the incorrect information and subsequently correct information was supplied, dated, and initialed.
- **Sample Tracking Table:** Documentation of collected samples was recorded in an electronic sample tracking table on a daily basis. Field entries included the field sample identification, sample depth (where applicable), date collected, chain of custody and/or field parameter form number, and laboratory analyses requested.

Sampling activities were performed in compliance with standard operating procedures (SOPs) and each individual performing sampling was aware of the requisite protocols for collection of environmental samples. Each geologist was experienced in characterization of soil samples and soil sampling techniques.

Data Reporting

Data packages were provided to Shaw in CLP-like deliverables with electronic data deliverable files from the laboratory. Detected target compound values above the reporting limit and within the acceptable calibration range were reported as determined to no more than three significant figures. Target analytes detected below the lower calibration standard or reporting limit and above the method detection limit were reported as estimated values. Appropriate data qualifiers were applied during validation process and recorded in an electronic database.

Data Reduction and Validation

Data validation determines the acceptability or unacceptability of the data quality based on a set of pre-defined criteria. Data validation is defined as the systematic process for reviewing a data package against a set of criteria to provide assurance that the data is adequate for its intended uses. These criteria depend upon the type(s) of data involved and the purpose for which data are collected. The intended use of the data and the associated acceptance criteria for data quality was identified before the data collection effort began. Both the organic and inorganic chemical data (except for the waste characterization) were validated. The validation services for the sampling effort were performed using (as appropriate) USEPA-SW846, Third Edition, Test Methods for Evaluating Solid Waste, Update III (USEPA, 1996e), laboratory SOP, USEPA Region III Modification to the National Functional Guidelines for Organic Data Review, Multimedia, Multi-concentration (USEPA, 1994c), the USEPA Region III Modifications of the Functional Guidelines for Inorganic Data Review (USEPA, 1993b), and the USEPA Region III

Dioxin/Furan Data Validation Guidance (USEPA, 1999d) in providing validation support for this project.

Data packages were validated to ensure compliance with specified analytical, Quality Assurance/Quality Control (QA/QC) requirements, data reduction procedures, data reporting requirements, and required accuracy, precision, and completeness criteria. This includes (as applicable), but is not limited to:

- Sample preservation and holding times;
- Instrument performance check;
- Calibration (initial and continuing);
- Blanks (calibration, preparatory, rinse, trip);
- Matrix spike and spike duplicate recoveries;
- Sample duplicate;
- Surrogate spike recoveries;
- Laboratory control samples;
- Interference check sample (for metals);
- Serial dilution (for metals);
- Internal standards and retention times (for GC/GC/MS/IC); and,
- Quantitative verification.

Results were assessed for accuracy and precision of laboratory analysis to identify the limitations and quantity of data. The data validation reports are presented on the CD located at the back of this report. The quality of the data collected in support of the sampling activity was considered acceptable, unless qualified rejected "R" during the validation process. Samples qualified "B" were considered non-detect at the MRL or level of blank contamination, whichever was greater. Samples qualified "J", "UJ", "L", "UL", or "K" were considered acceptable as estimated.

Data Review

Data obtained from both the laboratory and data validation were reviewed by the Shaw Project Chemist to assess whether the project-specific data quality objectives, as defined in the associated QAP, were met.

Data Quality Objectives

Data quality objectives were developed concurrently with the Work Plan to ensure: (1) the reliability of field sampling, chemical analyses, and physical analyses; (2) the collection of sufficient data; (3) the quality of data generated was acceptable for its intended use; and (4) valid assumptions could be inferred from the data. Attainment of data quality objectives was assessed through evaluation of data collected using the following data quality indicators:

- **Precision** - a quantitative measure of the variability of a group of measurements in comparison to the average value;
- **Accuracy** - the bias in a measurement system;

- **Representativeness** - the degree to which the measured results accurately reflect the medium being sampled. Representativeness will be assessed based on accuracy, precision, and completeness;
- **Completeness** - the percentage of measurements which are judged to be useable;
- **Comparability** - defined as a qualitative parameter expressing the confidence with which one data set can be compared with another; and,
- **Sensitivity** - describes the method detection, quantitation, and reporting limits. It also may be expressed as the slope of the analytical curve (intensity verses concentration).

Data quality was assessed through the evaluation of sampling activities and field measurements associated with the chemical data in order to verify the reliability of the chemical analyses and the accuracy and precision of information acquired from the laboratory.

Precision. Method or laboratory precision performed by the laboratory was evaluated during the validation process. Overall sampling or field precision was evaluated during the data review process. Precision is measured by calculating and evaluating the relative percent difference (RPD) between the results of field or laboratory duplicates. The RPD is calculated by the following equation:

$$\text{RPD (\%)} = \frac{/\text{XA} - \text{XB})/}{\text{XM} * 100}$$

Where:
XA and XB are duplicate analyses, and
XM is the mean value [(XA + XB)/2] of the duplicate analyses.

The RPD was calculated for those analytes which were detected at levels exceeding the method detection limits in both samples of the duplicate pair. Analytes that were qualified because of blank contamination (B-qualified) or were rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Analytical results were qualified as estimated (J) for RPDs exceeding criteria for both the sample and its duplicate pair.

Laboratory duplicate sample determinations were used to demonstrate acceptable method precision by the laboratory at the time of analysis and evaluated. Laboratory precision was performed either on the sample and its duplicate pair or the matrix spike and its spike duplicate pair. Duplicate analyses were performed to generate data in order to assess the long-term precision of the analytical method on various matrices. RPDs must be within established control limits. Laboratory duplicate pairs or laboratory spiked duplicate pairs were evaluated. Laboratory duplicate pairs or laboratory spiked duplicate pairs were within specified precision criteria for each parameter and/or compound except for 2,4-D, 2,4-DB, dinoseb, cadmium, lead, thallium, and endrin aldehyde. Analytical results were qualified as estimated (J) for RPDs exceeding criteria for where the associated compounds were detected. While these parameters were qualified estimated due to the high RPDs, the data was still considered useable, the precision data quality goal was met, and the qualified data did not impact the data quality for the RFI. Further discussion may be found in the data validation reports located on the CD at the back of this report.

Field duplicates were collected site-wide during the RFI on a 10% frequency per matrix to identify the cumulative precision of the sampling and analytical process, which includes the homogenization of soil and sediment samples. Precision control criterion was established at 35% RPD for the soil samples. Field precision frequency was conducted on a site-wide basis. Field duplicates were not collected at Building 4343 because the site-wide 10% frequency had not yet been obtained for soil, therefore the precision data quality goal was met and no impact reflected toward the data quality for the RFI.

Accuracy. Accuracy is the measure of bias in a system. The accuracy of the results is measured by percent recovery (%R). Laboratory analytical accuracy was assessed through the use of laboratory blanks (method and instrument), rinse blanks, laboratory control samples (LCSs), and matrix spikes (MSs). Laboratory analytical accuracy was reviewed during the validation of data. Sampling accuracy was assessed by evaluating blank contamination and the impact of contaminant contributions originating from non-point sources, such as field sampling equipment decontamination procedures, or laboratory contamination. QC samples evaluated for this assessment included equipment blanks and laboratory method or preparatory blanks. The data validation qualifiers would be applied for analytical non-conformances as outlined in the USEPA Region III validation guidance. For non-spiked samples, accuracy was measured by the following equation:

$$\%R = \frac{\text{test value}}{\text{true value}} * 100$$

For spiked samples, accuracy was measured by the following equation:

$$\%R = \frac{\text{test value} - \text{spiked value}}{\text{true value}} * 100$$

Method blanks, laboratory control samples, matrix spikes, and rinse blanks discussion follows. Method blanks, laboratory control samples, matrix spikes, and rinse blanks were evaluated.

- **Method blanks.** A method blank is a volume of analyte-free water or soil that is processed through the entire analytical scheme (i.e., extraction, digestion, concentration, and analysis) as with the actual samples. Method blanks monitor potential laboratory-induced contamination. Results were qualified “B” for blank contamination by the laboratory and/or through the data validation process. In accordance with USEPA Region III data validation guidelines, reported sample results were considered "non-detect" and qualified with the letter "B" if the detected sample concentration was within 5 times (10 times for common laboratory contaminants: methylene chloride, acetone, 2-butanone, OCDD/OCDF, and common phthalate esters) the concentration in the associated method blank. The method blank contamination assessment was evaluated during the data validation process and may be found in the data validation reports located on the CD at the back of this report. Method blanks were calculated and compared

against the same matrix environmental samples on a batch specific basis. No unit conversions were necessary for method blanks since they were treated in the same manner as the samples. Calibration blanks were also compared against the environmental samples. Calibration blanks are aqueous samples and were reported in µg/L or mg/L units. Performing blank assessments for solid matrix samples, action levels were calculated and expressed in soil units µg/kg or mg/kg from the given aqueous rinse blank concentrations to be compared against actual solid sample concentrations. This conversion is dependent upon the method performed, sample amounts used, and final digestate or extract volumes used during the analytical analysis. Action levels were based upon 100% solids and 1x dilution factor and adjusted for each sample as appropriate. Method and calibration blanks were within specified criteria for each parameter and/or compound except for silver, magnesium, vanadium, lead, selenium, naphthalene, 2-methylnaphthalene, bis(2-ethylhexyl)phthalate, di-n-octylphthalate, and TOC. Select samples were qualified "B" for silver, naphthalene, 2-methylnaphthalene, bis(2-ethylhexyl)phthalate, and di-n-octylphthalate and were considered non-detect at the MRL or level of contamination, whichever was greater. While these parameters were qualified "B" due to the blank contamination, the data was still considered useable, the accuracy data quality goal was met, and the qualified data did not impact the data quality for the RFI.

- **Laboratory control sample.** The LCS was analyzed to assess general method performance by the ability of the laboratory to successfully recover the target analytes from a control matrix. The LCS is similar in composition to the method blank. For aqueous analyses, spiked analyte-free reagent water was used. For soil analyses, a purified solid matrix (e.g., sand, sodium sulfate, or other purified solid) was used. The LCS was spiked with single-component target analytes before it is carried through the preparation, cleanup, and determinative procedures. LCSs were performed at a rate of one per preparation batch per matrix. When samples were not subjected to a separate preparatory procedure (i.e., purge and trap VOC analyses, or aqueous Hg analysis), the CCV may have been used as the LCS, provided the CCV acceptance limits were used for evaluation. The results of the LCS were evaluated, in conjunction with other QC information during the data validation process to ascertain the acceptability of the data generated for that batch of samples. LCSs were within specified criteria for each parameter and/or compound except for 4-amino-2,6-dinitrotoluene, 2-butanone, acetone, cis-1,3-dichloropropene, and trans-1,3-dichloropropene. The LCS recoveries were high for these associated compounds. While LCS recoveries were outside criteria, the data was still considered useable, the accuracy data quality goal was met, and the qualified data did not impact the data quality for the RFI. Further details may be found in the data validation reports located on the CD at the back of this report.

- **Matrix spikes.** The MS was used to assess the performance of the method as applied to a particular project matrix. An MS is an environmental sample to which known concentrations of certain target analytes have been added before sample manipulation from the preparation, cleanup, and determinative procedures have been implemented. The original field sample was mixed or shaken to ensure homogeneous fractions when allowed by the method. MSs were performed at a rate of one per preparation batch or 5% whichever was more frequent per matrix. The results of the MS are evaluated, in

conjunction with other QC information during the validation process to assess the effect of the matrix on the bias of the analysis. Matrix spikes and matrix spike duplicates were within specified criteria for each parameter and/or compound except for 2,4-DB, dicamba, dinoseb, zinc, antimony, mercury, endrin aldehyde, 1,2-dibromo-3-chloropropane, 1,2-dibromoethane, bromoform, chlorobenzene, dibromochloromethane, styrene, trichloroethene, cis-1,3-dichloropropene, and trans-1,3-dichloropropene. Samples were qualified as applicable. While qualification was applied due to high or low MS or MSD recoveries, the data was still considered useable, the accuracy data quality goal was met, and the qualified data did not impact the data quality for the RFI. Further details may be found in the data validation reports located on the CD at the back of this report.

- **Rinse blanks.** The blank contamination assessment was performed to assess the impact of contaminant contributions originating from non-point sources, such as field sampling equipment decontamination procedures. Rinse blanks are intended to identify cross-contamination between samples as a result of sampling equipment decontamination procedures. Rinse blanks were collected by pouring the required volume of deionized, organic-free water over the equipment and collecting the water in the appropriate sample containers. Rinse blanks were performed at a rate of one per 20 samples collected or 5% per matrix per sampling technique. The rinse blank results were evaluated to ascertain the efficiency of decontamination and assess the potential for cross-contamination. Rinse blanks were analyzed for the analytes of concern for the RFI. In accordance with USEPA Region III data validation guidelines, the detected concentration in the sample was qualified "B" for blank contamination and was considered non-detect if the sample concentration was within five times (10 times for common laboratory contaminants such as acetone, 2-butanone, methylene chloride, OCDD/OCDF, and phthalate esters) the concentration in the associated equipment blank. Rinse blanks are aqueous samples and were reported in μg/L or mg/L units. Performing blank assessments for solid matrix samples, action levels were calculated and expressed in soil units μg/kg or mg/kg from the given aqueous rinse blank concentrations to be compared against actual solid sample concentrations. This conversion is dependent upon the method performed, sample amounts used, and final digestate or extract volumes used during the analytical analysis. Action levels were based upon 100% solids and 1x dilution factor and adjusted for each sample as appropriate.

- Soil rinse blanks included samples 061102R, 061902R1, 071002R2, and 072502RB. The maximum concentration from these rinse blanks was used for this assessment. Rinse blanks were within specified criteria for each parameter and/or compound except for 1,3,5-trinitrobenzene, 2-nitrotoluene, 4-nitrotoluene, PETN, nitroglycerine, 2,4-DB, MCPP, antimony, beryllium, cadmium, lead, calcium, chromium, iron, manganese, sodium, naphthalene, 2-methylnaphthalene, acenaphthene, 4,4'-DDE, 4,4'-DDT, lindane, phenol, benzyl alcohol, 2-methylphenol, 4-methylphenol, benzoic acid, diethylphthalate, di-n-butylphthalate, butylbenzylphthalate, bis(2-ethylhexyl)phthalate, acetone, carbon disulfide, methylene chloride, chloroform, carbon tetrachloride, bromodichloromethane, 4-methyl-2-pentanone, toluene, and m&p-xylene. Select samples were qualified "B" as applicable and were considered non-detect at the MRL or level of contamination, whichever was greater. While these parameters were qualified "B" due to the blank

contamination, the data was still considered useable, the accuracy data quality goal was met, and the qualified data did not impact the data quality for the RFI. A discussion of the blank results is provided within each validation report located on the CD at the back of this report. **Table A-4** indicates those data that are "B" flagged due to blank contamination and should be considered non-detect. Those compounds that were detected in both the blanks and the associated samples below the USEPA guidance blank action levels are listed.

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

The amount and type of data that may be lost due to sampling or analytical error cannot be predicted or evaluated in advance. The importance of lost or suspect data will be evaluated in terms of the sample location, analytical parameter, nature of the problem, decision to be made, and the consequence of an erroneous decision. Critical locations or parameters for which data is found to be inadequate will either be re-sampled and re-analyzed or the data will be appropriately qualified based on the decision of the project QA manager. The completeness goal percentage of usable data is set at 98+2%.

Sampling completeness was assessed through evaluation of the total number of samples proposed for collection in the work plan versus the actual number of samples collected and analyzed. Analytical completeness was assessed by comparing the number of useable data points collected to the total number of data points generated. Completeness is calculated using the following equations:

$$\%\,\text{Sampling Completeness} = \frac{\text{No. of actual samples collected}}{\text{No. of proposed samples}}$$

$$\%\,\text{Analytical Completeness} = \frac{\text{No. of usable data}}{\text{No. of requested analyses}}$$

For the purposes of this report, unusable data are defined to include rejected data points ("R" qualifier). No data points were rejected through the validation process.

One surface water and seven soil samples were proposed for collection at Building 4343 in MWP Addendum 12 (IT, 2002a). The field duplicate and rinse blanks were collected on a site-wide basis. Every soil sample was collected and analyzed for the parameters specified in the Work Plan.

Table A-4
B-Qualified Data Summary

Field ID	Analyte	Result	Lab Q	Units
B43SB35A	Acenaphthene	5.5		UG/KG
B43SB35B	Naphthalene	1.7	JB*	UG/KG
B43SB34A	2-Methylnaphthalene	1.7	JB*	UG/KG
B43SB34A	Naphthalene	2.7	B*	UG/KG
B43SB34B	Naphthalene	2.0	JB*	UG/KG
B43SB35A	Bis(2-ethylhexyl)phthalate	53	JB*	UG/KG
B43SB35B	Bis(2-ethylhexyl)phthalate	86	JB*	UG/KG
B43SB35B	Di-n-octylphthalate	23	JB*	UG/KG
B43SB34A	Bis(2-ethylhexyl)phthalate	55	JB*	UG/KG
B43SB34A	Di-n-octylphthalate	51	JB*	UG/KG
B43SB34B	Bis(2-ethylhexyl)phthalate	66	JB*	UG/KG
B43SB34B	Di-n-octylphthalate	11	JB*	UG/KG
B43SB35B	Silver	0.80	B**	MG/KG
B43SB35B	Sodium	12.0	B**	MG/KG
B43SS01	Silver	0.69	B**	MG/KG
B43SS02	Silver	0.66	B**	MG/KG
B43SS02	Sodium	13.0	B**	MG/KG
B43SS03	Silver	0.73	B**	MG/KG
B43SS03	Sodium	8.50	B**	MG/KG
B43SB34B	Sodium	31.1		MG/KG
B43SS01	Antimony	0.39	B**	MG/KG
B43SS02	Antimony	0.20	B**	MG/KG
B43SS03	Antimony	0.20	B**	MG/KG

B* = the analyte or compound has been detected in the sample and laboratory method blank and/or associated field sample.

B** = Value <MRL and >MDL. Reported value may be biased (estimated).

J = Value <MRL and >MDL. Reported value may be biased (estimated).

Surface water sample B43SW01 was not collected due to the drought conditions at the time. The resulting sampling completeness quotient is 87.5%. Although this did not meet the completeness goal, the impact of the sampling completeness did not affect the data quality of the RFI.

The overall analytical percent completeness was also assessed by parameter group for the soil samples collected. Analysis of the soil samples resulted in the generation of 792 out of 792 data points determined to be useable, resulting in an overall analytical completeness quotient of 100%. The overall completeness percentages met the pre-defined goal of 98±2% for the soil sampling event.

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

Sampling protocols were developed to assure that samples collected are representative of the media. Field handling protocols (e.g., storage, handling in the field, and shipping) were designed to protect the representativeness of the collected samples. Proper field documentation and QC inspections were used to establish that protocols were followed and that sample identification and integrity was maintained and met pre-defined goals.

Comparability. Comparability is the confidence with which one data set can be compared to another. Comparability was controlled through the use of SOPs that have been developed to standardize the collection of measurements and samples and approved analytical technique with defined QC criteria. USEPA-approved methodologies were used in providing laboratory analytical support for this project. Laboratory SOPs were developed from these methods. Consistent and proper calibration of equipment throughout the field exercises, as described in the MQAP and QAPA, will assist in the comparability of measurements. Field documentation and QA audits were used to establish that protocols for sampling and measurement follow appropriate SOPs and met pre-defined goals.

Sensitivity (quantitation, reporting, and detection limits). The term sensitivity is used broadly to describe the method detection, quantitation, and reporting limits established to meet project-specific data quality objectives; and not limited to the definition which describes the capability of a method or instrument to discriminate between measurement responses. The method detection limits (MDLs) and the practical quantitation limits (PQLs) published within USEPA methods are based upon a reagent water matrix, and are not necessarily reflective of typical sample matrices; therefore, care was taken in establishing limits for laboratory analysis. Methods were selected based upon their sensitivity, technological, and economical considerations while keeping the screening values and available methodology in mind and were sufficient in meeting the given levels of concern (LOCs). Each target compound for every sample was reported at a specific method reporting limit (MRL). The target analytes detected above the MDL, but less than the MRL, were reported as estimated values “J”. Target analytes detected above the upper calibration standard were diluted and analyzed within established calibration windows.

The MQLs and MDLs were compared at the onset of the project. The MDL is the minimum concentration of an analyte that can be measured and reported with a 99% confidence that the analyte is above zero and is identified from the analysis of a sample in a given matrix containing the analyte. The MDLs are derived by the method based upon 40 CFR (Code of Federal Regulations) Chapter 136 Appendix B. The MDL established using this procedure was used to assess the importance of the measurement of a future sample. The laboratory MDLs derived were less than the MQLs. The laboratory has statistically derived MDLs below the MQLs. The MDL values are different and change periodically because each MDL is laboratory, instrument, analyst, matrix, and method specific.

MQLs are the values at which the laboratory has demonstrated the ability to reliably quantitate the target value of an analyte for the method performed. MQLs are based upon the lowest calibration standard used for the initial calibration curve or the lowest verification standard performed. Data is calculated over a linear range. The highest concentration of the standards is truncated until linearity is achieved (minimum of three concentration levels must remain). The resulting highest concentration within the linear range represents the upper quantitation limit.

The laboratory used a MRL for each sample. The MRL is the USACE term for sample quantitation limit (USACE, 1998). The reporting limit is the threshold value below which the

laboratory reports non-detected values as “U,” “ND,” or “<” and will vary for each sample based upon dilution, sample volumes, percent moistures (for solids), and the method performed. Positive values found in blanks (method, rinse, and trip) above the MDL were reported. Positive results below the MRL and above the MDL were reported as estimated “J” for both inorganics and organics. The units for aqueous samples were µg/L and for solid samples were mg/kg, µg/kg, or ng/kg.

The method sensitivities (i.e., MDLs) were adequate to meet the data quality objectives for Building 4343, except for the following. Comparing against the soil screening levels (SSLs), compounds 1,1,2-trichloroethane, trichloroethene, vinyl chloride, cis-1,3-dichloropropene, trans-1,3-dichloropropene, 1,4-dichlorobenzene, 3,3'-dichlorobenzidine, bis(2-chloroethyl)ether, bis(2-chloroisopropyl)ether, n-nitrosodi-n-propylamine, nitrobenzene, MCPA, MCPP, and arsenic had MDLs greater than the given SSLs for select samples. Comparing against the residential RBCs, MCPP, MCPA, vinyl chloride, and arsenic had MDLs greater than the given residential RBCs for select samples. Comparing against the industrial RBCs, MCPA had a MDL greater than the given industrial RBCs for select samples. Though an uncertainty may be present with these sensitivity gaps between the SSLs/RBCs and MDLs for these compounds, it is unlikely that they present an impact to the decisions regarding the RFI.

Levels Of Concern

An integral part of the identification of DQOs is the establishment of LOCs. These levels were compared with analytical method reporting limits prior to analytical method selection to ensure the method was capable of addressing project DQOs, preclude occurrence of false negative issues, and assess best available technology limitations. Although LOCs selected as potential concerns may not necessarily reflect RFI-specific objectives, they were developed to ensure that the chosen analytical methods have detection limits sensitive enough to achieve compliance with appropriate site-specific screening levels or other specified criteria for soil, sediment, and surface water. The laboratory MDLs were sufficient to meet (i.e., below) the LOCs for the Building 4343 RFI. LOCs for Building 4343 are based on soil applicable or relevant and appropriate requirements (ARARs) and To-Be-Considered Guidance (TBG). The soil TBC guidance includes:

- Facility-Wide Background inorganic concentrations (IT, 2001).
- USEPA Region III risk based concentrations (April, 2003).

Appendix B
Previous Investigation Analytical Data Tables and Lithologic Boring Logs

This Appendix Contains:

Appendix B-1 Previous Investigation Analytical Data Tables
Appendix B-2 Lithologic Boring Logs

Appendix B-1
Previous Investigation Analytical Data Tables

Appendix B-1
Master Table Legend

12	J	Shading and black font indicates an industrial RBC exceedence
12	J	Bold outline indicates a residential RBC exceedence.
12	**J**	Bold, underlined font indicates a background exceedence.
12	J	Shading and white font indicates a SSL exceedence.
12	J	Mixed shading indicates an industrial RBC and a SSL exceedence.
12	*12*	Shading in the MDL/MRL columns indicates the MDL exceeds a criterion.

RBCs for non-Carcinogenic compounds have been recalculated to an HI of 0.1.
The pyrene RBCs and SSL were used for acenaphthylene, benzo(g,h,i)perylene and phenanthrene.
Inorganic results below background UTLs are not indicated as exceedences on the table.
RBC = Risk Based Concentration (April, 2003).
RBC values in table are for the more conservative chromium VI
RBC values for chromium III are 150,000 (ind) and 12,000 (res), which were not exceeded
Lead screening values from Technical Review Workgroup for Lead: Guidance Document (April, 1999)
ug/kg = micrograms per kilogram (parts per billion).
mg/kg = milligrams per kilogram (parts per million).
NA = not applicable.
NT = analyte not tested.
LQ = Lab Data Qualifiers
B = (organics) Blank contamination. Value detected in sample and associated blank.
B = (metals) Value <MRL and >MDL and is considered estimated.
E (metals) = Reported value is estimated because of the presence of interferences.
J = (organics) Value <MRL and >MDL and is considered estimated.
JP = Estimated value <CRQL or <RL and MDL
U = Analyte not-detected at the method reporting limit.
VQ = 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
U = analyte not detected
UJ = estimated concentration non-detect
UL = estimated concentration non-detect bias low

Table B-1
Building 4343 - TCLP Cadmium Soil Results - 1996

Sample ID	Cadmium TCLP Limits (ug/L)	Cadmium TCLP (ug/L)	Theoretical Cadmium Conc. in Soil (mg/kg)
4343-01-SVR	1000	14050	680
4343-02-SVR	1000	2850	140
4343-03-SVR	1000	590	28
4343-04-SVR	1000	1340	65
4343-05-SVR	1000	36800	1800

Shading indicates that the value exceeds the TCLP criteria.

Theoretical concentrations are based on the SSL equations and the average soil pH (6.4) for the site (USEPA, 1996a).

Table B-2
Building 4343 - Detected Metal Results in Surface Soil - 1999

Analyte	Sample ID				B43SSB4					B43SSB5					B43SSB6					B43SSB7				
	Sample Date				5/25/99					5/25/99					5/25/99					5/25/99				
	Sample Depth				0-1					0-1					0-1					0-1				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																								
Aluminum	100000	7800	40041	na	15700			*0.7*	*0.7*	18100			*0.69*	*0.69*	15800			*0.69*	*0.69*	16900			*0.69*	*0.69*
Antimony	41	3.1	na	13	1.4	JP	B	*0.5*	*0.5*	0.62	U	U	*0.5*	*0.5*	0.65	U	U	*0.5*	*0.5*	0.77	JP	B	*0.5*	*0.5*
Arsenic	1.9	0.43	15.8	0.026	5.1		B	*0.6*	*0.6*	4.2		B	*0.59*	*0.59*	4.3		B	*0.59*	*0.59*	1.8		B	*0.59*	*0.59*
Barium	7200	550	209	2100	37			*0.1*	*0.1*	30.5			*0.099*	*0.099*	43.4			*0.099*	*0.099*	36.9			*0.099*	*0.099*
Beryllium	200	16	1.02	1200	0.13	U	U	*0.1*	*0.1*	0.12	U	U	*0.099*	*0.099*	0.13	U	U	*0.099*	*0.099*	0.13	U	U	*0.099*	*0.099*
Cadmium	51	3.9	0.69	27	**16.2**			*0.1*	*0.1*	**19.3**			*0.099*	*0.099*	**9.6**			*0.099*	*0.099*	**3.1**			*0.099*	*0.099*
Calcium	na	na	na	na	1800			*1*	*1*	891			*0.99*	*0.99*	1130			*0.99*	*0.99*	824			*0.99*	*0.99*
Chromium	310	23	65.3	42	37			*0.1*	*0.1*	27			*0.099*	*0.099*	34.6			*0.099*	*0.099*	20			*0.099*	*0.099*
Cobalt	2000	160	72.3	na	3.8	JP	J	*0.1*	*0.1*	3.9	JP	J	*0.099*	*0.099*	3.9	JP	J	*0.099*	*0.099*	4.2	JP	J	*0.099*	*0.099*
Copper	4100	310	53.5	11000	19.7			*0.1*	*0.1*	23.2			*0.099*	*0.099*	14.8			*0.099*	*0.099*	15.6			*0.099*	*0.099*
Iron	31000	2300	50962	na	46400			*2*	*2*	43200			*2*	*2*	40400			*2*	*2*	40100			*2*	*2*
Lead	750	400	26.8	na	14.8			*0.2*	*0.2*	16.6			*0.2*	*0.2*	22.4			*0.2*	*0.2*	15.7			*0.2*	*0.2*
Magnesium	na	na	na	na	559	JP	J	*1.6*	*1.6*	660			*1.6*	*1.6*	547	JP	J	*1.6*	*1.6*	762			*1.6*	*1.6*
Manganese	2000	160	2543	950	152			*0.1*	*0.1*	122			*0.099*	*0.099*	138			*0.099*	*0.099*	136			*0.099*	*0.099*
Mercury	31	2.3	0.13	na	0.13	U	U	*0.1*	*0.1*	0.13	U	U	*0.1*	*0.1*	0.13	U	U	*0.1*	*0.1*	0.13	U	U	*0.095*	*0.095*
Nickel	2000	160	62.8	na	5.2	JP	J	*0.1*	*0.1*	6.8			*0.099*	*0.099*	5.8			*0.099*	*0.099*	6.8			*0.099*	*0.099*
Potassium	na	na	na	na	373	JP	J	*2.9*	*2.9*	725			*2.9*	*2.9*	558	JP	J	*2.9*	*2.9*	686			*2.9*	*2.9*
Selenium	510	39	na	19	0.53	U	U	*0.4*	*0.4*	0.5	U	U	*0.4*	*0.4*	0.52	U	U	*0.4*	*0.4*	0.52	U	U	*0.4*	*0.4*
Silver	510	39	na	31	0.46	JP	B	*0.1*	*0.1*	0.42	JP	B	*0.099*	*0.099*	0.38	JP	B	*0.099*	*0.099*	0.27	JP	B	*0.099*	*0.099*
Sodium	na	na	na	na	138	JP	J	*1.8*	*1.8*	110	JP	J	*1.8*	*1.8*	110	JP	J	*1.8*	*1.8*	124	JP	J	*1.8*	*1.8*
Vanadium	720	55	108	5100	91.4			*0.1*	*0.1*	92.5			*0.099*	*0.099*	87.1			*0.099*	*0.099*	90.3			*0.099*	*0.099*
Zinc	31000	2300	202	14000	28.4			*0.1*	*0.1*	36.8			*0.099*	*0.099*	34.5			*0.099*	*0.099*	37.9			*0.099*	*0.099*

Note: Refer to the Master Table Legend at the beginning of this Appendix
for a list of definitions and table notes

Table B-2
Building 4343 - Detected Metal Results in Surface Soil - 1999

Analyte	Sample ID				B43SSB8					B43SSB9					B43SSB10					B43SSB11				
	Sample Date				5/25/99					5/25/99					5/25/99					5/25/99				
	Sample Depth				0-1					0-1					0-1					0-1				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																								
Aluminum	100000	7800	40041	na	23900			*0.7*	*0.7*	21400			*0.7*	*0.7*	25100			*0.67*	*0.67*	552			*0.7*	*0.7*
Antimony	41	3.1	na	13	0.66	JP	B	*0.5*	*0.5*	0.62	U	U	*0.5*	*0.5*	0.63	U	U	*0.48*	*0.48*	0.51	U	U	*0.5*	*0.5*
Arsenic	1.9	0.43	15.8	0.026	4.3		B	*0.6*	*0.6*	4.1		B	*0.6*	*0.6*	5.6		B	*0.58*	*0.58*	1.4		B	*0.6*	*0.6*
Barium	7200	550	209	2100	38.7			*0.1*	*0.1*	31.3			*0.1*	*0.1*	46.9			*0.096*	*0.096*	88.7			*0.1*	*0.1*
Beryllium	200	16	1.02	1200	0.13	U	U	*0.1*	*0.1*	0.12	U	U	*0.1*	*0.1*	0.13	JP	B	*0.096*	*0.096*	0.1	U	U	*0.1*	*0.1*
Cadmium	51	3.9	0.69	27	**2.7**			*0.1*	*0.1*	**1.2**			*0.1*	*0.1*	**8.4**			*0.096*	*0.096*	**1.7**			*0.1*	*0.1*
Calcium	na	na	na	na	664			*1*	*1*	1630			*1*	*1*	2420			*0.96*	*0.96*	91000			*1*	*1*
Chromium	310	23	65.3	42	29.6			*0.1*	*0.1*	38.6			*0.1*	*0.1*	44.4			*0.096*	*0.096*	4.2			*0.1*	*0.1*
Cobalt	2000	160	72.3	na	4.7	JP	K	*0.1*	*0.1*	3.4	JP	K	*0.1*	*0.1*	3.8	JP	K	*0.096*	*0.096*	1.1	JP	B	*0.1*	*0.1*
Copper	4100	310	53.5	11000	23.8			*0.1*	*0.1*	24.2			*0.1*	*0.1*	38.6			*0.096*	*0.096*	8.6			*0.1*	*0.1*
Iron	31000	2300	50962	na	44900			*2*	*2*	44000			*2*	*2*	**51400**			*1.9*	*1.9*	2340			*2*	*2*
Lead	750	400	26.8	na	**28.4**			*0.2*	*0.2*	11.2			*0.2*	*0.2*	16.6			*0.19*	*0.19*	3.1			*0.2*	*0.2*
Magnesium	na	na	na	na	588	JP	J	*1.6*	*1.6*	804			*1.6*	*1.6*	1240			*1.5*	*1.5*	8000			*1.6*	*1.6*
Manganese	2000	160	2543	950	193			*0.1*	*0.1*	88.2			*0.1*	*0.1*	108			*0.096*	*0.096*	70.5			*0.1*	*0.1*
Mercury	31	2.3	0.13	na	**0.37**			*0.1*	*0.1*	**0.53**			*0.095*	*0.095*	**0.21**			*0.095*	*0.095*	0.1	U	U	*0.095*	*0.095*
Nickel	2000	160	62.8	na	7.9		K	*0.1*	*0.1*	7.1		K	*0.1*	*0.1*	8		K	*0.096*	*0.096*	0.1	U	U	*0.1*	*0.1*
Potassium	na	na	na	na	683			*2.9*	*2.9*	492	JP		*2.9*	*2.9*	669			*2.8*	*2.8*	323	JP	J	*2.9*	*2.9*
Selenium	510	39	na	19	0.52	U	U	*0.4*	*0.4*	0.5	U	U	*0.4*	*0.4*	0.5	U	U	*0.38*	*0.38*	1.1		K	*0.4*	*0.4*
Silver	510	39	na	31	0.48	JP	B	*0.1*	*0.1*	0.36	JP	B	*0.1*	*0.1*	0.53	JP	B	*0.096*	*0.096*	0.1	U	U	*0.1*	*0.1*
Sodium	na	na	na	na	151	JP	B	*1.8*	*1.8*	140	JP	B	*1.8*	*1.8*	164	JP	B	*1.7*	*1.7*	443	JP	B	*1.8*	*1.8*
Vanadium	720	55	108	5100	96.5			*0.1*	*0.1*	92.8			*0.1*	*0.1*	**108**			*0.096*	*0.096*	5.7		K	*0.1*	*0.1*
Zinc	31000	2300	202	14000	42.6			*0.1*	*0.1*	32.9			*0.1*	*0.1*	47.8			*0.096*	*0.096*	8.6		B	*0.1*	*0.1*

Note: Refer to the Master Table Legend at the beginning of this Appendix for a list of definitions and table notes

Table B-2
Building 4343 - Detected Metal Results in Surface Soil - 1999

Analyte	Sample ID				B43SSB12					B43SSB13					B43SSB14					B43SSB15				
	Sample Date				5/25/99					5/25/99					5/25/99					8/17/99				
	Sample Depth				0-1					0-1					0-1					0-1				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																								
Aluminum	100000	7800	40041	na	10800			*0.7*	*0.7*	16900			*0.7*	*0.7*	20300			*0.7*	*0.7*	19700			*0.4*	*0.4*
Antimony	41	3.1	na	13	0.59	U	U	*0.5*	*0.5*	0.63	U	U	*0.5*	*0.5*	0.64	U	U	*0.5*	*0.5*	1.7	B	B	*0.5*	*0.5*
Arsenic	1.9	0.43	15.8	0.026	2.9		B	*0.6*	*0.6*	4.2		B	*0.6*	*0.6*	2.2		B	*0.6*	*0.6*	4.8		B	*0.6*	*0.6*
Barium	7200	550	209	2100	81			*0.1*	*0.1*	42.2			*0.1*	*0.1*	35			*0.1*	*0.1*	98.8			*0.1*	*0.1*
Beryllium	200	16	1.02	1200	0.12	U	U	*0.1*	*0.1*	0.13	U	U	*0.1*	*0.1*	0.13	U	U	*0.1*	*0.1*	0.69		B	*0.1*	*0.1*
Cadmium	51	3.9	0.69	27	0.12	U	U	*0.1*	*0.1*	**6.3**			*0.1*	*0.1*	**9**			*0.1*	*0.1*	**2.6**			*0.1*	*0.1*
Calcium	na	na	na	na	1220			*1*	*1*	1480			*1*	*1*	270	JP	J	*1*	*1*	1810			*1*	*1*
Chromium	310	23	65.3	42	19.7			*0.1*	*0.1*	34.1			*0.1*	*0.1*	22.8			*0.1*	*0.1*	27.6			*0.1*	*0.1*
Cobalt	2000	160	72.3	na	11.3		K	*0.1*	*0.1*	3.3	JP	K	*0.1*	*0.1*	3.3	JP	K	*0.1*	*0.1*	14.4			*0.2*	*0.2*
Copper	4100	310	53.5	11000	12			*0.1*	*0.1*	15.2			*0.1*	*0.1*	18			*0.1*	*0.1*	20.5			*0.1*	*0.1*
Iron	31000	2300	50962	na	22400			*2*	*2*	43300			*2*	*2*	32100			*2*	*2*	28200			*2.1*	*2.1*
Lead	750	400	26.8	na	9.7			*0.2*	*0.2*	11.9			*0.2*	*0.2*	15.6			*0.2*	*0.2*	18.8			*0.3*	*0.3*
Magnesium	na	na	na	na	1350			*1.6*	*1.6*	818			*1.6*	*1.6*	862			*1.6*	*1.6*	4120			*1.1*	*1.1*
Manganese	2000	160	2543	950	486			*0.1*	*0.1*	102			*0.1*	*0.1*	101			*0.1*	*0.1*	534			*0.1*	*0.1*
Mercury	31	2.3	0.13	na	0.12	U	U	*0.1*	*0.1*	0.13	U	U	*0.1*	*0.1*	0.13	U	U	*0.1*	*0.1*	0.11	U	U	*0.1*	*0.1*
Nickel	2000	160	62.8	na	7.5		K	*0.1*	*0.1*	5.6		K	*0.1*	*0.1*	7.9		K	*0.1*	*0.1*	17			*0.2*	*0.2*
Potassium	na	na	na	na	790			*2.9*	*2.9*	485	JP	J	*2.9*	*2.9*	884			*2.9*	*2.9*	2020	E	J	*1.4*	*1.4*
Selenium	510	39	na	19	0.47	U	U	*0.4*	*0.4*	0.5	U	U	*0.4*	*0.4*	0.51	U	U	*0.4*	*0.4*	0.56	U	U	*0.5*	*0.5*
Silver	510	39	na	31	0.15	JP	B	*0.1*	*0.1*	0.34	JP	B	*0.1*	*0.1*	0.32	JP	B	*0.1*	*0.1*	0.11	U	UL	*0.1*	*0.1*
Sodium	na	na	na	na	110	JP	B	*1.8*	*1.8*	123	JP	B	*1.8*	*1.8*	129	JP	B	*1.8*	*1.8*	189	E	B	*0.8*	*0.8*
Vanadium	720	55	108	5100	45.2			*0.1*	*0.1*	92.4			*0.1*	*0.1*	75.9			*0.1*	*0.1*	47.3			*0.2*	*0.2*
Zinc	31000	2300	202	14000	52.7			*0.1*	*0.1*	31.3			*0.1*	*0.1*	32.1			*0.1*	*0.1*	60.6			*0.3*	*0.3*

Note: Refer to the Master Table Legend at the beginning of this Appendix for a list of definitions and table notes

Table B-2
Building 4343 - Detected Metal Results in Surface Soil - 1999

Analyte	Sample ID				B43SSB16					B43SSB17					B43SSB18					B43SSB28				
	Sample Date				8/17/99					8/17/99					8/17/99					10/5/99				
	Sample Depth				0-1					0-1					0-1					0-1				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																								
Aluminum	100000	7800	40041	na	15100			*0.4*	*0.4*	17100			*0.39*	*0.39*	18300			*0.39*	*0.39*	14600			*1.4*	*1.4*
Antimony	41	3.1	na	13	1.2	B	B	*0.5*	*0.5*	1.7	B	B	*0.49*	*0.49*	3.1	B	B	*0.49*	*0.49*	0.63	U	U	*0.5*	*0.5*
Arsenic	1.9	0.43	15.8	0.026	3.5		B	*0.6*	*0.6*	4.4		B	*0.58*	*0.58*	5.1		B	*0.58*	*0.58*	4			*0.6*	*0.6*
Barium	7200	550	209	2100	74.1			*0.1*	*0.1*	77.8			*0.097*	*0.097*	77.8			*0.097*	*0.097*	33.6			*0.1*	*0.1*
Beryllium	200	16	1.02	1200	0.28	B	B	*0.1*	*0.1*	0.81		B	*0.097*	*0.097*	**1.1**		**B**	*0.097*	*0.097*	0.38	B	B	*0.1*	*0.1*
Cadmium	51	3.9	0.69	27	0.5	B	J	*0.1*	*0.1*	**137**		**J**	*0.097*	*0.097*	**339**		**J**	*0.097*	*0.097*	0.13	U	U	*0.1*	*0.1*
Calcium	na	na	na	na	601			*1*	*1*	9730			*0.97*	*0.97*	1990			*0.97*	*0.97*	401	B	J	*1.6*	*1.6*
Chromium	310	23	65.3	42	27.9			*0.1*	*0.1*	46.2			*0.097*	*0.097*	**160**			*0.097*	*0.097*	26.7			*0.1*	*0.1*
Cobalt	2000	160	72.3	na	5.8			*0.2*	*0.2*	14			*0.19*	*0.19*	19.8			*0.19*	*0.19*	3.1	B	J	*0.1*	*0.1*
Copper	4100	310	53.5	11000	10.2			*0.1*	*0.1*	30.2			*0.097*	*0.097*	**62.6**			*0.097*	*0.097*	13.1			*0.1*	*0.1*
Iron	31000	2300	50962	na	23400			*2.1*	*2.1*	27900			*2*	*2*	32400			*2*	*2*	30000			*1.6*	*1.6*
Lead	750	400	26.8	na	15.9			*0.3*	*0.3*	20.2			*0.29*	*0.29*	22.9			*0.29*	*0.29*	14.4			*0.2*	*0.2*
Magnesium	na	na	na	na	622			*1.1*	*1.1*	8980			*1.1*	*1.1*	6250			*1.1*	*1.1*	403	B	J	*2.3*	*2.3*
Manganese	2000	160	2543	950	441			*0.1*	*0.1*	550			*0.097*	*0.097*	642			*0.097*	*0.097*	99.3			*0.1*	*0.1*
Mercury	31	2.3	0.13	na	0.11	U	U	*0.1*	*0.1*	0.11	U	U	*0.095*	*0.095*	0.11	U	U	*0.095*	*0.095*	0.13	U	U	*0.1*	*0.1*
Nickel	2000	160	62.8	na	5.2			*0.2*	*0.2*	22.1			*0.19*	*0.19*	26.6			*0.19*	*0.19*	2.9	B	J	*0.2*	*0.2*
Potassium	na	na	na	na	516	E	J	*1.4*	*1.4*	1780	E	J	*1.4*	*1.4*	2050	E	J	*1.4*	*1.4*	574	B	J	*3.9*	*3.9*
Selenium	510	39	na	19	0.6			*0.5*	*0.5*	0.55	U	U	*0.49*	*0.49*	0.55	U	U	*0.49*	*0.49*	0.63	U	U	*0.5*	*0.5*
Silver	510	39	na	31	0.11	U	UL	*0.1*	*0.1*	0.11	U	UL	*0.097*	*0.097*	0.11	U	UL	*0.097*	*0.097*	0.87	B	J	*0.1*	*0.1*
Sodium	na	na	na	na	89.8	E	B	*0.8*	*0.8*	149	E	B	*0.78*	*0.78*	125	E	B	*0.78*	*0.78*	94.1	B	B	*2.3*	*2.3*
Vanadium	720	55	108	5100	48.7			*0.2*	*0.2*	43.1			*0.19*	*0.19*	41.7			*0.19*	*0.19*	66.1			*0.2*	*0.2*
Zinc	31000	2300	202	14000	29.9		K	*0.3*	*0.3*	56.5			*0.29*	*0.29*	69			*0.29*	*0.29*	19.1			*0.2*	*0.2*

Note: Refer to the Master Table Legend at the beginning of this Appendix for a list of definitions and table notes

Table B-2
Building 4343 - Detected Metal Results in Surface Soil - 1999

Analyte	Sample ID				B43SSD1					B43SSD2					B43SSD3					B43SSD4				
	Sample Date				5/25/99					5/25/99					5/25/99					5/25/99				
	Sample Depth				0-1					0-1					0-1					0-1				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																								
Aluminum	100000	7800	40041	na	5850			*0.69*	*0.69*	9970			*0.7*	*0.7*	7380			*0.67*	*0.67*	6200			*0.7*	*0.7*
Antimony	41	3.1	na	13	41.2		J	*0.5*	*0.5*	2.2	JP	B	*0.5*	*0.5*	1.4	JP	B	*0.48*	*0.48*	1.5	JP	B	*0.5*	*0.5*
Arsenic	1.9	0.43	15.8	0.026	4.9		B	*0.59*	*0.59*	5.3		B	*0.6*	*0.6*	2.9		B	*0.58*	*0.58*	3.8		B	*0.6*	*0.6*
Barium	7200	550	209	2100	**242**			*0.099*	*0.099*	42.8			*0.1*	*0.1*	58.4			*0.096*	*0.096*	28.9			*0.1*	*0.1*
Beryllium	200	16	1.02	1200	0.13	U	U	*0.099*	*0.099*	0.25	JP	K	*0.1*	*0.1*	0.22	JP	K	*0.096*	*0.096*	0.12	U	U	*0.1*	*0.1*
Cadmium	51	3.9	0.69	27	**24300**			*0.099*	*0.099*	**157**			*0.1*	*0.1*	**124**			*0.096*	*0.096*	**134**			*0.1*	*0.1*
Calcium	na	na	na	na	16700			*0.99*	*0.99*	473	JP	J	*1*	*1*	490	JP	J	*0.96*	*0.96*	425	JP	J	*1*	*1*
Chromium	310	23	65.3	42	**1820**			*0.099*	*0.099*	**192**			*0.1*	*0.1*	**124**			*0.096*	*0.096*	**102**			*0.1*	*0.1*
Cobalt	2000	160	72.3	na	0.13	U	U	*0.099*	*0.099*	5.1	JP	K	*0.1*	*0.1*	4.6	JP	K	*0.096*	*0.096*	3.6	JP	K	*0.1*	*0.1*
Copper	4100	310	53.5	11000	**677**			*0.099*	*0.099*	**63.8**			*0.1*	*0.1*	**60.4**			*0.096*	*0.096*	43.5			*0.1*	*0.1*
Iron	31000	2300	50962	na	33000			*2*	*2*	35300			*2*	*2*	17800			*1.9*	*1.9*	19100			*2*	*2*
Lead	750	400	26.8	na	**1410**			*0.2*	*0.2*	**36.3**			*0.2*	*0.2*	22.4			*0.19*	*0.19*	20.9			*0.2*	*0.2*
Magnesium	na	na	na	na	1440			*1.6*	*1.6*	363	JP	J	*1.6*	*1.6*	307	JP	J	*1.5*	*1.5*	222	JP	J	*1.6*	*1.6*
Manganese	2000	160	2543	950	306			*0.099*	*0.099*	348			*0.1*	*0.1*	507			*0.096*	*0.096*	210			*0.1*	*0.1*
Mercury	31	2.3	0.13	na	0.12	U	U	*0.095*	*0.095*	0.13	U	U	*0.1*	*0.1*	0.12	U	U	*0.095*	*0.095*	**0.2**			*0.095*	*0.095*
Nickel	2000	160	62.8	na	32.6			*0.099*	*0.099*	9.1		K	*0.1*	*0.1*	4.1	JP	K	*0.096*	*0.096*	2.8	JP	K	*0.1*	*0.1*
Potassium	na	na	na	na	363	JP	J	*2.9*	*2.9*	450	JP	J	*2.9*	*2.9*	301	JP	J	*2.8*	*2.8*	272	JP	J	*2.9*	*2.9*
Selenium	510	39	na	19	0.51	U	U	*0.4*	*0.4*	0.52	U	U	*0.4*	*0.4*	0.48	U	U	*0.38*	*0.38*	0.49	U	U	*0.4*	*0.4*
Silver	510	39	na	31	36			*0.099*	*0.099*	0.54	JP	B	*0.1*	*0.1*	0.65	JP	B	*0.096*	*0.096*	0.33	JP	B	*0.1*	*0.1*
Sodium	na	na	na	na	209	JP	B	*1.8*	*1.8*	107	JP	B	*1.8*	*1.8*	101	JP	B	*1.7*	*1.7*	90.3	JP	B	*1.8*	*1.8*
Vanadium	720	55	108	5100	35.3			*0.099*	*0.099*	73.7			*0.1*	*0.1*	40			*0.096*	*0.096*	42.5			*0.1*	*0.1*
Zinc	31000	2300	202	14000	**1780**			*0.099*	*0.099*	47.7			*0.1*	*0.1*	27.2			*0.096*	*0.096*	28.9			*0.1*	*0.1*

Note: Refer to the Master Table Legend at the beginning of this Appendix for a list of definitions and table notes

Table B-2
Building 4343 - Detected Metal Results in Surface Soil - 1999

Analyte	Sample ID				B43SSD4D					B43SSD5					B43SSD6				
	Sample Date				5/25/99					5/25/99					5/25/99				
	Sample Depth				0-1					0-1					0-1				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																			
Aluminum	100000	7800	40041	na	7060			*0.7*	*0.7*	9170			*0.69*	*0.69*	6790			*0.68*	*0.68*
Antimony	41	3.1	na	13	1.2	JP	B	*0.5*	*0.5*	3.2	JP	B	*0.5*	*0.5*	5.3	JP	B	*0.49*	*0.49*
Arsenic	1.9	0.43	15.8	0.026	3.5		B	*0.6*	*0.6*	3.2		B	*0.59*	*0.59*	3.6		B	*0.58*	*0.58*
Barium	7200	550	209	2100	34.2			*0.1*	*0.1*	26.7			*0.099*	*0.099*	31.9			*0.097*	*0.097*
Beryllium	200	16	1.02	1200	0.12	U	U	*0.1*	*0.1*	0.12	U	U	*0.099*	*0.099*	0.12	U	U	*0.097*	*0.097*
Cadmium	51	3.9	0.69	27	**147**			*0.1*	*0.1*	**222**			*0.099*	*0.099*	**1040**			*0.097*	*0.097*
Calcium	na	na	na	na	481	JP		*1*	*1*	578	JP	J	*0.99*	*0.99*	785			*0.97*	*0.97*
Chromium	310	23	65.3	42	**105**			*0.1*	*0.1*	**301**			*0.099*	*0.099*	**402**			*0.097*	*0.097*
Cobalt	2000	160	72.3	na	3.3	JP	K	*0.1*	*0.1*	2.2	JP	K	*0.099*	*0.099*	2.9	JP	K	*0.097*	*0.097*
Copper	4100	310	53.5	11000	49.6			*0.1*	*0.1*	**72.9**			*0.099*	*0.099*	**127**			*0.097*	*0.097*
Iron	31000	2300	50962	na	19600			*2*	*2*	22800			*2*	*2*	21900			*1.9*	*1.9*
Lead	750	400	26.8	na	19.4			*0.2*	*0.2*	21			*0.2*	*0.2*	**47**			*0.19*	*0.19*
Magnesium	na	na	na	na	258	JP	J	*1.6*	*1.6*	251	JP	J	*1.6*	*1.6*	277	JP	J	*1.6*	*1.6*
Manganese	2000	160	2543	950	240			*0.1*	*0.1*	96.3			*0.099*	*0.099*	190			*0.097*	*0.097*
Mercury	31	2.3	0.13	na	0.12	U	U	*0.1*	*0.1*	0.12	U	U	*0.095*	*0.095*	0.12	U	U	*0.095*	*0.095*
Nickel	2000	160	62.8	na	3.3	JP	K	*0.1*	*0.1*	3.9	JP	K	*0.099*	*0.099*	4.9		K	*0.097*	*0.097*
Potassium	na	na	na	na	299	JP	J	*2.9*	*2.9*	394	JP	J	*2.9*	*2.9*	326	JP	J	*2.8*	*2.8*
Selenium	510	39	na	19	0.5	U	U	*0.4*	*0.4*	0.49	U	U	*0.4*	*0.4*	0.48	U	U	*0.39*	*0.39*
Silver	510	39	na	31	0.34	JP	B	*0.1*	*0.1*	0.12	U	U	*0.099*	*0.099*	0.32	JP	B	*0.097*	*0.097*
Sodium	na	na	na	na	100	JP	B	*1.8*	*1.8*	93.5	JP	B	*1.8*	*1.8*	97.8	JP	B	*1.7*	*1.7*
Vanadium	720	55	108	5100	44.4			*0.1*	*0.1*	51.6			*0.099*	*0.099*	48			*0.097*	*0.097*
Zinc	31000	2300	202	14000	32.9			*0.1*	*0.1*	44.2			*0.099*	*0.099*	118			*0.097*	*0.097*

Note: Refer to the Master Table Legend at the beginning of this Appendix for a list of definitions and table notes

Table B-3
Building 4343 - TCLP Metal Results in Surface Soil - 1999

FIELD ID	TCLP	B43SSB1	B43SSB2	B43SSB3	B43SSB13	B43SSB14	B43SSB15	B43SSB17	B43SSB18	B43SSB19
SAMPLING DATE	REGULATORY	5/25/1999	5/25/1999	5/25/1999	5/25/1999	5/25/1999	8/17/1999	8/17/1999	8/17/1999	10/5/1999
DEPTH (ft)	LEVELS	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
UNITS	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
TCLP Metals										
Arsenic	5000	6.1	6 U	6 U	6 U	6 U	6 U	6 U	6 U	6 U
Barium	100000	36.2	91.3	43.7	47.5	49.2	299	510	382	78
Cadmium	1000	15.5	3890	150	48.4	186	1.7	1040	6750	2.8
Chromium	5000	1 U	1 U	1 U	1 U	1 U	1 U	1 U	19.5	1 U
Lead	5000	2 U	776	10	2 U	2 U	18.9	77.5	6.3	2 U
Mercury	200	0.2 U	0.2 U	0.2 U	0.2 U	0.43	0.2 U	0.2 U	0.2 U	0.2 U
Silver	5000	1.4	1.5	1 U	1 U	1 U	1 U	1 U	1 U	1 U

Shading indicates that the value exceeds the TCLP criteria

Table B-3
Building 4343 - TCLP Metal Results in Surface Soil - 1999

FIELD ID	TCLP	B43SSB20	B43SSB21	B43SSB22	B43SSB23	B43SSB24	B43SSB25	B43SSB26	B43SSB27	B43SSB28
SAMPLING DATE	REGULATORY	10/5/1999	10/5/1999	10/5/1999	10/5/1999	10/5/1999	10/5/1999	10/5/1999	10/5/1999	10/5/1999
DEPTH (ft)	LEVELS	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
UNITS	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
TCLP Metals										
Arsenic	5000	6 U	6 U	6 U	6 U	6 U	6 U	6 U	6 U	6 U
Barium	100000	107	170	211	231	198	186	168 J	201	139 J
Cadmium	1000	109	16.5	21.6	4.2	2.1	4.6	2.4 J	3.8	1.8 J
Chromium	5000	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Lead	5000	2 U	2 U	2 U	2 U	2 U	2 U	2.9 B	2 U	
Mercury	200	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Silver	5000	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U

Shading indicates that the value exceeds the TCLP criteria

Table B-3
Building 4343 - TCLP Metal Results in Surface Soil - 1999

FIELD ID	TCLP	B43SSB29	B43SSB30	B43SSB31	B43SSB32	B43SSB33	B43SSD1	B43SSD3	B43SSD5
SAMPLING DATE	REGULATORY	10/5/1999	10/5/1999	10/5/1999	10/5/1999	10/5/1999	5/25/1999	5/25/1999	5/25/1999
DEPTH (ft)	LEVELS	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1
UNITS	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
TCLP Metals									
Arsenic	5000	6 U	6 U	6 U	6 U	6 U	6 U	6 U	6 U
Barium	100000	281	349	426	257	304	672	76.4	51.4
Cadmium	1000	1 U	1 U	4.2 J	37.9	2140	26800	1520	2540
Chromium	5000	1 U	1 U	1 U	1 U	7.5 J	15.8	12.1	53.2
Lead	5000	2 U	3.2 B	2 U	2 U	2 U	12.1	2 U	2 U
Mercury	200	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Silver	5000	1 U	1 U	1 U	1 U	1 U	1.5	1 U	1 U

Shading indicates that the value exceeds the TCLP criteria

Table B-4
Building 4343 - Detected Metal Results in Subsurface Soil - 1999

Analyte	Sample ID				B43SB4A					B43SB5A					B43SB6A					B43SB7A				
	Sample Date				5/25/99					5/25/99					5/25/99					5/25/99				
	Sample Depth				2-4					2-4					2-4					2-4				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																								
Aluminum	100000	7800	40041	na	17300			*0.67*	*0.67*	22300			*0.7*	*0.7*	19200			*0.68*	*0.68*	18000			*0.7*	*0.7*
Antimony	41	3.1	na	13	0.66	JP	B	*0.48*	*0.48*	0.9	JP	B	*0.5*	*0.5*	0.63	U	U	*0.49*	*0.49*	0.71	JP	B	*0.5*	*0.5*
Arsenic	1.9	0.43	15.8	0.026	2.5		B	*0.58*	*0.58*	3.2		B	*0.6*	*0.6*	2.4		B	*0.58*	*0.58*	3.1		B	*0.6*	*0.6*
Barium	7200	550	209	2100	25.5	JP		*0.096*	*0.096*	38.4			*0.1*	*0.1*	37.1			*0.097*	*0.097*	30.3			*0.1*	*0.1*
Beryllium	200	16	1.02	1200	0.13	U	U	*0.096*	*0.096*	0.13	U	U	*0.1*	*0.1*	0.13	U	U	*0.097*	*0.097*	0.13	U	U	*0.1*	*0.1*
Cadmium	51	3.9	0.69	27	**2.9**			*0.096*	*0.096*	**0.76**			*0.1*	*0.1*	**0.69**			*0.097*	*0.097*	0.56	JP	J	*0.1*	*0.1*
Calcium	na	na	na	na	601	JP	J	*0.96*	*0.96*	255	JP	J	*1*	*1*	586	JP	J	*0.97*	*0.97*	430	JP	J	*1*	*1*
Chromium	310	23	65.3	42	18.9			*0.096*	*0.096*	22.9			*0.1*	*0.1*	22.1			*0.097*	*0.097*	19			*0.1*	*0.1*
Cobalt	2000	160	72.3	na	3.7	JP	J	*0.096*	*0.096*	5	JP	J	*0.1*	*0.1*	5.1	JP	J	*0.097*	*0.097*	4.1	JP	J	*0.1*	*0.1*
Copper	4100	310	53.5	11000	27.6			*0.096*	*0.096*	19			*0.1*	*0.1*	18.2			*0.097*	*0.097*	16.5			*0.1*	*0.1*
Iron	31000	2300	50962	na	41100			*1.9*	*1.9*	43300			*2*	*2*	42900			*1.9*	*1.9*	39000			*2*	*2*
Lead	750	400	26.8	na	14.1			*0.19*	*0.19*	15.3			*0.2*	*0.2*	15.9			*0.19*	*0.19*	15.9			*0.2*	*0.2*
Magnesium	na	na	na	na	610	JP	J	*1.5*	*1.5*	776			*1.6*	*1.6*	1160			*1.6*	*1.6*	833			*1.6*	*1.6*
Manganese	2000	160	2543	950	125			*0.096*	*0.096*	182			*0.1*	*0.1*	147			*0.097*	*0.097*	133			*0.1*	*0.1*
Mercury	31	2.3	0.13	na	**0.15**			*0.095*	*0.095*	0.13	U	U	*0.1*	*0.1*	0.12	U	U	*0.095*	*0.095*	0.13	U	U	*0.1*	*0.1*
Nickel	2000	160	62.8	na	6.2			*0.096*	*0.096*	8.2			*0.1*	*0.1*	8.7			*0.097*	*0.097*	7.4			*0.1*	*0.1*
Potassium	na	na	na	na	687			*2.8*	*2.8*	838			*2.9*	*2.9*	1110			*2.8*	*2.8*	832			*2.9*	*2.9*
Selenium	510	39	na	19	0.51	U	U	*0.38*	*0.38*	0.51	U	U	*0.4*	*0.4*	0.5	U	U	*0.39*	*0.39*	0.51	U	U	*0.4*	*0.4*
Silver	510	39	na	31	0.35	JP	B	*0.096*	*0.096*	0.38	JP	B	*0.1*	*0.1*	0.42	JP	B	*0.097*	*0.097*	0.39	JP	B	*0.1*	*0.1*
Sodium	na	na	na	na	116	JP	J	*1.7*	*1.7*	133	JP	J	*1.8*	*1.8*	127	JP	J	*1.7*	*1.7*	106	JP	B	*1.8*	*1.8*
Thallium	7.2	0.55	2.11	3.6	0.9	U	U	*0.67*	*0.67*	0.89	U	U	*0.7*	*0.7*	0.88	U	U	*0.68*	*0.68*	0.9	U	U	*0.7*	*0.7*
Vanadium	720	55	108	5100	89.5			*0.096*	*0.096*	94.1			*0.1*	*0.1*	91.8			*0.097*	*0.097*	85.6			*0.1*	*0.1*
Zinc	31000	2300	202	14000	39.2			*0.096*	*0.096*	41.2			*0.1*	*0.1*	46.9			*0.097*	*0.097*	37.7			*0.1*	*0.1*

Note: Refer to the Master Table Legend at the beginning of this Appendix
for a list of definitions and table notes

Table B-4
Building 4343 - Detected Metal Results in Subsurface Soil - 1999

Analyte	Sample ID				B43SB7AD					B43SB8A					B43SB9A					B43SB10A				
	Sample Date				5/25/99					5/25/99					5/25/99					5/25/99				
	Sample Depth				2-4					2-4					2-4					2-4				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																								
Aluminum	100000	7800	40041	na	15700			*0.7*	*0.7*	18600			*0.7*	*0.7*	19500			*0.67*	*0.67*	20900			*0.7*	*0.7*
Antimony	41	3.1	na	13	0.86	JP	B	*0.5*	*0.5*	0.68	U	U	*0.5*	*0.5*	0.67	JP	B	*0.48*	*0.48*	0.65	U	U	*0.5*	*0.5*
Arsenic	1.9	0.43	15.8	0.026	2.2		B	*0.6*	*0.6*	3.3		B	*0.6*	*0.6*	3.2		B	*0.58*	*0.58*	3.7		B	*0.6*	*0.6*
Barium	7200	550	209	2100	33			*0.1*	*0.1*	26.8	JP		*0.1*	*0.1*	25.9			*0.096*	*0.096*	35.1			*0.1*	*0.1*
Beryllium	200	16	1.02	1200	0.13	U	U	*0.1*	*0.1*	0.14	U	U	*0.1*	*0.1*	0.12	U	U	*0.096*	*0.096*	0.13	U	U	*0.1*	*0.1*
Cadmium	51	3.9	0.69	27	0.31	JP	J	*0.1*	*0.1*	0.41	JP	J	*0.1*	*0.1*	0.12	U	U	*0.096*	*0.096*	0.13	U	U	*0.1*	*0.1*
Calcium	na	na	na	na	359	JP	J	*1*	*1*	949			*1*	*1*	275	JP	J	*0.96*	*0.96*	1430			*1*	*1*
Chromium	310	23	65.3	42	14.6			*0.1*	*0.1*	28			*0.1*	*0.1*	24.5			*0.096*	*0.096*	28			*0.1*	*0.1*
Cobalt	2000	160	72.3	na	4.6	JP	J	*0.1*	*0.1*	4.2	JP	J	*0.1*	*0.1*	3.5	JP	J	*0.096*	*0.096*	3.3	JP	J	*0.1*	*0.1*
Copper	4100	310	53.5	11000	16.9			*0.1*	*0.1*	17.8			*0.1*	*0.1*	16.5			*0.096*	*0.096*	18.9			*0.1*	*0.1*
Iron	31000	2300	50962	na	36800			*2*	*2*	46100			*2*	*2*	45100			*1.9*	*1.9*	45600			*2*	*2*
Lead	750	400	26.8	na	16.9			*0.2*	*0.2*	**88.6**			*0.2*	*0.2*	13.6			*0.19*	*0.19*	15.9			*0.2*	*0.2*
Magnesium	na	na	na	na	1080			*1.6*	*1.6*	528	JP	J	*1.6*	*1.6*	350	JP	J	*1.5*	*1.5*	622	JP	J	*1.6*	*1.6*
Manganese	2000	160	2543	950	129			*0.1*	*0.1*	133			*0.1*	*0.1*	119			*0.096*	*0.096*	118			*0.1*	*0.1*
Mercury	31	2.3	0.13	na	0.12	U	U	*0.095*	*0.095*	0.14	U	U	*0.1*	*0.1*	0.12	U	U	*0.095*	*0.095*	0.12	U	U	*0.095*	*0.095*
Nickel	2000	160	62.8	na	7.2			*0.1*	*0.1*	6.5			*0.1*	*0.1*	6.2			*0.096*	*0.096*	7.1			*0.1*	*0.1*
Potassium	na	na	na	na	1050			*2.9*	*2.9*	529	JP	J	*2.9*	*2.9*	488	JP	J	*2.8*	*2.8*	678			*2.9*	*2.9*
Selenium	510	39	na	19	0.51	U	U	*0.4*	*0.4*	0.54	U	U	*0.4*	*0.4*	0.5	U	U	*0.38*	*0.38*	0.52	U	U	*0.4*	*0.4*
Silver	510	39	na	31	0.33	JP	B	*0.1*	*0.1*	0.41	JP	B	*0.1*	*0.1*	0.35	JP	B	*0.096*	*0.096*	0.41	JP	B	*0.1*	*0.1*
Sodium	na	na	na	na	112	JP	J	*1.8*	*1.8*	131	JP	J	*1.8*	*1.8*	118	JP	J	*1.7*	*1.7*	131	JP	J	*1.8*	*1.8*
Thallium	7.2	0.55	2.11	3.6	0.88	U	U	*0.7*	*0.7*	0.95	U	U	*0.7*	*0.7*	0.87	U	U	*0.67*	*0.67*	0.91	U	U	*0.7*	*0.7*
Vanadium	720	55	108	5100	81			*0.1*	*0.1*	98.2			*0.1*	*0.1*	99.6			*0.096*	*0.096*	98.5			*0.1*	*0.1*
Zinc	31000	2300	202	14000	37.3			*0.1*	*0.1*	42.3			*0.1*	*0.1*	32.2			*0.096*	*0.096*	35.4			*0.1*	*0.1*

Note: Refer to the Master Table Legend at the beginning of this Appendix for a list of definitions and table notes

Table B-4
Building 4343 - Detected Metal Results in Subsurface Soil - 1999

Analyte					Sample ID	B43SB11A					B43SB11B					B43SB12A					B43SB13A				
					Sample Date	5/25/99					5/25/99					5/25/99					5/25/99				
					Sample Depth	2-4					2-4					2-4					2-4				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																									
Aluminum	100000	7800	40041	na	18300			*0.67*	*0.67*	12700			*0.7*	*0.7*	15500			*0.7*	*0.7*	20300			*0.68*	*0.68*
Antimony	41	3.1	na	13	0.82	JP	B	*0.48*	*0.48*	0.63	U	U	*0.5*	*0.5*	0.65	U	U	*0.5*	*0.5*	0.78	JP	B	*0.49*	*0.49*
Arsenic	1.9	0.43	15.8	0.026	5		B	*0.58*	*0.58*	3.2		B	*0.6*	*0.6*	1.8		B	*0.6*	*0.6*	2.8		B	*0.58*	*0.58*
Barium	7200	550	209	2100	59.6			*0.096*	*0.096*	38.8			*0.1*	*0.1*	25.4	JP	J	*0.1*	*0.1*	32.8			*0.097*	*0.097*
Beryllium	200	16	1.02	1200	0.15	JP	K	*0.096*	*0.096*	0.53	JP	B	*0.1*	*0.1*	0.13	U	U	*0.1*	*0.1*	0.12	U	U	*0.097*	*0.097*
Cadmium	51	3.9	0.69	27	0.2	JP	J	*0.096*	*0.096*	0.25	JP	J	*0.1*	*0.1*	0.13	U	U	*0.1*	*0.1*	0.12	U	U	*0.097*	*0.097*
Calcium	na	na	na	na	5160			*0.96*	*0.96*	467	JP	J	*1*	*1*	1200			*1*	*1*	267	JP	J	*0.97*	*0.97*
Chromium	310	23	65.3	42	39.7			*0.096*	*0.096*	37.9			*0.1*	*0.1*	23.2			*0.1*	*0.1*	28.1			*0.097*	*0.097*
Cobalt	2000	160	72.3	na	4	JP	K	*0.096*	*0.096*	6.8		K	*0.1*	*0.1*	3.1	JP	K	*0.1*	*0.1*	4.4	JP	K	*0.097*	*0.097*
Copper	4100	310	53.5	11000	16.3			*0.096*	*0.096*	29.1			*0.1*	*0.1*	14.3			*0.1*	*0.1*	17.8			*0.097*	*0.097*
Iron	31000	2300	50962	na	46900			*1.9*	*1.9*	29300			*2*	*2*	42300			*2*	*2*	43200			*1.9*	*1.9*
Lead	750	400	26.8	na	15			*0.19*	*0.19*	0.82		B	*0.2*	*0.2*	10			*0.2*	*0.2*	15.2			*0.19*	*0.19*
Magnesium	na	na	na	na	2400			*1.5*	*1.5*	6150			*1.6*	*1.6*	487	JP	J	*1.6*	*1.6*	683			*1.6*	*1.6*
Manganese	2000	160	2543	950	183			*0.096*	*0.096*	345			*0.1*	*0.1*	111			*0.1*	*0.1*	147			*0.097*	*0.097*
Mercury	31	2.3	0.13	na	**0.21**			*0.1*	*0.1*	0.13	U	U	*0.1*	*0.1*	0.13	U	U	*0.1*	*0.1*	0.13	U	U	*0.1*	*0.1*
Nickel	2000	160	62.8	na	5.9		K	*0.096*	*0.096*	20.3			*0.1*	*0.1*	5	JP	K	*0.1*	*0.1*	8.4		K	*0.097*	*0.097*
Potassium	na	na	na	na	482	JP	J	*2.8*	*2.8*	746			*2.9*	*2.9*	487	JP	J	*2.9*	*2.9*	773			*2.8*	*2.8*
Selenium	510	39	na	19	0.48	U	U	*0.38*	*0.38*	0.51	U	U	*0.4*	*0.4*	0.52	U	U	*0.4*	*0.4*	0.5	U	U	*0.39*	*0.39*
Silver	510	39	na	31	0.48	JP	B	*0.096*	*0.096*	0.17	JP	B	*0.1*	*0.1*	0.28	JP	B	*0.1*	*0.1*	0.25	JP	B	*0.097*	*0.097*
Sodium	na	na	na	na	131	JP	B	*1.7*	*1.7*	167	JP	B	*1.8*	*1.8*	116	JP	B	*1.8*	*1.8*	116	JP	B	*1.7*	*1.7*
Thallium	7.2	0.55	2.11	3.6	0.83	U	U	*0.67*	*0.67*	0.89	U	U	*0.7*	*0.7*	1.2	JP	J	*0.7*	*0.7*	0.87	U	U	*0.68*	*0.68*
Vanadium	720	55	108	5100	97.4			*0.096*	*0.096*	29.4			*0.1*	*0.1*	94.6			*0.1*	*0.1*	96.2			*0.097*	*0.097*
Zinc	31000	2300	202	14000	38.1			*0.096*	*0.096*	18.6			*0.1*	*0.1*	28.7			*0.1*	*0.1*	36.7			*0.097*	*0.097*

Note: Refer to the Master Table Legend at the beginning of this Appendix for a list of definitions and table notes

Table B-4
Building 4343 - Detected Metal Results in Subsurface Soil - 1999

Analyte	Sample ID				B43SB14A					B43SB15A					B43SB15B					B43SB16A				
	Sample Date				5/25/99					8/17/99					8/17/99					8/17/99				
	Sample Depth				2-4					2-4					16-18					2-4				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																								
Aluminum	100000	7800	40041	na	17600			*0.7*	*0.7*	11200			*0.4*	*0.4*	25100			*0.39*	*0.39*	32300			*0.4*	*0.4*
Antimony	41	3.1	na	13	1.8	JP	B	*0.5*	*0.5*	0.6	B	B	*0.5*	*0.5*	0.9	B	B	*0.49*	*0.49*	2.2	B		*0.5*	*0.5*
Arsenic	1.9	0.43	15.8	0.026	5.2		B	*0.6*	*0.6*	2.7		B	*0.6*	*0.6*	4.1		B	*0.59*	*0.59*	5.6		B	*0.6*	*0.6*
Barium	7200	550	209	2100	58.9			*0.1*	*0.1*	143			*0.1*	*0.1*	32.8			*0.098*	*0.098*	49.3			*0.1*	*0.1*
Beryllium	200	16	1.02	1200	0.13	U	U	*0.1*	*0.1*	0.67		B	*0.1*	*0.1*	**1.6**			*0.098*	*0.098*	0.28	B	B	*0.1*	*0.1*
Cadmium	51	3.9	0.69	27	**191**			*0.1*	*0.1*	0.29	B	J	*0.1*	*0.1*	0.52	B	J	*0.098*	*0.098*	**1.8**			*0.1*	*0.1*
Calcium	na	na	na	na	1530			*1*	*1*	1070			*1*	*1*	295	B	J	*0.98*	*0.98*	444	B	J	*1*	*1*
Chromium	310	23	65.3	42	**196**			*0.1*	*0.1*	24.6			*0.1*	*0.1*	21.1			*0.098*	*0.098*	54.6			*0.1*	*0.1*
Cobalt	2000	160	72.3	na	3	JP	J	*0.1*	*0.1*	4.1	B	J	*0.2*	*0.2*	14.8			*0.2*	*0.2*	4	B	J	*0.2*	*0.2*
Copper	4100	310	53.5	11000	32			*0.1*	*0.1*	7.3			*0.1*	*0.1*	10.7			*0.098*	*0.098*	20.9			*0.1*	*0.1*
Iron	31000	2300	50962	na	43400			*2*	*2*	10700			*2.1*	*2.1*	29100			*2.1*	*2.1*	46700			*2.1*	*2.1*
Lead	750	400	26.8	na	10.7			*0.2*	*0.2*	13.1			*0.3*	*0.3*	8			*0.29*	*0.29*	18.4			*0.3*	*0.3*
Magnesium	na	na	na	na	515	JP	J	*1.6*	*1.6*	672			*1.1*	*1.1*	1710			*1.1*	*1.1*	1050			*1.1*	*1.1*
Manganese	2000	160	2543	950	95.1			*0.1*	*0.1*	657			*0.1*	*0.1*	261			*0.098*	*0.098*	99.4			*0.1*	*0.1*
Mercury	31	2.3	0.13	na	**0.15**			*0.1*	*0.1*	0.11	U	U	*0.1*	*0.1*	0.12	U	U	*0.095*	*0.095*	**0.26**			*0.1*	*0.1*
Nickel	2000	160	62.8	na	6.5			*0.1*	*0.1*	6.3			*0.2*	*0.2*	12.2			*0.2*	*0.2*	7.3			*0.2*	*0.2*
Potassium	na	na	na	na	537	JP	J	*2.9*	*2.9*	394	E	J	*1.4*	*1.4*	2960	E	J	*1.4*	*1.4*	1090	E	J	*1.4*	*1.4*
Selenium	510	39	na	19	0.51	U	U	*0.4*	*0.4*	0.56	U	U	*0.5*	*0.5*	0.6	U	U	*0.49*	*0.49*	0.62	U	U	*0.5*	*0.5*
Silver	510	39	na	31	1.6		K	*0.1*	*0.1*	0.11	U	UL	*0.1*	*0.1*	0.12	U	UL	*0.098*	*0.098*	0.12	U	UL	*0.1*	*0.1*
Sodium	na	na	na	na	139	JP	J	*1.8*	*1.8*	97.1	E	B	*0.8*	*0.8*	125	E	B	*0.78*	*0.78*	115	E	B	*0.8*	*0.8*
Thallium	7.2	0.55	2.11	3.6	0.89	U	U	*0.7*	*0.7*	0.79	U	U	*0.7*	*0.7*	0.84	U	U	*0.69*	*0.69*	0.87	U	U	*0.7*	*0.7*
Vanadium	720	55	108	5100	94.1			*0.1*	*0.1*	27.7			*0.2*	*0.2*	25.4			*0.2*	*0.2*	96			*0.2*	*0.2*
Zinc	31000	2300	202	14000	29.8			*0.1*	*0.1*	26		K	*0.3*	*0.3*	42.4			*0.29*	*0.29*	49.8			*0.3*	*0.3*

Note: Refer to the Master Table Legend at the beginning of this Appendix for a list of definitions and table notes

Table B-4
Building 4343 - Detected Metal Results in Subsurface Soil - 1999

Analyte	Sample ID				B43SB17A					B43SB17B					B43SB18A					B43SB19A				
	Sample Date				8/17/99					8/17/99					8/17/99					10/5/99				
	Sample Depth				2-4					58-60					2-4					2-4				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																								
Aluminum	100000	7800	40041	na	10800			*0.4*	*0.4*	28800			*0.38*	*0.38*	16200			*0.39*	*0.39*	**43000**			*2.8*	*2.8*
Antimony	41	3.1	na	13	0.57	U	U	*0.5*	*0.5*	1.6	B	B	*0.48*	*0.48*	0.64	B	B	*0.49*	*0.49*	1.4	U	U	*1*	*1*
Arsenic	1.9	0.43	15.8	0.026	2		B	*0.6*	*0.6*	9.4		K	*0.58*	*0.58*	2.7		B	*0.58*	*0.58*	3.9		B	*1.2*	*1.2*
Barium	7200	550	209	2100	146			*0.1*	*0.1*	87.9			*0.096*	*0.096*	194			*0.097*	*0.097*	53.7	JP	J	*0.2*	*0.2*
Beryllium	200	16	1.02	1200	0.48	B	B	*0.1*	*0.1*	**1.2**		**B**	*0.096*	*0.096*	0.83		B	*0.097*	*0.097*	0.7	JP	B	*0.2*	*0.2*
Cadmium	51	3.9	0.69	27	**15.9**		**J**	*0.1*	*0.1*	0.13	U	U	*0.096*	*0.096*	**3.2**		**J**	*0.097*	*0.097*	0.28	U	U	*0.2*	*0.2*
Calcium	na	na	na	na	928			*1*	*1*	719			*0.96*	*0.96*	1150			*0.97*	*0.97*	1450			*3.2*	*3.2*
Chromium	310	23	65.3	42	27.7			*0.1*	*0.1*	36.1			*0.096*	*0.096*	30			*0.097*	*0.097*	**81.5**			*0.2*	*0.2*
Cobalt	2000	160	72.3	na	3.9	B	J	*0.2*	*0.2*	17.8			*0.19*	*0.19*	4.7	B	J	*0.19*	*0.19*	6.6	JP	J	*0.2*	*0.2*
Copper	4100	310	53.5	11000	17.8			*0.1*	*0.1*	27.5			*0.096*	*0.096*	10.6			*0.097*	*0.097*	37.6			*0.2*	*0.2*
Iron	31000	2300	50962	na	8160			*2.1*	*2.1*	44500			*2*	*2*	7730			*2*	*2*	**96600**			*3.2*	*3.2*
Lead	750	400	26.8	na	11.7			*0.3*	*0.3*	18.6			*0.29*	*0.29*	14.5			*0.29*	*0.29*	**39**			*0.4*	*0.4*
Magnesium	na	na	na	na	636			*1.1*	*1.1*	6130			*1.1*	*1.1*	899			*1.1*	*1.1*	645	JP	J	*4.6*	*4.6*
Manganese	2000	160	2543	950	540			*0.1*	*0.1*	212			*0.096*	*0.096*	839			*0.097*	*0.097*	213			*0.2*	*0.2*
Mercury	31	2.3	0.13	na	0.11	U	U	*0.095*	*0.095*	0.13	U	U	*0.1*	*0.1*	0.12	U	U	*0.1*	*0.1*	0.13	U	U	*0.095*	*0.095*
Nickel	2000	160	62.8	na	5.8			*0.2*	*0.2*	32.7			*0.19*	*0.19*	9.2			*0.19*	*0.19*	4.3	JP	J	*0.4*	*0.4*
Potassium	na	na	na	na	398	E	J	*1.4*	*1.4*	2990	E	J	*1.3*	*1.3*	616	E	J	*1.4*	*1.4*	1030	JP	J	*7.8*	*7.8*
Selenium	510	39	na	19	0.57	U	U	*0.5*	*0.5*	0.65	U	U	*0.48*	*0.48*	0.63			*0.49*	*0.49*	1.4	U	U	*1*	*1*
Silver	510	39	na	31	0.11	U	UL	*0.1*	*0.1*	0.13	U	UL	*0.096*	*0.096*	0.12	U	UL	*0.097*	*0.097*	1.4	JP	J	*0.2*	*0.2*
Sodium	na	na	na	na	84.4	E	B	*0.8*	*0.8*	139	E	B	*0.77*	*0.77*	110	E	B	*0.78*	*0.78*	176	JP	B	*4.6*	*4.6*
Thallium	7.2	0.55	2.11	3.6	0.8	U	U	*0.7*	*0.7*	0.91	U	U	*0.67*	*0.67*	0.81	U	U	*0.68*	*0.68*	2	U	UL	*1.4*	*1.4*
Vanadium	720	55	108	5100	24.7			*0.2*	*0.2*	59			*0.19*	*0.19*	23.4			*0.19*	*0.19*	**203**			*0.4*	*0.4*
Zinc	31000	2300	202	14000	25.4		K	*0.3*	*0.3*	62.2			*0.29*	*0.29*	39.6		K	*0.29*	*0.29*	48.2			*0.4*	*0.4*

Note: Refer to the Master Table Legend at the beginning of this Appendix
for a list of definitions and table notes

Table B-4
Building 4343 - Detected Metal Results in Subsurface Soil - 1999

Analyte					Sample ID	B43SB20A					B43SB20AD					B43SB21A					B43SB22A				
					Sample Date	10/5/99					10/5/99					10/5/99					10/5/99				
					Sample Depth	2-4					2-4					2-4					2-4				
	i-RBC	r-RBC	Background	SSL Transfer		Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																									
Aluminum	100000	7800	40041	na		**55300**			*2.8*	*2.8*	**52700**			*2.8*	*2.8*	**48200**			*2.8*	*2.8*	**44100**			*2.8*	*2.8*
Antimony	41	3.1	na	13		1.3	U	U	*1*	*1*	1.3	U	U	*1*	*1*	1.3	U	U	*1*	*1*	1.3	U	U	*1*	*1*
Arsenic	1.9	0.43	15.8	0.026		6		B	*1.2*	*1.2*	4.9		B	*1.2*	*1.2*	8.2			*1.2*	*1.2*	5.9		B	*1.2*	*1.2*
Barium	7200	550	209	2100		54.6			*0.2*	*0.2*	49.5	JP	J	*0.2*	*0.2*	75.5			*0.2*	*0.2*	58			*0.2*	*0.2*
Beryllium	200	16	1.02	1200		0.92	JP	B	*0.2*	*0.2*	0.88	JP	B	*0.2*	*0.2*	0.98	JP	B	*0.2*	*0.2*	0.93	JP	B	*0.2*	*0.2*
Cadmium	51	3.9	0.69	27		0.26	U	U	*0.2*	*0.2*	0.26	U	U	*0.2*	*0.2*	**4.7**			*0.2*	*0.2*	**57.1**			*0.2*	*0.2*
Calcium	na	na	na	na		1410			*3.2*	*3.2*	1320			*3.2*	*3.2*	6420			*3.2*	*3.2*	2850			*3.2*	*3.2*
Chromium	310	23	65.3	42		55.6			*0.2*	*0.2*	52.4			*0.2*	*0.2*	**72.5**			*0.2*	*0.2*	**206**			*0.2*	*0.2*
Cobalt	2000	160	72.3	na		7.5	JP	J	*0.2*	*0.2*	7.2	JP	J	*0.2*	*0.2*	7.4	JP	J	*0.2*	*0.2*	7.4	JP	J	*0.2*	*0.2*
Copper	4100	310	53.5	11000		41.5			*0.2*	*0.2*	35.3			*0.2*	*0.2*	44.7			*0.2*	*0.2*	35.4			*0.2*	*0.2*
Iron	31000	2300	50962	na		**96500**			*3.2*	*3.2*	**93200**			*3.2*	*3.2*	7000			*3.2*	*3.2*	**99100**			*3.2*	*3.2*
Lead	750	400	26.8	na		**40.1**			*0.4*	*0.4*	**39.1**			*0.4*	*0.4*	**42**			*0.4*	*0.4*	**36**			*0.4*	*0.4*
Magnesium	na	na	na	na		1140	JP	J	*4.6*	*4.6*	988	JP	J	*4.6*	*4.6*	3140			*4.6*	*4.6*	1340			*4.6*	*4.6*
Manganese	2000	160	2543	950		256			*0.2*	*0.2*	255			*0.2*	*0.2*	251			*0.2*	*0.2*	239			*0.2*	*0.2*
Mercury	31	2.3	0.13	na		0.13	U	U	*0.1*	*0.1*	0.13	U	U	*0.1*	*0.1*	**0.2**			*0.095*	*0.095*	0.13	U	U	*0.1*	*0.1*
Nickel	2000	160	62.8	na		10.8			*0.4*	*0.4*	9.9	JP	J	*0.4*	*0.4*	7.7	JP	J	*0.4*	*0.4*	12.4			*0.4*	*0.4*
Potassium	na	na	na	na		1400	JP	J	*7.8*	*7.8*	1220	JP	J	*7.8*	*7.8*	1240	JP	J	*7.8*	*7.8*	1200	JP	J	*7.8*	*7.8*
Selenium	510	39	na	19		1.3	U	U	*1*	*1*	1.3	U	U	*1*	*1*	1.3	U	U	*1*	*1*	1.3	U	U	*1*	*1*
Silver	510	39	na	31		2	JP	J	*0.2*	*0.2*	2	JP	J	*0.2*	*0.2*	2.3	JP	J	*0.2*	*0.2*	1.5	JP	J	*0.2*	*0.2*
Sodium	na	na	na	na		213	JP	B	*4.6*	*4.6*	240	JP	B	*4.6*	*4.6*	227	JP	B	*4.6*	*4.6*	190	JP	B	*4.6*	*4.6*
Thallium	7.2	0.55	2.11	3.6		1.8	U	UL	*1.4*	*1.4*	1.8	U	UL	*1.4*	*1.4*	1.8	U	UL	*1.4*	*1.4*	1.9	U	UL	*1.4*	*1.4*
Vanadium	720	55	108	5100		**194**			*0.4*	*0.4*	**189**			*0.4*	*0.4*	**205**			*0.4*	*0.4*	**196**			*0.4*	*0.4*
Zinc	31000	2300	202	14000		68.8		K	*0.4*	*0.4*	63.6			*0.4*	*0.4*	79.6		K	*0.4*	*0.4*	62.5		K	*0.4*	*0.4*

Note: Refer to the Master Table Legend at the beginning of this Appendix for a list of definitions and table notes

Table B-4
Building 4343 - Detected Metal Results in Subsurface Soil - 1999

Analyte	Sample ID				B43SB23A					B43SB23AD					B43SB24A					B43SB25A				
	Sample Date				10/5/99					10/5/99					10/5/99					10/5/99				
	Sample Depth				2-4					2-4					2-4					2-4				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																								
Aluminum	100000	7800	40041	na	28900			*2.8*	*2.8*	24300			*2.8*	*2.8*	**47900**			*2.8*	*2.8*	36400			*2.8*	*2.8*
Antimony	41	3.1	na	13	1.2	U	U	*1*	*1*	1.2	U	U	*1*	*1*	1.4	U	U	*1*	*1*	1.5	JP	B	*1*	*1*
Arsenic	1.9	0.43	15.8	0.026	6.8		B	*1.2*	*1.2*	6		B	*1.2*	*1.2*	7.5		B	*1.2*	*1.2*	8.2			*1.2*	*1.2*
Barium	7200	550	209	2100	101			*0.2*	*0.2*	86.6			*0.2*	*0.2*	70.8			*0.2*	*0.2*	91.3			*0.2*	*0.2*
Beryllium	200	16	1.02	1200	0.96	JP	B	*0.2*	*0.2*	0.94	JP	B	*0.2*	*0.2*	**1.3**	**JP**	**B**	*0.2*	*0.2*	**1.1**	**JP**	**B**	*0.2*	*0.2*
Cadmium	51	3.9	0.69	27	0.23	U	U	*0.2*	*0.2*	0.24	U	U	*0.2*	*0.2*	**2.9**			*0.2*	*0.2*	0.25	U	U	*0.2*	*0.2*
Calcium	na	na	na	na	26300			*3.2*	*3.2*	11400			*3.2*	*3.2*	1190	JP	J	*3.2*	*3.2*	708	JP	J	*3.2*	*3.2*
Chromium	310	23	65.3	42	59.9			*0.2*	*0.2*	46.1			*0.2*	*0.2*	**69.8**			*0.2*	*0.2*	**82.2**			*0.2*	*0.2*
Cobalt	2000	160	72.3	na	7.4	JP	J	*0.2*	*0.2*	6.7	JP	J	*0.2*	*0.2*	6.7	JP	J	*0.2*	*0.2*	5.7	JP	J	*0.2*	*0.2*
Copper	4100	310	53.5	11000	36.1			*0.2*	*0.2*	31			*0.2*	*0.2*	45.8			*0.2*	*0.2*	33.5			*0.2*	*0.2*
Iron	31000	2300	50962	na	**61000**			*3.2*	*3.2*	**57700**			*3.2*	*3.2*	1000			*3.2*	*3.2*	**88300**			*3.2*	*3.2*
Lead	750	400	26.8	na	**31**			*0.4*	*0.4*	**29.1**			*0.4*	*0.4*	**39.3**			*0.4*	*0.4*	**34.3**			*0.4*	*0.4*
Magnesium	na	na	na	na	7500			*4.6*	*4.6*	4230			*4.6*	*4.6*	1350	JP	J	*4.6*	*4.6*	1280			*4.6*	*4.6*
Manganese	2000	160	2543	950	415			*0.2*	*0.2*	276			*0.2*	*0.2*	244			*0.2*	*0.2*	196			*0.2*	*0.2*
Mercury	31	2.3	0.13	na	0.11	U	U	*0.095*	*0.095*	0.12	U	U	*0.1*	*0.1*	**0.14**			*0.095*	*0.095*	**0.19**			*0.095*	*0.095*
Nickel	2000	160	62.8	na	6.9	JP	J	*0.4*	*0.4*	6	JP	J	*0.4*	*0.4*	10.3	JP	J	*0.4*	*0.4*	5.6	JP	J	*0.4*	*0.4*
Potassium	na	na	na	na	1390	JP	J	*7.8*	*7.8*	1200	JP	J	*7.8*	*7.8*	1370	JP	J	*7.8*	*7.8*	1490	JP	J	*7.8*	*7.8*
Selenium	510	39	na	19	1.2	U	U	*1*	*1*	1.2	U	U	*1*	*1*	1.4	U	U	*1*	*1*	1.3	U	U	*1*	*1*
Silver	510	39	na	31	1.2	JP	J	*0.2*	*0.2*	1	JP	J	*0.2*	*0.2*	2	JP	J	*0.2*	*0.2*	1	JP	J	*0.2*	*0.2*
Sodium	na	na	na	na	194	JP	B	*4.6*	*4.6*	256	JP	B	*4.6*	*4.6*	233	JP	B	*4.6*	*4.6*	188	JP	B	*4.6*	*4.6*
Thallium	7.2	0.55	2.11	3.6	1.6	U	UL	*1.4*	*1.4*	1.7	U	UL	*1.4*	*1.4*	1.9	U	UL	*1.4*	*1.4*	1.8	U	UL	*1.4*	*1.4*
Vanadium	720	55	108	5100	**124**			*0.4*	*0.4*	**116**			*0.4*	*0.4*	**202**			*0.4*	*0.4*	**156**			*0.4*	*0.4*
Zinc	31000	2300	202	14000	55.4			*0.4*	*0.4*	46.8		K	*0.4*	*0.4*	57.5		K	*0.4*	*0.4*	46.6			*0.4*	*0.4*

Note: Refer to the Master Table Legend at the beginning of this Appendix for a list of definitions and table notes

Table B-4
Building 4343 - Detected Metal Results in Subsurface Soil - 1999

Analyte	Sample ID				B43SB26A					B43SB27A					B43SB28A					B43SB28AD				
	Sample Date				10/5/99					10/5/99					10/5/99					10/5/99				
	Sample Depth				2-4					2-4					2-4					2-4				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																								
Aluminum	100000	7800	40041	na	23300			*1.4*	*1.4*	11600			*2.8*	*2.8*	18100			*1.4*	*1.4*	14300			*1.4*	*1.4*
Antimony	41	3.1	na	13	0.64	U	U	*0.49*	*0.49*	1.1	U	U	*1*	*1*	0.61	U	U	*0.49*	*0.49*	0.6	U	U	*0.49*	*0.49*
Arsenic	1.9	0.43	15.8	0.026	3.9			*0.59*	*0.59*	5		B	*1.2*	*1.2*	4.1			*0.59*	*0.59*	2.4			*0.59*	*0.59*
Barium	7200	550	209	2100	62.9			*0.098*	*0.098*	72.5			*0.2*	*0.2*	32.2			*0.098*	*0.098*	27.1			*0.098*	*0.098*
Beryllium	200	16	1.02	1200	0.9		B	*0.098*	*0.098*	0.66	JP	B	*0.2*	*0.2*	0.39	B	B	*0.098*	*0.098*	0.32	B	B	*0.098*	*0.098*
Cadmium	51	3.9	0.69	27	**9.9**			*0.098*	*0.098*	0.22	U	U	*0.2*	*0.2*	0.12	U	U	*0.098*	*0.098*	0.12	U	U	*0.098*	*0.098*
Calcium	na	na	na	na	329	B	J	*1.6*	*1.6*	551	JP	J	*3.2*	*3.2*	260	B	J	*1.6*	*1.6*	251	B	J	*1.6*	*1.6*
Chromium	310	23	65.3	42	43.9			*0.098*	*0.098*	35.1			*0.2*	*0.2*	27.7			*0.098*	*0.098*	17.1			*0.098*	*0.098*
Cobalt	2000	160	72.3	na	4.9	B	J	*0.098*	*0.098*	5.9	JP	J	*0.2*	*0.2*	3.1	B	J	*0.098*	*0.098*	2.4	B	J	*0.098*	*0.098*
Copper	4100	310	53.5	11000	34.7			*0.098*	*0.098*	10.6			*0.2*	*0.2*	12.4			*0.098*	*0.098*	10.6			*0.098*	*0.098*
Iron	31000	2300	50962	na	**53500**			*1.6*	*1.6*	21000			*3.2*	*3.2*	32900			*1.6*	*1.6*	26700			*1.6*	*1.6*
Lead	750	400	26.8	na	18.5			*0.2*	*0.2*	18.3			*0.4*	*0.4*	14.6			*0.2*	*0.2*	11.6			*0.2*	*0.2*
Magnesium	na	na	na	na	1060			*2.3*	*2.3*	485	JP	J	*4.6*	*4.6*	478	B	J	*2.3*	*2.3*	383	B	J	*2.3*	*2.3*
Manganese	2000	160	2543	950	96.5			*0.098*	*0.098*	367			*0.2*	*0.2*	126			*0.098*	*0.098*	83.6			*0.098*	*0.098*
Mercury	31	2.3	0.13	na	**0.21**			*0.1*	*0.1*	0.11	U	U	*0.1*	*0.1*	0.12	U	U	*0.095*	*0.095*	0.12	U	U	*0.095*	*0.095*
Nickel	2000	160	62.8	na	8.8		J	*0.2*	*0.2*	3.5	JP	J	*0.4*	*0.4*	3.7	B	J	*0.2*	*0.2*	2.7	B	J	*0.2*	*0.2*
Potassium	na	na	na	na	1260	B		*3.8*	*3.8*	478	JP	J	*7.8*	*7.8*	678	B		*3.8*	*3.8*	555	B	J	*3.8*	*3.8*
Selenium	510	39	na	19	0.64	U	U	*0.49*	*0.49*	1.1	U	U	*1*	*1*	0.61	U	U	*0.49*	*0.49*	0.6	U	U	*0.49*	*0.49*
Silver	510	39	na	31	1.7			*0.098*	*0.098*	0.55	JP	J	*0.2*	*0.2*	0.73	B	J	*0.098*	*0.098*	0.66	B	J	*0.098*	*0.098*
Sodium	na	na	na	na	114	B	B	*2.3*	*2.3*	126	JP	B	*4.6*	*4.6*	92.9	B	B	*2.3*	*2.3*	101	B	B	*2.3*	*2.3*
Thallium	7.2	0.55	2.11	3.6	0.9	U	UL	*0.69*	*0.69*	1.5	U	UL	*1.4*	*1.4*	0.85	U	UL	*0.69*	*0.69*	0.84	U	UL	*0.69*	*0.69*
Vanadium	720	55	108	5100	97.7			*0.2*	*0.2*	44.1			*0.4*	*0.4*	67.4			*0.2*	*0.2*	56.5			*0.2*	*0.2*
Zinc	31000	2300	202	14000	41.6			*0.2*	*0.2*	23		K	*0.4*	*0.4*	23.9			*0.2*	*0.2*	18.5			*0.2*	*0.2*

Note: Refer to the Master Table Legend at the beginning of this Appendix for a list of definitions and table notes

Table B-4
Building 4343 - Detected Metal Results in Subsurface Soil - 1999

Analyte	Sample ID				B43SB29A					B43SB30A					B43SB31A					B43SB31AD				
	Sample Date				10/5/99					10/5/99					10/5/99					10/5/99				
	Sample Depth				2-4					2-4					2-4					2-4				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																								
Aluminum	100000	7800	40041	na	6860			*1.4*	*1.4*	8650			*1.4*	*1.4*	7920			*1.4*	*1.4*	8920			*1.4*	*1.4*
Antimony	41	3.1	na	13	0.56	U	U	*0.5*	*0.5*	0.55	U	U	*0.49*	*0.49*	0.58	U	U	*0.49*	*0.49*	0.59	U	U	*0.5*	*0.5*
Arsenic	1.9	0.43	15.8	0.026	2.2			*0.6*	*0.6*	3.5			*0.58*	*0.58*	2.1			*0.58*	*0.58*	2.8			*0.6*	*0.6*
Barium	7200	550	209	2100	91.6			*0.1*	*0.1*	113			*0.097*	*0.097*	104			*0.097*	*0.097*	109			*0.1*	*0.1*
Beryllium	200	16	1.02	1200	0.62		B	*0.1*	*0.1*	0.84		B	*0.097*	*0.097*	0.81		B	*0.097*	*0.097*	0.85		B	*0.1*	*0.1*
Cadmium	51	3.9	0.69	27	0.11	U	U	*0.1*	*0.1*	0.11	U	U	*0.097*	*0.097*	0.12	U	U	*0.097*	*0.097*	0.55	B	J	*0.1*	*0.1*
Calcium	na	na	na	na	501	B	J	*1.6*	*1.6*	1020			*1.6*	*1.6*	923			*1.6*	*1.6*	1040			*1.6*	*1.6*
Chromium	310	23	65.3	42	18.7			*0.1*	*0.1*	35.6			*0.097*	*0.097*	12.5			*0.097*	*0.097*	18.3			*0.1*	*0.1*
Cobalt	2000	160	72.3	na	3.5	B	J	*0.1*	*0.1*	4.5	B	J	*0.097*	*0.097*	7.3			*0.097*	*0.097*	7.2			*0.1*	*0.1*
Copper	4100	310	53.5	11000	6.9			*0.1*	*0.1*	8			*0.097*	*0.097*	12.9			*0.097*	*0.097*	10.4			*0.1*	*0.1*
Iron	31000	2300	50962	na	12400			*1.6*	*1.6*	17600			*1.6*	*1.6*	13600			*1.6*	*1.6*	16200			*1.6*	*1.6*
Lead	750	400	26.8	na	10.6			*0.2*	*0.2*	14.1			*0.19*	*0.19*	10			*0.19*	*0.19*	12.6			*0.2*	*0.2*
Magnesium	na	na	na	na	323	B	J	*2.3*	*2.3*	482	B	J	*2.2*	*2.2*	1460			*2.2*	*2.2*	1220			*2.3*	*2.3*
Manganese	2000	160	2543	950	513			*0.1*	*0.1*	484			*0.097*	*0.097*	703			*0.097*	*0.097*	649			*0.1*	*0.1*
Mercury	31	2.3	0.13	na	0.11	U	U	*0.1*	*0.1*	0.11	U	U	*0.1*	*0.1*	0.11	U	U	*0.095*	*0.095*	0.11	U	U	*0.095*	*0.095*
Nickel	2000	160	62.8	na	2.5	B	J	*0.2*	*0.2*	3.1	B	J	*0.19*	*0.19*	14.5		J	*0.19*	*0.19*	9.7		J	*0.2*	*0.2*
Potassium	na	na	na	na	236	B	J	*3.9*	*3.9*	317	B	J	*3.8*	*3.8*	368	B	J	*3.8*	*3.8*	432	B	J	*3.9*	*3.9*
Selenium	510	39	na	19	0.56	U	U	*0.5*	*0.5*	0.55	U	U	*0.49*	*0.49*	0.58	U	U	*0.49*	*0.49*	0.59	U	U	*0.5*	*0.5*
Silver	510	39	na	31	0.23	B	J	*0.1*	*0.1*	0.47	B	J	*0.097*	*0.097*	0.24	B	J	*0.097*	*0.097*	0.46	B	J	*0.1*	*0.1*
Sodium	na	na	na	na	70.2	B	B	*2.3*	*2.3*	102	B	B	*2.2*	*2.2*	86.2	B	B	*2.2*	*2.2*	110	B	B	*2.3*	*2.3*
Thallium	7.2	0.55	2.11	3.6	0.78	U	UL	*0.7*	*0.7*	0.77	U	UL	*0.68*	*0.68*	0.81	U	UL	*0.68*	*0.68*	0.82	U	UL	*0.7*	*0.7*
Vanadium	720	55	108	5100	29.2			*0.2*	*0.2*	40.1			*0.19*	*0.19*	19.2			*0.19*	*0.19*	23.8			*0.2*	*0.2*
Zinc	31000	2300	202	14000	15.2			*0.2*	*0.2*	16.7			*0.19*	*0.19*	19.5			*0.19*	*0.19*	24.6			*0.2*	*0.2*

Note: Refer to the Master Table Legend at the beginning of this Appendix for a list of definitions and table notes

Table B-4
Building 4343 - Detected Metal Results in Subsurface Soil - 1999

Analyte					Sample ID	B43SB32A				B43SB33A				
					Sample Date	10/5/99				10/5/99				
					Sample Depth	2-4				2-4				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)														
Aluminum	100000	7800	40041	na	9550			*1.4*	*1.4*	5740			*1.4*	*1.4*
Antimony	41	3.1	na	13	0.61	U	U	*0.49*	*0.49*	0.58	U	U	*0.5*	*0.5*
Arsenic	1.9	0.43	15.8	0.026	2.1			*0.58*	*0.58*	2.5			*0.6*	*0.6*
Barium	7200	550	209	2100	194			*0.097*	*0.097*	65.1			*0.1*	*0.1*
Beryllium	200	16	1.02	1200	0.85		B	*0.097*	*0.097*	0.53	B	B	*0.1*	*0.1*
Cadmium	51	3.9	0.69	27	0.12	U	U	*0.097*	*0.097*	**10.5**			*0.1*	*0.1*
Calcium	na	na	na	na	1040			*1.6*	*1.6*	727			*1.6*	*1.6*
Chromium	310	23	65.3	42	9.8			*0.097*	*0.097*	61.8			*0.1*	*0.1*
Cobalt	2000	160	72.3	na	3.7	B	J	*0.097*	*0.097*	3.2	B	J	*0.1*	*0.1*
Copper	4100	310	53.5	11000	8.3			*0.097*	*0.097*	7.3			*0.1*	*0.1*
Iron	31000	2300	50962	na	6010			*1.6*	*1.6*	10800			*1.6*	*1.6*
Lead	750	400	26.8	na	11.6			*0.19*	*0.19*	11.5			*0.2*	*0.2*
Magnesium	na	na	na	na	564	B	J	*2.2*	*2.2*	266	B		*2.3*	*2.3*
Manganese	2000	160	2543	950	1220			*0.097*	*0.097*	200		J	*0.1*	*0.1*
Mercury	31	2.3	0.13	na	0.13	U	U	*0.1*	*0.1*	0.12	U	U	*0.1*	*0.1*
Nickel	2000	160	62.8	na	4.8	B	J	*0.19*	*0.19*	2.3	B	J	*0.2*	*0.2*
Potassium	na	na	na	na	320	B	J	*3.8*	*3.8*	166	B	J	*3.9*	*3.9*
Selenium	510	39	na	19	0.61	U	U	*0.49*	*0.49*	0.7			*0.5*	*0.5*
Silver	510	39	na	31	0.28	B	J	*0.097*	*0.097*	0.16	B	J	*0.1*	*0.1*
Sodium	na	na	na	na	128	B	B	*2.2*	*2.2*	105	B	B	*2.3*	*2.3*
Thallium	7.2	0.55	2.11	3.6	0.85	U	UL	*0.68*	*0.68*	0.81	U	UL	*0.7*	*0.7*
Vanadium	720	55	108	5100	16.5			*0.19*	*0.19*	24.3			*0.2*	*0.2*
Zinc	31000	2300	202	14000	24.4			*0.19*	*0.19*	13			*0.2*	*0.2*

Note: Refer to the Master Table Legend at the beginning of this Appendix
for a list of definitions and table notes

Table B-5
Building 4343 - TCLP Metal Results in Subsurface Soil - 1999

FIELD ID	TCLP	B43SB1A	B43SB2A	B43SB3A	B43SB13A	B43SB14A	B43SB15A	B43SB15B	B43SB16A	B43SB17B
SAMPLING DATE	REGULATORY	5/25/1999	5/25/1999	5/25/1999	5/25/1999	5/25/1999	8/17/1999	8/17/1999	8/17/1999	8/17/1999
DEPTH (ft)	LEVELS	2-4	2-4	2-4	2-4	2-4	2-4	16-18	2-4	58-60
UNITS	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
TCLP Metals										
Arsenic	5000	6 U	6 U	7.2	6 U	6 U	6 U	9.1	6	6 U
Barium	100000	38.3	49.5	38	44.7	85.2	513	287	154	484
Cadmium	1000	6.8	336	6.4	44.2	1350	1 U	51.7	44.6	1
Chromium	5000	1 U	8.1	1 U	1 U	2.1	1 U	5.3	1	1 U
Lead	5000	2 U	3.5	2 U	2 U	2 U	3 U	78.2	46.8	3.4
Mercury	200	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2	0.2 U
Selenium	1000	4 U	4 U	4 U	4 U	4 U	5 U	5 U	5	5 U
Silver	5000	1.1	1 U	1	1 U	1.3	1 U	1 U	1	1 U

Shading indicates that the value exceeds the TCLP criteria

Table B-5
Building 4343 - TCLP Metal Results in Subsurface Soil - 1999

FIELD ID	TCLP	B43SB19A	B43SB20A	B43SB21A	B43SB22A	B43SB23A	B43SB24A	B43SB25A	B43SB26A	B43SB27A
SAMPLING DATE	REGULATORY	10/5/1999	10/5/1999	10/5/1999	10/5/1999	10/5/1999	10/5/1999	10/5/1999	10/5/1999	10/5/1999
DEPTH (ft)	LEVELS	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4	2-4
UNITS	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
TCLP Metals										
Arsenic	5000	6 U	6 U	6 U	6 U	6 U	6 U	6 U	6 U	6 U
Barium	100000	78.5	87	115	78.8	231	76	111	179 J	180
Cadmium	1000	1 U	15.6	10	50.1	1 U	41.9	1 U	350	1 U
Chromium	5000	1 U	1 U	1 U	159	1 U	1 U	1 U	1 U	1 U
Lead	5000	2.6	2.8	2 U	2 U	2 U	2.4	10.4	3.1 B	5.9
Mercury	200	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Selenium	1000	5.1	5.9	5 U	5 U	5 U	6.9	5 U	5 U	5 U
Silver	5000	1 U	1 U	1 U	1	1 U	1 U	1 U	1 U	1 U

Shading indicates that the value exceeds the TCLP criteria

Table B-5
Building 4343 - TCLP Metal Results in Subsurface Soil - 1999

FIELD ID	TCLP	B43SB28A	B43SB29A	B43SB30A	B43SB31A	B43SB32A	B43SB33A
SAMPLING DATE	REGULATORY	10/5/1999	10/5/1999	10/5/1999	10/5/1999	10/5/1999	10/5/1999
DEPTH (ft)	LEVELS	2-4	2-4	2-4	2-4	2-4	2-4
UNITS	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
TCLP Metals							
Arsenic	5000	6 U	6 U	6 U	6 U	6 U	6 U
Barium	100000	129 J	388	203	368	376	304
Cadmium	1000	10.7	1 U	1 U	1 U	1 U	19.2
Chromium	5000	1 U	1 U	1 U	1 U	1 U	1 U
Lead	5000	3.1 B	3.5 B	2 U	2 U	2 U	2 U
Mercury	200	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Selenium	1000	5 U	5 U	5 U	5 U	5 U	5 U
Silver	5000	1 U	1 U	1 U	1 U	1 U	1 U

Shading indicates that the value exceeds the TCLP criteria

Table B-6
Building 4343 - Detected Metal Results in Sumps - 1999

Analyte	Sample ID				B43SL1					B43SL2					B43SL2D				
	Sample Date				5/25/99					5/25/99					5/25/99				
	Sample Depth				0-0.5					0-0.5					0-0.5				
	i-RBC	r-RBC	Background	SSL Transfer	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL	Result	Lab Q	Val Q	MDL	MRL
Metals (mg/kg)																			
Aluminum	100000	7800	40041	na	2560			*0.68*	*0.68*	4390			*0.69*	*0.69*	4320			*0.69*	*0.69*
Antimony	41	3.1	na	13	181		J	*0.49*	*0.49*	20.2		K	*0.49*	*0.49*	19.2		K	*0.5*	*0.5*
Arsenic	1.9	0.43	15.8	0.026	**31.5**			*0.58*	*0.58*	8.4			*0.59*	*0.59*	9.4			*0.59*	*0.59*
Barium	7200	550	209	2100	**1770**			*0.097*	*0.097*	82.8			*0.098*	*0.098*	83.5			*0.099*	*0.099*
Beryllium	200	16	1.02	1200	0.18	JP	K	*0.097*	*0.097*	0.18	JP	K	*0.098*	*0.098*	0.21	JP	K	*0.099*	*0.099*
Cadmium	51	3.9	0.69	27	**8890**			*0.097*	*0.097*	**2540**			*0.098*	*0.098*	**2720**			*0.099*	*0.099*
Calcium	na	na	na	na	18100			*0.97*	*0.97*	34800			*0.98*	*0.98*	23000			*0.99*	*0.99*
Chromium	310	23	65.3	42	**8430**			*0.097*	*0.097*	**2130**			*0.098*	*0.098*	**1920**			*0.099*	*0.099*
Cobalt	2000	160	72.3	na	9.8		K	*0.097*	*0.097*	5	JP	K	*0.098*	*0.098*	4.4	JP	K	*0.099*	*0.099*
Copper	4100	310	53.5	11000	**2390**			*0.097*	*0.097*	**365**			*0.098*	*0.098*	**551**			*0.099*	*0.099*
Iron	31000	2300	50962	na	30000			*1.9*	*1.9*	**91500**			*2*	*2*	**91400**			*2*	*2*
Lead	750	400	26.8	na	**3320**			*0.19*	*0.19*	**242**			*0.2*	*0.2*	**248**			*0.2*	*0.2*
Magnesium	na	na	na	na	4550			*1.6*	*1.6*	17100			*1.6*	*1.6*	10000			*1.6*	*1.6*
Manganese	2000	160	2543	950	583			*0.097*	*0.097*	584			*0.098*	*0.098*	517			*0.099*	*0.099*
Mercury	31	2.3	0.13	na	**0.28**			*0.1*	*0.1*	0.12	U	U	*0.095*	*0.095*	0.12	U	U	*0.1*	*0.1*
Nickel	2000	160	62.8	na	**84.2**			*0.097*	*0.097*	21.4			*0.098*	*0.098*	23.5			*0.099*	*0.099*
Potassium	na	na	na	na	554	JP	J	*2.8*	*2.8*	532	JP	J	*2.8*	*2.8*	519	JP		*2.9*	*2.9*
Selenium	510	39	na	19	13.2			*0.39*	*0.39*	0.48	U	U	*0.39*	*0.39*	1.1		K	*0.4*	*0.4*
Silver	510	39	na	31	5.9			*0.097*	*0.097*	11.8			*0.098*	*0.098*	8.2			*0.099*	*0.099*
Sodium	na	na	na	na	229	JP	B	*1.7*	*1.7*	213	JP	B	*1.8*	*1.8*	164	JP	B	*1.8*	*1.8*
Vanadium	720	55	108	5100	59.6			*0.097*	*0.097*	25.9			*0.098*	*0.098*	27.8			*0.099*	*0.099*
Zinc	31000	2300	202	14000	**3390**			*0.097*	*0.097*	**892**			*0.098*	*0.098*	**973**			*0.099*	*0.099*

Note: Refer to the Master Table Legend at the beginning of this Appendix for a list of definitions and table notes

Table B-7
Building 4343 - Wipe Sample Results - 1999

FIELD ID	B43W1	B43W2	B43W3	B43W4	B43W5	B43W6
SAMPLING DATE	5/25/1999	5/25/1999	5/25/1999	8/18/1999	8/18/1999	8/18/1999
DEPTH (ft)	na	na	na	na	na	na
UNITS	mg/100 cm^2	mg/100 cm^2	mg/100 cm^2	mg/100 cm^2	mg/100 cm^2	mg/100 cm^2
Metals						
Aluminum	1410	672	606	194	NA	NA
Antimony	38.4 J	12.6 K	11.4 K	4.8 B	NA	NA
Arsenic	5.6 B	1.9 B	3.3 B	12.5 B	NA	NA
Barium	246	69.4	93.4	26.1	NA	NA
Beryllium	0.15 K	0.1 U	0.1 U	0.1 U	NA	NA
Cadmium	5740	876	1080	153 J	NA	NA
Calcium	13200	5510	6610	3470	NA	NA
Chromium	2510	222	273	67.2	NA	NA
Cobalt	2.9 K	2.3 K	1.4 B	0.67 J	NA	NA
Copper	353	101	115	40.9	NA	NA
Iron	19500	14500	6100	1300	NA	NA
Lead	511	157	206	50.4	NA	NA
Magnesium	1860	762	1150	927	NA	NA
Manganese	145	92	60.4	15.2	NA	NA
Mercury	nt	nt	nt	0.1 U	0.1 U	0.1 U
Nickel	14.8 K	5.2 K	7.2 K	1.6 J	NA	NA
Potassium	1500	1220	1460	245 J	NA	NA
Selenium	8.5	8.4	7.3	2	NA	NA
Silver	3 K	1.6 K	1.6 K	0.58 L	NA	NA
Sodium	2230	1510	1510	839 J	NA	NA
Thallium	0.7 U	0.7 U	0.7 U	2.2 B	NA	NA
Vanadium	8.4 K	3.5 K	2.7 K	1.1 J	NA	NA
Zinc	1260	503	555	118	NA	NA

No criteria are available for wipe samples.

Appendix B-2
Lithologic Boring Logs

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP-Main Plant Area	Soil Boring Number: B43SB1
Site Location: B4343	Ground Surface Elevation: 1822.63
Drilling Firm: Marshall Miller Associates	Total Depth: 4.0 ft.
Drilling Method: Truck Mounted Geoprobe Rig	Start Date: 05-25-99
Logged By: D. Batts	Finish Date: 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
				B43SSB1	0-0.5'- (7.5YR 3/3), dark brown silt, trace organics, fine gravel, dry, trace mica	ML		
					(2.5YR 4/6), red silty clay, trace fine gravel, mod. plasticity, dry			
		48	0.0	B43SB1A		CL		
5					End of boring at 4.0 feet.			
10								
15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP–Main Plant Area	Soil Boring Number: B43SB2
Site Location: B4343	Ground Surface Elevation: 1822.42
Drilling Firm: Marshall Miller Associates	Total Depth: 4.0 ft.
Drilling Method: Truck Mounted Geoprobe Rig	Start Date: 05-25-99
Logged By: D. Batts	Finish Date: 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
				B43SSB2	0–0.6'– (5YR 4/6), yellowish–red, silty clay, trace very fine gravel very slightly moist, moderate plasticity, trace mica			
		48	0.0	B43SSB2A	0.6'–4.0'– (7.5YR 4/6), red, silty clay, trace very fine gravel, low to moderate plasticity, dry	CL		
					End of boring at 4.0 feet.			
5								
10								
15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB3
Site Location B4343	Ground Surface Elevation 1821.04
Drilling Firm Marshall Miller Associates	Total Depth 4.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 05-25-99
Logged By D. Batts	Finish Date 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
				B43SSB3	0-0.3'- (10YR 4/4), Dark yellowish-brown silt, trace organics, loose, dry, trace mica	ML		
		48	0.0	B43SB3A	0.3'-4.0'- (5YR 4/6), yellowish-red, mottled with red (2.5YR 4/6), silt to clayey silt, low to no plasticity, dry, small glass shard at ~5" bgs.	ML		
5					End of boring at 4.0 feet.			
10								
15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP-Main Plant Area	Soil Boring Number: B43SB4
Site Location: B4343	Ground Surface Elevation: 1821.96
Drilling Firm: Marshall Miller Associates	Total Depth: 4.0 ft.
Drilling Method: Truck Mounted Geoprobe Rig	Start Date: 05-25-99
Logged By: D. Batts	Finish Date: 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48	0.0	B43SSB4	0-0.3'- (10YR 4/4), Dark yellowish-brown, clayey silt, trace fine sand (white) and trace organics, little fine subrounded gravel, dry, trace mica	ML		
				B43SB4A	0.3'-4.0'- (5YR 4/6), yellowish-red, mottled with red clayey silt, low plasticity, dry, trace mica	ML		
5					End of boring at 4.0 feet.			
10								
15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB5
Site Location B4343	Ground Surface Elevation 1823.69
Drilling Firm Marshall Miller Associates	Total Depth 4.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 05-25-99
Logged By D. Batts	Finish Date 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
				B43SSB5	0-0.4'- (10YR 3/3), Dark brown to dark yellowish-brown (10YR 4/4), silt with trace organics, trace clay, dry, loose, trace mica	ML		
		48	0.0	B43SB5A	0.4'-4.0'- (7.5YR 5/6) strong brown, mottled with red (2.5YR 4/6), silt and clayey silt, dry, low to no plasticity, trace mica	ML		
					End of boring at 4.0 feet.			
5								5
10								10
15								15

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP-Main Plant Area	Soil Boring Number: B43SB6
Site Location: B4343	Ground Surface Elevation: 1824.23
Drilling Firm: Marshall Miller Associates	Total Depth: 4.0 ft.
Drilling Method: Truck Mounted Geoprobe Rig	Start Date: 05-25-99
Logged By: D. Batts	Finish Date: 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
				B43SSB6	0-0.4'- (7.5YR 3/4), dark brown silt with clay, trace very fine gravel, dry, loose, trace mica	ML		
		48	0.0	B43SB6A	0.4'-4.0'- (5YR 4/6 to 2.5YR 4/6), yellowish-red to red, silty clay to clayey silt, slight plasticity, dry	CL		
					End of boring at 4.0 feet.			
5								5
10								10
15								15

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP-Main Plant Area	Soil Boring Number: B43SB7
Site Location: B4343	Ground Surface Elevation: 1825.95
Drilling Firm: Marshall Miller Associates	Total Depth: 4.0 ft.
Drilling Method: Truck Mounted Geoprobe Rig	Start Date: 05-25-99
Logged By: D. Batts	Finish Date: 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		36	0.0	B43SSB7	0-0.4'- (7.5YR 3/4), dark brown silt, trace organics, loose, crumbly, dry, trace mica	ML		
				B43SB7A	0.4'-4.0'- (5YR 4/6 to 2.5YR 4/6), yellowish-red to red silt to clayey silt, low to no plasticity, dry, gray weathered bedrock in bottom 2", trace mica	ML		
5					End of boring at 4.0 feet.			
10								
15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP-Main Plant Area	Soil Boring Number: B43SB8
Site Location: B4343	Ground Surface Elevation: 1823.51
Drilling Firm: Marshall Miller Associates	Total Depth: 4.0 ft.
Drilling Method: Truck Mounted Geoprobe Rig	Start Date: 05-25-99
Logged By: D. Batts	Finish Date: 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (In)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
			0.5	B43SSB8	0-0.3'- (10YR 4/4), Dark, yellowish-brown, clayey silt, trace fine sand, (white) and trace organics, little fine subrounded gravel, dry, trace mica	ML		
		48		B43SB8A	0.3'-4.0'- (5YR 4/6), yellowish-red, mottled with red clayey silt, low plasticity, dry, trace mica	ML		
			0.0					
5					End of boring at 4.0 feet.			
10								
15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB9
Site Location B4343	Ground Surface Elevation 1822.56
Drilling Firm Marshall Miller Associates	Total Depth 4.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 05-25-99
Logged By D. Batts	Finish Date 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48	0.0	B43SSB9	0-4.0'- (2.5YR 3/4), Red with yellowish-red mottling, clayey silt, trace organics in top 3", low to no plasticity, dry, 1.25" gravel cobble at 0.3', trace mica	ML		
				B43SB9A		ML		
5					End of boring at 4.0 feet.			
10								
15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP- Main Plant Area	Soil Boring Number: B43SB10
Site Location: B4343	Ground Surface Elevation: 1825.48
Drilling Firm: Marshall Miller Associates	Total Depth: 4.0 ft.
Drilling Method: Truck Mounted Geoprobe Rig	Start Date: 05-25-99
Logged By: D. Batts	Finish Date: 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
				B43SSB10	0-0.5'- (5YR 4/6), yellowish-red and dark brown silt to silty clay, low to no plasticity, dry, trace fine gravel and organics	ML		
		48	0.0	B43SB10A	0.5'-4.0'- (7.5YR 4/6), red, silty clay, trace very fine gravel, moderate plasticity, dry, trace mica	CL		
					End of boring at 4.0 feet.			
5								
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15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB11
Site Location B4343	Ground Surface Elevation NA
Drilling Firm Marshall Miller Associates	Total Depth 55.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 05-25-99
Logged By D. Batts	Finish Date 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
				B43SSB11	0-0.2'-Dark brown (10YR 3/3), silt and organics (root material), dry	ML		
					0.2'-1.2'-Gray sand and gravel, (fill material), sand, very fine to fine quartz, gravel (quartz), cobbles to 1" diameter, angular to subangular	ML		
		36	0.0'	B43SB11A B43SB11B	1.2'-3.0'- (5YR 4/6) yellowish-red clay and silt, trace cobbles, to 3/4", subangular, trace fine sand throughout, low to moderate plasticity, dry to very slightly moist.			
5		48	0.0'		4.0'-8.0' 0'-0.5' (5YR 4/6) yellowish-red, clayey silt mixed with gray sand and gravel material, dry, crumbly, trace mica and fine sand 0.5'-2.0'- (5YR 4/6) yellowish-red, clayey silt, trace fine sand, low to no plasticity, dry to very slightly moist, trace mica 2.0'-4.0' (10YR 5/4) yellowish brown, clayey silt, trace very fine sand, trace mica, dry to very slightly moist	ML		
10		24	0.0'		8.0'-10.0' 0-2.0' (10YR 5/4) yellowish-brown, clayey silt, trace very fine sand and mica, thin gray clay seam (2) at 0.7', trace red mottling from 1.0'-1.5'			

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP–Main Plant Area	Soil Boring Number B43SB11
Site Location B4343	Ground Surface Elevation NA
Drilling Firm Marshall Miller Associates	Total Depth 55.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 05-25-99
Logged By D. Batts	Finish Date 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		36	0.0'		10.0'–13.0' 0–0.5' as above with clay content increasing, low to moderate plasticity 0.5'–1.5' (10YR 5/4) yellowish brown clay and silt, trace fine sand and gravel, grading to gray sand and gravel, (fine subangular), very slightly moist to dry, trace mica 1.5'–3.0' (10YR 5/4) yellowish brown, fine sand and silt, sand content increasing downward, loose, dry to very slightly moist			
15		36	0.0		13.0'–16.0' 0–1.0' as above 1.0'–2.0' (10YR 5/4) yellowish-brown, fine sand, silt and clay, trace fine gravel, trace black "staining"), very slightly moist, low to no plasticity 2.0'–3.0' as above grading to silt and clay mixture, very slightly moist, trace mica	ML		15
		48	0.0		16.0'–20.0'–as above with trace fine sand and fine weathered bedrock material, little red mottling throughout; black organic material (coal?), at 0.5' to 0.7', very slightly moist, crumbly, trace mica			
20								20

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP–Main Plant Area	Soil Boring Number B43SB11
Site Location B4343	Ground Surface Elevation NA
Drilling Firm Marshall Miller Associates	Total Depth 55.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 05-25-99
Logged By D. Batts	Finish Date 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48	0.0		20.0'–24.0' As avbove with thin wet layer (perched?) at 1.8'to 2.3', otherwise very slightly moist to dry			
25		48	0.0		24.0'–28.0'As above	ML		25
		41	0.0		28.0'–32.0' (10YR 4/4) dark yellowish brown, silty clay, trace fine sand, moderate plasticity, very slightly moist, trace mica 1.5'–3.5'–mottled dark yellowish brown (10YR 4/4) with red and light gray, clayey silt with trace fine sand, dry, trace mica			
30								30

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP-Main Plant Area
Site Location: B4343
Drilling Firm: Marshall Miller Associates
Drilling Method: Truck Mounted Geoprobe Rig
Logged By: D. Batts

Soil Boring Number: B43SB11
Ground Surface Elevation: NA
Total Depth: 55.0 ft.
Start Date: 05-25-99
Finish Date: 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		41	0.0					
		48	0.0		32.0'-36.0' 0-1.5' as above, 1.5'-4.0' (10YR 5/4) yellowish brown silt and clay and fine sand, trace fine gravel, slightly moist, (wet from 2.0' to 2.5') low to no plasticity	ML		
35								35
		48	0.0		36.0'-40.0'0'0.8' (10YR 5/4) yellowish brown, silty clay, trace fine sand, moderate plasticity, slightly moist, 0.8'-4.0' (10YR 5/4) yellowish brown, mottled with light gray and strong brown (7.5YR 5/6) clayey silt, trace fine sand, very slightly moist, low plasticity			
40								40

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP–Main Plant Area
Site Location: B4343
Drilling Firm: Marshall Miller Associates
Drilling Method: Truck Mounted Geoprobe Rig
Logged By: D. Batts

Soil Boring Number: B43SB11
Ground Surface Elevation: NA
Total Depth: 55.0 ft.
Start Date: 05-25-99
Finish Date: 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		41	0.0		40.0'–44.0'–0–2.8' as above, 2.8'–3.5' as above with weak red mottling (2.5YR 4/2), dry crumbly (iron?)			
45		41	0.0		44.0'–48.0'–0–1.5" as above (40.0'–44.0', 0–2.8" interval), trace weathered bedrock 1.5'–2.0' (10YR 5/4) yellowish brown, fine sandy clay, low plasticity, slightly moist to moist, trace mica 2.0'–3.5' (10YR 5/4) yellowish brown, clayey silt with fine clay laminate (light gray and red), trace fine weathered bedrock, dry, trace mica	ML		45
		41	0.0		48.0'–52.0'–as above with interbedded red and light gray layers throughout, very slightly moist to dry			
50								50

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB11
Site Location B4343	Ground Surface Elevation NA
Drilling Firm Marshall Miller Associates	Total Depth 55.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 05-25-99
Logged By D. Batts	Finish Date 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		41	0.0					
		32	0.0		52.0'-55.0'-Dark yellowish brown with yellowish-brown, fine sandy clay, trace silt, trace dark brown mottling (7.5YR 3/3), moist to wet, low plasticity 2.2'-2.8' as above (at 48.0'-52.0') grading to weathered bedrock, bedrock found inside sampler shoe	ML		
55				B43SB11B	End of boring at 55.0 feet.			55
60								60

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB12
Site Location B4343	Ground Surface Elevation 1821.95
Drilling Firm Marshall Miller Associates	Total Depth 4.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 05-25-99
Logged By D. Batts	Finish Date 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
				B43SSB12	0-0.8'- (7.5YR 3/4), dark yellowish-brown silt with trace organics, grading to silty clay, trace very fine gravel and sand, very slightly moist, low plasticity	ML		
		48	0.0	B43SB12A	0.8'-4.0'- (3.5YR 4/6), red, silty clay, trace fine limestone gravel, low to moderate plasticity, very slightly moist to dry, black staining at 2.0' (included in sample)	CL		
					End of boring at 4.0 feet.			
5								5
10								10
15								15

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP-Main Plant Area	Soil Boring Number: B43SB13
Site Location: B4343	Ground Surface Elevation: 1821.96
Drilling Firm: Marshall Miller Associates	Total Depth: 4.0 ft.
Drilling Method: Truck Mounted Geoprobe Rig	Start Date: 05-25-99
Logged By: D. Batts	Finish Date: 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
				B43SSB13	0-0.4'- (7.5YR 3/3), dark brown silt, clay and organic material (roots, etc.), no plasticity, dry	ML		
		48	0.0	B43SB13A	0.4'-4.0'- (5YR 4/6), yellowish-red silt to clayey silt, low to no plasticity, dry, trace mica	ML		
					End of boring at 4.0 feet.			
5								
10								
15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB14
Site Location B4343	Ground Surface Elevation 1822.79
Drilling Firm Marshall Miller Associates	Total Depth 4.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 05-25-99
Logged By D. Batts	Finish Date 05-25-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		41	0.0	B43SSB14	0-1.0'- (10YR 4/4) with (10YR 5/4) dark yellowish-brown to yellowish- brown, clayey silt, low plasticity, very slightly moist, trace mica and fine quartz sand	ML		
				B43SB14A	1.0'-4.0'- (5YR 4/6), yellowish-red silt to clayey silt, trace fine sand, dry, crumbly, no plasticity, trace mica	ML		
					End of boring at 4.0 feet.			
5								5
10								10
15								15

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB15
Site Location B4343	Ground Surface Elevation 1821.38
Drilling Firm Marshall Miller Associates	Total Depth 18.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 08-17-99
Logged By D. Batts	Finish Date 08-17-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		12		B43SSB15	0-2.0'-Dark yellowish-brown (10YR 4/4) with some yellowish-brown (10YR 5/8), mottling silt with clay, trace to little organics, trace fine sand and gravel, dry, no plasticity	ML		
		24		B43SB15A	2.0'-4.0'-Light olive brown (2.5YR 5/3) sand with silt, grading downward to fine sand with clay (trace), slightly moist, loose			
5		48			4.0'-8.0', strong brown (7.5YR 4/6) with yellowish red (5YR 5/8) silty clay, (tight) with fine quartz sand, dry, 3.0-4.0, yellowish brown (10YR 5/8) with strong brown (7.5YR 4/6) fine sand with silt, dry, crumbly, 2 1 1/2" chucks of cemented, fine quartz sand at 3.3', fine weathered bedrock fragments at bottom of sample			5
10		48			8.0'-12.0'-Mottled, clayey silt, strong brown (7.5YR 4/6), with yellowish brown (10YR 5/8), trace gray (10YR 5/1), up to 40% broken weathered bedrock throughout, dry	ML		10
15		48			12.0'-16.0'-As above			15

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP-Main Plant Area	Soil Boring Number: B43SB15
Site Location: B4343	Ground Surface Elevation: 1821.38
Drilling Firm: Marshall Miller Associates	Total Depth: 18.0 ft.
Drilling Method: Truck Mounted Geoprobe Rig	Start Date: 08-17-99
Logged By: D. Batts	Finish Date: 08-17-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48						
		24		B43SB15B	16.0'-18.0'- As above, grading to all weathered bedrock fragments in bottom 0.3'	ML		
					End of boring at 18.0 feet.			
20								20
25								25
30								30

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP-Main Plant Area	Soil Boring Number: B43SB16
Site Location: B4343	Ground Surface Elevation: 1800.76
Drilling Firm: Marshall Miller Associates	Total Depth: 4.0 ft.
Drilling Method: Truck Mounted Geoprobe Rig	Start Date: 08-17-99
Logged By: D. Batts	Finish Date: 08-17-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		12		B43SSB16	Dark yellowish-brown (10YR 4/4) mottled with yellowish-red (5YR 4/6), clayey silt, trace fine sand, trace organics, dry, crumbly, no plasticity	ML		
		24		B43SB16A	Yellowish red (5YR 4/6) silt with clay, trace fine sand, dry, no plasticity	ML		
5					End of boring at 4.0 feet.			
10								
15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB17
Site Location B4343	Ground Surface Elevation 1799.40
Drilling Firm Marshall Miller Associates	Total Depth 60.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 08-17-99
Logged By D. Batts	Finish Date 08-17-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		12		B43SSB17	0-0.3'-Dark brown (10YR 3/3) silt with organics, trace to little clay, dry, no plasticity	ML		
		24		B43SB17A	2.0'-4.0'-Yellowish brown (10YR 5/6) mottled with dark yellowish-brown (10YR 3/4) silty clay, trace to little fine sand, (decreasing downward), dry, low plasticity			
5		48			4.0'-8.0'-As above 0.5'-4.0'-gray (10YR 5/1) mottled with yellowish-red (5YR 4/6) tight clay, trace silt, dry, low plasticity	ML		5
10		48			8.0'-12.0'-Gray (10YR 5/1) with little yellowish-red mottling (5YR 4/6), fat clay with trace very fine sand, slightly moist, medium plasticity			10
15		48			12.0'-16.0'-As above, slightly moist			15

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB17
Site Location B4343	Ground Surface Elevation 1799.40
Drilling Firm Marshall Miller Associates	Total Depth 60.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 08-17-99
Logged By D. Batts	Finish Date 08-17-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48			16.0'-20.0'-As above, grading to a fine sandy clay, slightly moist, low plasticity			
		48						
20					20.0'-24.0'-0-2.0' As above, slightly moist 2.0'-4.0'gray (10YR 5/1) mottled with yellowish-red (5YR 4/6), tight clay, low plasticity			
		48				ML		
					24.0'-28.0'-Gray (10YR 5/1) clay (fat), trace to little very fine sand, reddish-iron staining in bottom 12", slightly moist, low to medium plasticity			
25		48						25
					28.0'-32.0'-Grayish-brown (10YR 5/2) fat clay with trace to little very fine sand, slightly moist, medium plasticity			
		48						
30								30

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB17
Site Location B4343	Ground Surface Elevation 1799.40
Drilling Firm Marshall Miller Associates	Total Depth 60.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 08-17-99
Logged By D. Batts	Finish Date 08-17-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48			32.0'-36.0'-As above to 3.0', 3.0'-4.0'-as above with dark yellowish-brown (10YR 4/6) mottling, slightly moist			
35		48						35
		48			36.0'-40.0'-0-3.0' as above, 3.0'-4.0'-yellowish-brown, silty clay, trace very fine sand, low plasticity, dry, trace dark yellowish-brown mottling	ML		
40		48			40.0'-48.0'-0-2.5' As above, at 0-2.2' (40.0'-44.0' interval), moist, low plasticity, 2.5'-4.0' as above at 2.2'-4.0' (40.0'-44.0' interval), moist, low plasticity			40
45		48						45

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP-Main Plant Area	Soil Boring Number: B43SB17
Site Location: B4343	Ground Surface Elevation: 1799.40
Drilling Firm: Marshall Miller Associates	Total Depth: 60.0 ft.
Drilling Method: Truck Mounted Geoprobe Rig	Start Date: 08-17-99
Logged By: D. Batts	Finish Date: 08-17-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48			48.0'-52.0'-0-3.0' As above at 0-2.5' (44.0'-48.0' interval), moist, 3.0'-4.0' As above at 2.5'-4.0' (44.0'-48.0' interval), moist			
50		48			52.0'-56.0'-0-3.5' As above at 0-3.0' (48.0'-52.0' interval), moist, 3.5'-4.0' as above at 3.0'-4.0' (48.0'-52.0' interval), moist	ML		
55								
60		48		B43SB17B	58.0'-60.0'-0-3.0' As above at 0-3.5' (52.0'-56.0' interval), moist, 3.0'-4.0' dark yellowish-brown (10YR 4/4) silty clay, trace fine sand and gravel, trace dark brown mottling, slightly moist, medium plasticity, trace fine chert fragments (to 1/8") at bottom of spoon			

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB18
Site Location B4343	Ground Surface Elevation 1803.19
Drilling Firm Marshall Miller Associates	Total Depth 4.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 08-17-99
Logged By D. Batts	Finish Date 08-17-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		12		B43SSB18	0-0.5'-Dark brown (10YR 3/3) silt with organics, trace clay trace fine sand, dry, loose	ML		
					0.5'-1.0'-Dark brown (10YR 3/3) with yellowish -brown (10YR 5/6) silt and clay, trace fine sand, dry, crumbly, no plasticity			
		24		B43SB18A	Dark gray (10YR 4/1) silt, trace clay, trace fine sand, dry to very slightly moist, loose, no plasticity	ML		
					End of boring at 4.0 feet.			
5								5
10								10
15								15

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP-Main Plant Area
Site Location: B4343
Drilling Firm: Marshall Miller Associates
Drilling Method: Truck Mounted Geoprobe Rig
Logged By: T. McCoun

Soil Boring Number: B43SB19
Ground Surface Elevation: 1831.36
Total Depth: 4.0 ft.
Start Date: 10-05-99
Finish Date: 10-05-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48		B43SSB19 B43SB19A	(5YR 5/6) clay and fine silt with 10% sand, moist, medium plasticity	CL		
					End of boring at 4.0 feet.			

5
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Sheet 1 of 1

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB20
Site Location B4343	Ground Surface Elevation 1824.22
Drilling Firm Marshall Miller Associates	Total Depth 4.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 10-05-99
Logged By T. McCoun	Finish Date 10-05-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48		B43SSB20 B43SB20A B43SB20AD	(5YR 5/6) clay and silt, fine sand 10%, medium plasticity	CL		
					End of boring at 4.0 feet.			
5								5
10								10
15								15

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB21
Site Location B4343	Ground Surface Elevation 1826.95
Drilling Firm Marshall Miller Associates	Total Depth 4.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 10-05-99
Logged By T. McCoun	Finish Date 10-05-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		36		B43SSB21 B43SB21A	0-4.0'- (0-1)-0.2' organics, dary black, fine sand 20% and silts, next (2.0') clay, moist, some silt and fine sand 10%	CL		
5					End of boring at 4.0 feet.			
10								
15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB22
Site Location B4343	Ground Surface Elevation 1828.96
Drilling Firm Marshall Miller Associates	Total Depth 4.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 10-05-99
Logged By T. McCoun	Finish Date 10-05-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48		B43SSB22 B43SB22A	(5YR 5/6) clay, moist, some silt and fine sand 10%	CL		
5					End of boring at 4.0 feet.			
10								
15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP-Main Plant Area	Soil Boring Number: B43SB23
Site Location: B4343	Ground Surface Elevation: 1825.31
Drilling Firm: Marshall Miller Associates	Total Depth: 4.0 ft.
Drilling Method: Truck Mounted Geoprobe Rig	Start Date: 10-05-99
Logged By: T. McCoun	Finish Date: 10-05-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		24			(5YR 5/6) Top 0.5" organic and dark sand and silt, next 1.0" clay, moist, some silt and fine sand, bottom 0.5" limestone rock and sand	CL		
					End of boring at 4.0 feet.			
5								5
10								10
15								15

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP-Main Plant Area	Soil Boring Number: B43SB24
Site Location: B4343	Ground Surface Elevation: 1825.15
Drilling Firm: Marshall Miller Associates	Total Depth: 4.0 ft.
Drilling Method: Truck Mounted Geoprobe Rig	Start Date: 10-05-99
Logged By: T. McCoun	Finish Date: 10-05-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48		B43SSB24 B43SB24A	(5YR 5/6) Clay, moist, some silt and fine sand (10%)	CL		
5					End of boring at 4.0 feet.			
10								
15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP–Main Plant Area	Soil Boring Number: B43SB25
Site Location: B4343	Ground Surface Elevation: 1822.95
Drilling Firm: Marshall Miller Associates	Total Depth: 4.0 ft.
Drilling Method: Truck Mounted Geoprobe Rig	Start Date: 10-05-99
Logged By: T. McCoun	Finish Date: 10-05-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48		B43SSB25 B43SB25A	(5YR 5/6) Clay, moist, some silt and fine sand (10%)	CL		
5					End of boring at 4.0 feet.			
10								
15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB26
Site Location B4343	Ground Surface Elevation 1825.66
Drilling Firm Marshall Miller Associates	Total Depth 4.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 10-05-99
Logged By T. McCoun	Finish Date 10-05-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48		B43SSB26 B43SB26A	(5YR 5/6) Clay, some silt, moist	CL		
					End of boring at 4.0 feet.			
5								5
10								10
15								15

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB27
Site Location B4343	Ground Surface Elevation 1823.37
Drilling Firm Marshall Miller Associates	Total Depth 4.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 10-05-99
Logged By T. McCoun	Finish Date 10-05-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48		B43SSB27 B43SB27A	(5YR 5/6 and 5YR 5/5) Top 0.1' moist organics rest clay, moist with silt and fine sand (20-30%), *more sandy than others	CL		
					End of boring at 4.0 feet.			
5								
10								
15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB28
Site Location B4343	Ground Surface Elevation 1823.73
Drilling Firm Marshall Miller Associates	Total Depth 4.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 10-05-99
Logged By T. McCoun	Finish Date 10-05-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48		B43SSB28 B43SB28A B43SB28AD	(5YR 5/5) Top 0.2', organic material next 3.8' clay with silt and 20-30% sand, moist	CL		
					End of boring at 4.0 feet.			
5								5
10								10
15								15

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP-Main Plant Area	Soil Boring Number: B43SB29
Site Location: B4343	Ground Surface Elevation: 1811.65
Drilling Firm: Marshall Miller Associates	Total Depth: 4.0 ft.
Drilling Method: Truck Mounted Geoprobe Rig	Start Date: 10-05-99
Logged By: T. McCoun	Finish Date: 10-05-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48			(5YR 5/5) 50% clay, 50% silt, fine sand	CL		
5					End of boring at 4.0 feet.			
10								
15								

Sheet 1 of 1

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP-Main Plant Area	Soil Boring Number: B43SB30
Site Location: B4343	Ground Surface Elevation: 1810.12
Drilling Firm: Marshall Miller Associates	Total Depth: 4.0 ft.
Drilling Method: Truck Mounted Geoprobe Rig	Start Date: 10-05-99
Logged By: T. McCoun	Finish Date: 10-05-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48		B43SSB30 B43SB30A	(5YR 5/5) Top 0.2' organic, dark brown, next 0.5' dry, fine to medium sand, (5YR 3/5) next 3.3' clay (50%) and silt (dry to moist), and fine sand (50%)	CL		
5					End of boring at 4.0 feet.			
10								
15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB31
Site Location B4343	Ground Surface Elevation 1808.87
Drilling Firm Marshall Miller Associates	Total Depth 4.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 10-05-99
Logged By T. McCoun	Finish Date 10-05-99

Depth (ft bgs)	Split Spoon Sample	Recovery (In)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		45		B43SSB31 B43SB31A B43SB31AD	Top 0.2 grass and organics, dark brown, next 1.0' clay plus 20% fine sand and silt, moist (5YR 5/5), next 2.55' clay, moist with some silt and fine sand 10%	CL		
5					End of boring at 4.0 feet.			
10								
15								

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name: RFAAP-Main Plant Area
Site Location: B4343
Drilling Firm: Marshall Miller Associates
Drilling Method: Truck Mounted Geoprobe Rig
Logged By: T. McCoun

Soil Boring Number: B43SB32
Ground Surface Elevation: 1806.05
Total Depth: 4.0 ft.
Start Date: 10-05-99
Finish Date: 10-05-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		40		B43SSB32 B43SB32A	Top 0.1' grass and organics, next 0.4' (2.5YR 4/6) clay, moist, next 2.0' clay with some silt and fine sand 10% (5YR 4/1), next 1.5' (5YR 4/1) moist, clay, apperas to be virgin material (saprolite?), has banding and mottled	CL		
					End of boring at 4.0 feet.			

5
10
15

RADFORD ARMY AMMUNITION PLANT — SOIL BORING LOG

Project Name RFAAP-Main Plant Area	Soil Boring Number B43SB33
Site Location B4343	Ground Surface Elevation 1806.22
Drilling Firm Marshall Miller Associates	Total Depth 4.0 ft.
Drilling Method Truck Mounted Geoprobe Rig	Start Date 10-05-99
Logged By T. McCoun	Finish Date 10-05-99

Depth (ft bgs)	Split Spoon Sample	Recovery (in)	PID (ppm)	Sample	Material Description	USCS Class.	Symbol	Remarks
		48		B43SSB33 B43SB33A	Top 0.1' grass and organics, dark brown, next 1.0' (5YR 6/5) clay and silt with some fine sand (30%), next 0.5' same as above (5YR 5/1), next 2.0' clay with some silt and fine sand (20-30%), moist (5YR 5/5)	CL		
					End of boring at 4.0 feet.			
5								5
10								10
15								15

Appendix C
Sample Location Coordinates and Elevations

RFI/RI Sample Location Coordinates and Elevations

Site ID	Northing	Easting	Elevation
Bag Loading Area			
BLASB01	283759.34	1368917.41	2084.76
BLASB02	283502.61	1368951.35	2084.35
BLASB03	283341.75	1369107.91	2084.86
BLASD01	283903.51	1369209.54	2073.65
BLASD02	283115.70	1368168.26	2072.20
BLASW/SD04	283971.07	1367733.04	2003.67
BLASW/SD05	284400.83	1368617.19	1994.87
BLASS01	283735.43	1368904.58	2087.90
BLASS02	283747.77	1368919.86	2085.32
BLASS03	283723.57	1369027.29	2088.47
BLASS04	283732.33	1368791.41	2086.38
BLASS05	283590.26	1368532.63	2086.33
BLASS06	283353.92	1368682.97	2086.15
BLASS07	283109.21	1368757.63	2082.85
BLASS08	283247.04	1369015.59	2068.37
BLASS09	283468.23	1369148.14	2086.32
BLASS10	283521.12	1369131.36	2085.47
BLASS11	283651.84	1369055.02	2081.54
BLATR01	283784.45	1368843.33	2084.80
BLATR02	283690.21	1369522.45	2076.28
BLATR03	283241.96	1369122.06	2084.10
Building Debris Disposal Trench			
DTSB46	284166.38	1371883.27	1960.03
DTSB47	284128.88	1371950.70	1958.73
DTSW/SD05	284005.92	1372244.52	1952.75
DTSW/SD06	284086.19	1372031.44	1954.19
DTSW/SD07	284096.56	1371844.27	1953.76
DTSW/SD08	284144.86	1371572.38	1956.36
DTSW/SD09	284186.47	1371237.62	1958.86
DTSW/SD10	283930.50	1372438.79	1948.05
Igniter Assembly Area			
IASB06	286793.22	1366464.42	2127.94
IASB07	286836.19	1366537.77	2127.80
IASB08	286844.39	1366540.86	2128.29
IASB09	286836.85	1366552.22	2122.26
IASB10	286914.21	1366737.27	2124.12
IASB11	286979.25	1366847.43	2120.85
IASB12	287192.44	1367238.81	2121.22
IASB13	286025.74	1367290.50	2112.37
IASB14	286028.60	1367313.30	2107.72
IASB15	286008.67	1367303.03	2108.68
IASD04	287910.37	1367497.94	2114.74
IASD05	287657.23	1367299.29	2118.76
IASD06	287170.01	1367537.44	2108.59
IASD07	286025.18	1367841.73	2080.95
IASD08	286514.15	1366312.47	2105.73

RFI/RI Sample Location Coordinates and Elevations

Site ID	Northing	Easting	Elevation
IASD09	286338.22	1366718.88	2122.81
IASD10	285779.61	1367016.88	2111.93
IASD11	286747.03	1366543.95	2126.90
IASD12	286943.25	1366899.46	2119.96
IASS01	286917.34	1366709.66	2123.41
IASS02	286897.08	1366725.28	2121.09
IASS03	286988.86	1366823.72	2121.87
IASS04	286947.80	1366843.37	2123.94
IASS05	286894.43	1367088.92	2126.78
IATR01	287823.59	1367495.93	2122.32
IATR02	287109.19	1366902.82	2126.63
IATR03	286905.87	1366899.75	2128.09
IATR04	287025.14	1367291.87	2121.66
IATR05	286459.03	1367090.96	2118.92
IATR06	286083.39	1367320.73	2109.75
IATR07	286161.33	1367703.26	2093.21
IATR08	285414.85	1366624.76	2081.53
Northern Burning Ground			
NBGSB11	288870.45	1368833.53	2154.81
NBGSB12	288871.04	1368826.40	2118.54
NBGSB13	288885.28	1368831.82	2128.63
NBGSB14	288893.22	1368805.31	2115.73
NBGSB15	288922.64	1368810.35	2110.33
NBGSB16	288859.88	1368801.27	2135.99
NBGSB17	288818.07	1368645.78	2130.78
NBGSB18	288797.04	1368646.91	2122.95
NBGSB19	288801.32	1368670.82	2130.48
NBGSD01	289003.59	1368849.12	2101.81
Rail Yard			
RYSB08	286615.43	1368757.30	2041.52
RYSB09	284542.93	1367320.88	2033.13
RYSD01	286830.09	1369221.73	2030.06
RYSW/SD03	286473.61	1369453.72	2013.26
RYSW/SD04	286368.75	1369597.05	2016.95
RYSW/SD05	286264.79	1369793.40	2002.11
RYSD06	284899.91	1370631.43	1971.93
RYSD07	285279.54	1368461.72	2039.99
RYSD08	284683.05	1368403.52	2003.63
RYSD09	284540.72	1367223.66	2035.61
RYSD10	284362.09	1366945.98	2037.34
RYSW/SD12	284208.69	1367255.84	2013.41
RYSW/SD13	283950.73	1367533.00	2007.47
RYSS01	285974.05	1368568.78	2045.32
RYSS02	285178.41	1368053.61	2047.59
RYSS03	284855.42	1368029.77	2041.99
RYSS04	286911.05	1369352.62	2048.07

RFI/RI Sample Location Coordinates and Elevations

Site ID	Northing	Easting	Elevation
RYSS05	286849.89	1369465.50	2048.13
RYSS06	286296.66	1368624.47	2043.12
RYSS07	286140.09	1369021.93	2054.61
RYSS08	286142.52	1368914.54	2047.75
RYSS09	285772.89	1368473.07	2043.17
RYSS10	285630.88	1368573.94	2039.95
RYSS11	285640.85	1368771.27	2042.85
RYSS12	285400.47	1368530.00	2043.83
RYSS13	285181.89	1367961.93	2045.67
RYSS14	284630.09	1367511.38	2039.10
RYSS15	284796.18	1367441.78	2046.45
RYSS16	284074.95	1366562.65	2065.39
RYSW02	286579.33	1369337.92	2020.67
RYSW15	284877.53	1368094.86	2049.27
RYTR01	286633.00	1369318.92	2044.84
RYTR02	285973.88	1369088.62	2046.17
RYTR03	284670.93	1367814.54	2048.24
Western Burning Ground			
WBGSB22	284851.29	1366227.70	2059.31
WBGSB23	284790.45	1366222.56	2047.80
WBGSB24	284961.73	1366250.12	2051.85
WBGSB25	284935.45	1366172.97	2042.82
WBGSW/SD07	284894.86	1365981.81	2035.08
WBGSW/SD08	284475.46	1366635.69	2031.46
WBGSW/SD09	284307.45	1366821.35	2023.52
WBGSW/SD10	284671.29	1366304.58	2033.71
WBGSD11	284645.80	1366262.78	2041.21
WBGSD12	284767.63	1366126.27	2038.34
WBGSW/SD13	284429.37	1366592.28	2027.15
WBGSW/SD14	283749.40	1367174.17	2013.71
WBGSW/SD15	284590.53	1365617.15	2043.91
SWMU 31			
31SB5	319274.11	1397144.57	1696.65
31SE07	319082.44	1396997.74	1678.92
31SE08	319195.52	1397149.85	1687.90
31SE09	319115.09	1397190.57	1685.51
31SE10	319032.18	1397061.01	1685.90
31SE11	319259.24	1397221.85	1684.85
31SE12	319285.59	1397386.15	1686.62
31SE13	319336.53	1397453.76	1693.18
31SE14	319395.27	1397412.05	1692.46
31SW10	319032.18	1397061.01	1685.90
31SW12	319285.59	1397386.15	1686.62
31SW14	319375.01	1397477.91	1693.98
SWMU 39			
39SS08	321302.51	1403422.04	1700.60

RFI/RI Sample Location Coordinates and Elevations

Site ID	Northing	Easting	Elevation
39SS07	321268.19	1403446.59	1701.35
39SB05	321280.53	1403572.97	1695.95
39SS10	321191.31	1403579.29	1701.35
39SB06	321168.54	1403484.18	1697.50
39SS12	321132.53	1403758.27	1700.54
39SS09	321359.21	1403646.31	1701.70
39SS11	321111.42	1403466.10	1698.86
SWMU 48			
48SB08	319794.89	1409321.52	1821.46
48SB09	319798.39	1409276.73	1818.62
48SB10	319883.83	1409354.18	1829.80
SWMU 49			
49SB02	319580.55	1409695.49	1822.51
49SS01	319564.90	1409729.76	1826.82
SWMU 50			
50SB04	319589.68	1409465.00	1817.07
50SB05	319535.10	1409565.65	1817.72
50SS01	319720.75	1409575.01	1817.54
50SS02	319594.60	1409300.53	1813.66
50SS03	319490.84	1409427.01	1814.32
SWMU 58			
58SB04	320598.06	1404050.91	1771.09
58SS04	320789.00	1404151.25	1736.95
SWMU 59			
59SB01	319758.86	1409727.32	1822.39
59SS03	319836.99	1409715.36	1826.83
59SS04	319833.15	1409669.00	1827.62
59SS05	319657.37	1409707.51	1822.70
Building 4343			
B43SB34	318498.04	1399103.57	1810.50
B43SB35	318221.52	1399079.40	1832.03
B43SS01	318172.98	1399050.16	1831.32
B43SS02	318551.51	1399055.04	1807.16
B43SS03	318560.34	1399094.03	1810.54
Former Lead Furnace Area			
LFSB12	313403.07	1404006.95	1885.30
LFSB13	313283.58	1403971.45	1875.13
LFSB14	313268.78	1404005.57	1888.08
LFSB15	313253.86	1403925.02	1875.74
LFSB16	313298.16	1403964.35	1871.75
LFSB17	313320.86	1403964.67	1872.85
LFSS01	313377.33	1403978.38	1875.17
LFSS02	313309.24	1404015.18	1888.10
LFSS03	313242.30	1403943.03	1880.75

Appendix D
Contaminant Fate and Transport

D.1 TRANSFORMATION AND FATE OF CONTAMINANTS

When contaminants are exposed to the environment, the potential for transformations of the chemical exists. The endpoint of the transformation process is referenced as the “fate” of the chemical. The ultimate "fate" refers to the expected final state that an element, compound, or group of compounds will achieve following release to the environment. The fate processes for organic contaminants may include sorption, volatilization, hydrolysis, and abiotic and biotic degradation, while the fate processes for inorganic contaminants may include ion exchange, chemical speciation, and oxidation/reduction. These fate processes dictate how contaminants will be transported in the environment. Contaminants can be transported with little attenuation or retardation due to these fate processes, or they can be delayed or transformed so that little migration occurs. Various fate processes, as well as the properties that may affect the fate of contaminants, are discussed below.

D.1.1 Contaminant Properties Affecting Fate

The physical and chemical properties of contaminants play a large role in determining their fate after release to the environment. The following section provides a discussion of several of these key properties.

D.1.1.1 Specific Gravity

Specific gravity is the ratio of the density of a compound to the density of water. It is a measure of the tendency of a compound to float (specific gravity <1) or sink (specific gravity >1) in water. Contaminants that are immiscible in water can exist as separate phase liquids and are referred to as Light Non-Aqueous Phase Liquids (LNAPLs) if their specific gravity is less than one, or Dense Non-Aqueous Phase Liquids (DNAPLs) if their specific gravity is greater than one.

D.1.1.2 Water Solubility

The solubility of a compound in water is the maximum or saturated concentration of the compound in pure water at a specific temperature. Compounds with high solubility in water tend to remain in the aqueous phase and not partition to soil or sediment, are less likely to volatilize from water, and are generally more likely to biodegrade. Conversely, compounds with low water solubilities tend to partition to soil or sediment, volatilize more readily from water, and are less likely to be biodegradable. The solubility of inorganic chemicals varies widely from insoluble to greater than 100,000 mg/L, depending on temperature, pH, ORP, and the concentrations of dissolved constituents such as humic and fulvic acids.

D.1.1.3 Vapor Pressure

Vapor pressure is a property of a chemical in its pure state, which indicates how readily it will volatilize to the atmosphere. Volatilization from water is dependent upon vapor pressure and Henry’s Law Constant. Vapor pressures for chemicals in their pure states range from 0.001 to 760 mm mercury (mm Hg) for liquids to less than 10^{-10} mm Hg for solids.

D.1.1.4 Henry's Law Constant

The Henry's Law Constant of a compound is essentially the air/water partition coefficient. In dimensional form, the Henry's Law Constant is the ratio of the vapor pressure to the water solubility (in atm-m^3/mole). The Henry's Law Constant indicates how a chemical will partition

between air and water at equilibrium, and can be used to calculate the rate of volatilization of a chemical from water.

D.1.1.5 Organic Carbon/Water Partition Coefficient

The organic carbon/water partition coefficient (K_{oc}) is a measure of the tendency for a chemical to be sorbed to the organic fraction of soil and sediment. Normal K_{oc} values range from 1 to 10^7 L/kg, with higher values indicating greater sorption potential by the soil and lower values indicating high leaching capabilities for the contaminants from the waste source into surface runoff and groundwater.

D.1.1.6 Octanol/Water Partition Coefficient

The octanol/water partition coefficient (K_{ow}) is a measure of the distribution of a compound at equilibrium between n-octanol and water. The octanol/water partition coefficient, K_{ow}, gives an indication of how a compound will preferentially distribute into a solvent or water, and is a measure of how hydrophobic a compound is. A chemical with a high K_{ow} is hydrophobic and may be relatively immobile in an aqueous system (e.g., contaminant sorbs to soil particles), but may be mobilized in the presence of an organic solvent.

D.1.2 Fate of Organic Contaminants

D.1.2.1 Sorption

Sorption and desorption are two major mechanisms affecting the fate of contaminants in the subsurface. Sorption includes both adsorption and absorption. Adsorption is defined as the accumulation occurring at an interface, while absorption is the partitioning between two phases (Knox et al., 1993).

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. The sorption of contaminants to suspended sediments and bottom sediment is an important factor affecting chemical transport in aquatic environments.

In general, sorption reactions may be classified as either sorbent or solvent-motivated. Sorbent-motivated sorption occurs when an attraction between the sorbent (subsurface material) and the solute (contaminant), and the contaminant accumulates at the surface due to the affinity of the surface for the contaminant. An example of sorbent-motivated sorption would be a highly polar or ionizable contaminant interaction with the cation exchange sites of clay minerals. This type of sorption typically occurs with inorganics and is more commonly referred to as ion exchange. Solvent-motivated sorption occurs when the contaminant is hydrophobic, such as nonpolar organics, which prefer nonpolar phases to the polar water phase. 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. The sorption of most neutral organic constituents falls into the category of hydrophobic, or solvent-motivated sorption (Knox et al., 1993). The best indicators of the partitioning of a compound between soil and water are the organic carbon/water partition coefficient (K_{oc}), the soil/water distribution coefficient (K_d), the octanol/water partition coefficient (K_{ow}), and the retardation factor (R).

For nonionic organic chemicals and aquifer materials, sorption is largely controlled by the clay and organic carbon content of the soil. The distribution of an organic chemical between water

and a specific soil matrix is characterized by the organic carbon/water partition coefficient, K_{oc}. This coefficient, which is based on the specific organic carbon content of the soil, is typically measured empirically using a linear adsorption isotherm where the partitioning between the two phases is determined by the following equation (Olsen and Davis, 1990):

$$K_d = \frac{C_s}{C_w} \qquad \textit{Equation 1}$$

where:

K_d = Soil/water distribution coefficient (L/kg)
C_s = Mass of the solute on the solid phase per unit mass of the solid phase (mg/kg)
C_w = Mass of the solute per unit volume of solution (mg/L)

The soil/water distribution coefficient, K_d, obtained from the above equation is then normalized to correct for variations in the organic carbon content of differing soil matrices to calculate K_{oc}:

$$K_{oc} = \frac{K_d}{f_{oc}} \qquad \textit{Equation 2}$$

where:

K_{oc} = Organic carbon/water partition coefficient (L/kg)
K_d = Soil/water distribution coefficient (L/kg)
f_{oc} = Fraction of organic carbon in the soil

The normalization of the adsorption coefficient to ascertain K_{oc} correlates well with other adsorption coefficient estimation methods which use other properties of the chemical such as water solubility or octanol/water partitioning (Callahan et al., 1979).

If the empirical K_d or K_{oc} value for the chemical is not available, the most widely accepted method of estimating the organic carbon/water partition coefficient involves the octanol/water partition coefficient, K_{ow}. The octanol/water partition coefficient, K_{ow}, has been correlated to water solubility, the organic carbon/water partition coefficient, and bioconcentration factors for aquatic life and represents the extent of partitioning by a chemical between organic and aqueous phases (Lyman et al., 1990). The relationship between K_{oc} and K_{ow} is expressed as a regression equation:

$$\log K_{oc} = a \log K_{ow} + b \qquad \textit{Equation 3}$$

where a and b are constants derived from specific data sets which represent differing classes of chemicals such as pesticides, aromatic compounds, and chlorinated hydrocarbons. Chemicals with low K_{ow} (i.e., less than 10 L/kg) are considered relatively hydrophilic and tend to have high water solubilities and small K_{oc} values. Conversely, hydrophobic compounds typically have K_{ow} values greater than 10^4 L/kg (Lyman et al., 1990). In general, the more hydrophobic a contaminant is, the more likely the contaminant will be sorbed to soil.

From Equation 1, when C_s is equal to zero, K_d also equals zero. Under this condition, no adsorption or retardation of the chemical occurs. This implies that the contaminant moves at the same velocity as the groundwater and in this case, the contaminant is termed a conservative or nonreactive solute. However, the velocity of the contaminant front can be substantially different for solutes that are adsorbed within the soil matrix. The retardation factor is defined as the ratio of the groundwater flow velocity to the contaminant front velocity:

$$R = 1 + \rho_b \frac{K_d}{n_e} \qquad \textit{Equation 4}$$

where:

R	=	Retardation factor (dimensionless)
θ_b	=	Bulk density of the soil (g/mL)
K_d	=	Distribution coefficient (mL/g)
n_e	=	Effective porosity of the soil (dimensionless)

The retardation factor indicates the extent of retardation of contaminant migration in groundwater due to adsorption. A retardation factor of 1.0 indicates that the contaminant has little tendency to bind to soils and, hence, moves freely in the groundwater. By contrast, the larger the R, the greater the tendency for a contaminant to bind to the soil matrix and the slower it will move in the groundwater. The retardation factor cannot fall below 1.0.

Other factors which affect the adsorption of chemicals to the soil matrix include temperature, pH of the soil and water, particle size distribution, and surface area of solids. The value of the distribution coefficient K_d usually decreases with increasing temperature because adsorption is an exothermic process. Neutral and slightly polarized organic compounds are somewhat affected by pH. Chemicals that tend to ionize are significantly affected by pH (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. A comparison of the pK_a of an organic acid with the pH of the groundwater indicates the potential importance of the dissociation of the organic compound in determining the degree of partitioning. The size of affected soil particles also plays a role in a contaminant's sorption characteristics. Particles of small size, such as particles of fine silt or clay, will have a greater tendency to adsorb chemicals.

D.1.2.2 Volatilization

Volatilization is a process whereby a compound changes state from the aqueous phase to the vapor phase. Compounds that do not adsorb onto soil/sediment or dissolve in water have the greatest tendency to volatilize. The volatility of a compound can be evaluated from its K_{oc} and by assessing its Henry's Law Constant. The value of K_{oc} indicates the degree of sorption of a compound to soil/sediment. A compound with a high K_{oc} value will have a reduced volatility because the compound sorbs extensively to the soil/sediment surface. The Henry's Law Constant can be considered the partition coefficient of the contaminant between the aqueous phase and the gas phase. A Henry's Law Constant of greater than 10^{-3} atm-m^3/mol indicates a high volatility, and a Henry's Law Constant of less than 10^{-5} atm-m^3/mol indicates a low volatility. **Table D-1** provides a rough outline of relative volatility of a solute according to its Henry's Law Constant.

Table D-1
Volatility of Compounds Based on Henry's Law Constants

Volatility	Henry's Law Constant
Volatilization is very slow, at a rate controlled by slow diffusion through air	$< 10^{-5}$ atm-m^3/mol
Volatilization is not rapid but significant	10^{-5} atm-m^3/mol to 10^{-3} atm-m^3/mol
Volatilization is rapid	$> 10^{-3}$ atm-m^3/mol

The Henry's Law Constant is related to other physical properties of the compound, the most important of which are vapor pressure and water solubility. Compounds exhibiting high vapor pressures and low water solubilities tend to have high volatilization rates. In fact, in the absence of literature values, Henry's Law Constants can be estimated from the following equation (Olsen and Davis, 1990):

$$H = \frac{(V_p)(MW)(16.04)}{(WS)(T)} \qquad Equation\ 5$$

where:

V_p = Vapor pressure of the chemical (mm Hg)
MW = Molecular weight of the chemical (g/mol)
WS = Solubility in water (mg/L)
T = Temperature (K)
H = Henry's Law Constant ([mg/L]/[mg/L])

From this equation, it is evident that the volatilization of a compound to air will depend on its vapor pressure, water solubility, and temperature. Other important factors affecting volatilization include wind speed, the depth of the aquifer, and the geology of the unsaturated zone.

D.1.2.3 Hydrolysis

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 (Cherry et al., 1983). 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. Surface effects also may affect the rate of hydrolysis. Halogenated aliphatics are susceptible to hydrolysis, with reactions proceeding most rapidly for monohalogenated compounds, and much more slowly as the number of halogen ions increases (Fetter, 1993).

Hydrolysis applies to a limited number of chemicals. These contain hydrolyzable groups, such as esters, aliphatic halogens, amides, carbamates, and phosphate esters (Howard, 1991). Compounds that are not susceptible include: alkanes, alkenes, aldehydes, amines, and carboxy-containing compounds (Olsen and Davis, 1990).

D.1.2.4 Abiotic Degradation

Abiotic degradation is the chemical degradation of compounds without the assistance of biological activities. In the natural environment, the most common abiotic degradation processes are hydrolysis and hydroxyl radical reactions. Other abiotic degradation processes include direct photolysis, dehydrohalogenation, and oxidation.

Hydrolysis, as mentioned above, is a chemical reaction in which compounds react with water molecules in the environment, resulting in the introduction of a hydroxyl group (-OH) and the loss of a leaving group (-X), typically a halogen.

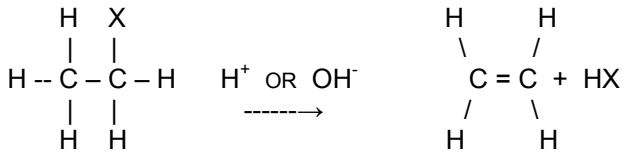
$$RX + H_2O \rightarrow ROH + HX \ (or\ H^+, X^-) \qquad Equation\ 6$$

These reactions are catalyzed mainly by hydronium (H_3O^+) and/or hydroxyl ions (OH^-). Therefore, as mentioned above, hydrolysis reactions are pH dependent. Selected metals may also catalyze a hydrolysis reaction (Olsen and Davis, 1990).

Hydroxyl radical reactions are reactions with hydroxyl radicals photochemically generated from sunlight. These reactions may occur mostly in the atmosphere and to a lesser degree in surface water. Once the free radicals are formed, they will react with organic molecules to form an intermediate organic-free radical, which usually reacts further with other compounds. For most chemicals in the atmosphere, reaction with photochemically-generated hydroxyl radicals is the most common degradation process. For many chemicals, experimental reaction rate constants for reactions involving hydroxyl radicals are available in the scientific literature and are used to calculate an estimated half-life by assuming an average hydroxyl radical concentrations of $5x10^5$ molecules/cm^3 in non-smog conditions (Howard, 1991).

Occasionally, other reactions besides hydroxyl radical reactions occur in the atmosphere such as ozone oxidation and direct photolysis. Direct photolysis is a photochemical alteration of the compound as a result of the compound absorbing direct sunlight. The possibility of direct photolysis in air or water can be partially assessed by examining the UV spectrum of the chemical. If the chemical does not absorb sunlight at wavelengths greater than 290 nm, the chemical cannot directly photolyze.

Dehydrohalogenation is an elimination reaction in which an alkyl derivative will eliminate HX to form an alkene, where X is commonly a halogen, hydroxyl radical, or ester group:



Equation 7

D.1.2.5 Biotic Degradation

Biodegradation is the process in which the chemical degradation of a compound is assisted by soil microorganisms (e.g., fungi, bacteria). Reactions include oxidation, reduction, hydrolysis, and sometimes rearrangement of the molecule. Though biodegradation may occur very slowly for some compounds, the eventual mineralization of almost every organic compound in the

terrestrial and aquatic environment can be attributed to biodegradation (Alexander, 1978). A typical range of half lives for different degradation rates are summarized in **Table D-2**.

Rates of biotic degradation depend on many factors. Microorganisms require a carbon source (e.g., organic matter), an electron acceptor (e.g., oxygen, nitrate), nutrients (e.g., nitrogen, phosphorus), and various trace elements in order to maintain existing cells and produce new cells. Many environmental factors can also serve to limit the occurrence of microbial metabolism in the subsurface. These factors include pH, temperature, toxics, substrate concentration, and the presence of microbes. 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). Microbial activity generally increases with increasing temperature. The presence of certain compounds may also be toxic to microorganisms. Heavy metals, acids, bases, or high concentrations of the substrate can serve to limit microbial activity. Finally, for biotic degradation to occur in the subsurface, microbes capable of metabolizing (or cometabolizing) the substrate must be present.

Table D-2
Rate of Biodegradation Based on Half Lives

Biodegradation Rate	Approximate Biodegradation Half-Life
Fast	1 day to 7 days
Moderately Fast	7 days to 4 weeks
Slow	4 weeks to 6 months
Resistant	6 months to 1 year

Complete biotic degradation of organic chemicals by microorganisms, utilizing enzymes to facilitate degradation, ultimately produces microbial cells, water, and carbon dioxide, which eventually lead to mineralization of the compound. Whether or not a chemical is transformed by enzymes depends on the configuration alignment of the enzyme with the organic chemical during the reaction. If an ideal configuration of the enzyme with organic chemicals occurs, the reaction will occur. Persistent chemicals have less favorable alignments, and non-reacting or recalcitrant chemicals fail to bond or produce favorable alignments.

Biotic degradation can be either aerobic or anaerobic. An aerobic reaction occurs in the presence of oxygen. Aerobic reactions occur in oxygen-rich environments such as surface soil (i.e., 0 to 6 inches bgs) and upper layers of sediment. An aerobic reaction is usually an oxidation reaction. An anaerobic reaction occurs in the absence of oxygen. Anaerobic reactions occur in such places as the saturated zone in terrestrial environments and the bottom layer of sediment in aquatic environments. Because of the lack of oxygen in these environments, an anaerobic reaction usually favors dehydrohalogenation reactions or reductive reactions.

D.1.3 Fate of Inorganic Contaminants

D.1.3.1 Ion Exchange

Metals in soil are generally immobile, particularly under neutral or alkaline conditions, and tend to sorb to soil particles. Sorption can be considered as either sorbent- or solvent-motivated. Solvent-motivated sorption (partitioning) typically occurs for nonpolar, hydrophobic organic chemicals in groundwater by accumulation occurring on the organic content of the media. Ion exchange is sorbent-motivated sorption and occurs for inorganic chemicals due to an affinity of the solid surface for the compound. Typically, the sorbent surface contains a charge deficiency and requires the accumulation of ions near the solid/liquid interface to neutralize the surface charge. In subsurface media, the mineral fraction most commonly involved in ion exchange is the clay fraction (Knox et al., 1993). Ion exchange occurs when the sorbent charge deficiency can be neutralized more efficiently by ions in solution than by those ions currently adsorbed. For example, if sodium ions (monovalent) have accumulated and calcium ions (divalent) suddenly appear, the excess surface charge can be more efficiently neutralized by the calcium ions than by sodium. Thus, the sodium ions will desorb, the calcium ions will adsorb, and an exchange of ions occurs. The cation exchange capacity of a given aquifer material indicates the probable type and amount of clay minerals present, and can be used as an indication of the ability of a soil to attenuate cations found in the groundwater (Makeig, 1982).

D.1.3.2 Chemical Speciation

Most inorganic chemicals occur in more than one ionic form, or species, in soils and groundwater. These species, which form as a result of hydrolysis, oxidation/reduction, and complexation reactions, may have different valences and mobilities in groundwater due to different affinities for adsorption and different solubility controls. Simple ionic species often combine with ligands to form ionic or neutral-charge aqueous complexes. The major inorganic ligands in groundwater are generally Cl^-, HCO_3^{-2}, CO_2, and SO_4^{-2}, and in some cases, NH_3, NO_3^- and F^- (Cherry et al., 1983). Environmental conditions which affect speciation of inorganic chemicals include pH, redox potential, and inorganic ligands.

D.1.3.3 Oxidation/Reduction

Oxidation and reduction ("redox") refers to the transfer of electrons and the resultant species change of ions or compounds. Oxidation is the loss of electrons, while reduction is the gain of electrons. Redox processes are important because they can cause changes in the mobility of many inorganic compounds. The ability of a redox reaction to occur is a function of the redox potential. The redox potential is defined in terms of the negative logarithm of the free-electron activity and is referred to as pE. The redox potential can also be expressed in terms of volts (E_h). Low values of pE indicate high electron activity and favor electron-rich species (reduced). High values of pE indicate low electron activity and favor electron-poor species (oxidized).

D.2 TRANSPORT OF CONTAMINANTS

Contaminant transport refers to the mechanisms and rates of migration of contaminants away from the source area. Migration pathways often include air, water, soil, and the interfaces between the phases of the contaminant (i.e., solid, liquid, or gas). Mechanisms controlling the movement of contaminants include advection, dispersion, diffusion, volatilization, and sorption. These mechanisms are dictated by the physical and chemical nature of the environmental media and their interaction with the potential COCs. Water pathways include surface water, storm

water runoff, groundwater, infiltration/percolation, and precipitation. The air pathways include uptake into the atmosphere and deposition from it either in a dry or wet form. The soil pathways include sediment and soil transported by erosion or by site activities such as construction and movement through the vadose zone as soil gas. Transport across an interface is primarily due to partitioning. The degree of partitioning will depend on the volatility, solubility, and sorptive capacity of the phases. The primary transport mechanism across the water-air and soil-air interfaces are volatilization and sorption, while transport across the soil-water interface is controlled by sorption/desorption and dissolution (solubilization).

D.2.1 Advection

Contaminant transport by advection occurs when the contaminant is moved in and with the bulk flow of either water or the atmosphere. The primary advective transport pathway at Building 4343 is migration into surface water.

D.2.2 Diffusion

Transport by diffusion is the result of a concentration gradient in the contaminant plume or the soil gas within the vadose zone. The rate of diffusion is expressed by the diffusivity coefficient, which is affected by temperature, pressure, density, and soil porosity. Diffusion in soil is strongly dependent on the effective porosity of the soil. Residual clays have high porosity but low effective (interconnected) porosity. Transport due to diffusion in clays is usually minimal.

D.2.3 Volatilization

Volatilization occurs when a liquid changes its phase to a gas. This is primarily a mechanism for organic contaminants migrating from the soil or surface water to the air. Volatilization is a mass transfer process that is limited by a compound's solubility in water, molecular weight, vapor pressure, K_{oc} value, and by the local temperature.

D.2.4 Sorption

As discussed previously, sorption is a general term used in place of the specific terms absorption or adsorption. Adsorption describes the process whereby a contaminant is bound to the surface of a medium, whereas absorption occurs when the contaminant is bound within the medium. The distinction between the two is not always relevant, but the fact that a contaminant has been sorbed indicates that it has been bound to its new medium and will be transported with this new medium. This transport mechanism may be significant when a high concentration of suspended solids is found in water samples.

Desorption is the release (leaching) of a contaminant from the sorbent phase. Sorption/desorption is a primary mechanism of transport for water and soil pathways. In a water-soil environment, soil is the adsorbent and the contaminants are the adsorbates. Sorption/desorption of organic and inorganic compounds within soil-water systems is assessed by several physical and chemical properties of both the compound and the soil or sediment (see *Section D.1.2.1*).

Appendix E
HHRA Tables and
Statistical Comparison Results and Data Plots

This Appendix Contains:

Appendix E-1 HHRA Tables
Appendix E-2 Statistical Comparison Results and Data Plots

Appendix E-1
HHRA Tables

Table E-1a
Occurrence, Distribution, and Selection of Chemicals of Potential Concern - Current/Future - Surface Soil at Building 4343

Scenario Timeframe: Current/Future
Medium: Surface 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	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (3)	(N/C)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
Surface Soil 0-2 ft.	7429-90-5	Aluminum	552	25100	mg/kg	B43SSB10	25/25	N/A	25100	40,041	7,821	N	N/A	N/A	Yes	ASL, ABKG
	7440-36-0	Antimony	41.2J	41.2	mg/kg	B43SSD1	1/25	0.2000-5.3000	41.2	N/A	3.13	N	N/A	N/A	Yes	ASL
	7440-38-2	Arsenic	2.05	4.97	mg/kg	B43SS01	4/25	1.4000-5.6000	4.97	15.8	0.426	C	N/A	N/A	No	BKG
	7440-39-3	Barium	26.7	242	mg/kg	B43SSD1	25/25	N/A	242	209	548	N	N/A	N/A	No	BSL
	7440-41-7	Beryllium	0.22K	0.57	mg/kg	B43SS02	5/25	0.1000-1.1000	0.57	1.02	15.6	N	N/A	N/A	No	BSL
	7440-43-9	Cadmium	0.5J	24300	mg/kg	B43SSD1	23/25	0.1200-0.1300	24300	0.690	3.91	N	N/A	N/A	Yes	ASL
	7440-70-2	Calcium	270J	91000	mg/kg	B43SSB11	25/25	N/A	91000	N/A	N/A		1000000	RDA	No	BSL
	7440-47-3	Chromium	4.2	1820	mg/kg	B43SSD1	25/25	N/A	1820	65.3	23.5	N	N/A	N/A	Yes	ASL
	7440-48-4	Cobalt	2.2K	19.8	mg/kg	B43SSB18	23/24	0.1300-0.1300	19.8	72.3	156	N	N/A	N/A	No	BSL
	7440-50-8	Copper	8.6	677	mg/kg	B43SSD1	25/25	N/A	677	53.5	313	N	N/A	N/A	Yes	ASL
	7439-89-6	Iron	2340	51400	mg/kg	B43SSB10	25/25	N/A	51400	50,962	2,346	N	N/A	N/A	Yes	ASL
	7439-92-1	Lead	3.1	1410	mg/kg	B43SSD1	25/25	N/A	1410	26.8	N/A		400	USEPA	Yes	ASL
	7439-95-4	Magnesium	240J	19400	mg/kg	B43SS01	25/25	N/A	19400	N/A	N/A		1000000	RDA	No	BSL
	7439-96-5	Manganese	70.5	642	mg/kg	B43SSB18	25/25	N/A	642	2,543	156	N	N/A	N/A	Yes	ASL, ABKG
	7439-97-6	Mercury (Inorganic)	0.025L	0.53	mg/kg	B43SSB9	7/25	0.1000-0.1300	0.53	0.130	0.780		N/A	N/A	No	BSL
	7440-02-0	Nickel	2.9J	32.6	mg/kg	B43SSD1	24/25	0.1000-0.1000	32.6	62.8	156	N	N/A	N/A	No	BSL
	7440-09-7	Potassium	285.5J	2050	mg/kg	B43SSB18	25/25	N/A	2050	N/A	N/A		1000000	RDA	No	BSL
	7782-49-2	Selenium	0.6	1.1	mg/kg	B43SSB11	2/25	0.4700-1.1700	1.1	N/A	39.1	N	N/A	N/A	No	BSL
	7440-22-4	Silver	0.87J	36	mg/kg	B43SSD1	2/25	0.1000-0.7300	36	N/A	39.1	N	N/A	N/A	No	BSL
	7440-23-5	Sodium	39.1	138	mg/kg	B43SSB4	5/25	8.5000-443.0000	138	N/A	N/A		1000000	RDA	No	BSL
	7440-28-0	Thallium	0.09J	0.18	mg/kg	B43SS01	3/25	0.7200-0.9200	0.18	2.11	0.548	N	N/A	N/A	No	BSL
	57-12-5	Total Cyanide	14.1	14.8	mg/kg	B43SSB5	2/17	0.2000-0.2600	14.8	N/A	156	N	N/A	N/A	No	BSL
	7440-62-2	Vanadium	5.7K	108	mg/kg	B43SSB10	25/25	N/A	108	108	54.8	N	N/A	N/A	Yes	ASL, ABKG
	7440-66-6	Zinc	19.1	1780	mg/kg	B43SSD1	24/24	N/A	1780	202	2,346	N	N/A	N/A	No	BSL
	7440-44-0	Total Organic Carbon	3950	6160	mg/kg	B43SSD5	3/3	N/A	6160	N/A	N/A		N/A	N/A	No	PHYS
	72-54-8	4,4'-DDD	0.000479J	0.00057J	mg/kg	B43SB34A	2/2	N/A	0.00057	N/A	2.66	C	N/A	N/A	No	BSL
	50-29-3	4,4'-DDT	0.0153	0.0218	mg/kg	B43SB35A	2/2	N/A	0.0218	N/A	1.88	C	N/A	N/A	No	BSL
	33213-65-9	Endosulfan II	0.00226	0.00246	mg/kg	B43SB35A	2/2	N/A	0.00246	N/A	46.9	N	N/A	N/A	No	BSL
	72-20-8	Endrin	0.000498J	0.000498J	mg/kg	B43SB34A	1/2	0.0007-0.0007	0.000498	N/A	2.35	N	N/A	N/A	No	BSL
	7421-93-4	Endrin aldehyde	0.00289J	0.00289J	mg/kg	B43SB35A	1/2	0.0007-0.0007	0.00289	N/A	2.35	N	N/A	N/A	No	BSL
	72-43-5	Methoxychlor	0.00197	0.00197	mg/kg	B43SB34A	1/2	0.0007-0.0007	0.00197	N/A	39.1	N	N/A	N/A	No	BSL
	11097-69-1	Aroclor 1254	0.0212J	0.344	mg/kg	B43SB35A	4/4	N/A	0.344	N/A	0.156	N	50	TSCA	Yes	ASL
	91-57-6	2-Methylnaphthalene	0.011	0.011	mg/kg	B43SB35A	1/1	N/A	0.011	N/A	156	N	N/A	N/A	No	BSL
	208-96-8	Acenaphthylene	0.00077J	0.0069	mg/kg	B43SB35A	2/2	N/A	0.0069	N/A	235	N	N/A	N/A	No	BSL
	120-12-7	Anthracene	0.0034	0.0034	mg/kg	B43SB35A	1/2	0.0019-0.0019	0.0034	N/A	2,346	N	N/A	N/A	No	BSL
	56-55-3	Benzo(a)anthracene	0.0031	0.0087	mg/kg	B43SB35A	2/2	N/A	0.0087	N/A	0.875	C	N/A	N/A	No	BSL
	50-32-8	Benzo(a)pyrene	0.0031	0.0074	mg/kg	B43SB35A	2/2	N/A	0.0074	N/A	0.0875	C	N/A	N/A	No	BSL
	205-99-2	Benzo(b)fluoranthene	0.0076	0.027	mg/kg	B43SB35A	2/2	N/A	0.027	N/A	0.875	C	N/A	N/A	No	BSL
	191-24-2	Benzo(g,h,i)perylene	0.0033	0.0065	mg/kg	B43SB35A	2/2	N/A	0.0065	N/A	235	N	N/A	N/A	No	BSL
	207-08-9	Benzo(k)fluoranthene	0.002	0.0081	mg/kg	B43SB35A	2/2	N/A	0.0081	N/A	8.75	C	N/A	N/A	No	BSL
	218-01-9	Chrysene	0.0073	0.016	mg/kg	B43SB35A	2/2	N/A	0.016	N/A	87.5	C	N/A	N/A	No	BSL
	53-70-3	Dibenz(a,h)anthracene	0.0008J	0.0019J	mg/kg	B43SB35A	2/2	N/A	0.0019	N/A	0.0875	C	N/A	N/A	No	BSL
	206-44-0	Fluoranthene	0.0093	0.015	mg/kg	B43SB35A	2/2	N/A	0.015	N/A	313	N	N/A	N/A	No	BSL

Table E-1a
Occurrence, Distribution, and Selection of Chemicals of Potential Concern - Current/Future - Surface Soil at Building 4343

Scenario Timeframe: Current/Future
Medium: Surface 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	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (3) (N/C)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
	86-73-7	Fluorene	0.0047	0.0047	mg/kg	B43SB35A	1/2	0.0019-0.0019	0.0047	N/A	313 N	N/A	N/A	No	BSL
	193-39-5	Indeno(1,2,3-cd)pyrene	0.0033	0.0084	mg/kg	B43SB35A	2/2	N/A	0.0084	N/A	0.875 C	N/A	N/A	No	BSL
	91-20-3	Naphthalene	0.011	0.011	mg/kg	B43SB35A	1/2	0.0027-0.0027	0.011	N/A	156 N	N/A	N/A	No	BSL
	85-01-8	Phenanthrene	0.0071	0.012	mg/kg	B43SB35A	2/2	N/A	0.012	N/A	235 N	N/A	N/A	No	BSL
	129-00-0	Pyrene	0.013J	0.02J	mg/kg	B43SB35A	2/2	N/A	0.02	N/A	235 N	N/A	N/A	No	BSL

(1) Maximum concentration used for screening.
(2) Refer to supporting information for background discussion.
Background values derived from site-specific statistical analysis. See text for supporting information.
(3) Screening toxicity values from USEPA Region 3 RBC Table (April 2003). See text for derivation of Nutrient RDAs.
(4) RBCs are based on a risk level of 1.0E-6 and a HQ = 0.1. See text for derivation of Nutrient RDAs.

Rationale Codes

Selection Reason:
- Infrequent Detection but Associated Historically (HIST)
- No Toxicity Information Available (NTX)
- Above Screening Levels (ASL)
- Break Down Product (BDP)
- Elevated Detected Concentration (EDC)
- Above Background Based on Statistical Comparison (ABKG)

Deletion Reason:
- Infrequent Detection (<= 5%, IFD)
- Background Levels (BKG)
- Below Screening and/or ARAR/TBC Level (BSL)
- Essential Nutrient (NUT)
- Physical/Chemical Property (PHYS)

Definitions:
- N/A = Not Applicable or Not Available
- ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
- COPC = Chemical of Potential Concern
- J = Estimated Value
- K = Reported Value May Be Biased High.
- L = Reported Value May Be Biased Low.
- C = Carcinogenic
- N = Non-Carcinogenic
- RDA = Recommended Daily Allowance
- TSCA = Toxic Substances Control Act

Table E-1b
Summary of Screening for Non-Detected Chemicals at Building 4343

Scenario Timeframe: Current/Future
Medium: Surface 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	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (3)	(N/C)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
	99-35-4	1,3,5-Trinitrobenzene			mg/kg		0/2	1.00E-01 - 1.00E-01	1.00E-01	N/A	2.35E+02	N	N/A	N/A	No	BSL
Surface Soil	99-65-0	1,3-Dinitrobenzene			mg/kg		0/2	1.00E-01 - 1.00E-01	1.00E-01	N/A	7.82E-01	N	N/A	N/A	No	BSL
(0 - 2 feet)	118-96-7	2,4,6-Trinitrotoluene			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	3.90E+00	N	N/A	N/A	No	BSL
	35572-78-2	2-amino-4,6-Dinitrotoluene			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	4.69E-01	N	N/A	N/A	No	BSL
	88-72-2	2-Nitrotoluene			mg/kg		0/2	4.00E-01 - 4.00E-01	4.00E-01	N/A	7.82E+01	N	N/A	N/A	No	BSL
	99-08-1	3-Nitrotoluene			mg/kg		0/2	4.00E-01 - 4.00E-01	4.00E-01	N/A	1.56E+02	N	N/A	N/A	No	BSL
	19406-51-0	4-amino-2,6-Dinitrotoluene			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	4.69E-01	N	N/A	N/A	No	BSL
	99-99-0	4-Nitrotoluene			mg/kg		0/2	4.00E-01 - 4.00E-01	4.00E-01	N/A	7.82E+01	N	N/A	N/A	No	BSL
	100-51-6	Benzyl alcohol			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	2.35E+03	N	N/A	N/A	No	BSL
	156-59-2	cis-1,2-Dichloroethene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	7.82E+01	N	N/A	N/A	No	BSL
	121-82-4	Cyclonite			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	5.81E+00	C	N/A	N/A	No	BSL
	2691-41-0	HMX			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	3.91E+02	N	N/A	N/A	No	BSL
	55-63-0	Nitroglycerin			mg/kg		0/2	3.12E-01 - 3.28E-01	3.28E-01	N/A	4.56E+01	C	N/A	N/A	No	BSL
	95-47-6	o-Xylene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.56E+03	N	N/A	N/A	No	BSL
	78-11-5	Pentaerythritol tetranitrate (PETN)			mg/kg		0/2	3.12E-01 - 3.28E-01	3.28E-01	N/A	N/A		N/A	N/A	No	NTX
	110-86-1	Pyridine			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	7.82E+00	N	N/A	N/A	No	BSL
	479-45-8	Tetryl			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	7.82E+01	N	N/A	N/A	No	BSL
	156-60-5	trans-1,2-Dichloroethene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.56E+02	N	N/A	N/A	No	BSL
	93-76-5	2,4,5-T			mg/kg		0/2	1.04E-01 - 1.09E-01	1.09E-01	N/A	7.82E+01	N	N/A	N/A	No	BSL
	93-72-1	2,4,5-TP (Silvex)			mg/kg		0/2	1.04E-01 - 1.09E-01	1.09E-01	N/A	6.26E+01	N	N/A	N/A	No	BSL
	94-75-7	2,4-D			mg/kg		0/2	2.08E-01 - 2.19E-01	2.19E-01	N/A	7.82E+01	N	N/A	N/A	No	BSL
	94-82-6	2,4-DB			mg/kg		0/2	1.04E+00 - 1.09E+00	1.09E+00	N/A	6.26E+01	N	N/A	N/A	No	BSL
	72-55-9	4,4'-DDE			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	1.88E+00	C	N/A	N/A	No	BSL
	309-00-2	Aldrin			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	3.76E-02	C	N/A	N/A	No	BSL
	319-84-6	alpha-BHC			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	1.01E-01	C	N/A	N/A	No	BSL
	5103-71-9	alpha-Chlordane			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	1.82E+00	C	N/A	N/A	No	BSL
	319-85-7	beta-BHC			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	3.55E-01	C	N/A	N/A	No	BSL
	75-99-0	Dalapon			mg/kg		0/2	1.04E+00 - 1.09E+00	1.09E+00	N/A	2.35E+02	N	N/A	N/A	No	BSL
	319-86-8	delta-BHC			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	4.91E-01	C	N/A	N/A	No	BSL
	1918-00-9	Dicamba			mg/kg		0/2	2.08E-01 - 2.19E-01	2.19E-01	N/A	2.35E+02	N	N/A	N/A	No	BSL
	120-36-5	Dichloroprop			mg/kg		0/2	2.08E-01 - 2.19E-01	2.19E-01	N/A	N/A		N/A	N/A	No	NTX
	60-57-1	Dieldrin			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	3.99E-02	C	N/A	N/A	No	BSL
	959-98-8	Endosulfan I			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	4.69E+01	N	N/A	N/A	No	BSL
	1031-07-8	Endosulfan sulfate			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	4.69E+01	N	N/A	N/A	No	BSL
	53494-70-5	Endrin ketone			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	2.35E+00	N	N/A	N/A	No	BSL
	58-89-9	gamma-BHC (Lindane)			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	4.91E-01	C	N/A	N/A	No	BSL
	5103-74-2	gamma-Chlordane			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	1.82E+00	C	N/A	N/A	No	BSL
	76-44-8	Heptachlor			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	1.42E-01	C	N/A	N/A	No	BSL
	1024-57-3	Heptachlor epoxide			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	7.02E-02	C	N/A	N/A	No	BSL
	94-74-6	**MCPA**			**mg/kg**		**0/4**	**1.04E+02 - 1.09E+02**	**1.09E+02**	**N/A**	**3.91E+00**	**N**	**N/A**	**N/A**	**Yes**	**ASL**
	93-65-2	**MCPP**			**mg/kg**		**0/2**	**1.04E+02 - 1.09E+02**	**1.09E+02**	**N/A**	**7.82E+00**	**N**	**N/A**	**N/A**	**Yes**	**ASL**
	8001-35-2	Toxaphene			mg/kg		0/2	3.46E-02 - 3.64E-02	3.64E-02	N/A	5.81E-01	C	N/A	N/A	No	BSL
	12674-11-2	Aroclor 1016			mg/kg		0/4	3.46E-02 - 3.89E-02	3.89E-02	N/A	5.50E-01	N	N/A	N/A	No	BSL
	11104-28-2	Aroclor 1221			mg/kg		0/4	6.93E-02 - 7.79E-02	7.79E-02	N/A	3.19E-01	C	N/A	N/A	No	BSL
	11141-16-5	Aroclor 1232			mg/kg		0/4	3.46E-02 - 3.89E-02	3.89E-02	N/A	3.19E-01	C	N/A	N/A	No	BSL
	53469-21-9	Aroclor 1242			mg/kg		0/4	3.46E-02 - 3.89E-02	3.89E-02	N/A	3.19E-01	C	N/A	N/A	No	BSL
	12672-29-6	Aroclor 1248			mg/kg		0/4	3.46E-02 - 3.89E-02	3.89E-02	N/A	3.19E-01	C	N/A	N/A	No	BSL
	11096-82-5	Aroclor 1260			mg/kg		0/4	3.46E-02 - 3.89E-02	3.89E-02	N/A	3.19E-01	C	N/A	N/A	No	BSL
	131-11-3	Dimethylphthalate			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	7.82E+04	N	N/A	N/A	No	BSL

Table E-1b
Summary of Screening for Non-Detected Chemicals at Building 4343

Scenario Timeframe: Current/Future
Medium: Surface 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	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (3)	(N/C)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
	120-82-1	1,2,4-Trichlorobenzene			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	7.82E+01	N	N/A	N/A	No	BSL
	95-50-1	1,2-Dichlorobenzene			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	7.04E+02	N	N/A	N/A	No	BSL
	541-73-1	1,3-Dichlorobenzene			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	2.35E+02	N	N/A	N/A	No	BSL
	106-46-7	1,4-Dichlorobenzene			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	2.66E+01	C	N/A	N/A	No	BSL
	95-95-4	2,4,5-Trichlorophenol			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	7.82E+02	N	N/A	N/A	No	BSL
	88-06-2	2,4,6-Trichlorophenol			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	5.81E+01	C	N/A	N/A	No	BSL
	120-83-2	2,4-Dichlorophenol			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	2.35E+01	N	N/A	N/A	No	BSL
	105-67-9	2,4-Dimethylphenol			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	1.56E+02	N	N/A	N/A	No	BSL
	51-28-5	2,4-Dinitrophenol			mg/kg		0/2	8.70E-01 - 9.10E-01	9.10E-01	N/A	1.56E+01	N	N/A	N/A	No	BSL
	121-14-2	2,4-Dinitrotoluene			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	1.56E+01	N	N/A	N/A	No	BSL
	606-20-2	2,6-Dinitrotoluene			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	7.82E+00	N	N/A	N/A	No	BSL
	91-58-7	2-Chloronaphthalene			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	6.26E+02	N	N/A	N/A	No	BSL
	95-57-8	2-Chlorophenol			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	3.91E+01	N	N/A	N/A	No	BSL
	88-74-4	2-Nitroaniline			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	N/A		N/A	N/A	No	NTX
	88-75-5	2-Nitrophenol			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	N/A		N/A	N/A	No	NTX
	88-85-7	2-sec-butyl-4,6-dinitrophenol			mg/kg		0/2	2.08E-01 - 2.19E-01	2.19E-01	N/A	7.82E+00	N	N/A	N/A	No	BSL
	91-94-1	3,3'-Dichlorobenzidine			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	1.42E+00	C	N/A	N/A	No	BSL
	99-09-2	3-Nitroaniline			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	2.35E+01	N	N/A	N/A	No	BSL
	534-52-1	**4,6-Dinitro-o-cresol**			**mg/kg**		**0/2**	**8.70E-01 - 9.10E-01**	**9.10E-01**	**N/A**	**7.82E-01**	**N**	**N/A**	**N/A**	**Yes**	**ASL**
	100-01-6	4-Nitroaniline			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	2.35E+01	N	N/A	N/A	No	BSL
	100-02-7	4-Nitrophenol			mg/kg		0/2	8.70E-01 - 9.10E-01	9.10E-01	N/A	6.26E+01	N	N/A	N/A	No	BSL
	83-32-9	Acenaphthene			mg/kg		0/1	1.90E-03 - 1.90E-03	1.90E-03	N/A	4.69E+02	N	N/A	N/A	No	BSL
	65-85-0	Benzoic Acid			mg/kg		0/2	8.70E-01 - 9.10E-01	9.10E-01	N/A	3.13E+04	N	N/A	N/A	No	BSL
	111-91-1	bis(2-Chloroethoxy)methane			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	N/A		N/A	N/A	No	NTX
	111-44-4	bis(2-Chloroethyl)ether			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	5.81E-01	C	N/A	N/A	No	BSL
	108-60-1	bis(2-Chloroisopropyl)ether			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	9.12E+00	C	N/A	N/A	No	BSL
	117-81-7	bis(2-Ethylhexyl) phthalate			mg/kg		0/2	5.30E-02 - 5.50E-02	5.50E-02	N/A	4.56E+01	C	N/A	N/A	No	BSL
	85-68-7	Butyl benzyl phthalate			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	1.56E+03	N	N/A	N/A	No	BSL
	86-74-8	Carbazole			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	3.19E+01	C	N/A	N/A	No	BSL
	84-74-2	Di-n-butyl phthalate			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	7.82E+02	N	N/A	N/A	No	BSL
	117-84-0	Di-n-octyl phthalate			mg/kg		0/2	5.10E-02 - 1.70E-01	1.70E-01	N/A	1.56E+02	N	N/A	N/A	No	BSL
	132-64-9	Dibenzofuran			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	1.56E+01	N	N/A	N/A	No	BSL
	84-66-2	Diethyl phthalate			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	6.26E+03	N	N/A	N/A	No	BSL
	118-74-1	Hexachlorobenzene			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	3.99E-01	C	N/A	N/A	No	BSL
	87-68-3	Hexachlorobutadiene			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	1.56E+00	N	N/A	N/A	No	BSL
	77-47-4	Hexachlorocyclopentadiene			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	4.69E+01	N	N/A	N/A	No	BSL
	67-72-1	Hexachloroethane			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	7.80E+00	N	N/A	N/A	No	BSL
	78-59-1	Isophorone			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	6.72E+02	C	N/A	N/A	No	BSL
	621-64-7	**n-Nitroso-di-n-propylamine**			**mg/kg**		**0/2**	**1.70E-01 - 1.80E-01**	**1.80E-01**	**N/A**	**9.12E-02**	**C**	**N/A**	**N/A**	**Yes**	**ASL**
	86-30-6	n-Nitrosodiphenylamine			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	1.30E+02	C	N/A	N/A	No	BSL
	98-95-3	Nitrobenzene			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	3.91E+00	N	N/A	N/A	No	BSL
	95-48-7	o-Cresol			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	3.91E+02	N	N/A	N/A	No	BSL
	59-50-7	p-Chloro-m-cresol			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	N/A		N/A	N/A	No	NTX
	106-47-8	p-Chloroaniline			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	3.13E+01	N	N/A	N/A	No	BSL
	106-44-5	p-Cresol			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	3.91E+01	N	N/A	N/A	No	BSL
	87-86-5	Pentachlorophenol			mg/kg		0/2	8.70E-01 - 9.10E-01	9.10E-01	N/A	5.32E+00	C	N/A	N/A	No	BSL
	108-95-2	Phenol			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	2.35E+03	N	N/A	N/A	No	BSL

Table E-1b
Summary of Screening for Non-Detected Chemicals at Building 4343

Scenario Timeframe: Current/Future
Medium: Surface 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	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (3) (N/C)		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
	71-55-6	1,1,1-Trichloroethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	2.19E+03	N	N/A	N/A	No	BSL
	79-34-5	1,1,2,2-Tetrachloroethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	3.19E+00	C	N/A	N/A	No	BSL
	79-00-5	1,1,2-Trichloroethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.12E+01	C	N/A	N/A	No	BSL
	75-34-3	1,1-Dichloroethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	7.82E+02	N	N/A	N/A	No	BSL
	75-35-4	1,1-Dichloroethene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	3.91E+02	N	N/A	N/A	No	BSL
	107-06-2	1,2-Dichloroethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	7.02E+00	C	N/A	N/A	No	BSL
	78-87-5	1,2-Dichloropropane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	9.39E+00	C	N/A	N/A	No	BSL
	78-93-3	2-Butanone			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	4.69E+03	N	N/A	N/A	No	BSL
	591-78-6	2-Hexanone			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	3.13E+02	N	N/A	N/A	No	BSL
	101-55-3	4-Bromophenyl phenylether			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	N/A		N/A	N/A	No	NTX
	7005-72-3	4-Chlorophenyl phenylether			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	N/A		N/A	N/A	No	NTX
	108-10-1	4-Methyl-2-pentanone			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	6.26E+02	N	N/A	N/A	No	BSL
	67-64-1	Acetone			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	7.80E+02	N	N/A	N/A	No	BSL
	71-43-2	Benzene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.16E+01	C	N/A	N/A	No	BSL
	75-27-4	Bromodichloromethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.03E+01	C	N/A	N/A	No	BSL
	74-83-9	Bromomethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.10E+01	N	N/A	N/A	No	BSL
	75-15-0	Carbon disulfide			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	7.82E+02	N	N/A	N/A	No	BSL
	56-23-5	Carbon tetrachloride			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	4.91E+00	C	N/A	N/A	No	BSL
	108-90-7	Chlorobenzene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.56E+02	N	N/A	N/A	No	BSL
	75-00-3	Chloroethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	2.20E+02	C	N/A	N/A	No	BSL
	74-87-3	Chloromethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	N/A		N/A	N/A	No	NTX
	10061-01-5	cis-1,3-Dichloro-1-propene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	6.40E+00	C	N/A	N/A	No	BSL
	124-48-1	Dibromochloromethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	7.60E+00	C	N/A	N/A	No	BSL
	100-41-4	Ethylbenzene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	7.82E+02	N	N/A	N/A	No	BSL
	75-09-2	Methylene chloride			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	8.52E+01	C	N/A	N/A	No	BSL
	100-42-5	Styrene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.56E+03	N	N/A	N/A	No	BSL
	127-18-4	Tetrachloroethene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	3.19E+01	C	N/A	N/A	No	BSL
	108-88-3	Toluene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.56E+03	N	N/A	N/A	No	BSL
	10061-02-6	trans-1,3-Dichloropropene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	6.39E+00	C	N/A	N/A	No	BSL
	75-25-2	Tribromomethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	8.09E+01	C	N/A	N/A	No	BSL
	79-01-6	Trichloroethene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.60E+00	C	N/A	N/A	No	BSL
	67-66-3	Trichloromethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	7.82E+02	C	N/A	N/A	No	BSL
	75-01-4	Vinyl Chloride			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	9.00E-02	C	N/A	N/A	No	BSL
	1330-20-7	Xylenes (total)			mg/kg		0/2	9.40E-03 - 9.80E-03	9.80E-03	N/A	1.56E+03	N	N/A	N/A	No	BSL

(1) Maximum concentration used for screening.

(2) N/A - Refer to supporting information for background discussion.
Background values derived from site-specific statistical analysis. See text for supporting information.

(3) Screening toxicity values from USEPA Region 3 RBC Table (April 2003). RBCs are based on a risk level of 1.0E-06 and HQ = 0.1. See text for derivation of Nutrient RDAs.

(4) Rationale Codes Selection Reason:
- Infrequent Detection but Associated Historically (HIST)
- Toxicity Information Available (TX)
- Above Screening Levels (ASL)
- Break Down Product (BDP)
- Elevated Detected Concentration (EDC)

Deletion Reason:
- Infrequent Detection (<= 5%, IFD)
- Background Levels (BKG)
- No Toxicity Information (NTX)
- Below Screening and/or ARAR/TBC Level (BSL)

Definitions:
- N/A = Not Applicable or Not Available
- SQL = Sample Quantitation Limit
- COPC = Chemical of Potential Concern
- ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
- MCL = Federal Maximum Contaminant Level
- SMCL = Secondary Maximum Contaminant Level
- C = Carcinogenic
- N = Non-Carcinogenic
- RDA = Recommended Daily Allowance (for nutrients)

Table E-2a
Occurrence, Distribution, and Selection of Chemicals of Potential Concern - Future - Total Soil at Building 4343

Scenario Timeframe: Future
Medium: Total Soil
Exposure Medium: Total Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (3)	(N/C)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
Total Soil	7429-90-5	Aluminum	552	54000	mg/kg	B43SB20A	57/57	N/A	54000	40,041	7,821	N	N/A	N/A	Yes	ASL
(mixed surface and	7440-36-0	Antimony	2.2	41.2J	mg/kg	B43SSD1	2/57	2.00E-01 - 5.30E+00	41.2J	N/A	3.13	N	N/A	N/A	Yes	ASL
subsurface soil)	7440-38-2	Arsenic	0.841	8.2	mg/kg	B43SB25A	15/57	1.40E+00 - 7.50E+00	8.2	15.8	0.426	C	N/A	N/A	No	BKG
	7440-39-3	Barium	25.4J	242	mg/kg	B43SSD1	57/57	N/A	242	209	548	N	N/A	N/A	No	BSL
	7440-41-7	Beryllium	0.15K	0.57J	mg/kg	B43SS02	8/57	1.00E-01 - 1.30E+00	0.57J	1.02	15.6	N	N/A	N/A	No	BSL
	7440-43-9	Cadmium	0.2J	24300	mg/kg	B43SSD1	42/57	1.10E-01 - 2.80E-01	24300	0.690	3.91	N	N/A	N/A	Yes	ASL
	7440-70-2	Calcium	255J	91000	mg/kg	B43SSB11	57/57	N/A	91000	N/A	N/A		1,000,000	RDA	No	BSL
	7440-47-3	Chromium	4.2	1820	mg/kg	B43SSD1	57/57	N/A	1820	65.3	23.5	N	N/A	N/A	Yes	ASL
	7440-48-4	Cobalt	2.2K	19.8	mg/kg	B43SSB18	55/56	1.30E-01 - 1.30E-01	19.8	72.3	156	N	N/A	N/A	No	BSL
	7440-50-8	Copper	6.9	677	mg/kg	B43SSD1	57/57	N/A	677	53.5	313	N	N/A	N/A	Yes	ASL
	7439-89-6	Iron	1000	99100	mg/kg	B43SB22A	57/57	N/A	99100	50,962	2,346	N	N/A	N/A	Yes	ASL
	7439-92-1	Lead	3.1	1410	mg/kg	B43SSD1	57/57	N/A	1410	26.8	N/A		400	USEPA	Yes	ASL
	7439-95-4	Magnesium	240J	19400	mg/kg	B43SS01	57/57	N/A	19400	N/A	N/A		1,000,000	RDA	No	BSL
	7439-96-5	Manganese	29.8J	1220	mg/kg	B43SB32A	57/57	N/A	1220	2,543	156	N	N/A	N/A	No	BKG
	7439-97-6	Mercury (Inorganic)	0.025L	0.53	mg/kg	B43SSB9	17/57	1.00E-01 - 1.40E-01	0.53	0.130	0.780		N/A	N/A	No	BSL
	7440-02-0	Nickel	2.3J	32.6	mg/kg	B43SSD1	56/57	1.00E-01 - 1.00E-01	32.6	62.8	156	N	N/A	N/A	No	BSL
	7440-09-7	Potassium	166J	2050J	mg/kg	B43SSB18	57/57	N/A	2050J	N/A	N/A		1,000,000	RDA	No	BSL
	7782-49-2	Selenium	0.6	1.1	mg/kg	B43SB27A	4/57	4.70E-01 - 1.40E+00	1.1	N/A	39.1	N	N/A	N/A	No	BSL
	7440-22-4	Silver	0.16J	36	mg/kg	B43SSD1	18/57	1.00E-01 - 1.30E+00	36	N/A	39.1	N	N/A	N/A	No	BSL
	7440-23-5	Sodium	39.1	139	mg/kg	B43SB14A	13/57	8.50E+00 - 4.43E+02	139	N/A	N/A		1,000,000	RDA	No	BSL
	7440-28-0	Thallium	0.09J	1.2J	mg/kg	B43SB12A	6/57	7.20E-01 - 2.00E+00	1.2J	2.11	0.548	N	N/A	N/A	Yes	ASL, ABKG
	57-12-5	Total Cyanide	14.1	14.8	mg/kg	B43SSB5	2/28	2.00E-01 - 2.70E-01	14.8	N/A	156	N	N/A	N/A	No	BSL
	7440-62-2	Vanadium	5.7K	205	mg/kg	B43SB21A	57/57	N/A	205	108	54.8	N	N/A	N/A	Yes	ASL
	7440-66-6	Zinc	13	1780	mg/kg	B43SSD1	56/56	N/A	1780	202	2,346	N	N/A	N/A	No	BSL
	7440-44-0	Total Organic Carbon	2038	6160	mg/kg	B43SSD5	4/4	N/A	6160	N/A	N/A		N/A	N/A	No	PHYS
	72-54-8	4,4'-DDD	0.000222J	0.00057J	mg/kg	B43SB34A	3/3	N/A	0.00057J	N/A	2.66	C	N/A	N/A	No	BSL
	50-29-3	4,4'-DDT	0.0153	0.0218	mg/kg	B43SB35A	2/3	8.37E-04 - 8.37E-04	0.0218	N/A	1.88	C	N/A	N/A	No	BSL
	33213-65-9	Endosulfan II	0.00226	0.00246	mg/kg	B43SB35A	2/3	8.37E-04 - 8.37E-04	0.00246	N/A	46.9	N	N/A	N/A	No	BSL
	72-20-8	Endrin	0.000498J	0.000498J	mg/kg	B43SB34A	1/3	6.93E-04 - 8.37E-04	0.000498J	N/A	2.35	N	N/A	N/A	No	BSL
	7421-93-4	Endrin aldehyde	0.00289J	0.00289J	mg/kg	B43SB35A	1/3	7.30E-04 - 8.37E-04	0.00289J	N/A	2.35	N	N/A	N/A	No	BSL
	72-43-5	Methoxychlor	0.00197	0.00197	mg/kg	B43SB34A	1/3	6.93E-04 - 8.37E-04	0.00197	N/A	39.1	N	N/A	N/A	No	BSL
	11097-69-1	Aroclor 1254	0.0212J	0.344	mg/kg	B43SB35A	4/6	4.18E-02 - 4.34E-02	0.344	N/A	0.156	N	50	TSCA	Yes	ASL
	91-57-6	2-Methylnaphthalene	0.011	0.011	mg/kg	B43SB35A	1/3	2.10E-03 - 2.20E-03	0.011	N/A	156	N	N/A	N/A	No	BSL
	208-96-8	Acenaphthylene	0.00077	0.0069	mg/kg	B43SB35A	2/4	2.10E-03 - 2.20E-03	0.0069	N/A	235	N	N/A	N/A	No	BSL
	120-12-7	Anthracene	0.0034	0.0034	mg/kg	B43SB35A	1/4	1.90E-03 - 2.20E-03	0.0034	N/A	2,346	N	N/A	N/A	No	BSL
	56-55-3	Benzo(a)anthracene	0.00096	0.0087	mg/kg	B43SB35A	3/4	2.10E-03 - 2.10E-03	0.0087	N/A	0.875	C	N/A	N/A	No	BSL
	50-32-8	Benzo(a)pyrene	0.00096	0.0074	mg/kg	B43SB35A	3/4	2.10E-03 - 2.10E-03	0.0074	N/A	0.0875	C	N/A	N/A	No	BSL

Table E-2a
Occurrence, Distribution, and Selection of Chemicals of Potential Concern - Future - Total Soil at Building 4343

Scenario Timeframe: Future
Medium: Total Soil
Exposure Medium: Total Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (3) (N/C)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
	205-99-2	Benzo(b)fluoranthene	0.0013	0.027	mg/kg	B43SB35A	3/4	2.10E-03 - 2.10E-03	0.027	N/A	0.875 C	N/A	N/A	No	BSL
	191-24-2	Benzo(g,h,i)perylene	0.0033	0.0065	mg/kg	B43SB35A	2/4	2.10E-03 - 2.20E-03	0.0065	N/A	235 N	N/A	N/A	No	BSL
	207-08-9	Benzo(k)fluoranthene	0.002	0.0081	mg/kg	B43SB35A	2/4	2.10E-03 - 2.20E-03	0.0081	N/A	8.75 C	N/A	N/A	No	BSL
	218-01-9	Chrysene	0.0014	0.016	mg/kg	B43SB35A	3/4	2.10E-03 - 2.10E-03	0.016	N/A	87.5 C	N/A	N/A	No	BSL
	53-70-3	Dibenz(a,h)anthracene	0.0008	0.0019J	mg/kg	B43SB35A	2/4	2.10E-03 - 2.20E-03	0.0019J	N/A	0.0875 C	N/A	N/A	No	BSL
	206-44-0	Fluoranthene	0.0016	0.015	mg/kg	B43SB35A	3/4	2.10E-03 - 2.10E-03	0.015	N/A	313 N	N/A	N/A	No	BSL
	86-73-7	Fluorene	0.0047	0.0047	mg/kg	B43SB35A	1/4	1.90E-03 - 2.20E-03	0.0047	N/A	313 N	N/A	N/A	No	BSL
	193-39-5	Indeno(1,2,3-cd)pyrene	0.0033	0.0084	mg/kg	B43SB35A	2/4	2.10E-03 - 2.20E-03	0.0084	N/A	0.875 C	N/A	N/A	No	BSL
	91-20-3	Naphthalene	0.011	0.011	mg/kg	B43SB35A	1/4	1.70E-03 - 2.70E-03	0.011	N/A	156 N	N/A	N/A	No	BSL
	85-01-8	Phenanthrene	0.0013	0.012	mg/kg	B43SB35A	3/4	2.10E-03 - 2.10E-03	0.012	N/A	235 N	N/A	N/A	No	BSL
	129-00-0	Pyrene	0.0033	0.02J	mg/kg	B43SB35A	3/4	2.10E-03 - 2.10E-03	0.02J	N/A	235 N	N/A	N/A	No	BSL

(1) Maximum concentration used for screening.
(2) Refer to supporting information for background discussion.
Background values derived from site-specific statistical analysis. See text for supporting information.
(3) Screening toxicity values for residential soil from USEPA Region 3 RBC Table (April 2003).
(4) RBCs are based on a risk level of 1.0E-6 and a HQ = 0.1. See text for derivation of Nutrient RDAs.

Rationale Codes Selection Reason:
- Infrequent Detection but Associated Historically (HIST)
- No Toxicity Information Available (NTX)
- Above Screening Levels (ASL)
- Break Down Product (BDP)
- Elevated Detected Concentration (EDC)
- Above Background Based on Statistical Comparison (ABKG)

Deletion Reason:
- Infrequent Detection (<= 5%, IFD)
- Background Levels (BKG)
- Physical/Chemical Property (PHYS)
- Below Screening and/or ARAR/TBC Level (BSL)

Definitions:
- N/A = Not Applicable or Not Available
- SQL = Sample Quantitation Limit
- COPC = Chemical of Potential Concern
- ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
- J = Estimated Value
- K = Reported Value May Be Biased High.
- C = Carcinogenic
- N = Non-Carcinogenic
- RDA = recommended daily allowance (for nutrients).
- TSCA = Toxic Substances Control Act

Table E-2b
Summary of Screening for Non-Detected Chemicals at Building 4343

Scenario Timeframe: Future
Medium: Total Soil
Exposure Medium: Total Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (3)	(N/C)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
Mixed Surface and Subsurface Soil (0 - 10 feet)	99-35-4	1,3,5-Trinitrobenzene			mg/kg		0/4	1.00E-01 - 1.00E-01	1.00E-01	N/A	2.35E+02	N	N/A	N/A	No	BSL
	99-65-0	1,3-Dinitrobenzene			mg/kg		0/4	1.00E-01 - 1.00E-01	1.00E-01	N/A	7.82E-01	N	N/A	N/A	No	BSL
	118-96-7	2,4,6-Trinitrotoluene			mg/kg		0/4	2.00E-01 - 2.00E-01	2.00E-01	N/A	3.90E+00	N	N/A	N/A	No	BSL
	35572-78-2	2-amino-4,6-Dinitrotoluene			mg/kg		0/4	2.00E-01 - 2.00E-01	2.00E-01	N/A	4.69E-01	N	N/A	N/A	No	BSL
	88-72-2	2-Nitrotoluene			mg/kg		0/4	4.00E-01 - 4.00E-01	4.00E-01	N/A	7.82E+01	N	N/A	N/A	No	BSL
	99-08-1	3-Nitrotoluene			mg/kg		0/4	4.00E-01 - 4.00E-01	4.00E-01	N/A	1.56E+02	N	N/A	N/A	No	BSL
	19406-51-0	4-amino-2,6-Dinitrotoluene			mg/kg		0/4	2.00E-01 - 2.00E-01	2.00E-01	N/A	4.69E-01	N	N/A	N/A	No	BSL
	99-99-0	4-Nitrotoluene			mg/kg		0/4	4.00E-01 - 4.00E-01	4.00E-01	N/A	7.82E+01	N	N/A	N/A	No	BSL
	100-51-6	Benzyl alcohol			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	2.35E+03	N	N/A	N/A	No	BSL
	156-59-2	cis-1,2-Dichloroethene			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	7.82E+01	N	N/A	N/A	No	BSL
	121-82-4	Cyclonite			mg/kg		0/4	2.00E-01 - 2.00E-01	2.00E-01	N/A	5.81E+00	C	N/A	N/A	No	BSL
	2691-41-0	HMX			mg/kg		0/4	2.00E-01 - 2.00E-01	2.00E-01	N/A	3.91E+02	N	N/A	N/A	No	BSL
	55-63-0	Nitroglycerin			mg/kg		0/4	3.12E-01 - 3.91E-01	3.91E-01	N/A	4.56E+01	C	N/A	N/A	No	BSL
	95-47-6	o-Xylene			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	1.56E+03	N	N/A	N/A	No	BSL
	78-11-5	Pentaerythritol tetranitrate			mg/kg		0/4	3.12E-01 - 3.91E-01	3.91E-01	N/A	N/A		N/A	N/A	No	NTX
	110-86-1	Pyridine			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	7.82E+00	N	N/A	N/A	No	BSL
	479-45-8	Tetryl			mg/kg		0/4	2.00E-01 - 2.00E-01	2.00E-01	N/A	7.82E+01	N	N/A	N/A	No	BSL
	156-60-5	trans-1,2-Dichloroethene			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	1.56E+02	N	N/A	N/A	No	BSL
	93-76-5	2,4,5-T			mg/kg		0/3	1.04E-01 - 1.25E-01	1.25E-01	N/A	7.82E+01	N	N/A	N/A	No	BSL
	93-72-1	2,4,5-TP (Silvex)			mg/kg		0/3	1.04E-01 - 1.25E-01	1.25E-01	N/A	6.26E+01	N	N/A	N/A	No	BSL
	94-75-7	2,4-D			mg/kg		0/3	2.08E-01 - 2.51E-01	2.51E-01	N/A	7.82E+01	N	N/A	N/A	No	BSL
	94-82-6	2,4-DB			mg/kg		0/3	1.04E+00 - 1.25E+00	1.25E+00	N/A	6.26E+01	N	N/A	N/A	No	BSL
	72-55-9	4,4'-DDE			mg/kg		0/3	7.00E-04 - 8.00E-04	8.00E-04	N/A	1.88E+00	C	N/A	N/A	No	BSL
	309-00-2	Aldrin			mg/kg		0/3	7.00E-04 - 8.00E-04	8.00E-04	N/A	3.76E-02	C	N/A	N/A	No	BSL
	319-84-6	alpha-BHC			mg/kg		0/3	7.00E-04 - 8.00E-04	8.00E-04	N/A	1.01E-01	C	N/A	N/A	No	BSL
	5103-71-9	alpha-Chlordane			mg/kg		0/3	7.00E-04 - 8.00E-04	8.00E-04	N/A	1.82E+00	C	N/A	N/A	No	BSL
	319-85-7	beta-BHC			mg/kg		0/3	7.00E-04 - 8.00E-04	8.00E-04	N/A	3.55E-01	C	N/A	N/A	No	BSL
	75-99-0	Dalapon			mg/kg		0/3	1.04E+00 - 1.25E+00	1.25E+00	N/A	2.35E+02	N	N/A	N/A	No	BSL
	319-86-8	delta-BHC			mg/kg		0/3	7.00E-04 - 8.00E-04	8.00E-04	N/A	4.91E-01	C	N/A	N/A	No	BSL
	1918-00-9	Dicamba			mg/kg		0/3	2.08E-01 - 2.51E-01	2.51E-01	N/A	2.35E+02	N	N/A	N/A	No	BSL
	120-36-5	Dichloroprop			mg/kg		0/3	2.08E-01 - 2.51E-01	2.51E-01	N/A	N/A		N/A	N/A	No	NTX
	60-57-1	Dieldrin			mg/kg		0/3	7.00E-04 - 8.00E-04	8.00E-04	N/A	3.99E-02	C	N/A	N/A	No	BSL
	959-98-8	Endosulfan I			mg/kg		0/3	7.00E-04 - 8.00E-04	8.00E-04	N/A	4.69E+01	N	N/A	N/A	No	BSL
	1031-07-8	Endosulfan sulfate			mg/kg		0/3	7.00E-04 - 8.00E-04	8.00E-04	N/A	4.69E+01	N	N/A	N/A	No	BSL
	53494-70-5	Endrin ketone			mg/kg		0/3	7.00E-04 - 8.00E-04	8.00E-04	N/A	2.35E+00	N	N/A	N/A	No	BSL
	58-89-9	gamma-BHC (Lindane)			mg/kg		0/3	7.00E-04 - 8.00E-04	8.00E-04	N/A	4.91E-01	C	N/A	N/A	No	BSL
	5103-74-2	gamma-Chlordane			mg/kg		0/3	7.00E-04 - 8.00E-04	8.00E-04	N/A	1.82E+00	C	N/A	N/A	No	BSL
	76-44-8	Heptachlor			mg/kg		0/3	7.00E-04 - 8.00E-04	8.00E-04	N/A	1.42E-01	C	N/A	N/A	No	BSL
	1024-57-3	Heptachlor epoxide			mg/kg		0/3	7.00E-04 - 8.00E-04	8.00E-04	N/A	7.02E-02	C	N/A	N/A	No	BSL
	94-74-6	**MCPA**			**mg/kg**		**0/6**	**1.04E+02 - 1.25E+02**	**1.25E+02**	**N/A**	**3.91E+00**	**N**	**N/A**	**N/A**	**Yes**	**ASL**
	93-65-2	**MCPP**			**mg/kg**		**0/3**	**1.04E+02 - 1.25E+02**	**1.25E+02**	**N/A**	**7.82E+00**	**N**	**N/A**	**N/A**	**Yes**	**ASL**
	8001-35-2	Toxaphene			mg/kg		0/3	3.46E-02 - 4.18E-02	4.18E-02	N/A	5.81E-01	C	N/A	N/A	No	BSL
	12674-11-2	Aroclor 1016			mg/kg		0/6	3.46E-02 - 4.34E-02	4.34E-02	N/A	5.50E-01	N	N/A	N/A	No	BSL
	11104-28-2	Aroclor 1221			mg/kg		0/6	6.93E-02 - 8.70E-02	8.70E-02	N/A	3.19E-01	C	N/A	N/A	No	BSL
	11141-16-5	Aroclor 1232			mg/kg		0/6	3.46E-02 - 4.34E-02	4.34E-02	N/A	3.19E-01	C	N/A	N/A	No	BSL
	53469-21-9	Aroclor 1242			mg/kg		0/6	3.46E-02 - 4.34E-02	4.34E-02	N/A	3.19E-01	C	N/A	N/A	No	BSL
	12672-29-6	Aroclor 1248			mg/kg		0/6	3.46E-02 - 4.34E-02	4.34E-02	N/A	3.19E-01	C	N/A	N/A	No	BSL
	11096-82-5	Aroclor 1260			mg/kg		0/6	3.46E-02 - 4.34E-02	4.34E-02	N/A	3.19E-01	C	N/A	N/A	No	BSL
	131-11-3	Dimethylphthalate			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	7.82E+04	N	N/A	N/A	No	BSL

Table E-2b
Summary of Screening for Non-Detected Chemicals at Building 4343

Scenario Timeframe: Future
Medium: Total Soil
Exposure Medium: Total Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (3)	(N/C)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
	120-82-1	1,2,4-Trichlorobenzene			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	7.82E+01	N	N/A	N/A	No	BSL
	95-50-1	1,2-Dichlorobenzene			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	7.04E+02	N	N/A	N/A	No	BSL
	541-73-1	1,3-Dichlorobenzene			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	2.35E+02	N	N/A	N/A	No	BSL
	106-46-7	1,4-Dichlorobenzene			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	2.66E+01	C	N/A	N/A	No	BSL
	95-95-4	2,4,5-Trichlorophenol			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	7.82E+02	N	N/A	N/A	No	BSL
	88-06-2	2,4,6-Trichlorophenol			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	5.81E+01	C	N/A	N/A	No	BSL
	120-83-2	2,4-Dichlorophenol			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	2.35E+01	N	N/A	N/A	No	BSL
	105-67-9	2,4-Dimethylphenol			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	1.56E+02	N	N/A	N/A	No	BSL
	51-28-5	2,4-Dinitrophenol			mg/kg		0/4	8.70E-01 - 1.10E+00	1.10E+00	N/A	1.56E+01	N	N/A	N/A	No	BSL
	121-14-2	2,4-Dinitrotoluene			mg/kg		0/4	2.00E-01 - 2.00E-01	2.00E-01	N/A	1.56E+01	N	N/A	N/A	No	BSL
	606-20-2	2,6-Dinitrotoluene			mg/kg		0/4	2.00E-01 - 2.00E-01	2.00E-01	N/A	7.82E+00	N	N/A	N/A	No	BSL
	91-58-7	2-Chloronaphthalene			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	6.26E+02	N	N/A	N/A	No	BSL
	95-57-8	2-Chlorophenol			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	3.91E+01	N	N/A	N/A	No	BSL
	88-74-4	2-Nitroaniline			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	N/A		N/A	N/A	No	NTX
	88-75-5	2-Nitrophenol			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	N/A		N/A	N/A	No	NTX
	88-85-7	2-sec-butyl-4,6-dinitrophenol			mg/kg		0/3	2.08E-01 - 2.51E-01	2.51E-01	N/A	7.82E+00	N	N/A	N/A	No	BSL
	91-94-1	3,3'-Dichlorobenzidine			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	1.42E+00	C	N/A	N/A	No	BSL
	99-09-2	3-Nitroaniline			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	2.35E+01	N	N/A	N/A	No	BSL
	534-52-1	**4,6-Dinitro-o-cresol**			**mg/kg**		**0/4**	**8.70E-01 - 1.10E+00**	**1.10E+00**	**N/A**	**7.82E-01**	**N**	**N/A**	**N/A**	**Yes**	**ASL**
	100-01-6	4-Nitroaniline			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	2.35E+01	N	N/A	N/A	No	BSL
	100-02-7	4-Nitrophenol			mg/kg		0/4	8.70E-01 - 1.10E+00	1.10E+00	N/A	6.26E+01	N	N/A	N/A	No	BSL
	83-32-9	Acenaphthene			mg/kg		0/3	1.90E-03 - 2.20E-03	2.20E-03	N/A	4.69E+02	N	N/A	N/A	No	BSL
	65-85-0	Benzoic Acid			mg/kg		0/4	8.70E-01 - 1.10E+00	1.10E+00	N/A	3.13E+04	N	N/A	N/A	No	BSL
	111-91-1	bis(2-Chloroethoxy)methane			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	N/A		N/A	N/A	No	NTX
	111-44-4	bis(2-Chloroethyl)ether			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	5.81E-01	C	N/A	N/A	No	BSL
	108-60-1	bis(2-Chloroisopropyl)ether			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	9.12E+00	C	N/A	N/A	No	BSL
	117-81-7	bis(2-Ethylhexyl) phthalate			mg/kg		0/4	5.30E-02 - 8.60E-02	8.60E-02	N/A	4.56E+01	C	N/A	N/A	No	BSL
	85-68-7	Butyl benzyl phthalate			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	1.56E+03	N	N/A	N/A	No	BSL
	86-74-8	Carbazole			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	3.19E+01	C	N/A	N/A	No	BSL
	84-74-2	Di-n-butyl phthalate			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	7.82E+02	N	N/A	N/A	No	BSL
	117-84-0	Di-n-octyl phthalate			mg/kg		0/4	1.10E-02 - 1.70E-01	1.70E-01	N/A	1.56E+02	N	N/A	N/A	No	BSL
	132-64-9	Dibenzofuran			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	1.56E+01	N	N/A	N/A	No	BSL
	84-66-2	Diethyl phthalate			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	6.26E+03	N	N/A	N/A	No	BSL
	118-74-1	Hexachlorobenzene			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	3.99E-01	C	N/A	N/A	No	BSL
	87-68-3	Hexachlorobutadiene			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	1.56E+00	N	N/A	N/A	No	BSL
	77-47-4	Hexachlorocyclopentadiene			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	4.69E+01	N	N/A	N/A	No	BSL
	67-72-1	Hexachloroethane			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	7.80E+00	N	N/A	N/A	No	BSL
	78-59-1	Isophorone			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	6.72E+02	C	N/A	N/A	No	BSL
	621-64-7	**n-Nitroso-di-n-propylamine**			**mg/kg**		**0/4**	**1.70E-01 - 2.20E-01**	**2.20E-01**	**N/A**	**9.12E-02**	**C**	**N/A**	**N/A**	**Yes**	**ASL**
	86-30-6	n-Nitrosodiphenylamine			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	1.30E+02	C	N/A	N/A	No	BSL
	98-95-3	Nitrobenzene			mg/kg		0/4	2.00E-01 - 2.00E-01	2.00E-01	N/A	3.91E+00	N	N/A	N/A	No	BSL
	95-48-7	o-Cresol			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	3.91E+02	N	N/A	N/A	No	BSL
	59-50-7	p-Chloro-m-cresol			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	N/A		N/A	N/A	No	NTX
	106-47-8	p-Chloroaniline			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	3.13E+01	N	N/A	N/A	No	BSL
	106-44-5	p-Cresol			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	3.91E+01	N	N/A	N/A	No	BSL
	87-86-5	Pentachlorophenol			mg/kg		0/4	8.70E-01 - 1.10E+00	1.10E+00	N/A	5.32E+00	C	N/A	N/A	No	BSL
	108-95-2	Phenol			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	2.35E+03	N	N/A	N/A	No	BSL
	71-55-6	1,1,1-Trichloroethane			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	2.19E+03	N	N/A	N/A	No	BSL
	79-34-5	1,1,2,2-Tetrachloroethane			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	3.19E+00	C	N/A	N/A	No	BSL

Table E-2b
Summary of Screening for Non-Detected Chemicals at Building 4343

Scenario Timeframe: Future
Medium: Total Soil
Exposure Medium: Total Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (3) (N/C)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
	79-00-5	1,1,2-Trichloroethane			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	1.12E+01 C	N/A	N/A	No	BSL
	75-34-3	1,1-Dichloroethane			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	7.82E+02 N	N/A	N/A	No	BSL
	75-35-4	1,1-Dichloroethene			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	3.91E+02 N	N/A	N/A	No	BSL
	107-06-2	1,2-Dichloroethane			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	7.02E+00 C	N/A	N/A	No	BSL
	78-87-5	1,2-Dichloropropane			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	9.39E+00 C	N/A	N/A	No	BSL
	78-93-3	2-Butanone			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	4.69E+03 N	N/A	N/A	No	BSL
	591-78-6	2-Hexanone			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	3.13E+02 N	N/A	N/A	No	BSL
	101-55-3	4-Bromophenyl phenylether			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	N/A	N/A	N/A	No	NTX
	7005-72-3	4-Chlorophenyl phenylether			mg/kg		0/4	1.70E-01 - 2.20E-01	2.20E-01	N/A	N/A	N/A	N/A	No	NTX
	108-10-1	4-Methyl-2-pentanone			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	6.26E+02 N	N/A	N/A	No	BSL
	67-64-1	Acetone			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	7.80E+02 N	N/A	N/A	No	BSL
	71-43-2	Benzene			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	1.16E+01 C	N/A	N/A	No	BSL
	75-27-4	Bromodichloromethane			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	1.03E+01 C	N/A	N/A	No	BSL
	74-83-9	Bromomethane			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	1.10E+01 N	N/A	N/A	No	BSL
	75-15-0	Carbon disulfide			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	7.82E+02 N	N/A	N/A	No	BSL
	56-23-5	Carbon tetrachloride			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	4.91E+00 C	N/A	N/A	No	BSL
	108-90-7	Chlorobenzene			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	1.56E+02 N	N/A	N/A	No	BSL
	75-00-3	Chloroethane			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	2.20E+02 C	N/A	N/A	No	BSL
	74-87-3	Chloromethane			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	N/A	N/A	N/A	No	NTX
	10061-01-5	cis-1,3-Dichloro-1-propene			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	6.40E+00 C	N/A	N/A	No	BSL
	124-48-1	Dibromochloromethane			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	7.60E+00 C	N/A	N/A	No	BSL
	100-41-4	Ethylbenzene			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	7.82E+02 N	N/A	N/A	No	BSL
	75-09-2	Methylene chloride			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	8.52E+01 C	N/A	N/A	No	BSL
	100-42-5	Styrene			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	1.56E+03 N	N/A	N/A	No	BSL
	127-18-4	Tetrachloroethene			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	3.19E+01 C	N/A	N/A	No	BSL
	108-88-3	Toluene			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	1.56E+03 N	N/A	N/A	No	BSL
	10061-02-6	trans-1,3-Dichloropropene			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	6.39E+00 C	N/A	N/A	No	BSL
	75-25-2	Tribromomethane			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	8.09E+01 C	N/A	N/A	No	BSL
	79-01-6	Trichloroethene			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	1.60E+00 C	N/A	N/A	No	BSL
	67-66-3	Trichloromethane			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	7.82E+02 C	N/A	N/A	No	BSL
	75-01-4	Vinyl Chloride			mg/kg		0/4	4.70E-03 - 6.30E-03	6.30E-03	N/A	9.00E-02 C	N/A	N/A	No	BSL
	1330-20-7	Xylenes (total)			mg/kg		0/4	9.40E-03 - 1.30E-02	1.30E-02	N/A	1.56E+03 N	N/A	N/A	No	BSL

(1) Maximum concentration used for screening.

(2) N/A - Refer to supporting information for background discussion.
Background values derived from site-specific statistical analysis. See text for supporting information.

(3) Screening toxicity values from USEPA Region 3 RBC Table (April 2003). RBCs are based on a risk level of 1.0E-06 and HQ = 0.1. See text for derivation of Nutrient RDAs.

(4) Rationale Codes Selection Reason:
Infrequent Detection but Associated Historically (HIST)
Toxicity Information Available (TX)
Above Screening Levels (ASL)
Break Down Product (BDP)
Elevated Detected Concentration (EDC)

Deletion Reason:
Infrequent Detection (<= 5%, IFD)
Background Levels (BKG)
No Toxicity Information (NTX)
Below Screening and/or ARAR/TBC Level (BSL)

Definitions:
N/A = Not Applicable or Not Available
SQL = Sample Quantitation Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
MCL = Federal Maximum Contaminant Level
SMCL = Secondary Maximum Contaminant Level
C = Carcinogenic
N = Non-Carcinogenic
RDA = Recommended Daily Allowance (for nutrients)

Table E-3
Exposure Point Concentration Summary
Surface Soil - Building 4343

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

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Surface Soil (0 - 2 ft.)	Aluminum	mg/kg	1.40E+04	1.61E+04 (N)	2.51E+04	1.61E+04	mg/kg	95%UCL-N	W-Test(4)
	Antimony	mg/kg	2.25E+00	3.89E+00 (NP)	4.12E+01	3.89E+00	mg/kg	95%UCL-Bst	W-Test(1)
	Cadmium	mg/kg	1.08E+03	5.17E+04 (T)	2.43E+04	2.43E+04	mg/kg	Max	W-Test(5)
	Chromium	mg/kg	1.45E+02	2.23E+02 (T)	1.82E+03	2.23E+02	mg/kg	95%UCL-T	W-Test(2)
	Copper	mg/kg	5.79E+01	8.50E+01 (NP)	6.77E+02	8.50E+01	mg/kg	95%UCL-Bst	W-Test(1)
	Iron	mg/kg	2.99E+04	3.42E+04 (N)	5.14E+04	3.42E+04	mg/kg	95%UCL-N	W-Test(4)
	Lead	mg/kg	7.72E+01	1.33E+02 (NP)	1.41E+03	1.33E+02	mg/kg	95%UCL-Bst	W-Test(1)
	Manganese	mg/kg	2.70E+02	3.75E+02 (T)	6.42E+02	3.75E+02	mg/kg	95%UCL-T	W-Test(2)
	PCB-1254	mg/kg	1.12E-01	3.45E+01 (T)	3.44E-01	3.44E-01	mg/kg	Max	W-Test(3)
	Vanadium	mg/kg	5.97E+01	6.94E+01 (N)	1.08E+02	6.94E+01	mg/kg	95%UCL-N	W-Test(4)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N), 95% UCL based on bootstrap statistic (95% UCL-Bst).

N/A - Not Applicable; Not Available

Distributions: Normal (N); Lognormal/Transformed (T); Undefined/Nonparametric (NP).

Test(1) The data were determined to be neither normally or lognormally distributed using Shapiro-Wilks (sample size<=50) or the Shapiro-Francia Calculation (sample size > 50), and the bootstrap statistic used.

Test(2) The data were determined to be lognormally distributed using Shapiro-Wilks (sample size<=50) or the Shapiro-Francia Calculation (sample size > 50).

Test(3) The 95% UCL was not calculated due to limited number of samples (n<=5); therefore, the maximum detect was used as the EPC.

Test(4) The data were determined to be normally distributed using Shapiro-Wilks Shapiro-Wilks (sample size<=50) or the Shapiro-Francia Calculation (sample size > 50).

Test(5) The 95% UCL exceeds the maximum detected concentration; therefore, the maximum detect was used as the EPC.

Table E-4
Exposure Point Concentration Summary
Total Soil - Building 4343

Scenario Timeframe: Future
Medium: Total Soil
Exposure Medium: Total Soil

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Mixed Surface and Subsurface Soil (0 - 10 ft)	Aluminum	mg/kg	1.91E+04	2.14E+04 (NP)	5.40E+04	2.14E+04	mg/kg	95%UCL-Bst	W-Test(1)
	Antimony	mg/kg	1.26E+00	1.98E+00 (NP)	4.12E+01	1.98E+00	mg/kg	95%UCL-Bst	W-Test(1)
	Cadmium	mg/kg	4.79E+02	9.03E+02 (NP)	2.43E+04	9.03E+02	mg/kg	95%UCL-Bst	W-Test(1)
	Chromium	mg/kg	9.15E+01	1.24E+02 (NP)	1.82E+03	1.24E+02	mg/kg	95%UCL-Bst	W-Test(1)
	Copper	mg/kg	3.73E+01	4.87E+01 (NP)	6.77E+02	4.87E+01	mg/kg	95%UCL-Bst	W-Test(1)
	Iron	mg/kg	3.45E+04	3.89E+04 (NP)	9.91E+04	3.89E+04	mg/kg	95%UCL-Bst	W-Test(1)
	Lead	mg/kg	4.60E+01	7.01E+01 (NP)	1.41E+03	7.07E+01	mg/kg	95%UCL-Bst	W-Test(1)
	PCB-1254	mg/kg	8.16E-02	1.37E-01 (NP)	3.44E-01	1.37E-01	mg/kg	95%UCL-Bst	W-Test(1)
	Thallium	mg/kg	4.81E-01	5.61E-01 (NP)	1.20E+00	5.61E-01	mg/kg	95%UCL-Bst	W-Test(1)
	Vanadium	mg/kg	7.77E+01	9.84E+01 (T)	2.05E+02	9.84E+01	mg/kg	95%UCL-T	W-Test(2)

Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T); Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N), 95% UCL based on bootstrap statistic (95% UCL-Bst).

N/A - Not Applicable; Not Available

Distributions: Normal (N); Lognormal/Transformed (T); Undefined/Nonparametric (NP).

Test(1) The data were determined to be neither normally or lognormally distributed using Shapiro-Wilks (sample size<=50) or the Shapiro-Francia Calculation (sample size > 50), and the bootstrap statistic used.

Test(2) The data were determined to be lognormally distributed using Shapiro-Wilks (sample size<=50) or the Shapiro-Francia Calculation (sample size > 50).

Test(3) The 95% UCL was not calculated due to limited number of samples (n<=5); therefore, the maximum detect was used as the EPC.

Test(4) The data were determined to be normally distributed using Shapiro-Wilks Shapiro-Wilks (sample size<=50) or the Shapiro-Francia Calculation (sample size > 50).

Test(5) The 95% UCL exceeds the maximum detected concentration; therefore, the maximum detect was used as the EPC.

Table E-5
Values Used for Daily Intake Calculations- Current and Future Exposures to Surface Soil

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

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Maintenance Worker	Adult	Building 4343	CS	Chemical Concentration in Soil	See site-specific EPC tables	mg/kg	See site-specific EPC tables	
				IR-S	Ingestion Rate of Soil	100	mg/day	USEPA, 2001	Potential (Lifetime) Average Daily Dose
				EF	Exposure Frequency	50	days/year	(1)	$[(L)ADD_{pot}]$ (mg/kg-day) =
				ED	Exposure Duration	25	years	USEPA, 2001	
				CF1	Conversion Factor 1	$1/10^6$	kg/mg	---	$\frac{CS \times IR\text{-}S \times EF \times ED \times CF1}{BW \times AT \times CF2}$
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	70	years	USEPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	25	years	USEPA, 2001	
				CF2	Conversion Factor 2	365	days/year	---	
Dermal Absorption	Maintenance Worker	Adult	Building 4343	CS	Chemical Concentration in Soil	See site-specific EPC tables	mg/kg	See site-specific EPC tables	
				SSAF	Soil to Skin Adherence Factor	0.2	mg/cm^2-day	USEPA, 1997, 2001	Internal (Lifetime) Average Daily Dose
				DABS	Dermal Absorption Factor (Solid)	(2)	--	USEPA, 1995	$[(L)ADD_{int}]$ (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	3,300 (3)	cm^2	USEPA, 1997	
				EF	Exposure Frequency	50	days/year	(1)	$\frac{CS \times SSAF \times DABS \times SA \times EF \times ED \times CF1}{BW \times AT \times CF2}$
				ED	Exposure Duration	25	years	USEPA, 2001	
				CF1	Conversion Factor 1	$1/10^6$	kg/mg	---	
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	70	years	USEPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	25	years	USEPA, 2001	
				CF2	Conversion Factor 2	365	days/year	---	

(1) Best professional judgement. Based on site maintenance/inspection activities conducted 1day/week and assuming 2 weeks on vacation.
(2) Dermal absorption factors are presented in *Section 6.2.3* of the text.
(3) Value derived from data presented in USEPA (1997), averaging across gender and age. It is assumed that head, hands, and forearms are exposed to surface soil.

USEPA, 1991: Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER 9285.6-03.
USEPA, 1995: Assessing Dermal Exposure from Soil Hazardous Waste Management Division. Office of Superfund Programs, Region III, Philadelphia, PA.
USEPA, 1997: Exposure Factors Handbook, Volume I. EPA/600/P-95/002Fa.
USEPA, 2001: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Peer Review Draft. OSWER 9355.4-24.

Table E-6
Values Used for Daily Intake Calculations- Future Exposures to Total Soil

Scenario Timeframe:	Future
Medium:	Total Soil
Exposure Medium:	Total Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Maintenance Worker	Adult	Building 4343	CS	Chemical Concentration in Soil	See site-specific EPC tables	mg/kg	See site-specific EPC tables	
				IR-S	Ingestion Rate of Soil	100	mg/day	USEPA, 2001	Potential (Lifetime) Average Daily Dose
				EF	Exposure Frequency	50	days/year	(1)	$[(L)ADD_{pot}]$ (mg/kg-day) =
				ED	Exposure Duration	25	years	USEPA, 2001	
				CF1	Conversion Factor 1	$1/10^6$	kg/mg	---	$\frac{CS \times IR\text{-}S \times EF \times ED \times CF1}{BW \times AT \times CF2}$
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	70	years	USEPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	25	years	USEPA, 2001	
				CF2	Conversion Factor 2	365	days/year	---	
	Excavation Worker	Adult	Building 4343	CS	Chemical Concentration in Soil	See site-specific EPC tables	mg/kg	See site-specific EPC tables	
				IR-S	Ingestion Rate of Soil	330	mg/day	USEPA, 2001	Potential (Lifetime) Average Daily Dose
				EF	Exposure Frequency	250	days/year	USEPA, 2001	$[(L)ADD_{pot}]$ (mg/kg-day) =
				ED	Exposure Duration	1	years	USEPA, 2001	
				CF1	Conversion Factor 1	$1/10^6$	kg/mg	---	$\frac{CS \times IR\text{-}S \times EF \times ED \times CF1}{BW \times AT \times CF2}$
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	70	years	USEPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	1	years	USEPA, 2001	
				CF2	Conversion Factor 2	365	days/year	---	
	Resident	Adult	Building 4343	CS	Chemical Concentration in Soil	See site-specific EPC tables	mg/kg	See site-specific EPC tables	
				IR-S	Ingestion Rate of Soil	100	mg/day	USEPA, 1991	Potential (Lifetime) Average Daily Dose
				EF	Exposure Frequency	350	days/year	USEPA, 1991	$[(L)ADD_{pot}]$ (mg/kg-day) =
				ED	Exposure Duration	30	years	USEPA, 1991	
				CF1	Conversion Factor 1	$1/10^6$	kg/mg	---	$\frac{CS \times IR\text{-}S \times EF \times ED \times CF1}{BW \times AT \times CF2}$
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	70	years	USEPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	30	years	USEPA, 1991	
				CF2	Conversion Factor 2	365	days/year	---	
		Child	Building 4343	CS	Chemical Concentration in Soil	See site-specific EPC tables	mg/kg	See site-specific EPC tables	
				IR-S	Ingestion Rate of Soil	200	mg/day	USEPA, 1991	Potential (Lifetime) Average Daily Dose
				EF	Exposure Frequency	350	days/year	USEPA, 1991	$[(L)ADD_{pot}]$ (mg/kg-day) =
				ED	Exposure Duration	6	years	USEPA, 1991	
				CF1	Conversion Factor 1	$1/10^6$	kg/mg	---	$\frac{CS \times IR\text{-}S \times EF \times ED \times CF1}{BW \times AT \times CF2}$
				BW	Body Weight	15	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	70	years	USEPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	6	years	USEPA, 1991	
				CF2	Conversion Factor 2	365	days/year	---	
Dermal Absorption	Maintenance Worker	Adult	Building 4343	CS	Chemical Concentration in Soil	See site-specific EPC tables	mg/kg	See site-specific EPC tables	
				SSAF	Soil to Skin Adherence Factor	0.2	mg/cm^2-day	USEPA, 1997, 2001	Internal (Lifetime) Average Daily Dose
				DABS	Dermal Absorption Factor (Solid)	(2)	--	USEPA, 1995	$[(L)ADD_{int}]$ (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	3,300 (3)	cm^2	USEPA, 1997	
				EF	Exposure Frequency	50	days/year	(1)	$\frac{CS \times SSAF \times DABS \times SA \times EF \times ED \times CF1}{BW \times AT \times CF2}$
				ED	Exposure Duration	25	years	USEPA, 2001	
				CF1	Conversion Factor 1	$1/10^6$	kg/mg	---	
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	70	years	USEPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	25	years	USEPA, 2001	
				CF2	Conversion Factor 2	365	days/year	---	

Table E-6
Values Used for Daily Intake Calculations- Future Exposures to Total Soil

Scenario Timeframe:	Future
Medium:	Total Soil
Exposure Medium:	Total Soil

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Dermal Absorption (con't)	Excavation Worker	Adult	Building 4343	CS	Chemical Concentration in Soil	See site-specific EPC tables	mg/kg	See site-specific EPC tables	
				SSAF	Soil to Skin Adherence Factor	0.3	mg/cm^2-day	USEPA, 2001	Internal (Lifetime) Average Daily Dose
				DABS	Dermal Absorption Factor (Solid)	(2)	--	USEPA, 1995	[(L)ADD$_{int}$] (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	3,300 (3)	cm^2	USEPA, 1997	
				EF	Exposure Frequency	250	days/year	USEPA, 2001	CS x SSAF x DABS x SA x EF x ED x CF1
				ED	Exposure Duration	1	years	USEPA, 2001	BW x AT x CF2
				CF1	Conversion Factor 1	1/10^6	kg/mg	---	
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	70	years	USEPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	1	years	USEPA, 2001	
				CF2	Conversion Factor 2	365	days/year	---	
	Resident	Adult	Building 4343	CS	Chemical Concentration in Soil	See site-specific EPC tables	mg/kg	See site-specific EPC tables	
				SSAF	Soil to Skin Adherence Factor	0.07	mg/cm^2-day	USEPA, 1997, 2001	Internal (Lifetime) Average Daily Dose
				DABS	Dermal Absorption Factor (Solid)	(2)	--	USEPA, 1995	[(L)ADD$_{int}$] (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	5,700 (4)	cm^2	USEPA, 1997	
				EF	Exposure Frequency	350	days/year	USEPA, 1991	CS x SSAF x DABS x SA x EF x ED x CF1
				ED	Exposure Duration	30	years	USEPA, 1991	BW x AT x CF2
				CF1	Conversion Factor 1	1/10^6	kg/mg	---	
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	70	years	USEPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	30	years	USEPA, 1991	
				CF2	Conversion Factor 2	365	days/year	---	
		Child	Building 4343	CS	Chemical Concentration in Soil	See site-specific EPC tables	mg/kg	See site-specific EPC tables	
				SSAF	Soil to Skin Adherence Factor	0.2	mg/cm^2-day	USEPA, 1997, 2001	Internal (Lifetime) Average Daily Dose
				DABS	Dermal Absorption Factor (Solid)	(2)	--	USEPA, 1995	[(L)ADD$_{int}$] (mg/kg-day) =
				SA	Skin Surface Area Available for Contact	2,800 (5)	cm^2	USEPA, 1997	
				EF	Exposure Frequency	350	days/year	USEPA, 1991	CS x SSAF x DABS x SA x EF x ED x CF1
				ED	Exposure Duration	6	years	USEPA, 1991	BW x AT x CF2
				CF1	Conversion Factor 1	1/10^6	kg/mg	---	
				BW	Body Weight	15	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	70	years	USEPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	6	years	USEPA, 1991	
				CF2	Conversion Factor 2	365	days/year	---	

(1) Best professional judgment. Based on site maintenance/inspection activities conducted 1day/week and assuming 2 weeks on vacation.
(2) Dermal absorption factors are presented in **Section 6.2.3** of the text.
(3) Value derived from data presented in USEPA (1997), averaging across gender and age. It is assumed that head, hands, and forearms are exposed to soil.
(4) Value derived from data presented in USEPA (1997), averaging across gender and age. It is assumed that head, hands, forearms, and lower legs are exposed to soil.
(5) Value derived from data presented in USEPA (1997), averaging across gender and age. It is assumed that head, hands, forearms, lower legs, and feet are exposed to soil.

USEPA, 1991: Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER 9285.6-03.
USEPA, 1995: Assessing Dermal Exposure from Soil Hazardous Waste Management Division. Office of Superfund Programs, Region III, Philadelphia, PA.
USEPA, 1997: Exposure Factors Handbook, Volume I. EPA/600/P-95/002Fa.
USEPA, 2001: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Peer Review Draft. OSWER 9355.4-24.

Table E-7
Values Used for Daily Intake Calculations- Current/Future Exposures to Surface Soil- Air

Scenario Timeframe:	Current and Future
Medium:	Surface Soil
Exposure Medium:	Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Maintenance Worker	Adult	Particulates	CS	Chemical Concentration in Soil	See site-specific EPC tables	mg/kg	See site-specific EPC tables	
				PEF	Particulate Emission Factor	Site-Specific PEF	m^3/kg	Site-Specific PEF	
				IN	Inhalation Rate	2.5	m^3/h	(1)	Potential (Lifetime) Average Daily Dose
				EF	Exposure Frequency	50	days/year	(2)	$[(L)ADD_{pot}]$ (mg/kg-day) =
				ED	Exposure Duration	25	years	USEPA, 2001	
				ET	Exposure Time	8	hr/day	USEPA, 1991	$\frac{CS \times (1/PEF) \times IN \times EF \times ED \times ET}{BW \times AT \times CF1}$
				BW	Body Weight	70	kg	USEPA, 1991	
				AT-C	Averaging Time (Cancer)	70	years	USEPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	25	years	USEPA, 2001	
				CF1	Conversion Factor 1	365	days/year	---	

(1) The hourly inhalation rate was derived by dividing the adult's daily 20 m^3/day USEPA (1991) inhalation rate by 8 hours per day.
(2) Best professional judgement. Based on site maintenance/inspection activities conducted 1day/week and assuming 2 weeks on vacation.

USEPA, 1991: Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER 9285.6-03.
USEPA, 2001: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Peer Review Draft. OSWER 9355.4-24.

Table E-8
Values Used for Daily Intake Calculations- Future Exposures to Total Soil- Air

Scenario Timeframe:	Future
Medium:	Total Soil
Exposure Medium:	Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Maintenance Worker	Adult	Particulates	CS	Chemical Concentration in Soil	See site-specific EPC tables	mg/kg	See site-specific EPC tables	
				PEF	Particulate Emission Factor	Site-Specific PEF	m^3/kg	Site-Specific PEF	
				IN	Inhalation Rate	2.5	m^3/h	(1)	Potential (Lifetime) Average Daily Dose
				EF	Exposure Frequency	50	days/year	(2)	$[(L)ADD_{pot}]$ (mg/kg-day) =
				ED	Exposure Duration	25	years	USEPA, 2001	
				ET	Exposure Time	8	hr/day	USEPA, 1991	CS x (1/PEF) x IN x EF x ED x ET
				BW	Body Weight	70	kg	USEPA, 1991	BW x AT x CF1
				AT-C	Averaging Time (Cancer)	70	years	USEPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	25	years	USEPA, 2001	
				CF1	Conversion Factor 1	365	days/year	---	
	Excavation Worker	Adult	Particulates	CS	Chemical Concentration in Soil	See site-specific EPC tables	mg/kg	See site-specific EPC tables	
				PEF	Particulate Emission Factor	Site-Specific PEF	m^3/kg	Site-Specific PEF	
				IN	Inhalation Rate	2.5	m^3/h	(1)	Potential (Lifetime) Average Daily Dose
				EF	Exposure Frequency	250	days/year	USEPA, 2001	$[(L)ADD_{pot}]$ (mg/kg-day) =
				ED	Exposure Duration	1	years	USEPA, 2001	
				ET	Exposure Time	8	hr/day	USEPA, 1991	CS x (1/PEF) x IN x EF x ED x ET
				BW	Body Weight	70	kg	USEPA, 1991	BW x AT x CF1
				AT-C	Averaging Time (Cancer)	70	years	USEPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	1	years	USEPA, 2001	
				CF1	Conversion Factor 1	365	days/year	---	
	Resident	Adult	Particulates	CS	Chemical Concentration in Soil	See site-specific EPC tables	mg/kg	See site-specific EPC tables	
				PEF	Particulate Emission Factor	Site-Specific PEF	m^3/kg	Site-Specific PEF	
				IN	Inhalation Rate	0.83	m^3/h	(3)	Potential (Lifetime) Average Daily Dose
				EF	Exposure Frequency	350	days/year	USEPA, 1991	$[(L)ADD_{pot}]$ (mg/kg-day) =
				ED	Exposure Duration	30	years	USEPA, 1991	
				ET	Exposure Time	1	hr/day	(4)	CS x (1/PEF) x IN x EF x ED x ET
				BW	Body Weight	70	kg	USEPA, 1991	BW x AT x CF1
				AT-C	Averaging Time (Cancer)	70	years	USEPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	30	years	USEPA, 1991	
				CF1	Conversion Factor 1	365	days/year	---	
		Child	Particulates	CS	Chemical Concentration in Soil	See site-specific EPC tables	mg/kg	See site-specific EPC tables	
				PEF	Particulate Emission Factor	Site-Specific PEF	m^3/kg	Site-Specific PEF	
				IN	Inhalation Rate	1	m^3/h	(5)	Potential (Lifetime) Average Daily Dose
				EF	Exposure Frequency	350	days/year	USEPA, 1991	$[(L)ADD_{pot}]$ (mg/kg-day) =
				ED	Exposure Duration	6	years	USEPA, 1991	
				ET	Exposure Time	1	hr/day	(6)	CS x (1/PEF) x IN x EF x ED x ET
				BW	Body Weight	15	kg	USEPA, 1991	BW x AT x CF1
				AT-C	Averaging Time (Cancer)	70	years	USEPA, 1991	
				AT-N	Averaging Time (Non-Cancer)	6	years	USEPA, 1991	
				CF1	Conversion Factor 1	365	days/year	---	

(1) The maintenance worker and excavation worker hourly inhalation rate was derived by dividing the adult's daily 20 m^3/day USEPA (1991) inhalation rate by 8 hours per day.
(2) Best professional judgement. Based on site maintenance/inspection activities conducted 1day/week and assuming 2 weeks on vacation.
(3) The adult resident hourly inhalation rate was derived by dividing the adult daily 20 m^3/day USEPA (1991) inhalation rate by 24 hours per day.
(4) Exposure time is based upon the average time an adult spends outdoors, assuming 1.5 hours/day (USEPA, 1997) with the exception of the three coldest months of the year.
(5) The child resident hourly inhalation rate was based on light activities (USEPA, 1997).
(6) Exposure time is based upon the assumption that children (ages 6 years and under) would be accompanied or supervised by an adult during time spent outdoors. Therefore, the exposure time for the child is is equivalent to the adult, i.e., an average time of 1.5 hours/day (USEPA, 1997) with the exception of the coldest months of the year.

USEPA, 1991: Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER 9285.6-03.
USEPA, 2001: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Peer Review Draft. OSWER 9355.4-24.

Table E-9
Non-Cancer Toxicity Data - Oral/Dermal

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral to Dermal Efficiency for Dermal (1)	Absorbed RfD for Dermal (2)		Primary Target Organ(s)	Combined Uncertainty/ Modifying Factors	RfD:Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Dates of RfD (3): (MM/DD/YY)
Aluminum	Chronic	1E+00	mg/kg-day	27%	2.7E-01	mg/kg-day	Developmental Neurotoxicity	100	NCEA	8/26/96
Antimony	Chronic	4E-04	mg/kg-day	15%	6.0E-05	mg/kg-day	Blood Chemistry	1,000	IRIS	7/25/03:2/1/91
Cadmium (food)	Chronic	1E-03	mg/kg-day	2.5%	2.5E-05	mg/kg-day	Kidney	10	IRIS	7/25/03:2/1/94
Chromium (III)	Chronic	1.5E+00	mg/kg-day	1.3%	2.0E-02	mg/kg-day	NOAEL	1,000	IRIS	7/25/03:9/3/98
Copper	Chronic	4E-02	mg/kg-day	100%	4.0E-02	mg/kg-day	GI Tract	N/A	HEAST	1997
Iron	Chronic	3E-01	mg/kg-day	100%	3.0E-01	mg/kg-day	GI Irritation, Blood, Liver	1	VDEQ, 2003; NCEA	7/23/96
Lead	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (non-food)	Chronic	2.0E-02	mg/kg-day	4%	8.0E-04	mg/kg-day	CNS	1	IRIS	7/25/03:5/1/96
Aroclor 1254	Chronic	2E-05	mg/kg-day	100%	2.0E-05	mg/kg-day	Eyes, Immune System	300	IRIS	7/25/03:11/1/96
Thallium (4)	Chronic	8E-05	mg/kg-day	100%	8.0E-05	mg/kg-day	Liver, Blood, Hair	3,000	IRIS; VDEQ, 2003	7/25/03:9/1/90
Vanadium	Chronic	7E-03	mg/kg-day	2.6%	1.8E-04	mg/kg-day	NOAEL	100	HEAST	1997

(1) Source: Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. Section 4.2 and Exhibit 4-1.
(2) The equation used to derive the adjusted dermal RfD is presented in the text.
(3) For IRIS values, the date IRIS was searched and the date of the most recent review are provided. For HEAST values, the date of HEAST is provided. For NCEA values, the date of the article provided by NCEA is provided.
(4) The toxicity information for thallium chloride was used.

Definitions:
N/A = Not Available
IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
NCEA = National Center for Environmental Assessment
EPA, 2003 = EPA Region III April 25, 2003 RBC table.
VDEQ, 2003 = Virginia Department of Environmental Quality, Voluntary Remediation Program, Table 4.1, Non-Cancer Toxicity Data, June 19, 2003.

Table E-10
Cancer Toxicity Data - Oral/Dermal

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal (1)	Absorbed Cancer Slope Factor for Dermal (2)		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units		Value	Units		Source	Date (3) (MM/DD/YY)
Aluminum	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Antimony	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium (water/food)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chromium (III)	N/A	N/A	N/A	N/A	N/A	D	IRIS	7/25/03:9/3/98
Copper	N/A	N/A	N/A	N/A	N/A	D	IRIS	7/25/03:8/1/91
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese	N/A	N/A	N/A	N/A	N/A	D	IRIS	7/25/03:12/1/96
Aroclor 1254 (4)	2.0E+00	$(mg/kg\text{-}day)^{-1}$	100%	2.0E+00	$(mg/kg\text{-}day)^{-1}$	B2	EPA, 2002	7/25/03:6/1/97
Thallium	N/A	N/A	N/A	N/A	N/A	D	IRIS	7/25/03:9/1/90
Vanadium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(1) Source: Risk Assessment Guidance for Fuperfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. Section 4.2 and Exhibit 4-1.

(2) The equation for deriving the adjusted dermal cancer slope factors are presented in the text.

(3) For IRIS values, the date IRIS was searched and the date of the most recent review are provided. For HEAST values, the date of HEAST is provided. For NCEA values, the date of the article provided by NCEA is provided.

(4) Value for polychlorinated biphenyls was used.

Definitions: N/A = Not Available
IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables
NCEA = National Center for Environmental Assessment
EPA, 2003 = EPA Region III April 25, 2003 RBC table.

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

Table E-11
Non-Cancer Toxicity Data - Inhalation

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD (1)		Primary Target Organ (s)	Combined Uncertainty/ Modifying Factors	RfC:Target Organ(s)	
		Value	Units	Value	Units			Source(s) (2)	Dates of RfD: (MM/DD/YY)
Aluminum	N/A	N/A	N/A	1.0E-03	mg/kg-day	N/A	N/A	EPA, 2003; NCEA	4/25/2003
Antimony	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium	Chronic	2.0E-04	mg/m^3	5.7E-05	mg/kg-day	Kidney	N/A	NCEA	3/20/1996
Chromium (3)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Copper	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese	Chronic	5.0E-05	mg/m^3	1.43E-05	mg/kg-day	CNS	1,000	IRIS	7/25/03:12/1/93
Aroclor 1254	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Thallium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vanadium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(1) The adjusted inhalation RfD was derived from the RfC value assuming a 70 kg adult inhales 20 m^3/day as follows: RfD = RfC * (20 m^3/day / 70 kg).

(2) For NCEA values, the date of the article provided by NCEA is provided.
For IRIS values, the date IRIS was searched and the date of the most recent review are provided.
For HEAST values, the date of HEAST is provided.

(3) No inhalation RfC is available for chromium III.

Definitions: N/A = Not Available
IRIS = Integrated Risk Information System
NCEA = National Center for Environmental Assessment
HEAST = Health Effects Assessment Tables
EPA, 2003 = EPA Region III April 25, 2003 RBC table.

Table E-12
Cancer Toxicity Data - Inhalation

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor		Weight of Evidence/ Cancer Guideline Description	Unit Risk: Inhalation CSF	
	Value	Units	Value	Units		Source	Date (1) (MM/DD/YY)
Aluminum	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Antimony	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium	1.8E-03	$(ug/m^3)^{-1}$	6.3E+00	$(mg/kg\text{-}day)^{-1}$	B1	IRIS	10/16/02:6/01/92
Chromium (III)	N/A	N/A	N/A	N/A	D	IRIS	7/25/03:9/3/98
Copper	N/A	N/A	N/A	N/A	D	IRIS	7/25/03:8/1/91
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aroclor 1254 (2)	5.7E-04	$(ug/m^3)^{-1}$	2.0E+00	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	7/25/03:6/1/97
Thallium	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vanadium	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(1) For IRIS values, the date IRIS was searched and the date of the most recent review are provided.
(2) Value for polychlorinated biphenyls used.

Definitions: IRIS = Integrated Risk Information System

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE E-13a
RAGS D ADULT LEAD WORKSHEET
Radford Army Ammunition Plant – Building 4343
Calculations of Blood Lead Concentrations – Surface Soil – Maintenance Worker

1. Lead Screening Questions

Medium	Lead Concentration used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	77	mg/kg	Average Detected Value	800	mg/kg	Recommended Soil Screening Level

2. Lead Model Questions

Question	Response
What lead model was used? Provide reference and version	USEPA Adult Lead Model, Version dated 5/19/03
If the EPA Adult Lead Model (ALM) was not used provide rationale for model selected.	N/A
Where are the input values located in the risk assessment report?	Located in **Appendix E, Table E-13b**
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure point concentration was based on the arithmetic mean of lead concentrations in surface soil; See Appendix E
What was the point of exposure and location?	Surface Soil – Building 4343
Where are the output values located in the risk assessment report?	Located in **Appendix E, Table E-13b**
What GSD value was used? If this is outside the recommended range of 1.8 to 2.1), provide rationale in Appendix <Y>.	GSD = 2.2 as the midrange value of updated GSD values (2.1 to 2.3) from NHANES III (USEPA, 2002)
What baseline blood lead concentration (PbB_0) value was used? If this is outside the default range of 1.7 to 2.2 provide rationale in Appendix <Y>	PbB_0 = 1.6 ug/dL as the midrange value of updated PbB_0 values (1.5 to 1.7 ug/dL) from NHANES III (USEPA, 2002)
Was the default exposure frequency (EF; 219 days/year) used?	Yes. Default value was used as a conservative estimate for intermittent maintenance activities (50 days/year).
Was the default BKSF used (0.4 ug/dL per ug/day) used?	Yes
Was the default absorption fraction (AF; 0.12) used?	Yes
Was the default soil ingestion rate (IR; 50 mg/day) used?	Yes
If non-default values were used for any of the parameters listed above, where is the rationale for the values located in the risk assessment report?	Discussion of parameters in *Section 6.3.2* and **Appendix E**

3. Final Result

Medium	Result	Comment/RBRG [1]
Soil	Input value of 77 ppm in soil results in 0.9% of receptors above a geometric mean blood lead = 1.7 ug/dL. This is below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children (fetuses of exposed women) exceeding 10 ug/dL blood lead.	PRG not calculated.

1. The ALM spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used is presented as **Appendix E, Table E-13b**. For additional information, see www.epa.gov/superfund/programs/lead

Table E-13b
Calculations of Blood Lead Concentrations (PbBs)
USEPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 05/19/03

Exposure Variable	PbB Equation[1] 1*	PbB Equation[1] 2**	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Using Equation 1, GSDi = Hom	Using Equation 1, GSDi = Het	Using Equation 2, GSDi = Hom	Using Equation 2, GSDi = Het
PbS	X	X	Soil lead concentration	ug/g or ppm	77	77	77	77
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	2.2	2.2	2.2	2.2
PbB_0	X	X	Baseline PbB	ug/dL	1.6	1.6	1.6	1.6
IR_S	X		Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050	0.050	--	--
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	0.050	0.050
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	1.0	1.0
K_{SD}		X	Mass fraction of soil in dust	--	--	--	0.7	0.7
$AF_{S,D}$	X	X	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12
$EF_{S,D}$	X	X	Exposure frequency (same for soil and dust)	days/yr	219	219	219	219
$AT_{S,D}$	X	X	Averaging time (same for soil and dust)	days/yr	365	365	365	365
PbB_{adult}	**PbB of adult worker, geometric mean**			**ug/dL**	**1.7**	**1.7**	**1.7**	**1.7**
$PbB_{fetal,\ 0.95}$	**95th percentile PbB among fetuses of adult workers**			**ug/dL**	**5.6**	**5.6**	**5.6**	**5.6**
PbB_t	**Target PbB level of concern (e.g., 10 ug/dL)**			**ug/dL**	**10.0**	**10.0**	**10.0**	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**			**%**	**0.9%**	**0.9%**	**0.9%**	**0.9%**

[1] Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}).
When $IR_S = IR_{S+D}$ and $W_S = 1.0$, the equations yield the same $PbB_{fetal,0.95}$.

***Equation 1, based on Eq. 1, 2 in USEPA (1996).**

PbB_{adult} =	$(PbS*BKSF*IR_{S+D}*AF_{S,D}*EF_S/AT_{S,D}) + PbB_0$
$PbB_{fetal,\ 0.95}$ =	$PbB_{adult} * (GSD_i^{1.645} * R)$

****Equation 2, alternate approach based on Eq. 1, 2, and A-19 in USEPA (1996).**

PbB_{adult} =	$PbS*BKSF*([(IR_{S+D})*AF_S*EF_S*W_S]+[K_{SD}*(IR_{S+D})*(1-W_S)*AF_D*EF_D])/365+PbB_0$
$PbB_{fetal,\ 0.95}$ =	$PbB_{adult} * (GSD_i^{1.645} * R)$

Source: USEPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

TABLE E-14a
RAGS D ADULT LEAD WORKSHEET
Radford Army Ammunition Plant – Building 4343
Calculations of Blood Lead Concentrations – Total Soil – Maintenance Worker

1. Lead Screening Questions

Medium	Lead Concentration used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	46	mg/kg	Average Detected Value	800	mg/kg	Recommended Soil Screening Level

2. Lead Model Questions

Question	Response
What lead model was used? Provide reference and version	USEPA Adult Lead Model, Version dated 5/19/03
If the EPA Adult Lead Model (ALM) was not used provide rationale for model selected.	N/A
Where are the input values located in the risk assessment report?	Located in **Appendix E, Table E-14b**
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure point concentration was based on the arithmetic mean of lead concentrations in total soil; See Appendix E
What was the point of exposure and location?	Total Soil – Building 4343
Where are the output values located in the risk assessment report?	Located in **Appendix E, Table E-14b**
What GSD value was used? If this is outside the recommended range of 1.8 to 2.1), provide rationale in Appendix <Y>.	GSD = 2.2 as the midrange value of updated GSD values (2.1 to 2.3) from NHANES III (USEPA, 2002)
What baseline blood lead concentration (PbB_0) value was used? If this is outside the default range of 1.7 to 2.2 provide rationale in Appendix <Y>	PbB_0 = 1.6 ug/dL as the midrange value of updated PbB_0 values (1.5 to 1.7 ug/dL) from NHANES III (USEPA, 2002)
Was the default exposure frequency (EF; 219 days/year) used?	Yes. Default value was used as a conservative estimate for intermittent maintenance activities (50 days/year).
Was the default BKSF used (0.4 ug/dL per ug/day) used?	Yes
Was the default absorption fraction (AF; 0.12) used?	Yes
Was the default soil ingestion rate (IR; 50 mg/day) used?	Yes
If non-default values were used for any of the parameters listed above, where is the rationale for the values located in the risk assessment report?	Discussion of parameters in *Section 6.3.2* and **Appendix E**

3. Final Result

Medium	Result	Comment/RBRG [1]
Soil	Input value of 46 ppm in soil results in 0.8% of receptors above a geometric mean blood lead = 1.7 ug/dL. This is below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children (fetuses of exposed women) exceeding 10 ug/dL blood lead.	PRG not calculated.

1. The ALM spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used is presented as **Appendix E, Table E-14b**. For additional information, see www.epa.gov/superfund/programs/lead

Table E-14b
Calculations of Blood Lead Concentrations (PbBs)
USEPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 05/19/03

Exposure Variable	PbB Equation[1] 1*	PbB Equation[1] 2**	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Using Equation 1, GSDi = Hom	Using Equation 1, GSDi = Het	Using Equation 2, GSDi = Hom	Using Equation 2, GSDi = Het
PbS	X	X	Soil lead concentration	ug/g or ppm	46	46	46	46
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	2.2	2.2	2.2	2.2
PbB_0	X	X	Baseline PbB	ug/dL	1.6	1.6	1.6	1.6
IR_S	X		Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050	0.050	--	--
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	0.050	0.050
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	1.0	1.0
K_{SD}		X	Mass fraction of soil in dust	--	--	--	0.7	0.7
$AF_{S,D}$	X	X	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12
$EF_{S,D}$	X	X	Exposure frequency (same for soil and dust)	days/yr	219	219	219	219
$AT_{S,D}$	X	X	Averaging time (same for soil and dust)	days/yr	365	365	365	365
PbB_{adult}	**PbB of adult worker, geometric mean**			**ug/dL**	**1.7**	**1.7**	**1.7**	**1.7**
$PbB_{fetal,\ 0.95}$	**95th percentile PbB among fetuses of adult workers**			**ug/dL**	**5.5**	**5.5**	**5.5**	**5.5**
PbB_t	**Target PbB level of concern (e.g., 10 ug/dL)**			**ug/dL**	**10.0**	**10.0**	**10.0**	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**			**%**	**0.8%**	**0.8%**	**0.8%**	**0.8%**

[1] Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}).
When $IR_S = IR_{S+D}$ and $W_S = 1.0$, the equations yield the same $PbB_{fetal,0.95}$.

***Equation 1, based on Eq. 1, 2 in USEPA (1996).**

PbB_{adult} =	$(PbS*BKSF*IR_{S+D}*AF_{S,D}*EF_S/AT_{S,D}) + PbB_0$
$PbB_{fetal,\ 0.95}$ =	$PbB_{adult} * (GSD_i^{1.645} * R)$

****Equation 2, alternate approach based on Eq. 1, 2, and A-19 in USEPA (1996).**

PbB_{adult} =	$PbS*BKSF*([(IR_{S+D})*AF_S*EF_S*W_S]+[K_{SD}*(IR_{S+D})*(1-W_S)*AF_D*EF_D])/365+PbB_0$
$PbB_{fetal,\ 0.95}$ =	$PbB_{adult} * (GSD_i^{1.645} * R)$

Source: USEPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

TABLE E-15a
RAGS D ADULT LEAD WORKSHEET
Radford Army Ammunition Plant – Building 4343
Calculations of Blood Lead Concentrations – Total Soil – Excavation Worker

1. Lead Screening Questions

Medium	Lead Concentration used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	46	mg/kg	Average Detected Value	800	mg/kg	Recommended Soil Screening Level

2. Lead Model Questions

Question	Response
What lead model was used? Provide reference and version	USEPA Adult Lead Model, Version dated 5/19/03
If the EPA Adult Lead Model (ALM) was not used provide rationale for model selected.	N/A
Where are the input values located in the risk assessment report?	Located in **Appendix E, Table E-15b**
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure point concentration was based on the arithmetic mean of lead concentrations in total soil; See **Appendix E**
What was the point of exposure and location?	Total Soil – Building 4343
Where are the output values located in the risk assessment report?	Located in **Appendix E, Table E-15b**
What GSD value was used? If this is outside the recommended range of 1.8 to 2.1), provide rationale in Appendix <Y>.	GSD = 2.2 as the midrange value of updated GSD values (2.1 to 2.3) from NHANES III (USEPA, 2002)
What baseline blood lead concentration (PbB_0) value was used? If this is outside the default range of 1.7 to 2.2 provide rationale in Appendix <Y>	PbB_0 = 1.6 ug/dL as the midrange value of updated PbB_0 values (1.5 to 1.7 ug/dL) from NHANES III (USEPA, 2002)
Was the default exposure frequency (EF; 219 days/year) used?	EF = 250 days/year based on full-time exposure to soil during excavation (USEPA, 2003)
Was the default BKSF used (0.4 ug/dL per ug/day) used?	Yes
Was the default absorption fraction (AF; 0.12) used?	Yes
Was the default soil ingestion rate (IR; 50 mg/day) used?	IR = 100 mg/kg based on contact-intensive excavation activities (USEPA, 2003)
If non-default values were used for any of the parameters listed above, where is the rationale for the values located in the risk assessment report?	Discussion of parameters in *Section 6.3.2* and **Appendix E**

3. Final Result

Medium	Result	Comment/RBRG [1]
Soil	Input value of 46 ppm in soil results in 1.0% of receptors above a geometric mean blood lead = 1.8 ug/dL. This is below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children (fetuses of exposed women) exceeding 10 ug/dL blood lead.	PRG not calculated.

1. The ALM spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used is presented as **Appendix E, Table E-15b**. For additional information, see www.epa.gov/superfund/programs/lead

Table E-15b
Calculations of Blood Lead Concentrations (PbBs)
USEPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 05/19/03

Exposure Variable	PbB Equation[1] 1*	PbB Equation[1] 2**	Description of Exposure Variable	Units	Values for Non-Residential Exposure Scenario: Using Equation 1, GSDi = Hom	Using Equation 1, GSDi = Het	Using Equation 2, GSDi = Hom	Using Equation 2, GSDi = Het
PbS	X	X	Soil lead concentration	ug/g or ppm	46	46	46	46
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	2.2	2.2	2.2	2.2
PbB_0	X	X	Baseline PbB	ug/dL	1.6	1.6	1.6	1.6
IR_S	X		Soil ingestion rate (including soil-derived indoor dust)	g/day	0.100	0.100	--	--
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	0.100	0.100
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	1.0	1.0
K_{SD}		X	Mass fraction of soil in dust	--	--	--	0.7	0.7
$AF_{S,D}$	X	X	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12
$EF_{S,D}$	X	X	Exposure frequency (same for soil and dust)	days/yr	250	250	250	250
$AT_{S,D}$	X	X	Averaging time (same for soil and dust)	days/yr	365	365	365	365
PbB_{adult}	**PbB of adult worker, geometric mean**			**ug/dL**	**1.8**	**1.8**	**1.8**	**1.8**
$PbB_{fetal,\ 0.95}$	**95th percentile PbB among fetuses of adult workers**			**ug/dL**	**5.8**	**5.8**	**5.8**	**5.8**
PbB_t	**Target PbB level of concern (e.g., 10 ug/dL)**			**ug/dL**	**10.0**	**10.0**	**10.0**	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**			**%**	**1.0%**	**1.0%**	**1.0%**	**1.0%**

[1] Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}).
When $IR_S = IR_{S+D}$ and $W_S = 1.0$, the equations yield the same $PbB_{fetal,0.95}$.

***Equation 1, based on Eq. 1, 2 in USEPA (1996).**

PbB_{adult} =	$(PbS*BKSF*IR_{S+D}*AF_{S,D}*EF_S/AT_{S,D}) + PbB_0$
$PbB_{fetal,\ 0.95}$ =	$PbB_{adult} * (GSD_i^{1.645} * R)$

****Equation 2, alternate approach based on Eq. 1, 2, and A-19 in USEPA (1996).**

PbB_{adult} =	$PbS*BKSF*([(IR_{S+D})*AF_S*EF_S*W_S]+[K_{SD}*(IR_{S+D})*(1-W_S)*AF_D*EF_D])/365+PbB_0$
$PbB_{fetal,\ 0.95}$ =	$PbB_{adult} * (GSD_i^{1.645} * R)$

Source: USEPA (1996). Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

TABLE E-16
RAGS D IEUBK LEAD WORKSHEET
Radford Army Ammunition Plant – Building 4343
Child (Age 0 – 84 Months), Exposure to Total Soil

1. Lead Screening Questions

Medium	Lead Concentration Used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	46	mg/kg	Average Detected Value	400	mg/kg	Recommended Soil Screening Level
Water	15	ug/L	Average Detected Value	15	ug/L	Recommended Drinking Water Action Level

2. Lead Model Questions

Question	Response for Residential Lead Model
What lead model (version and date) was used?	Lead Model for Windows, Version 1.0 Build 253
Where are the input values located in the risk assessment report?	Located in Appendix E, IEUBKwin OUTPUT (Attached)
What range of media concentrations were used for the model?	3.1 – 1,440 mg/kg
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Arithmetic Mean Concentration; Data are located in **Appendix E**
Was soil sample taken from top 2 cm? If not, why?	No – Future scenario based on assumption that soil would be disturbed. Surface and subsurface data sets were combined to represent total soil.
Was soil sample sieved? What size screen was used? If not sieved, provide rationale.	No -- Soil samples were collected for multiple analyses.
What was the point of exposure/location?	Total soil – Building 4343
Where are the output values located in the risk assessment report?	IEUBKwin OUTPUT (Attached)
Was the model run using default values only?	No – Assumed site-specific arithmetic mean concentration of lead in soil and concentration of lead in drinking water at action level.
Was the default soil bioavailability used?	Yes -- Default is 30%
Was the default soil ingestion rate used?	Yes -- Default values for 7 age groups are 85, 135, 135, 100, 090, and 85 mg/day
If non-default values were used, where is the rationale for the values located in the risk assessment report?	Located in **Appendix E**.

3. Final Result

Medium	Result	Comment/PRG [1]
Total Soil	Input value of 46 ppm in total soil results in 0.4% of children above a blood lead level of 10 ug/dL. Geometric mean blood lead = 2.9 ug/dL. This is below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children exceeding 10 ug/dL blood lead.	PRG not calculated.

1. The IEUBK text output file and graph upon which the PRG was based immediately follows this table. For additional information, see www.epa.gov/superfund/programs/lead

LEAD MODEL FOR WINDOWS Version 1.0

==========

Model Version: 1.0 Build 253
User Name: Shaw Environmental, Inc.
Date: 8/8/2003
Site Name: Radford AAP
Operable Unit: Building 4343 - Total Soil
Run Mode: Site Risk Assessment

Soil/Dust Data
Total soil - arithmetic mean = 46 ug/g
Water Data
Assumed drinking water action level = 15 ug/L

==========

The time step used in this model run: 1 - Every 4 Hours (6 times a day).

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (ug Pb/m^3)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

****** Diet ******

Age	Diet Intake(ug/day)
.5-1	5.530
1-2	5.780
2-3	6.490
3-4	6.240
4-5	6.010
5-6	6.340
6-7	7.000

****** Drinking Water ******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 15.000 ug Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 42.200 ug/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
.5-1	46.000	42.200
1-2	46.000	42.200
2-3	46.000	42.200
3-4	46.000	42.200
4-5	46.000	42.200
5-6	46.000	42.200
6-7	46.000	42.200

****** Alternate Intake ******

Age	Alternate (ug Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

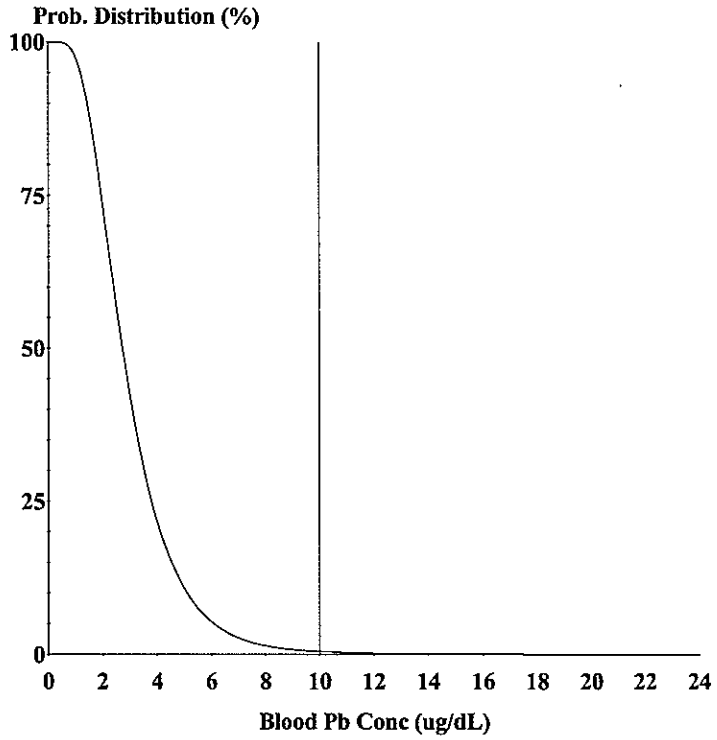
****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 2.500 ug Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Year	Air (ug/dL)	Diet (ug/day)	Alternate (ug/day)	Water (ug/day)
.5-1	0.021	2.610	0.000	1.416
1-2	0.034	2.697	0.000	3.500
2-3	0.062	3.049	0.000	3.664
3-4	0.067	2.958	0.000	3.768
4-5	0.067	2.875	0.000	3.946
5-6	0.093	3.044	0.000	4.177
6-7	0.093	3.367	0.000	4.257

Year	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
.5-1	1.057	5.103	2.8
1-2	1.660	7.892	3.3
2-3	1.671	8.445	3.1
3-4	1.686	8.478	3.0
4-5	1.260	8.148	2.7
5-6	1.138	8.453	2.6
6-7	1.077	8.794	2.5



Cutoff = 10.000 ug/dl
Geo Mean = 2.856
GSD = 1.600
% Above = 0.383

Age Range = 0 to 84 months
Time Step = Every 4 Hours
Run Mode = Site Risk Assessment

Table E-17
Calculation of Chemical Cancer Risks
Reasonable Maximum Exposure
Current/Future - Maintenance Worker - Surface Soil

Scenario Timeframe: Current/Future
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
							Intake/Exposure Concentration		CSF/Unit Risk		
					Value	Units	Value	Units	Value	Units	Cancer Risk
Surface Soil	Surface Soil	Surface Soil at Building 4343	**Ingestion**	**Organics**							
				Aroclor 1254	3.44E-01	mg/kg	2.4E-08	mg/kg-day	2.0E+00	$(mg/kg\text{-}day)^{-1}$	4.8E-08
				Inorganics							
				Aluminum	1.61E+04	mg/kg	1.1E-03	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Antimony	3.89E+00	mg/kg	2.7E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Cadmium	2.43E+04	mg/kg	1.7E-03	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Chromium	2.23E+02	mg/kg	1.6E-05	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Copper	8.50E+01	mg/kg	5.9E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Iron	3.42E+04	mg/kg	2.4E-03	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Lead	1.33E+02	mg/kg	9.3E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Manganese	3.75E+02	mg/kg	2.6E-05	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Vanadium	6.94E+01	mg/kg	4.9E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
			Exp. Route Total								4.8E-08
			Dermal Absorption	**Organics**							
				Aroclor 1254	3.44E-01	mg/kg	2.2E-08	mg/kg-day	2.0E+00	$(mg/kg\text{-}day)^{-1}$	4.4E-08
				Inorganics							
				Aluminum	1.61E+04	mg/kg	7.4E-05	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Antimony	3.89E+00	mg/kg	1.8E-08	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Cadmium	2.43E+04	mg/kg	1.1E-05	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Chromium	2.23E+02	mg/kg	1.0E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Copper	8.50E+01	mg/kg	3.9E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Iron	3.42E+04	mg/kg	1.6E-04	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Lead	1.33E+02	mg/kg	6.1E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Manganese	3.75E+02	mg/kg	1.7E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Vanadium	6.94E+01	mg/kg	3.2E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
			Exp. Route Total								4.4E-08
		Exposure Point Total									9.3E-08
	Exposure Media Total										9.3E-08
	Air	Particulates	**Inhalation**	**Organics**							
				Aroclor 1254	3.44E-01	mg/kg	7.0E-12	mg/kg-day	2.0E+00	$(mg/kg\text{-}day)^{-1}$	1.4E-11
				Inorganics							
				Aluminum	1.61E+04	mg/kg	3.3E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Antimony	3.89E+00	mg/kg	7.9E-11	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Cadmium	2.43E+04	mg/kg	5.0E-07	mg/kg-day	6.3E+00	$(mg/kg\text{-}day)^{-1}$	3.1E-06
				Chromium	2.23E+02	mg/kg	4.6E-09	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Copper	8.50E+01	mg/kg	1.7E-09	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Iron	3.42E+04	mg/kg	7.0E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Lead	1.33E+02	mg/kg	2.7E-09	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Manganese	3.75E+02	mg/kg	7.7E-09	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Vanadium	6.94E+01	mg/kg	1.4E-09	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
			Exp. Route Total								3.1E-06
		Exposure Point Total									3.1E-06
	Exposure Media Total										3.1E-06
Soil Total											3.2E-06
										Total of Receptor Risks Across All Media	3.2E-06

N/A = Not Applicable.

Table E-18
Calculation of Chemical Cancer Risks
Reasonable Maximum Exposure
Future - Maintenance Worker - Total Soil

Scenario Timeframe: Future
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
							Intake/Exposure Concentration		CSF/Unit Risk		
					Value	Units	Value	Units	Value	Units	Cancer Risk
Total Soil	Total Soil	Total Soil at Building 4343	**Ingestion**	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	9.6E-09	mg/kg-day	2.0E+00	$(mg/kg\text{-}day)^{-1}$	1.9E-08
				Inorganics							
				Aluminum	2.14E+04	mg/kg	1.5E-03	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Antimony	1.98E+00	mg/kg	1.4E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Cadmium	9.03E+02	mg/kg	6.3E-05	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Chromium	1.24E+02	mg/kg	8.7E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Copper	4.87E+01	mg/kg	3.4E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Iron	3.89E+04	mg/kg	2.7E-03	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Lead	7.07E+01	mg/kg	4.9E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Thallium	5.61E-01	mg/kg	3.9E-08	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Vanadium	9.84E+01	mg/kg	6.9E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
			Exp. Route Total								1.9E-08
			Dermal Absorption	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	8.8E-09	mg/kg-day	2.0E+00	$(mg/kg\text{-}day)^{-1}$	1.8E-08
				Inorganics							
				Aluminum	2.14E+04	mg/kg	9.9E-05	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Antimony	1.98E+00	mg/kg	9.1E-09	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Cadmium	9.03E+02	mg/kg	4.2E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Chromium	1.24E+02	mg/kg	5.7E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Copper	4.87E+01	mg/kg	2.2E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Iron	3.89E+04	mg/kg	1.8E-04	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Lead	7.07E+01	mg/kg	3.3E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Thallium	5.61E-01	mg/kg	2.6E-09	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Vanadium	9.84E+01	mg/kg	4.5E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
			Exp. Route Total								1.8E-08
		Exposure Point Total									3.7E-08
	Exposure Media Total										3.7E-08
	Air	Particulates	**Inhalation**	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	2.8E-12	mg/kg-day	2.0E+00	$(mg/kg\text{-}day)^{-1}$	5.6E-12
				Inorganics							
				Aluminum	2.14E+04	mg/kg	4.4E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Antimony	1.98E+00	mg/kg	4.0E-11	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Cadmium	9.03E+02	mg/kg	1.8E-08	mg/kg-day	6.3E+00	$(mg/kg\text{-}day)^{-1}$	1.2E-07
				Chromium	1.24E+02	mg/kg	2.5E-09	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Copper	4.87E+01	mg/kg	9.9E-10	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Iron	3.89E+04	mg/kg	7.9E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Lead	7.07E+01	mg/kg	1.4E-09	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Thallium	5.61E-01	mg/kg	1.1E-11	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Vanadium	9.84E+01	mg/kg	2.0E-09	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
			Exp. Route Total								1.2E-07
		Exposure Point Total									1.2E-07
	Exposure Media Total										1.2E-07
Soil Total											1.5E-07
										Total of Receptor Risks Across All Media	1.5E-07

N/A = Not Applicable.

Table E-19
Calculation of Chemical Cancer Risks
Reasonable Maximum Exposure
Future - Excavation Worker - Total Soil

Scenario Timeframe: Future
Receptor Population: Excavation Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
							Intake/Exposure Concentration		CSF/Unit Risk		
					Value	Units	Value	Units	Value	Units	Cancer Risk
Total Soil	Total Soil	Total Soil at Building 4343	**Ingestion**	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	6.3E-09	mg/kg-day	2.0E+00	$(mg/kg\text{-}day)^{-1}$	1.3E-08
				Inorganics							
				Aluminum	2.14E+04	mg/kg	9.9E-04	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Antimony	1.98E+00	mg/kg	9.1E-08	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Cadmium	9.03E+02	mg/kg	4.2E-05	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Chromium	1.24E+02	mg/kg	5.7E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Copper	4.87E+01	mg/kg	2.2E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Iron	3.89E+04	mg/kg	1.8E-03	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Lead	7.07E+01	mg/kg	3.3E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Thallium	5.61E-01	mg/kg	2.6E-08	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Vanadium	9.84E+01	mg/kg	4.5E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
			Exp. Route Total								1.3E-08
			Dermal Absorption	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	2.7E-09	mg/kg-day	2.0E+00	$(mg/kg\text{-}day)^{-1}$	5.3E-09
				Inorganics							
				Aluminum	2.14E+04	mg/kg	3.0E-05	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Antimony	1.98E+00	mg/kg	2.7E-09	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Cadmium	9.03E+02	mg/kg	1.2E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Chromium	1.24E+02	mg/kg	1.7E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Copper	4.87E+01	mg/kg	6.7E-08	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Iron	3.89E+04	mg/kg	5.4E-05	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Lead	7.07E+01	mg/kg	9.8E-08	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Thallium	5.61E-01	mg/kg	7.8E-10	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Vanadium	9.84E+01	mg/kg	1.4E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
			Exp. Route Total								5.3E-09
		Exposure Point Total									1.8E-08
	Exposure Media Total										1.8E-08
	Air	Particulates	**Inhalation**	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	5.6E-13	mg/kg-day	2.0E+00	$(mg/kg\text{-}day)^{-1}$	1.1E-12
				Inorganics							
				Aluminum	2.14E+04	mg/kg	8.7E-08	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Antimony	1.98E+00	mg/kg	8.1E-12	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Cadmium	9.03E+02	mg/kg	3.7E-09	mg/kg-day	6.3E+00	$(mg/kg\text{-}day)^{-1}$	2.3E-08
				Chromium	1.24E+02	mg/kg	5.1E-10	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Copper	4.87E+01	mg/kg	2.0E-10	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Iron	3.89E+04	mg/kg	1.6E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Lead	7.07E+01	mg/kg	2.9E-10	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Thallium	5.61E-01	mg/kg	2.3E-12	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Vanadium	9.84E+01	mg/kg	4.0E-10	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
			Exp. Route Total								2.3E-08
		Exposure Point Total									2.3E-08
	Exposure Media Total										2.3E-08
Soil Total											4.1E-08
										Total of Receptor Risks Across All Media	4.1E-08

N/A = Not Applicable.

Table E-20
Calculation of Chemical Cancer Risks
Reasonable Maximum Exposure
Future - Adult Resident - Total Soil

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
							Intake/Exposure Concentration		CSF/Unit Risk		
					Value	Units	Value	Units	Value	Units	Cancer Risk
Total Soil	Total Soil	Total Soil at Building 4343	**Ingestion**	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	8.0E-08	mg/kg-day	2.0E+00	$(mg/kg\text{-}day)^{-1}$	1.6E-07
				Inorganics							
				Aluminum	2.14E+04	mg/kg	1.3E-02	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Antimony	1.98E+00	mg/kg	1.2E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Cadmium	9.03E+02	mg/kg	5.3E-04	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Chromium	1.24E+02	mg/kg	7.3E-05	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Copper	4.87E+01	mg/kg	2.9E-05	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Iron	3.89E+04	mg/kg	2.3E-02	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Lead	7.07E+01	mg/kg	4.2E-05	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Thallium	5.61E-01	mg/kg	3.3E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Vanadium	9.84E+01	mg/kg	5.8E-05	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
			Exp. Route Total								1.6E-07
			Dermal Absorption	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	4.5E-08	mg/kg-day	2.0E+00	$(mg/kg\text{-}day)^{-1}$	9.0E-08
				Inorganics							
				Aluminum	2.14E+04	mg/kg	5.0E-04	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Antimony	1.98E+00	mg/kg	4.6E-08	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Cadmium	9.03E+02	mg/kg	2.1E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Chromium	1.24E+02	mg/kg	2.9E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Copper	4.87E+01	mg/kg	1.1E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Iron	3.89E+04	mg/kg	9.1E-04	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Lead	7.07E+01	mg/kg	1.7E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Thallium	5.61E-01	mg/kg	1.3E-08	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Vanadium	9.84E+01	mg/kg	2.3E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
			Exp. Route Total								9.0E-08
		Exposure Point Total									2.5E-07
	Exposure Media Total										2.5E-07
	Air	Particulates	**Inhalation**	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	9.7E-13	mg/kg-day	2.0E+00	$(mg/kg\text{-}day)^{-1}$	1.9E-12
				Inorganics							
				Aluminum	2.14E+04	mg/kg	1.5E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Antimony	1.98E+00	mg/kg	1.4E-11	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Cadmium	9.03E+02	mg/kg	6.4E-09	mg/kg-day	6.3E+00	$(mg/kg\text{-}day)^{-1}$	4.0E-08
				Chromium	1.24E+02	mg/kg	8.8E-10	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Copper	4.87E+01	mg/kg	3.5E-10	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Iron	3.89E+04	mg/kg	2.8E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Lead	7.07E+01	mg/kg	5.0E-10	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Thallium	5.61E-01	mg/kg	4.0E-12	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Vanadium	9.84E+01	mg/kg	7.0E-10	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
			Exp. Route Total								4.0E-08
		Exposure Point Total									4.0E-08
	Exposure Media Total										4.0E-08
Soil Total											2.9E-07
										Total of Receptor Risks Across All Media	2.9E-07

N/A = Not Applicable.

Table E-21
Calculation of Chemical Cancer Risks
Reasonable Maximum Exposure
Future - Child Resident - Total Soil

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations				
							Intake/Exposure Concentration		CSF/Unit Risk		
					Value	Units	Value	Units	Value	Units	Cancer Risk
Total Soil	Total Soil	Total Soil at Building 4343	**Ingestion**	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	1.5E-07	mg/kg-day	2.0E+00	$(mg/kg\text{-}day)^{-1}$	3.0E-07
				Inorganics							
				Aluminum	2.14E+04	mg/kg	2.3E-02	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Antimony	1.98E+00	mg/kg	2.2E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Cadmium	9.03E+02	mg/kg	9.9E-04	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Chromium	1.24E+02	mg/kg	1.4E-04	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Copper	4.87E+01	mg/kg	5.3E-05	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Iron	3.89E+04	mg/kg	4.3E-02	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Lead	7.07E+01	mg/kg	7.7E-05	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Thallium	5.61E-01	mg/kg	6.1E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Vanadium	9.84E+01	mg/kg	1.1E-04	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
			Exp. Route Total								3.0E-07
			Dermal Absorption	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	5.9E-08	mg/kg-day	2.0E+00	$(mg/kg\text{-}day)^{-1}$	1.2E-07
				Inorganics							
				Aluminum	2.14E+04	mg/kg	6.6E-04	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Antimony	1.98E+00	mg/kg	6.1E-08	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Cadmium	9.03E+02	mg/kg	2.8E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Chromium	1.24E+02	mg/kg	3.8E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Copper	4.87E+01	mg/kg	1.5E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Iron	3.89E+04	mg/kg	1.2E-03	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Lead	7.07E+01	mg/kg	2.2E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Thallium	5.61E-01	mg/kg	1.7E-08	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Vanadium	9.84E+01	mg/kg	3.0E-06	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
			Exp. Route Total								1.2E-07
		Exposure Point Total									4.2E-07
	Exposure Media Total										4.2E-07
	Air	Particulates	**Inhalation**	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	1.1E-12	mg/kg-day	2.0E+00	$(mg/kg\text{-}day)^{-1}$	2.2E-12
				Inorganics							
				Aluminum	2.14E+04	mg/kg	1.7E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Antimony	1.98E+00	mg/kg	1.6E-11	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Cadmium	9.03E+02	mg/kg	7.2E-09	mg/kg-day	6.3E+00	$(mg/kg\text{-}day)^{-1}$	4.6E-08
				Chromium	1.24E+02	mg/kg	9.9E-10	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Copper	4.87E+01	mg/kg	3.9E-10	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Iron	3.89E+04	mg/kg	3.1E-07	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Lead	7.07E+01	mg/kg	5.7E-10	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Thallium	5.61E-01	mg/kg	4.5E-12	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
				Vanadium	9.84E+01	mg/kg	7.9E-10	mg/kg-day	N/A	$(mg/kg\text{-}day)^{-1}$	---
			Exp. Route Total								4.6E-08
		Exposure Point Total									4.6E-08
	Exposure Media Total										4.6E-08
Soil Total											4.6E-07
										Total of Receptor Risks Across All Media	4.6E-07

N/A = Not Applicable.

Table E-22
Calculation of Non-cancer Hazards
Reasonable Maximum Exposure
Current/Future - Maintenance Worker - Surface Soil

Scenario Timeframe: Current/Future
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
							Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
					Value	Units	Value	Units	Value	Units	
Surface Soil	Surface Soil	Surface Soil at Building 4343	**Ingestion**	**Organics**							
				Aroclor 1254	3.44E-01	mg/kg	6.7E-08	mg/kg-day	2.0E-05	mg/kg-day	3.4E-03
				Inorganics							
				Aluminum	1.61E+04	mg/kg	3.2E-03	mg/kg-day	1.0E+00	mg/kg-day	3.2E-03
				Antimony	3.89E+00	mg/kg	7.6E-07	mg/kg-day	4.0E-04	mg/kg-day	1.9E-03
				Cadmium	2.43E+04	mg/kg	4.8E-03	mg/kg-day	1.0E-03	mg/kg-day	4.8E+00
				Chromium	2.23E+02	mg/kg	4.4E-05	mg/kg-day	1.5E+00	mg/kg-day	2.9E-05
				Copper	8.50E+01	mg/kg	1.7E-05	mg/kg-day	4.0E-02	mg/kg-day	4.2E-04
				Iron	3.42E+04	mg/kg	6.7E-03	mg/kg-day	3.0E-01	mg/kg-day	2.2E-02
				Lead	1.33E+02	mg/kg	2.6E-05	mg/kg-day	N/A	mg/kg-day	---
				Manganese	3.75E+02	mg/kg	7.3E-05	mg/kg-day	2.0E-02	mg/kg-day	3.7E-03
				Vanadium	6.94E+01	mg/kg	1.4E-05	mg/kg-day	7.0E-03	mg/kg-day	1.9E-03
			Exp. Route Total								4.8E+00
			Dermal Absorption	**Organics**							
				Aroclor 1254	3.44E-01	mg/kg	6.2E-08	mg/kg-day	2.0E-05	mg/kg-day	3.1E-03
				Inorganics							
				Aluminum	1.61E+04	mg/kg	2.1E-04	mg/kg-day	2.7E-01	mg/kg-day	7.7E-04
				Antimony	3.89E+00	mg/kg	5.0E-08	mg/kg-day	6.0E-05	mg/kg-day	8.4E-04
				Cadmium	2.43E+04	mg/kg	3.1E-05	mg/kg-day	2.5E-05	mg/kg-day	1.3E+00
				Chromium	2.23E+02	mg/kg	2.9E-06	mg/kg-day	2.0E-02	mg/kg-day	1.5E-04
				Copper	8.50E+01	mg/kg	1.1E-06	mg/kg-day	4.0E-02	mg/kg-day	2.7E-05
				Iron	3.42E+04	mg/kg	4.4E-04	mg/kg-day	3.0E-01	mg/kg-day	1.5E-03
				Lead	1.33E+02	mg/kg	1.7E-06	mg/kg-day	N/A	mg/kg-day	---
				Manganese	3.75E+02	mg/kg	4.8E-06	mg/kg-day	8.0E-04	mg/kg-day	6.1E-03
				Vanadium	6.94E+01	mg/kg	9.0E-07	mg/kg-day	1.8E-04	mg/kg-day	4.9E-03
			Exp. Route Total								1.3E+00
		Exposure Point Total									6.1E+00
	Exposure Media Total										6.1E+00
	Air	Particulates	**Inhalation**	**Organics**							
				Aroclor 1254	3.44E-01	mg/kg	2.0E-11	mg/kg-day	N/A	mg/kg-day	---
				Inorganics							
				Aluminum	1.61E+04	mg/kg	9.2E-07	mg/kg-day	1.0E-03	mg/kg-day	9.2E-04
				Antimony	3.89E+00	mg/kg	2.2E-10	mg/kg-day	N/A	mg/kg-day	---
				Cadmium	2.43E+04	mg/kg	1.4E-06	mg/kg-day	5.7E-05	mg/kg-day	2.4E-02
				Chromium	2.23E+02	mg/kg	1.3E-08	mg/kg-day	N/A	mg/kg-day	---
				Copper	8.50E+01	mg/kg	4.9E-09	mg/kg-day	N/A	mg/kg-day	---
				Iron	3.42E+04	mg/kg	2.0E-06	mg/kg-day	N/A	mg/kg-day	---
				Lead	1.33E+02	mg/kg	7.6E-09	mg/kg-day	N/A	mg/kg-day	---
				Manganese	3.75E+02	mg/kg	2.1E-08	mg/kg-day	1.4E-05	mg/kg-day	1.5E-03
				Vanadium	6.94E+01	mg/kg	4.0E-09	mg/kg-day	N/A	mg/kg-day	---
			Exp. Route Total								2.7E-02
		Exposure Point Total									2.7E-02
	Exposure Media Total										2.7E-02
Soil Total											6.1E+00
										Total of Receptor Hazards Across All Media	6.1E+00

N/A = Not Applicable.

Table E-23
Calculation of Non-cancer Hazards
Reasonable Maximum Exposure
Future - Maintenance Worker - Total Soil

Scenario Timeframe: Future
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
							Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
					Value	Units	Value	Units	Value	Units	
Total Soil	Total Soil	Total Soil at Building 4343	**Ingestion**	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	2.7E-08	mg/kg-day	2.0E-05	mg/kg-day	1.3E-03
				Inorganics							
				Aluminum	2.14E+04	mg/kg	4.2E-03	mg/kg-day	1.0E+00	mg/kg-day	4.2E-03
				Antimony	1.98E+00	mg/kg	3.9E-07	mg/kg-day	4.0E-04	mg/kg-day	9.7E-04
				Cadmium	9.03E+02	mg/kg	1.8E-04	mg/kg-day	1.0E-03	mg/kg-day	1.8E-01
				Chromium	1.24E+02	mg/kg	2.4E-05	mg/kg-day	1.5E+00	mg/kg-day	1.6E-05
				Copper	4.87E+01	mg/kg	9.5E-06	mg/kg-day	4.0E-02	mg/kg-day	2.4E-04
				Iron	3.89E+04	mg/kg	7.6E-03	mg/kg-day	3.0E-01	mg/kg-day	2.5E-02
				Lead	7.07E+01	mg/kg	1.4E-05	mg/kg-day	N/A	mg/kg-day	---
				Thallium	5.61E-01	mg/kg	1.1E-07	mg/kg-day	8.0E-05	mg/kg-day	1.4E-03
				Vanadium	9.84E+01	mg/kg	1.9E-05	mg/kg-day	7.0E-03	mg/kg-day	2.8E-03
			Exp. Route Total								2.1E-01
			Dermal Absorption	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	2.5E-08	mg/kg-day	2.0E-05	mg/kg-day	1.2E-03
				Inorganics							
				Aluminum	2.14E+04	mg/kg	2.8E-04	mg/kg-day	2.7E-01	mg/kg-day	1.0E-03
				Antimony	1.98E+00	mg/kg	2.6E-08	mg/kg-day	6.0E-05	mg/kg-day	4.3E-04
				Cadmium	9.03E+02	mg/kg	1.2E-06	mg/kg-day	2.5E-05	mg/kg-day	4.7E-02
				Chromium	1.24E+02	mg/kg	1.6E-06	mg/kg-day	2.0E-02	mg/kg-day	8.2E-05
				Copper	4.87E+01	mg/kg	6.3E-07	mg/kg-day	4.0E-02	mg/kg-day	1.6E-05
				Iron	3.89E+04	mg/kg	5.0E-04	mg/kg-day	3.0E-01	mg/kg-day	1.7E-03
				Lead	7.07E+01	mg/kg	9.1E-07	mg/kg-day	N/A	mg/kg-day	---
				Thallium	5.61E-01	mg/kg	7.2E-09	mg/kg-day	8.0E-05	mg/kg-day	9.1E-05
				Vanadium	9.84E+01	mg/kg	1.3E-06	mg/kg-day	1.8E-04	mg/kg-day	7.0E-03
			Exp. Route Total								5.8E-02
		Exposure Point Total									2.7E-01
	Exposure Media Total										2.7E-01
	Air	Particulates	**Inhalation**	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	7.8E-12	mg/kg-day	N/A	mg/kg-day	---
				Inorganics							
				Aluminum	2.14E+04	mg/kg	1.2E-06	mg/kg-day	1.0E-03	mg/kg-day	1.2E-03
				Antimony	1.98E+00	mg/kg	1.1E-10	mg/kg-day	N/A	mg/kg-day	---
				Cadmium	9.03E+02	mg/kg	5.2E-08	mg/kg-day	5.7E-05	mg/kg-day	9.1E-04
				Chromium	1.24E+02	mg/kg	7.1E-09	mg/kg-day	N/A	mg/kg-day	---
				Copper	4.87E+01	mg/kg	2.8E-09	mg/kg-day	N/A	mg/kg-day	---
				Iron	3.89E+04	mg/kg	2.2E-06	mg/kg-day	N/A	mg/kg-day	---
				Lead	7.07E+01	mg/kg	4.0E-09	mg/kg-day	N/A	mg/kg-day	---
				Thallium	5.61E-01	mg/kg	3.2E-11	mg/kg-day	N/A	mg/kg-day	---
				Vanadium	9.84E+01	mg/kg	5.6E-09	mg/kg-day	N/A	mg/kg-day	---
			Exp. Route Total								2.1E-03
		Exposure Point Total									2.1E-03
	Exposure Media Total										2.1E-03
Soil Total											2.7E-01
										Total of Receptor Hazards Across All Media	2.7E-01

N/A = Not Applicable.

Table E-24
Calculation of Non-cancer Hazards
Reasonable Maximum Exposure
Future - Excavation Worker - Total Soil

Scenario Timeframe: Future
Receptor Population: Excavation Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
							Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
					Value	Units	Value	Units	Value	Units	
Total Soil	Total Soil	Total Soil at Building 4343	**Ingestion**	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	4.4E-07	mg/kg-day	2.0E-05	mg/kg-day	2.2E-02
				Inorganics							
				Aluminum	2.14E+04	mg/kg	6.9E-02	mg/kg-day	1.0E+00	mg/kg-day	6.9E-02
				Antimony	1.98E+00	mg/kg	6.4E-06	mg/kg-day	4.0E-04	mg/kg-day	1.6E-02
				Cadmium	9.03E+02	mg/kg	2.9E-03	mg/kg-day	1.0E-03	mg/kg-day	2.9E+00
				Chromium	1.24E+02	mg/kg	4.0E-04	mg/kg-day	1.5E+00	mg/kg-day	2.7E-04
				Copper	4.87E+01	mg/kg	1.6E-04	mg/kg-day	4.0E-02	mg/kg-day	3.9E-03
				Iron	3.89E+04	mg/kg	1.3E-01	mg/kg-day	3.0E-01	mg/kg-day	4.2E-01
				Lead	7.07E+01	mg/kg	2.3E-04	mg/kg-day	N/A	mg/kg-day	---
				Thallium	5.61E-01	mg/kg	1.8E-06	mg/kg-day	8.0E-05	mg/kg-day	2.3E-02
				Vanadium	9.84E+01	mg/kg	3.2E-04	mg/kg-day	7.0E-03	mg/kg-day	4.5E-02
			Exp. Route Total								3.5E+00
			Dermal Absorption	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	1.9E-07	mg/kg-day	2.0E-05	mg/kg-day	9.3E-03
				Inorganics							
				Aluminum	2.14E+04	mg/kg	2.1E-03	mg/kg-day	2.7E-01	mg/kg-day	7.7E-03
				Antimony	1.98E+00	mg/kg	1.9E-07	mg/kg-day	6.0E-05	mg/kg-day	3.2E-03
				Cadmium	9.03E+02	mg/kg	8.7E-06	mg/kg-day	2.5E-05	mg/kg-day	3.5E-01
				Chromium	1.24E+02	mg/kg	1.2E-05	mg/kg-day	2.0E-02	mg/kg-day	6.2E-04
				Copper	4.87E+01	mg/kg	4.7E-06	mg/kg-day	4.0E-02	mg/kg-day	1.2E-04
				Iron	3.89E+04	mg/kg	3.8E-03	mg/kg-day	3.0E-01	mg/kg-day	1.3E-02
				Lead	7.07E+01	mg/kg	6.8E-06	mg/kg-day	N/A	mg/kg-day	---
				Thallium	5.61E-01	mg/kg	5.4E-08	mg/kg-day	8.0E-05	mg/kg-day	6.8E-04
				Vanadium	9.84E+01	mg/kg	9.5E-06	mg/kg-day	1.8E-04	mg/kg-day	5.2E-02
			Exp. Route Total								4.4E-01
		Exposure Point Total									4.0E+00
	Exposure Media Total										4.0E+00
	Air	Particulates	**Inhalation**	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	3.9E-11	mg/kg-day	N/A	mg/kg-day	---
				Inorganics							
				Aluminum	2.14E+04	mg/kg	6.1E-06	mg/kg-day	1.0E-03	mg/kg-day	6.1E-03
				Antimony	1.98E+00	mg/kg	5.7E-10	mg/kg-day	N/A	mg/kg-day	---
				Cadmium	9.03E+02	mg/kg	2.6E-07	mg/kg-day	5.7E-05	mg/kg-day	4.5E-03
				Chromium	1.24E+02	mg/kg	3.5E-08	mg/kg-day	N/A	mg/kg-day	---
				Copper	4.87E+01	mg/kg	1.4E-08	mg/kg-day	N/A	mg/kg-day	---
				Iron	3.89E+04	mg/kg	1.1E-05	mg/kg-day	N/A	mg/kg-day	---
				Lead	7.07E+01	mg/kg	2.0E-08	mg/kg-day	N/A	mg/kg-day	---
				Thallium	5.61E-01	mg/kg	1.6E-10	mg/kg-day	N/A	mg/kg-day	---
				Vanadium	9.84E+01	mg/kg	2.8E-08	mg/kg-day	N/A	mg/kg-day	---
			Exp. Route Total								1.1E-02
		Exposure Point Total									1.1E-02
	Exposure Media Total										1.1E-02
Soil Total											4.0E+00
										Total of Receptor Hazards Across All Media	4.0E+00

N/A = Not Applicable.

Table E-25
Calculation of Non-cancer Hazards
Reasonable Maximum Exposure
Future - Adult Resident - Total Soil

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
							Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
					Value	Units	Value	Units	Value	Units	
Total Soil	Total Soil	Total Soil at Building 4343	**Ingestion**	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	1.9E-07	mg/kg-day	2.0E-05	mg/kg-day	9.4E-03
				Inorganics							
				Aluminum	2.14E+04	mg/kg	2.9E-02	mg/kg-day	1.0E+00	mg/kg-day	2.9E-02
				Antimony	1.98E+00	mg/kg	2.7E-06	mg/kg-day	4.0E-04	mg/kg-day	6.8E-03
				Cadmium	9.03E+02	mg/kg	1.2E-03	mg/kg-day	1.0E-03	mg/kg-day	1.2E+00
				Chromium	1.24E+02	mg/kg	1.7E-04	mg/kg-day	1.5E+00	mg/kg-day	1.1E-04
				Copper	4.87E+01	mg/kg	6.7E-05	mg/kg-day	4.0E-02	mg/kg-day	1.7E-03
				Iron	3.89E+04	mg/kg	5.3E-02	mg/kg-day	3.0E-01	mg/kg-day	1.8E-01
				Lead	7.07E+01	mg/kg	9.7E-05	mg/kg-day	N/A	mg/kg-day	---
				Thallium	5.61E-01	mg/kg	7.7E-07	mg/kg-day	8.0E-05	mg/kg-day	9.6E-03
				Vanadium	9.84E+01	mg/kg	1.3E-04	mg/kg-day	7.0E-03	mg/kg-day	1.9E-02
			Exp. Route Total								1.5E+00
			Dermal Absorption	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	1.0E-07	mg/kg-day	2.0E-05	mg/kg-day	5.2E-03
				Inorganics							
				Aluminum	2.14E+04	mg/kg	1.2E-03	mg/kg-day	2.7E-01	mg/kg-day	4.3E-03
				Antimony	1.98E+00	mg/kg	1.1E-07	mg/kg-day	6.0E-05	mg/kg-day	1.8E-03
				Cadmium	9.03E+02	mg/kg	4.9E-06	mg/kg-day	2.5E-05	mg/kg-day	2.0E-01
				Chromium	1.24E+02	mg/kg	6.8E-06	mg/kg-day	2.0E-02	mg/kg-day	3.5E-04
				Copper	4.87E+01	mg/kg	2.7E-06	mg/kg-day	4.0E-02	mg/kg-day	6.7E-05
				Iron	3.89E+04	mg/kg	2.1E-03	mg/kg-day	3.0E-01	mg/kg-day	7.1E-03
				Lead	7.07E+01	mg/kg	3.9E-06	mg/kg-day	N/A	mg/kg-day	---
				Thallium	5.61E-01	mg/kg	3.1E-08	mg/kg-day	8.0E-05	mg/kg-day	3.8E-04
				Vanadium	9.84E+01	mg/kg	5.4E-06	mg/kg-day	1.8E-04	mg/kg-day	3.0E-02
			Exp. Route Total								2.5E-01
		Exposure Point Total									1.7E+00
	Exposure Media Total										1.7E+00
	Air	Particulates	**Inhalation**	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	2.3E-12	mg/kg-day	N/A	mg/kg-day	---
				Inorganics							
				Aluminum	2.14E+04	mg/kg	3.6E-07	mg/kg-day	1.0E-03	mg/kg-day	3.6E-04
				Antimony	1.98E+00	mg/kg	3.3E-11	mg/kg-day	N/A	mg/kg-day	---
				Cadmium	9.03E+02	mg/kg	1.5E-08	mg/kg-day	5.7E-05	mg/kg-day	2.6E-04
				Chromium	1.24E+02	mg/kg	2.1E-09	mg/kg-day	N/A	mg/kg-day	---
				Copper	4.87E+01	mg/kg	8.1E-10	mg/kg-day	N/A	mg/kg-day	---
				Iron	3.89E+04	mg/kg	6.5E-07	mg/kg-day	N/A	mg/kg-day	---
				Lead	7.07E+01	mg/kg	1.2E-09	mg/kg-day	N/A	mg/kg-day	---
				Thallium	5.61E-01	mg/kg	9.3E-12	mg/kg-day	N/A	mg/kg-day	---
				Vanadium	9.84E+01	mg/kg	1.6E-09	mg/kg-day	N/A	mg/kg-day	---
			Exp. Route Total								6.2E-04
		Exposure Point Total									6.2E-04
	Exposure Media Total										6.2E-04
Soil Total											1.7E+00
										Total of Receptor Hazards Across All Media	1.7E+00

N/A = Not Applicable.

Table E-26
Calculation of Non-cancer Hazards
Reasonable Maximum Exposure
Future - Child Resident - Total Soil

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Non-Cancer Hazard Calculations				
							Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
					Value	Units	Value	Units	Value	Units	
Total Soil	Total Soil	Total Soil at Building 4343	**Ingestion**	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	1.8E-06	mg/kg-day	2.0E-05	mg/kg-day	8.8E-02
				Inorganics							
				Aluminum	2.14E+04	mg/kg	2.7E-01	mg/kg-day	1.0E+00	mg/kg-day	2.7E-01
				Antimony	1.98E+00	mg/kg	2.5E-05	mg/kg-day	4.0E-04	mg/kg-day	6.3E-02
				Cadmium	9.03E+02	mg/kg	1.2E-02	mg/kg-day	1.0E-03	mg/kg-day	1.2E+01
				Chromium	1.24E+02	mg/kg	1.6E-03	mg/kg-day	1.5E+00	mg/kg-day	1.1E-03
				Copper	4.87E+01	mg/kg	6.2E-04	mg/kg-day	4.0E-02	mg/kg-day	1.6E-02
				Iron	3.89E+04	mg/kg	5.0E-01	mg/kg-day	3.0E-01	mg/kg-day	1.7E+00
				Lead	7.07E+01	mg/kg	9.0E-04	mg/kg-day	N/A	mg/kg-day	---
				Thallium	5.61E-01	mg/kg	7.2E-06	mg/kg-day	8.0E-05	mg/kg-day	9.0E-02
				Vanadium	9.84E+01	mg/kg	1.3E-03	mg/kg-day	7.0E-03	mg/kg-day	1.8E-01
			Exp. Route Total								1.4E+01
			Dermal Absorption	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	6.9E-07	mg/kg-day	2.0E-05	mg/kg-day	3.4E-02
				Inorganics							
				Aluminum	2.14E+04	mg/kg	7.7E-03	mg/kg-day	2.7E-01	mg/kg-day	2.8E-02
				Antimony	1.98E+00	mg/kg	7.1E-07	mg/kg-day	6.0E-05	mg/kg-day	1.2E-02
				Cadmium	9.03E+02	mg/kg	3.2E-05	mg/kg-day	2.5E-05	mg/kg-day	1.3E+00
				Chromium	1.24E+02	mg/kg	4.4E-05	mg/kg-day	2.0E-02	mg/kg-day	2.3E-03
				Copper	4.87E+01	mg/kg	1.7E-05	mg/kg-day	4.0E-02	mg/kg-day	4.4E-04
				Iron	3.89E+04	mg/kg	1.4E-02	mg/kg-day	3.0E-01	mg/kg-day	4.6E-02
				Lead	7.07E+01	mg/kg	2.5E-05	mg/kg-day	N/A	mg/kg-day	---
				Thallium	5.61E-01	mg/kg	2.0E-07	mg/kg-day	8.0E-05	mg/kg-day	2.5E-03
				Vanadium	9.84E+01	mg/kg	3.5E-05	mg/kg-day	1.8E-04	mg/kg-day	1.9E-01
			Exp. Route Total								1.6E+00
		Exposure Point Total									1.6E+01
	Exposure Media Total										1.6E+01
	Air	Particulates	**Inhalation**	**Organics**							
				Aroclor 1254	1.37E-01	mg/kg	1.3E-11	mg/kg-day	N/A	mg/kg-day	---
				Inorganics							
				Aluminum	2.14E+04	mg/kg	2.0E-06	mg/kg-day	1.0E-03	mg/kg-day	2.0E-03
				Antimony	1.98E+00	mg/kg	1.8E-10	mg/kg-day	N/A	mg/kg-day	---
				Cadmium	9.03E+02	mg/kg	8.4E-08	mg/kg-day	5.7E-05	mg/kg-day	1.5E-03
				Chromium	1.24E+02	mg/kg	1.2E-08	mg/kg-day	N/A	mg/kg-day	---
				Copper	4.87E+01	mg/kg	4.5E-09	mg/kg-day	N/A	mg/kg-day	---
				Iron	3.89E+04	mg/kg	3.6E-06	mg/kg-day	N/A	mg/kg-day	---
				Lead	7.07E+01	mg/kg	6.6E-09	mg/kg-day	N/A	mg/kg-day	---
				Thallium	5.61E-01	mg/kg	5.2E-11	mg/kg-day	N/A	mg/kg-day	---
				Vanadium	9.84E+01	mg/kg	9.2E-09	mg/kg-day	N/A	mg/kg-day	---
			Exp. Route Total								3.5E-03
		Exposure Point Total									3.5E-03
	Exposure Media Total										3.5E-03
Soil Total											1.6E+01
										Total of Receptor Hazards Across All Media	1.6E+01

N/A = Not Applicable.

Table E-27
Summary of Exposure Risks and Hazards for COPCs
Reasonable Maximum Exposure
Current - Maintenance Worker

Scenario Timeframe: Current
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Building 4343	Aroclor 1254	4.8E-08		4.4E-08		9.3E-08	Eyes, Immune System	3.4E-03		3.1E-03	6.5E-03
			Aluminum	---		---		---	Developmental Neurotoxicity	3.2E-03		7.7E-04	3.9E-03
			Antimony	---		---		---	Blood Chemistry	1.9E-03		8.4E-04	2.7E-03
			Cadmium	---		---		---	Kidney	4.8E+00		1.3E+00	6.0E+00
			Chromium[a]	---		---		---	NOAEL	2.9E-05		1.5E-04	1.8E-04
			Copper	---		---		---	GI Tract	4.2E-04		2.7E-05	4.4E-04
			Iron	---		---		---	GI Irritation, Blood, Liver	2.2E-02		1.5E-03	2.4E-02
			Lead	---		---		---	N/A	---		---	---
			Manganese	---		---		---	CNS	3.7E-03		6.1E-03	9.7E-03
			Vanadium[a]	---		---		---	NOAEL	1.9E-03		4.9E-03	6.9E-03
			Chemical Total	4.8E-08		4.4E-08		9.3E-08		4.8		1.3	6.1
			Radionuclide Total										
		Exposure Point Total						9.3E-08					6.1
	Exposure Media Total							9.3E-08					6.1
	Air (Particulates)	Building 4343	Aroclor 1254		1.4E-11			1.4E-11	N/A		---		---
			Aluminum		---			---	N/A		9.2E-04		9.2E-04
			Antimony		---			---	N/A		---		---
			Cadmium		3.1E-06			3.1E-06	Kidney		2.4E-02		2.4E-02
			Chromium		---			---	N/A		---		---
			Copper		---			---	N/A		---		---
			Iron		---			---	N/A		---		---
			Lead		---			---	N/A		---		---
			Manganese		---			---	CNS		1.5E-03		1.5E-03
			Vanadium		---			---	N/A		---		---
			Chemical Total		3.1E-06			3.1E-06			0.027		0.027
			Radionuclide Total										
		Exposure Point Total						3.1E-06					0.027
	Exposure Media Total							3.1E-06					0.027
Surface Soil Total								3.2E-06					6.1
Receptor Total								3.2E-06					6.1

Total Risk Across All Media = 3.2E-06

Total Hazard Across All Media = 6.1

(a) The RfD is based on NOAEL; no target organ is identified.

CNS = Central Nervous System
GI = Gastrointestinal.
NOAEL = No Observed Adverse Effect Level.
N/A = Not Available.

Total Eyes HI Across All Media =	0.0065
Total Immune System HI Across All Media =	0.0065
Total Developmental Neurotoxicity HI Across All Media =	0.0039
Total Blood Chemistry/Blood HI Across All Media =	0.027
Total Kidney HI Across All Media =	6.0
Total NOAEL HI Across All Media =	0.0070
Total GI Irritation/GI Tract HI Across All Media =	0.024
Total Liver HI Across All Media =	0.024
Total CNS HI Across All Media =	0.011

Table E-28
Summary of Exposure Risks and Hazards for COPCs
Reasonable Maximum Exposure
Future - Maintenance Worker

Scenario Timeframe: Future
Receptor Population: Maintenance Worke
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Building 4343	Aroclor 1254	4.8E-08		4.4E-08		9.3E-08	Eyes, Immune System	3.4E-03		3.1E-03	6.5E-03
			Aluminum	---		---		---	Developmental Neurotoxicity	3.2E-03		7.7E-04	3.9E-03
			Antimony	---		---		---	Blood Chemistry	1.9E-03		8.4E-04	2.7E-03
			Cadmium	---		---		---	Kidney	4.8E+00		1.3E+00	6.0E+00
			Chromium[a]	---		---		---	NOAEL	2.9E-05		1.5E-04	1.8E-04
			Copper	---		---		---	GI Tract	4.2E-04		2.7E-05	4.4E-04
			Iron	---		---		---	GI Irritation, Blood, Liver	2.2E-02		1.5E-03	2.4E-02
			Lead	---		---		---	N/A	---		---	---
			Manganese	---		---		---	CNS	3.7E-03		6.1E-03	9.7E-03
			Vanadium[a]	---		---		---	NOAEL	1.9E-03		4.9E-03	6.9E-03
			Chemical Total	4.8E-08		4.4E-08		9.3E-08		4.8		1.3	6.1
			Radionuclide Total										
		Exposure Point Total						9.3E-08					6.1
	Exposure Media Total							9.3E-08					6.1
	Air (Particulates)	Building 4343	Aroclor 1254		1.4E-11			1.4E-11	N/A		---		---
			Aluminum		---			---	N/A		9.2E-04		9.2E-04
			Antimony		---			---	N/A		---		---
			Cadmium		3.1E-06			3.1E-06	Kidney		2.4E-02		2.4E-02
			Chromium		---			---	N/A		---		---
			Copper		---			---	N/A		---		---
			Iron		---			---	N/A		---		---
			Lead		---			---	N/A		---		---
			Manganese		---			---	CNS		1.5E-03		1.5E-03
			Vanadium		---			---	N/A		---		---
			Chemical Total		3.1E-06			3.1E-06			0.027		0.027
			Radionuclide Total										
		Exposure Point Total						3.1E-06					0.027
	Exposure Media Total							3.1E-06					0.027
Surface Soil Total								3.1E-06					6.1
Total Soil	Total Soil	Building 4343	Aroclor 1254	1.9E-08		1.8E-08		3.7E-08	Eyes, Immune System	1.3E-03		1.2E-03	2.6E-03
			Aluminum	---		---		---	Developmental Neurotoxicity	4.2E-03		1.0E-03	5.2E-03
			Antimony	---		---		---	Blood Chemistry	9.7E-04		4.3E-04	1.4E-03
			Cadmium	---		---		---	Kidney	1.8E-01		4.7E-02	2.2E-01
			Chromium[a]	---		---		---	NOAEL	1.6E-05		8.2E-05	9.8E-05
			Copper	---		---		---	GI Tract	2.4E-04		1.6E-05	2.5E-04
			Iron	---		---		---	GI Irritation, Blood, Liver	2.5E-02		1.7E-03	2.7E-02
			Lead	---		---		---	N/A	---		---	---
			Thallium	---		---		---	Liver, Blood, Hair	1.4E-03		9.1E-05	1.5E-03
			Vanadium[a]	---		---		---	NOAEL	2.8E-03		7.0E-03	9.7E-03
			Chemical Total	1.9E-08		1.8E-08		3.7E-08		0.21		0.06	0.27
			Radionuclide Total										
		Exposure Point Total						3.7E-08					0.27
	Exposure Media Total							3.7E-08					0.27

Table E-28
Summary of Exposure Risks and Hazards for COPCs
Reasonable Maximum Exposure
Future - Maintenance Worker

Scenario Timeframe: Future
Receptor Population: Maintenance Worke
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
	Air (Particulates)	Building 4343	Aroclor 1254		5.6E-12			5.6E-12	N/A		---		---
			Aluminum		---			---	N/A		1.2E-03		1.2E-03
			Antimony		---			---	N/A		---		---
			Cadmium		1.2E-07			1.2E-07	Kidney		9.1E-04		9.1E-04
			Chromium		---			---	N/A		---		---
			Copper		---			---	N/A		---		---
			Iron		---			---	N/A		---		---
			Lead		---			---	N/A		---		---
			Thallium		---			---	N/A		---		---
			Vanadium		---			---	N/A		---		---
			Chemical Total		1.2E-07			1.2E-07			0.0021		0.0021
			Radionuclide Total										
		Exposure Point Total						1.2E-07					0.0021
	Exposure Media Total							1.2E-07					0.0021
Total Soil Total								1.5E-07					0.27
Receptor Total[b]								3.1E-06					6.1

Total Risk Across All Media[b] = 3.1E-06

Total Hazard Across All Media[b] = 6.1

(a) The RfD is based on NOAEL; no target organ is identified.

(b) Since surface soil represents the more highly contaminated portion of soil, total risk and hazard estimates are conservatively based on this soil data grouping.

GI = Gastrointestinal.
NOAEL = No Observed Adverse Effect Level.
N/A = Not Available.

Total Eyes HI Across All Media =	0.0065
Total Immune System HI Across All Media =	0.0065
Total Developmental Neurotoxicity HI Across All Media =	0.0039
Total Blood Chemistry/Blood HI Across All Media =	0.027
Total Kidney HI Across All Media =	6.0
Total NOAEL HI Across All Media =	0.0070
Total GI Irritation/GI Tract HI Across All Media =	0.024
Total Liver HI Across All Media =	0.024
Total CNS HI Across All Media =	0.011

Table E-29
Summary of Exposure Risks and Hazards for COPCs
Reasonable Maximum Exposure
Future - Excavation Worker

Scenario Timeframe: Future
Receptor Population: Excavation Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Total Soil	Total Soil	Building 4343	Aroclor 1254	1.3E-08		5.3E-09		1.8E-08	Eyes, Immune System	2.2E-02		9.3E-03	3.1E-02
			Aluminum	---		---		---	Developmental Neurotoxicity	6.9E-02		7.7E-03	7.7E-02
			Antimony	---		---		---	Blood Chemistry	1.6E-02		3.2E-03	1.9E-02
			Cadmium	---		---		---	Kidney	2.9E+00		3.5E-01	3.3E+00
			Chromium[a]	---		---		---	NOAEL	2.7E-04		6.2E-04	8.8E-04
			Copper	---		---		---	GI Tract	3.9E-03		1.2E-04	4.0E-03
			Iron	---		---		---	GI Irritation, Blood, Liver	4.2E-01		1.3E-02	4.3E-01
			Lead	---		---		---	N/A	---		---	---
			Thallium	---		---		---	Liver, Blood, Hair	2.3E-02		6.8E-04	2.3E-02
			Vanadium[a]	---		---		---	NOAEL	4.5E-02		5.2E-02	9.8E-02
			Chemical Total	1.3E-08		5.3E-09		1.8E-08		3.5		0.4	4.0
			Radionuclide Total										
		Exposure Point Total						1.8E-08					4.0
	Exposure Media Total							1.8E-08					4.0
	Air (Particulates)	Building 4343	Aroclor 1254		1.1E-12			1.1E-12	N/A		---		---
			Aluminum		---			---	N/A		6.1E-03		6.1E-03
			Antimony		---			---	N/A		---		---
			Cadmium		2.3E-08			2.3E-08	Kidney		4.5E-03		4.5E-03
			Chromium		---			---	N/A		---		---
			Copper		---			---	N/A		---		---
			Iron		---			---	N/A		---		---
			Lead		---			---	N/A		---		---
			Thallium		---			---	N/A		---		---
			Vanadium		---			---	N/A		---		---
			Chemical Total		2.3E-08			2.3E-08			0.011		0.011
			Radionuclide Total										
		Exposure Point Total						2.3E-08					0.011
	Exposure Media Total							2.3E-08					0.011
Soil Total								4.1E-08					4.0
Receptor Total								4.1E-08					4.0

Total Risk Across All Media = 4.1E-08

Total Hazard Across All Media = 4.0

(a) The RfD is based on NOAEL; no target organ is identified.

GI = Gastrointestinal.
NOAEL = No Observed Adverse Effect Level.
N/A = Not Available.

Total Eyes HI Across All Media =	0.031
Total Immune System HI Across All Media =	0.031
Total Developmental Neurotoxicity HI Across All Media =	0.077
Total Blood/Blood Chemistry HI Across All Media =	0.47
Total Kidney HI Across All Media =	3.3
Total NOAEL HI Across All Media =	0.10
Total GI Tract/GI Irritation HI Across All Media =	0.44
Total Liver HI Across All Media =	0.45
Total Hair HI Across All Media =	0.023

Table E-30
Summary of Exposure Risks and Hazards for COPCs
Reasonable Maximum Exposure
Future - Adult Resident

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Total Soil	Total Soil	Building 4343	Aroclor 1254	1.6E-07		9.0E-08		2.5E-07	Eyes, Immune System	9.4E-03		5.2E-03	1.5E-02
			Aluminum	---		---		---	Developmental Neurotoxicity	2.9E-02		4.3E-03	3.4E-02
			Antimony	---		---		---	Blood Chemistry	6.8E-03		1.8E-03	8.6E-03
			Cadmium	---		---		---	Kidney	1.2E+00		2.0E-01	1.4E+00
			Chromium[a]	---		---		---	NOAEL	1.1E-04		3.5E-04	4.6E-04
			Copper	---		---		---	GI Tract	1.7E-03		6.7E-05	1.7E-03
			Iron	---		---		---	GI Irritation, Blood, Liver	1.8E-01		7.1E-03	1.8E-01
			Lead	---		---		---	N/A	---		---	---
			Thallium	---		---		---	Liver, Blood, Hair	9.6E-03		3.8E-04	1.0E-02
			Vanadium[a]	---		---		---	NOAEL	1.9E-02		3.0E-02	4.9E-02
			Chemical Total	1.6E-07		9.0E-08		2.5E-07		1.5		0.24	1.7
			Radionuclide Total										
		Exposure Point Total						2.5E-07					1.7
	Exposure Media Total							2.5E-07					1.7
	Air (Particulates)	Building 4343	Aroclor 1254		1.9E-12			1.9E-12	N/A		---		---
			Aluminum		---			---	N/A		3.6E-04		3.6E-04
			Antimony		---			---	N/A		---		---
			Cadmium		4.0E-08			4.0E-08	Kidney		2.6E-04		2.6E-04
			Chromium		---			---	N/A		---		---
			Copper		---			---	N/A		---		---
			Iron		---			---	N/A		---		---
			Lead		---			---	N/A		---		---
			Thallium		---			---	N/A		---		---
			Vanadium		---			---	N/A		---		---
			Chemical Total		4.0E-08			4.0E-08			0.00062		0.00062
			Radionuclide Total										
		Exposure Point Total						4.0E-08					0.00062
	Exposure Media Total							4.0E-08					0.00062
Soil Total								2.9E-07					1.7
Receptor Total								2.9E-07					1.7

Total Risk Across All Media = 2.9E-07

Total Hazard Across All Media = 1.7

(a) The RfD is based on NOAEL; no target organ is identified.

GI = Gastrointestinal.
NOAEL = No Observed Adverse Effect Level.
N/A = Not Available.

Total Eyes HI Across All Media =	0.015
Total Immune System HI Across All Media =	0.015
Total Developmental Neurotoxicity HI Across All Media =	0.034
Total Blood/Blood Chemistry HI Across All Media =	0.20
Total Kidney HI Across All Media =	1.4
Total NOAEL HI Across All Media =	0.049
Total GI Tract/GI Irritation HI Across All Media =	0.19
Total Liver HI Across All Media =	0.19
Total Hair HI Across All Media =	0.010

Table E-31
Summary of Exposure Risks and Hazards for COPCs
Reasonable Maximum Exposure
Future - Child Resident

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Total Soil	Total Soil	Building 4343	Aroclor 1254	3.0E-07		1.2E-07		4.2E-07	Eyes, Immune System	8.8E-02		3.4E-02	1.2E-01
			Aluminum	---		---		---	Developmental Neurotoxicity	2.7E-01		2.8E-02	3.0E-01
			Antimony	---		---		---	Blood Chemistry	6.3E-02		1.2E-02	7.5E-02
			Cadmium	---		---		---	Kidney	1.2E+01		1.3E+00	1.3E+01
			Chromium[a]	---		---		---	NOAEL	1.1E-03		2.3E-03	3.3E-03
			Copper	---		---		---	GI Tract	1.6E-02		4.4E-04	1.6E-02
			Iron	---		---		---	GI Irritation, Blood, Liver	1.7E+00		4.6E-02	1.7E+00
			Lead	---		---		---	N/A	---		---	---
			Thallium	---		---		---	Liver, Blood, Hair	9.0E-02		2.5E-03	9.2E-02
			Vanadium[a]	---		---		---	NOAEL	1.8E-01		1.9E-01	3.7E-01
			Chemical Total	3.0E-07		1.2E-07		4.2E-07		13.8		1.6	15.5
			Radionuclide Total										
		Exposure Point Total						4.2E-07					15.5
	Exposure Media Total							4.2E-07					15.5
	Air (Particulates)	Building 4343	Aroclor 1254		2.2E-12			2.2E-12	N/A		---		---
			Aluminum		---			---	N/A		2.0E-03		2.0E-03
			Antimony		---			---	N/A		---		---
			Cadmium		4.6E-08			4.6E-08	Kidney		1.5E-03		1.5E-03
			Chromium		---			---	N/A		---		---
			Copper		---			---	N/A		---		---
			Iron		---			---	N/A		---		---
			Lead		---			---	N/A		---		---
			Thallium		---			---	N/A		---		---
			Vanadium[a]		---			---	N/A		---		---
			Chemical Total		4.6E-08			4.6E-08			0.0035		0.0035
			Radionuclide Total										
		Exposure Point Total						4.6E-08					0.0035
	Exposure Media Total							4.6E-08					0.0035
Soil Total								4.6E-07					15.5
Receptor Total								4.6E-07					15.5

Total Risk Across All Media = 4.6E-07

Total Hazard Across All Media = 15.5

(a) The RfD is based on NOAEL; no target organ is identified.

GI = Gastrointestinal.
NOAEL = No Observed Adverse Effect Level.
N/A = Not Available.

Total Eyes HI Across All Media =	0.12
Total Immune System HI Across All Media =	0.12
Total Developmental Neurotoxicity HI Across All Media =	0.30
Total Blood/Blood Chemistry HI Across All Media =	1.9
Total Kidney HI Across All Media =	12.8
Total NOAEL HI Across All Media =	0.38
Total GI Tract/GI Irritation HI Across All Media =	1.7
Total Liver HI Across All Media =	1.8
Total Hair HI Across All Media =	0.092

Table E-32
Risk Assessment Summary
Reasonable Maximum Exposure
Current - Maintenance Worker

Scenario Timeframe: Current
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Building 4343	Cadmiun						Kidney	4.8E+00		1.3E+00	6.0E+00
			Chemical Total					<1.0E-06		4.8		1.3	6.0
			Radionuclide Total										
		Exposure Point Total						<1.0E-06					6.0
	Exposure Media Total							<1.0E-06					6.0
	Air (Particulates)	Building 4343	Cadmium		3.1E-06			3.1E-06					
			Chemical Total		3.1E-06			3.1E-06					<1
			Radionuclide Total										
		Exposure Point Total						3.1E-06					<1
	Exposure Media Total							3.1E-06					<1
Surface Soil Total								3.1E-06					6.0
Receptor Total								3.1E-06					6.0

Total Risk Across All Media = 3.1E-06

Total Hazard Across All Media = 6.0

Total Kidney HI Across All Media = 6.0

Table E-33
Risk Assessment Summary
Reasonable Maximum Exposure
Future - Maintenance Worker

Scenario Timeframe: Future
Receptor Population: Maintenance Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Building 4343	Cadmium						Kidney	4.8E+00		1.3E+00	6.0E+00
			Chemical Total					<1.0E-06		4.8		1.3	6.0
			Radionuclide Total										
		Exposure Point Total						<1.0E-06					6.0
	Exposure Media Total							<1.0E-06					6.0
	Air	Building 4343	Cadmium		3.1E-06			3.1E-06					
			Chemical Total		3.1E-06			3.1E-06					<1
			Radionuclide Total										
		Exposure Point Total						3.1E-06					<1
	Exposure Media Total							3.1E-06					<1
Surface Soil Total								3.1E-06					6.0
Total Soil	Total Soil	Building 4343											
			Chemical Total					<1.0E-06					<1
			Radionuclide Total										
		Exposure Point Total						<1.0E-06					<1
	Exposure Media Total							<1.0E-06					<1
	Air (Particulates)	Building 4343											
			Chemical Total					<1.0E-06					<1
			Radionuclide Total										
		Exposure Point Total						<1.0E-06					<1
	Exposure Media Total							<1.0E-06					<1
Total Soil Total								<1.0E-06					<1
Receptor Total[b]								3.1E-06					6.0

Total Risk Across All Media[a] = 3.1E-06

Total Hazard Across All Media[a] = 6.0

Total Kidney HI Across All Media = 6.0

(a) Since surface soil represents the more highly contaminated portion of soil, total risk and hazard estimates are conservatively based on this soil data grouping.

Table E-34
Risk Assessment Summary
Reasonable Maximum Exposure
Future - Excavation Worker

Scenario Timeframe: Future
Receptor Population: Excavation Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Total Soil	Total Soil	Building 4343	Cadmium						Kidney	2.9E+00		3.5E-01	3.3E+00
			Chemical Total					<1.0E-06		2.9		0.3	3.3
			Radionuclide Total										
		Exposure Point Total						<1.0E-06					3.3
	Exposure Media Total							<1.0E-06					3.3
	Air (Particulates)	Building 4343											
			Chemical Total					<1.0E-06					<1
			Radionuclide Total										
		Exposure Point Total						<1.0E-06					<1
	Exposure Media Total							<1.0E-06					<1
Soil Total								<1.0E-06					3.3
Receptor Total								<1.0E-06					3.3

Total Risk Across All Media = <1.0E-06

Total Hazard Across All Media = 3.3

Total Kidney HI Across All Media = 3.3

Table E-35
Risk Assessment Summary
Reasonable Maximum Exposure
Future - Adult Resident

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Total Soil	Total Soil	Building 4343	Cadmium						Kidney	1.2E+00		2.0E-01	1.4E+00
			Chemical Total					<1.0E-06		1.2		0.2	1.4
			Radionuclide Total										
		Exposure Point Total						<1.0E-06					1.4
	Exposure Media Total							<1.0E-06					1.4
	Air (Particulates)	Building 4343											
			Chemical Total					<1.0E-06					<1
			Radionuclide Total										
		Exposure Point Total						<1.0E-06					<1
	Exposure Media Total							<1.0E-06					<1
Soil Total								<1.0E-06					1.4
Receptor Total								<1.0E-06					1.4

Total Risk Across All Media = <1.0E-06

Total Hazard Across All Media = 1.4

Total Kidney HI Across All Media = 1.4

Table E-36
Risk Assessment Summary
Reasonable Maximum Exposure
Future - Child Resident

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Total Soil	Total Soil	Building 4343	Cadmium						Kidney	1.2E+01		1.3E+00	1.3E+01
			Iron						GI Irritation, Blood, Liver	1.7E+00		4.6E-02	1.7E+00
			Chemical Total					<1.0E-06		13.2		1.3	14.5
			Radionuclide Total										
		Exposure Point Total						<1.0E-06					14.5
	Exposure Media Total							<1.0E-06					14.5
	Air (Particulates)	Building 4343											
			Chemical Total					<1.0E-06					<1
			Radionuclide Total										
		Exposure Point Total						<1.0E-06					<1
	Exposure Media Total							<1.0E-06					<1
Soil Total								<1.0E-06					14.5
Receptor Total								<1.0E-06					14.5

Total Risk Across All Media = <1.0E-06

Total Hazard Across All Media = 14.5

GI = Gastrointestinal.

Total Kidney HI Across All Media = 12.8
Total GI Irritation HI Across All Media = 1.7
Total Blood HI Across All Media = 1.7
Total Liver HI Across All Media = 1.7

Appendix E-2
Statistical Comparison Results and Data Plots

Appendix E-2, Table 1
Statistical Summary Spreadsheet
Building 4343 and Background

>BG?	Compound	Distribution		Sample Size		Test?	Levene's Test (F) Variances Similar?	T-Test Site > Background?	Mann Whitney Site>Background?
		On-site	Background	On-site	Background				
	Total Soil								
X	Aluminum	Neither	Lognormal	57	79	MWU	===>	===>	**Yes**
	Arsenic	Lognormal	Lognormal	57	69	T-test	No, (0.001)	===>	No
	Barium	Lognormal	Neither	57	79	MWU	===>	===>	No
	Beryllium	Neither	Neither	57	79	MWU	===>	===>	No
X	Cadmium	Neither	Neither	57	79	MWU	===>	===>	**Yes**
X	Calcium	Neither	Lognormal	57	79	MWU	===>	===>	**Yes**
X	Chromium	Neither	Lognormal	57	79	MWU	===>	===>	**Yes**
	Cobalt	Neither	Lognormal	56	79	MWU	===>	===>	No
X	Copper	Neither	Lognormal	57	79	MWU	===>	===>	**Yes**
X	Iron	Neither	Normal	57	79	MWU	===>	===>	**Yes**
X	Lead	Neither	Neither	57	79	MWU	===>	===>	**Yes**
	Magnesium	Neither	Lognormal	57	79	MWU	===>	===>	No
	Manganese	Lognormal	Lognormal	57	79	T-test	No	===>	No
X	Mercury	Neither	Neither	57	79	MWU	===>	===>	**Yes**
	Nickel	Neither	Lognormal	57	79	MWU	===>	===>	No
	Potassium	Lognormal	Lognormal	57	79	T-test	No, (0.000)	===>	No
X	Thallium	Neither	Neither	57	79	MWU	===>	===>	**Yes**
X	Vanadium	Lognormal	Lognormal	57	79	T-test	No, (0.001)	===>	**Yes**
X	Zinc	Neither	Lognormal	56	79	MWU	===>	===>	**Yes**
	Surface Soil								
X	Aluminum	Normal	Lognormal	25	28	MWU	===>	===>	**Yes**
	Arsenic	Lognormal	Lognormal	25	24	T-test	No, (0.019)	===>	No
	Barium	Lognormal	Normal	25	28	MWU	===>	===>	No
	Beryllium	Neither	Neither	25	28	MWU	===>	===>	No
X	Cadmium	Lognormal	Neither	25	28	MWU	===>	===>	**Yes**
X	Calcium	Neither	Lognormal	25	28	MWU	===>	===>	**Yes**
X	Chromium	Lognormal	Lognormal	25	28	T-test	No, (0.005)	===>	**Yes**
	Cobalt	Neither	Neither	24	28	MWU	===>	===>	No
X	Copper	Neither	Normal	25	28	MWU	===>	===>	**Yes**
X	Iron	Normal	Lognormal	25	28	MWU	===>	===>	**Yes**
	Lead	Neither	Neither	25	28	MWU	===>	===>	No
	Magnesium	Lognormal	Lognormal	25	28	T-test	Yes (0.993)	No (0.499)	
X	Manganese	Lognormal	Lognormal	25	28	T-test	Yes (0.409)	**Yes (0.001)**	
X	Mercury	Neither	Neither	25	28	MWU	===>	===>	**Yes**
	Nickel	Neither	Neither	25	28	MWU	===>	===>	No
	Potassium	Lognormal	Lognormal	25	28	T-test	Yes (0.059)	No (0.113)	
X	Thallium	Neither	Neither	25	28	MWU	===>	===>	**Yes**
X	Vanadium	Normal	Lognormal	25	28	MWU	===>	===>	**Yes**
X	Zinc	Neither	Lognormal	24	28	MWU	===>	===>	**Yes**

X = Site concentrations of this chemical are significantly greater than background concentrations; or chemical was detected on-site but not detected (or not analyzed for) in background samples.

M = Maximum to maximum comparison will be performed because not enough samples were available for statistical comparison.

Appendix E-2, Table 2
Mann-Whitney Test (General) Results Spreadsheet
Building 4343 and Background

Chemical	Distribution		Site Samples	Background Samples	Site Rank Sum (a)	$W_{.05}$	$W_{.95}$	On-site Concentrations > Background
	On-site	Background	n	m	T	(b)		Concentrations? (c)
Total Soil								
Aluminum	Neither	Lognormal	57	79	4530.5	3532	4277	**Yes**
Arsenic	Lognormal	Neither	57	69	3822	3284	3955	No
Barium	Lognormal	Neither	57	79	4248	3532	4277	No
Beryllium	Neither	Neither	57	79	2907	3532	4277	No
Cadmium	Neither	Neither	57	79	4740	3532	4277	**Yes**
Calcium	Neither	Lognormal	57	79	4744	3532	4277	**Yes**
Chromium	Neither	Normal	57	79	4677	3532	4277	**Yes**
Cobalt	Neither	Neither	56	79	2896	3440	4176	No
Copper	Neither	Lognormal	57	79	5121	3532	4277	**Yes**
Iron	Neither	Normal	57	79	4323.5	3532	4277	**Yes**
Lead	Neither	Neither	57	79	4786	3532	4277	**Yes**
Magnesium	Neither	Lognormal	57	79	3650	3532	4277	No
Manganese	Lognormal	Lognormal	57	79	3374	3532	4277	No
Mercury	Neither	Neither	57	79	5519.5	3532	4277	**Yes**
Nickel	Neither	Neither	57	79	3376.5	3532	4277	No
Potassium	Lognormal	Neither	57	79	3873.5	3532	4277	No
Thallium	Neither	Neither	57	79	4950.5	3532	4277	**Yes**
Vanadium	Lognormal	Lognormal	57	79	4786	3532	4277	**Yes**
Zinc	Neither	Lognormal	56	79	4183	3440	4176	**Yes**
Surface Soil								
Aluminum	Normal	Lognormal	25	28	881	583	767	**Yes**
Arsenic	Lognormal	Lognormal	25	24	698	543	707	No
Barium	Lognormal	Lognormal	25	28	651	583	767	No
Beryllium	Neither	Neither	25	28	440	583	767	No
Cadmium	Lognormal	Neither	25	28	966	583	767	**Yes**
Calcium	Neither	Lognormal	25	28	812.5	583	767	**Yes**
Chromium	Lognormal	Lognormal	25	28	893	583	767	**Yes**
Cobalt	Neither	Neither	34	28	533.5	955	1187	No
Copper	Neither	Neither	25	28	997	583	767	**Yes**
Iron	Normal	Lognormal	25	28	838.5	583	767	**Yes**
Lead	Neither	Neither	25	28	758	583	767	No
Mercury	Neither	Neither	25	28	950.5	583	767	**Yes**
Nickel	Neither	Neither	25	28	752	583	767	No
Thallium	Neither	Neither	25	28	853	583	767	**Yes**
Vanadium	Normal	Lognormal	25	28	877.5	583	767	**Yes**
Zinc	Neither	Lognormal	24	28	727	546	726	**Yes**

(a) Site rank sum calculated in SPSS by Mann-Whitney test.

(b) For sample sizes <20, the $W_{.05}$ can be obtained from Quantiles of the Mann-Whitney Test Statistic tables in Conover (1980); for sample sizes >20 the $W_{.05}$ must be calculated. The $W_{.95}$ is then calculated from the $W_{.05}$.

(c) Onsite concentrations were determined to be greater than background concentrations if the site rank sum (T) exceeded the $W_{.95}$.

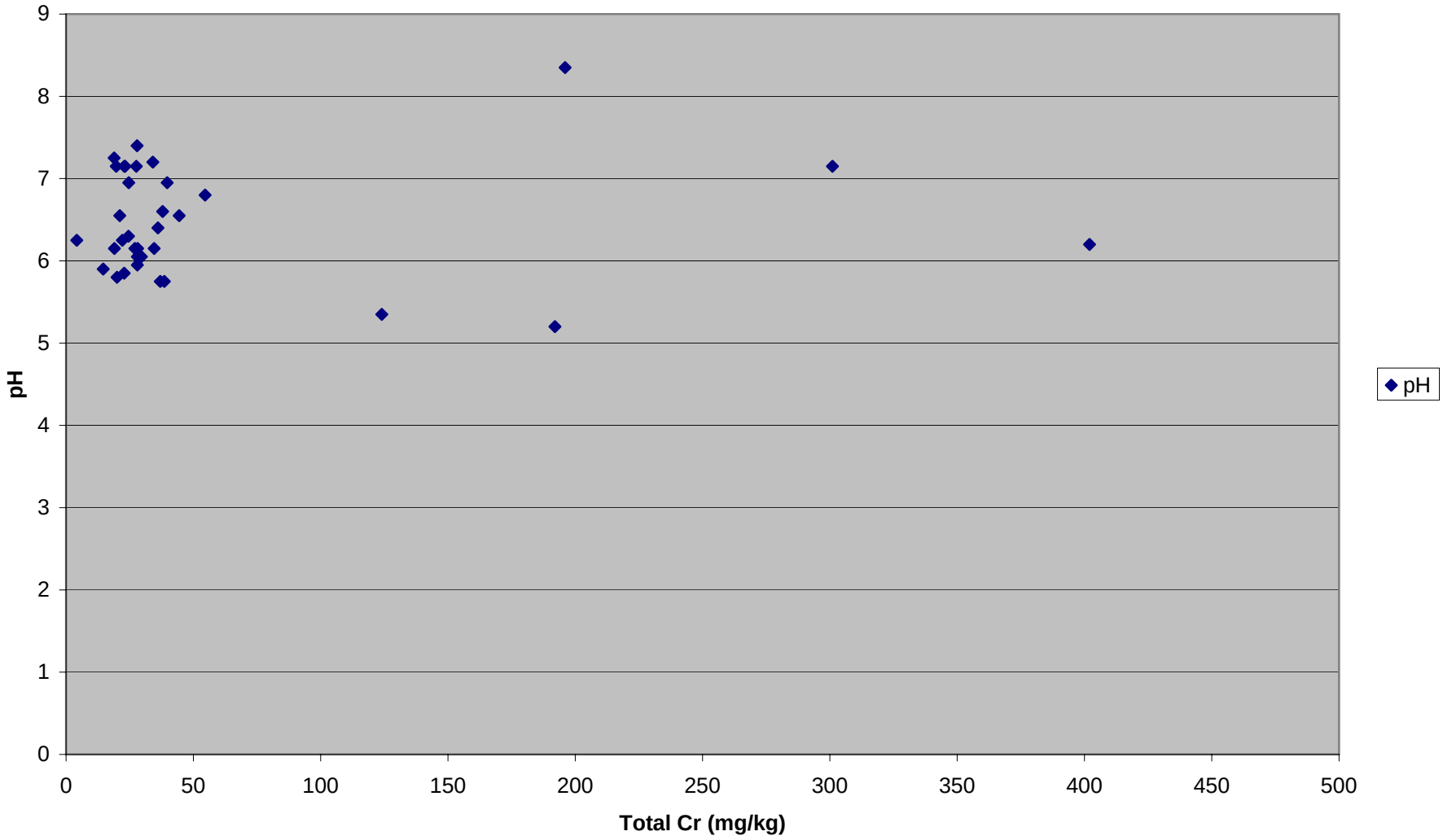
Appendix E-2, Table 3
Mann-Whitney Test Results Spreadsheet with Correction for Non-Detects (Ties)
Building 4343 and Background

Chemical	Number of Non-Detects	Site Samples n	Background Samples m	Site Rank Sum T	W.95	On-site Concentrations > Background Concentrations
Surface Soil						
Calcium	2	26	28	866.5	810	Yes
Chromium	3	26	28	947	810	Yes

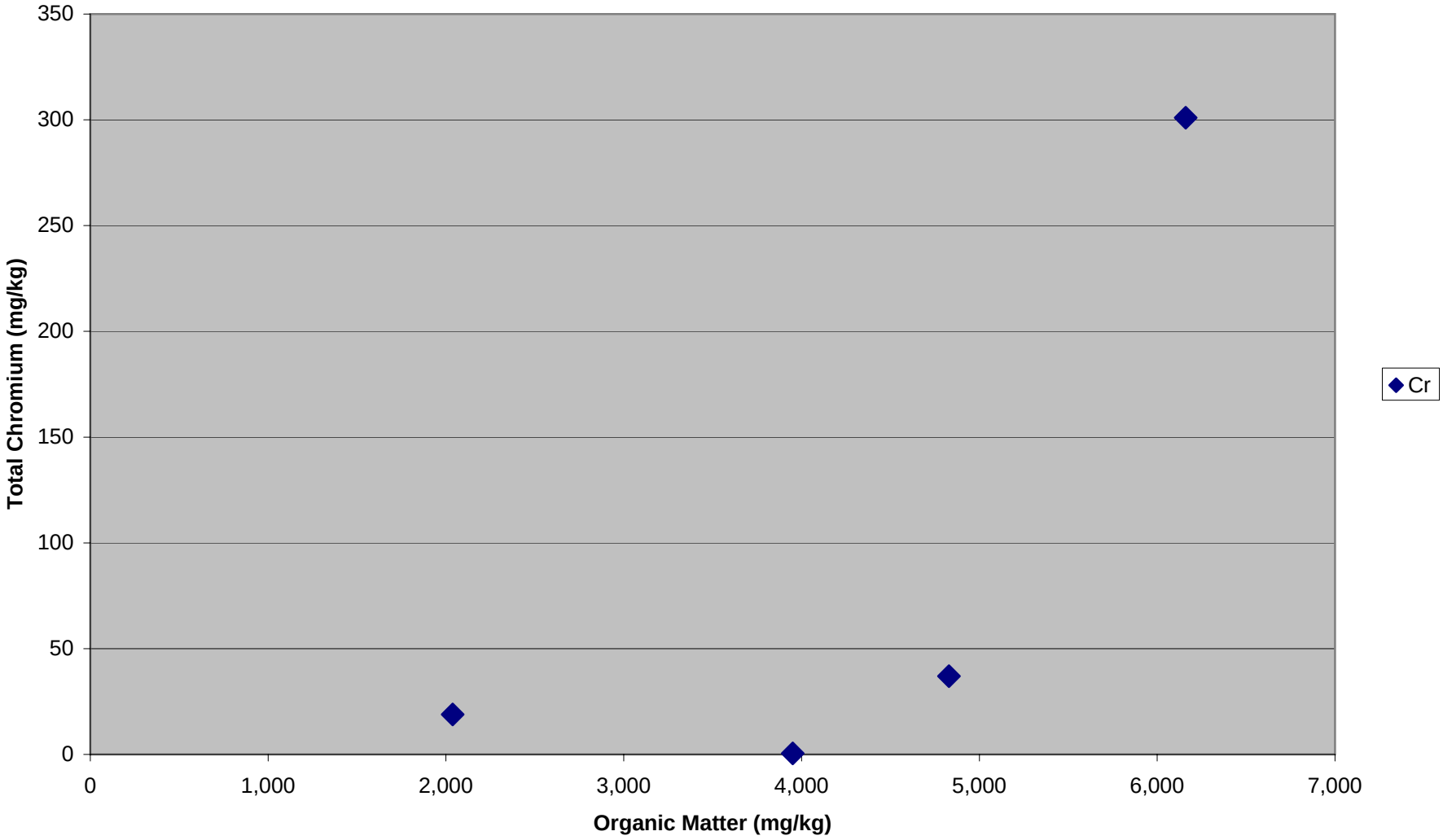
Appendix E-2, Table 4
Mann-Whitney Test Results Spreadsheet with Correction for All Ties
Building 4343 and Background

Chemical	t^3-t	Site Samples n	Background Samples m	Site Rank Sum T	W.95	On-site Concentrations > Background Concentrations
Total Soil						
Aluminum	162	60	79	4893.5	4587	Yes
Barium	228	60	79	4546	4587	No
Cadmium	3906	61	79	5119	4692	Yes
Calcium	72	61	79	5165	4692	Yes
Chromium	144	61	79	5147.5	4692	Yes
Copper	174	61	79	5623	4692	Yes
Iron	90	61	79	4802.5	4692	Yes
Lead	240	60	79	5115.5	4587	Yes
Mercury	34122	61	79	6037.5	4689	Yes
Thallium	46122	61	79	5440.5	4689	Yes
Vanadium	54	61	79	5117	4692	Yes
Zinc	66	60	79	4633	4587	Yes
Surface Soil						
Aluminum	18	25	28	881	767	Yes
Arsenic	54	25	24	698	707	No
Cadmium	384	26	28	1020	810	Yes
Copper	42	26	28	1051	810	Yes
Iron	18	26	28	892.5	810	Yes
Lead	24	26	28	812	810	Yes
Mercury	2928	26	28	1002.5	809	Yes
Nickel	150	26	28	806	810	No
Thallium	4188	26	28	903	809	Yes
Vanadium	12	26	28	912.5	810	Yes

Appendix E-2, Plot 1
Cr vs pH (in soil)



Appendix E-2, Plot 2
Cr vs. Organic Matter (soil)



Appendix F
SLERA Site Reconnaissance Photographs and SLERA Risk Characterization Tables

This Appendix Contains:

Appendix F-1 SLERA Site Reconnaissance Photographs
Appendix F-2 SLERA Risk Characterization Tables

Appendix F-1
SLERA Site Reconnaissance Photographs



Photo 1. Northwest side of Building 4343. Remaining structure. 27 June 2002.



Photo 2. Former lead catch tank pipe remnants. 27 June 2002.



Photo 3. Aerial photograph of Building 4343 and surrounding land use.



Photo 4. Close up of habitat adjacent to Building 4343. Cement footers for former fire water tanks in background. 27 June 2002.



Photo 5. Close up of groundhog hole immediately adjacent to the process water drainage ditch. 27 June 2002.



Photo 6. Looking north from discharge culvert at the process water drainage ditch. 27 June 2002.



Photo 7. View of habitat surrounding Building 4343. 27 June 2002.



Photo 8. View looking upslope towards Building 4343 from the alluvial fan where topography flattens out. 27 June 2002.



Photo 9. Photograph of interior sump during sludge sampling.



Photo 10. Photograph of exterior sump during sludge sampling.

Appendix F-2
SLERA Risk Characterization Tables

Table F-1
Data Used to Model Exposure[a] in the Indicator Wildlife Species

Indicator Species	Body Weight Range (average) (kg)	Average Home Range (ha) [ac]	Maximum Dietary Intake[b] (kg[dw]/day)	Average Dietary Intake[c] (kg[dw]/day)	Soil/Sed. Intake[d] (%Diet) (Avg – Max) (kg[dw]/day)	Maximum Water Intake[b] (L/day)	Average Water Intake[c] (L/day)	Trophic Level	Dietary Composition
Meadow vole (*Microtus pennsylvanicus*)	0.0170-0.0524 (0.037)	0.036 [0.089]	0.010	0.0080	(2.4%) 0.00019-0.00024	0.0070	0.0051	Herbivore	Plants: 100%
Short-tailed shrew *(Blarina brevicauda)*	0.0125-0.0225 (0.015)	0.39 [0.96]	0.0030	0.0022	(10.4%) 0.00023-0.00031	0.0033	0.0023	Insectivore	Terrestrial Invertebrates: 100%
American robin *(Turdus migratorius)*	0.0635-0.103 (0.0773)	0.48 [1.2]	0.020	0.016	(4%) 0.00064-0.00080	0.013	0.011	Omnivore	Plants: 62% Terrestrial Invertebrates: 38%
Red-tailed hawk (*Buteo jamaicensis*)	0.957-1.235 (1.134)	842 [2081]	0.063	0.059	(0%)	0.068	0.064	Carnivore	Mammals: 76% Birds: 24%
Red fox *(Vulpes vulpes)*	2.95-7.04 (4.53)	892 [2204]	0.34	0.24	(2.8%) 0.0067-0.0095	0.57	0.39	Carnivore	Mammals: 65% Birds: 14% Plants: 17% Terr. Inverts: 4%

[a] From USEPA (1993), except as noted.
[b] Maximum dietary and water intake based on appropriate allometric equation using maximum body weight.
[c] Average dietary and water intake based on appropriate allometric equation using average body weight.
[d] Soil/sediment ingestion rate based on estimated percent soil in diet (dry weight), and maximum or average dietary intake.

Allometric equations for mammals and birds from USEPA (1993), as follows, where FI = food ingestion (dry weight [dw]), WI = water ingestion, Wt = body weight, kg = kilogram, L = liter, and g = gram:

FI (kg/day) = 0.0687 $Wt^{0.822}$ for mammals (shrew and red fox),
FI (g/day) = 0.577 $Wt^{0.727}$ for herbivores (meadow vole),
FI (g/day) = 0.301 $Wt^{0.751}$ for non-passerine birds (red-tail hawk),
FI (g/day) = 0.398 $Wt^{0.850}$ for passerine birds (American robin).
WI (L/day) = 0.099 $Wt^{0.90}$ (Wt in kg) for mammals,
WI (L/day) = 0.059 $Wt^{0.67}$ (Wt in kg) for birds.

ha = hectare
ac = acre, and a hectare = 2.471 acres.

Notes:
The soil ingestion rate for the shrew set equal to the rate for the American woodcock (10.4% of diet), as both species feed predominantly on earthworms.
The soil ingestion rate for the American robin set equal to 48% of the American woodcock value (0.38 x 10.4% = 4%), based on a robin diet of 38% invertebrates (earthworms).

Table F-2
Recommended Bioaccumulation/Bioconcentration Factors or Regression Equations
Soil-to-Plant Pathway

Constituent	USEPA, 2000 [a]				Regression Equation [b]	Other BAF/BCF	Recommended Tier 1 (Maximum) BAF/BCF	Recommended Tier 2 (RME) BAF/BCF	Rationale for Recommended Tier 2 BAF/BCF
	Minimum BAF/BCF	Median BAF/BCF	90th Percentile BAF/BCF [b]	Maximum BAF/BCF					
Antimony	0.003	0.037	--[c]	0.22	--	0.12 [d]	0.22	0.037	Median BAF from USEPA (2000)
Cadmium	0.0087	0.58571	3.3	22.8788	ln (AGP)=0.55(ln[soil])-0.48	0.35 [d]	23	Regression Equation	Chemical-specific Regression Eq.
Chromium	0.021	0.041	--	0.48	--	0.001 [e]	0.48	0.041	Median BAF from USEPA (2000)
Copper	0.0011	0.12432	0.63	7.4	ln (AGP)=0.39(ln[soil])+0.67	0.8 [e]	7.4	Regression Equation	Chemical-specific Regression Eq.
Cyanide	--	--	--	--	--	--	2.7[f]	1.6	Geom. mean of eight 90th-percentile values, See Note (1)
Iron	--	--	--	--	--	0.004 [e]	0.004	0.004	Value from IAEA (1994).
Lead	0.00011	0.0388	0.47	10.611	ln (AGP)=0.56(ln[soil])-1.33	0.0011 [e]	11	Regression Equation	Chemical-specific Regression Eq.
Mercury	0.0015[b]	0.65[b]	5	12[b]	ln (AGP)=0.54(ln[soil])-1.00	0.55 [d]	12	Regression Equation	Chemical-specific Regression Eq.
Nickel	0.00217	0.01786	1.4	22.2143	ln (AGP)=0.75(ln[soil])-2.22	0.18 [e]	22	Regression Equation	Chemical-specific Regression Eq.
Selenium	0.02	0.67189	3.0	77	ln (AGP)=1.1(ln[soil])-0.68	0.025 [d]	77	Regression Equation	Chemical-specific Regression Eq.
Silver	0.0029	0.014	--	0.04	--	0.15 [e]	0.15	0.04	Maximum BAF from USEPA (2000)
Zinc	0.00855	0.36616	1.8	34.2857	ln (APG)=0.56(ln[soil])+1.58	1.2 [d]	34	Regression Equation	Chemical-specific Regression Eq.
4,4'-DDT	0.00035	0.028	-	0.08	-	-	0.08	0.028	Median BAF from USEPA (2000)

[a] USEPA, 2000, *Ecological Soil Screening Level Guidance* , Draft.

[b] Efroymson, R.A., et. al., 2001, *Uptake of Inorganic Chemicals from Soil by Plant Leaves: Regressions of Field Data* , Environ. Tox. Chem., 20:2561-2571.

AGP = above ground plant.

[c] -- indicates that a BAF/BCF or regression equation is not available.

[d] Baes et al. (1984); note: value from this reference used if no appropriate value available from IAEA (1994).

[e] IAEA (1994); note: value from this reference used, compared with Baes et al (1984), as IAEA (1994) is more current.

[f] Geometric mean of fourteen maximum BAF/BCF values, see Note (1).

Note (1): For inorganics without BAF/BCF data, the following data from USEPA (2000) and Efroymson et al (2001) were used to estimate Tier 1 and Tier 2 values:

	Max BAF/BCF	90th Percentile BAF/BCF
Antimony	0.22	
Arsenic	9.0741	1.1
Barium	0.92	
Cadmium	22.8788	3.3
Chromium	0.48	
Cobalt	0.045	
Copper	7.4	0.63
Manganese	0.433	
Mercury	12	5
Nickel	22.2143	1.4
Lead	10.6011	0.47
Selenium	77	3
Silver	0.04	
Zinc	34.2857	1.8
Geometric Mean	2.65	1.59

Table F-3
Recommended Bioaccumulation/Bioconcentration Factors or Regression Equations
Soil-to-Earthworm Pathway

Constituent	Sample, et. al. [a]			Regression Equation [b]	Beyer [c] BAF/BCF	Recommended Tier 1 (Maximum) BAF/BCF	Recommended Tier 2 (RME) BAF/BCF	Rationale for Tier 2 (RME) BAF/BCF
	Median BAF/BCF	90th Percentile BAF/BCF	Maximum BAF/BCF					
Antimony	--[d]	--	--	--	--	3.2	1.2	Geom. mean of 18 values, see Note (1).
Cadmium	7.708	40.69	190	ln (EW)=0.55(ln[soil])+2.82	--	190	Regression Equation	Chemical-specific Regression Eq.
Chromium	0.306	3.162	11.416	--	--	11	3.2	90th percentile value, from field studies.
Copper	0.515	1.531	5.492	ln (EW)=0.24(ln[soil])+1.8	--	5.5	Regression Equation	Chemical-specific Regression Eq.
Cyanide	--	--	--	--	--	3.2	1.2	Geom. mean of 18 values, see Note (1).
Iron	0.036	0.078	0.1	--	--	0.1	0.078	90th percentile value, from field studies.
Lead	0.266	1.522	228.261	ln (EW)=0.81(ln[soil])-0.21	--	228	Regression Equation	Chemical-specific Regression Eq.
Mercury	1.693	20.625	33	ln (EW)=0.33(ln[soil])+0.078	--	33	Regression Equation	Chemical-specific Regression Eq.
Nickel	1.059	4.73	7.802	--	--	7.8	4.7	90th percentile value, from field studies.
Selenium	0.985	1.34	13.733	ln (EW)=0.73(ln[soil])-0.075	--	14	Regression Equation	Chemical-specific Regression Eq.
Silver	2.045	15.338	19.5	--	--	19.5	15	90th percentile value, from field studies.
Zinc	3.201	12.885	49.51	ln (EW)=0.33(ln[soil])+4.44	--	50	Regression Equation	Chemical-specific Regression Eq.
4,4-DDT	--	--	--	see footnote "e" below	--	67	55	Kow Regression Eq., using arith. average TOC

[a] Sample, B. E, et. al., 1998. Development and Validation of Bioaccumulation Models for Earthworms, ES/ER/TM-220.

[b] For Inorganics: Sample, B.E, et. al., 1999, Literature-Derived Bioaccumulation Models for Earthworms: Development and Validation, Environ. Toxicol. Chem., 18:2,110-2,120. (models from Table 3 of publication). EW = earthworm tissue concentration.

[c] Beyer, W. N., 1990. Evaluating Soil Contamination, Biological Report 90(2), U.S. Department of the Interior, U.S. Fish and Wildlife Service.

[d] -- indicates that a BAF/BCF or regression equation is either not available or not recommended.

[e] For 4,4-DDT, Ecological Soil Screening Level (SSL) Guidance, USEPA, 2000 (Section 2.0 in Appendix 4-1) was used, given site specific soil total organic carbon [TOC]). TOC concentrations utilized are as follows: Lower-bound (geometric mean) Bldg. 4343 surface soil TOC = 0.49% and arithmetic mean TOC = 0.595% (from three surface soil samples). The 4,4-DDT BAF was estimated using the following regression equation and a log Kow value from http://esc.syrres.com/interkow:

$$BAF = \frac{10^{(\log Kow - 0.6)}}{foc * 10^{(0.983 * \log Kow + 0.00028)}}$$

Constituent	Log Kow
DDT	6.79

Note (1): For inorganics without BAF/BCF data, the following data (from Sample et al., 1998) were used to estimate Tier 1 and Tier 2 values:

	Max BAF/BCF	90th Percentile BAF/BCF
Aluminum	0.197	0.118
Arsenic	0.925	0.523
Barium	0.31	0.16
Beryllium	1.429	1.182
Cadmium	190	40.69
Chromium	11.416	3.162
Cobalt	0.321	0.291
Copper	5.492	1.531
Iron	0.1	0.078
Manganese	0.228	0.124
Mercury	33	20.625
Molybdenum	2.091	2.091
Nickel	7.802	4.73
Lead	228.261	1.522
Selenium	13.733	1.34
Silver	19.5	15.338
Vanadium	0.088	0.088
Zinc	49.51	12.885
Geometric Mean	3.16	1.24

Table F-4
Recommended Bioaccumulation/Bioconcentration Factors
Soil-to-Small Mammal and Bird Pathways

Constituent	Sample et al., 1998 [a]						Recommended Tier 1 (Maximum) BAF/BCF	Recommended Tier 2 (90^{th} Percentile - RME) BAF/BCF	Rationale for Recommended BAF/BCF
	Insectivore Median BAF/BCF	Herbivore Median BAF/BCF	Omnivore Median BAF/BCF	General [b] Median BAF/BCF	General [b] Maximum BAF/BCF	General [b] 90^{th} percentile BAF/BCF			
Antimony	--[c]	--	--	--	--	--	0.83	0.27	Geometric mean of 13 90th percentile values, see Note (2)
Cadmium	2.105	0.1258	0.1217	0.3333	69.561	3.9905	70	4.0	General 90th percentile conservative for other groups' median.
Chromium	0.0815	0.0884	0.0699	0.0846	0.8	0.3333	0.8	0.33	General 90th percentile conservative for other groups' median.
Copper	0.7714	0.1086	0.1272	0.1963	1.398	1.045	1.4	1.1	General 90th percentile conservative for other groups' median.
Cyanide	--	--	--	--	--	--	0.83	0.27	Geometric mean of 13 90th percentile values, see Note (2)
Iron	--	0.0126	0.0124	0.0124	0.031	0.0171	0.031	0.017	General 90th percentile conservative for other groups' median.
Lead	0.1601	0.0522	0.0659	0.1054	2.659	0.2864	2.7	0.29	General 90th percentile conservative for other groups' median.
Mercury	1.046 [d]	0.0239 [d]	0.0543	0.0543	1.046	0.192	1.1	0.19	General 90th percentile value is upper bound.
Nickel	0.3643	0.0513	0.1683	0.2488	1.143	0.5891	1.1	0.59	General 90th percentile conservative for other groups' median.
Selenium	0.7241	0.0221 [e]	0.2062	0.1619	1.754	1.1867	1.8	1.2	General 90th percentile conservative for other groups' median.
Silver	--	--	--	--	--	--	0.83	0.27	Geometric mean of 13 90th percentile values, see Note (2)
Zinc	0.83277	0.50429	0.55772	0.7717	16.364	2.6878	16	2.7	General 90th percentile conservative for other groups' median.
4,4-DDT	--	--	--	--	--	--	1	0.5	Conservative value for Tier 2 organics see "f."

[a] Sample et al., 1998, *Development and Validation of Bioaccumulation Models for Small Mammals*, ES/ER/TM-219.

[b] General = combination dataset used for insectivore, herbivore, and omnivore receptors to estimate a "general" receptor BAF/BCF value.

[c] -- indicates that a BAF/BCF is not available.

[d] Only one BAF/BCF value available for exposure to mercury in soil (median is also 90th percentile value and maximum value).

[e] Mean value presented, as median value not given in Sample et al. (1998).

[f] Known bioaccumulative organics (TCDD and TCDF) have BAFs/BCFs of 1.1 and 0.13 (median) and 2.2 and 0.16 (maximum) from Sample et al. (1998).
Conservative BAF/BCF default values of 1 and 0.5 were selected for other organics (e.g., 4,4-DDT) at the site, as they are not expected to be as bioaccumulative as TCDD/TCDF.

Notes:

(1) Bird BAF/BCF values were based on the recommended small mammal BAF/BCF values, as bird uptake values are not readily available.

(2) Geometric means for Maximum BAF/BCFs and 90th Percentile BAF/BCFs were calculated based on the data provided below, from Sample et al. (1998):

	Max BAF/BCF	90th Percentile BAF/BCF
Arsenic	0.071	0.0149
Barium	0.253	0.1121
Cadmium	69.561	3.9905
Cobalt	0.18	0.1
Chromium	0.8	0.3333
Copper	1.398	1.045
Iron	0.031	0.0171
Mercury	1.046	0.192
Nickel	1.143	0.5891
Lead	2.659	0.2864
Selenium	1.754	1.1867
Thallium	0.123	0.1227
Zinc	16.364	2.6878
Geometric Mean	**0.83**	**0.27**

Table F-5
NOAEL Toxicity Reference Values Used to Derive
Wildlife Toxicity Benchmarks for Chemicals of Potential Ecological Concern

COPEC	Mammalian Data				Avian Data			
	Toxicity Value	NOAEL (mg/kg/d)	Test Species	Reference	Toxicity Value	NOAEL (mg/kg/d)	Test Species	Reference
Antimony	--	0.125	mouse	Sample, et al. (1996)	NA	NA	NA	NA
Cadmium	--	1	rat	Sample, et al. (1996)	--	1.45	mallard duck	Sample, et al. (1996)
Chromium	--	2,737	rat	Sample, et al. (1996)	--	1.0	black duck	Sample, et al. (1996)
Copper	--	11.7	mink	Sample, et al. (1996)	--	47	chicks	Sample, et al. (1996)
Cyanide	--	68.7	rat	Sample, et al. (1996)	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA
Lead	--	8	rat	Sample, et al. (1996)	--	3.85	Am. Kestrel	Sample, et al. (1996)
Mercury	--	1.0	mink	Sample, et al. (1996)	--	0.45	Japanese quail	Sample, et al. (1996)
Nickel	--	40	rat	Sample, et al. (1996)	--	77.4	mallard duck	Sample, et al. (1996)
Selenium	--	0.2	rat	Sample, et al. (1996)	--	0.5	mallard duck	Sample, et al. (1996)
Silver	222 (LOAEL)	22.2	rat	ATSDR (1990)	26.7 (subchronic)	2.67	turkey	Eisler (1996)
Zinc	--	160	rat	Sample, et al. (1996)	--	14.5	hens	Sample, et al. (1996)
4,4-DDT	--	0.8	rat	Sample, et. al. (1996)	--	0.0028	brown pelican	Sample, et. al. (1996)

Notes:

NA indicates that the information is not available.

As recommended by Wentsel, et al. (1996), Tri-Service Procedural Guidelines for Ecological Risk Assessments, the following adjustments were made to toxicity data when NOAEL or LOAEL data were not avaiable

- Subchronic LOAELs were converted to chronic NOAELs by dividing by a factor of 20.
- Chronic NOAELs were converted to chronic LOAELs by multiplying by a factor of 5.0.
- Subchronic NOAELs/LOAELs were converted to chronic NOAELs/LOAELs by dividing by a factor of 10.
- Chronic LOAELs were converted to chronic NOAELs by dividing by a factor of 10.

ATSDR, 1990, Toxicological Profile for Silver, U.S. Public Health Service

Eisler, R., 1996, Silver hazards to Fish, Wildlife, and Invertebrates: A Synotic Review, National Biological Services, Biological Report 32, 44 pp.

Table F-6
LOAEL Toxicity Reference Values Used to Derive
Wildlife Toxicity Benchmarks for Chemicals of Potential Ecological Concern

COPEC	Mammalian Data				Avian Data			
	Toxicity Value	LOAEL (mg/kg/d)	Test Species	Reference	Toxicity Value	LOAEL (mg/kg/d)	Test Species	Reference
Antimony	--	1.25	mouse	Sample, et al. (1996)	NA	NA	NA	NA
Cadmium	--	10	rat	Sample, et al. (1996)	--	20	mallard duck	Sample, et al. (1996)
Chromium	2,737 (NOAEL)	13,690	rat	Sample, et al. (1996)	--	5.0	black duck	Sample, et al. (1996)
Copper	--	15.1	mink	Sample, et al. (1996)	--	62	chicks	Sample, et al. (1996)
Cyanide	68.7 (NOAEL)	344	rat	Sample, et al. (1996)	NA	NA	NA	NA
Iron	NA	NA	NA	NA	NA	NA	NA	NA
Lead	--	80	rat	Sample, et al. (1996)	--	38.5	Am. Kestrel	Sample, et al. (1996)
Mercury	1.0 (NOAEL)	5.0	mink	Sample, et al. (1996)	--	0.9	Japanese quail	Sample, et al. (1996)
Nickel	--	80	rat	Sample, et al. (1996)	--	107	mallard duck	Sample, et al. (1996)
Selenium	--	0.3	rat	Sample, et al. (1996)	--	1.0	mallard duck	Sample, et al. (1996)
Silver	--	222	rat	ATSDR (1990)	26.7 (subchronic NOAEL)	13.3	turkey	Eisler (1996)
Zinc	--	320	rat	Sample, et al. (1996)	--	131	hens	Sample, et al. (1996)
4,4-DDT	--	4	rat	Sample, et. al. (1996)	--	0.028	brown pelican	Sample, et. al. (1996)

Notes:

NA indicates that the information is not available.

As recommended by Wentsel, et. al. (1996), Tri-Service Procedural Guidelines for Ecological Risk Assessments, the following adjustments were made to toxicity data when NOAEL or LOAEL data were not avaiable

- Subchronic LOAELs were converted to chronic NOAELs by dividing by a factor of 20.
- Chronic NOAELs were converted to chronic LOAELs by multiplying by a factor of 5.0.
- Subchronic NOAELs/LOAELs were converted to chronic NOAELs/LOAELs by dividing by a factor of 10.
- Chronic LOAELs were converted to chronic NOAELs by dividing by a factor of 10.

ATSDR, 1990, Toxicological Profile for Silver, U.S. Public Health Service

Eisler, R., 1996, Silver hazards to Fish, Wildlife, and Invertebrates: A Synotic Review, National Biological Services, Biological Report 32, 44 pp.

Table F-7
Uncertainty Factors[a] for Ecological TRV[b] Extrapolations[c]

Laboratory Animals (toxicity data base)		Selected Site Receptor Species	
Rat	G: Rattus F: Muridae O: Rodentia	Meadow vole	G: Microtus F: Muridae O: Rodentia
Mouse	G: Mus F: Muridae O: Rodentia	Short-tailed shrew	G: Blarina F: Soricidae O: Insectivora
Mink	G: Mustela F: Mustelidae O: Carnivora	American robin	G: Turdus F: Muscicapidae O: Passeriformes
Brown pelican	G: Pelecanus F: Pelecanidae O: Ciconiiformes	Red-tailed hawk	G: Buteo F: Accipitridae O: Ciconiiformes
American kestrel	G: Falco F: Falconidae O: Ciconiiformes	Red fox	G: Vulpes F: Canidae O: Carnivora
Turkey	G: Meleagris F: Phasianidae O: Galliformes		
Chick, Poultry	G: Gallus F: Phasianidae O: Galliformes		
Black duck, Mallard	G: Anas F: Anatidae O: Anseriformes		
Japanese quail	G: Coturnix F: Phasianidae O: Galliformes		

[a] From ***Tri-Service Procedural Guidelines for Ecological Risk Assessment*** (Wentsel et al. 1996)
[b] TRV = Toxicity Reference Value
[c] Interclass extrapolations not performed; only within bird class or within mammal class.

The Uncertainty Factors Used for TRV Extrapolations are Summarized Below:

- Extrapolation between two different species = uncertainty factor of 2
- Extrapolation between two different genera (G) = uncertainty factor of 4
- Extrapolation between two different families (F) or orders (O) = uncertainty factor of 8
- Thus, for all extrapolations used in the SLERA food chain model (except for rat or mouse toxicity values extrapolated to the meadow vole), an uncertainty factor of 8 was used. For the latter, an uncertainty factor of 4 was used.

Table F-8
Tier 1 Chemicals of Potential Ecological Concern EEQs and Hazard Indices for Meadow Voles at Building 4343

Hazard Estimate - Tier 1
Meadow Vole

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Soil Exposure Point Concentration	Units	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Plant BAF	Mammal BAF	Bird BAF	PDE Surface Water	PDE Sediment	PDE Soil	PDE Fish	PDE Aq. Invert.	PDE Terr. Invert.	PDE Plants	PDE Mammals	PDE Birds	Total PDE	Chemical-Specific Toxicity Value UF	NOAEL	Adjusted NOAEL	EEQ N	LOAEL	Adjusted LOAEL	EEQ L	Percent Contribution to EEQ N	Percent Contribution to EEQ L
							---------- unitless ----------						mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d			
Antimony	0.00E+00	mg/L	0.0E+00	mg/kg	4.12E+01	mg/kg	NA	NA	3.20E+00	2.20E-01	8.30E-01	8.30E-01	0.00E+00	0.00E+00	5.82E-01	NA	NA	0.00E+00	5.33E+00	0.00E+00	0.00E+00	5.91E+00	4	1.25E-01	3.13E-02	1.89E+02	1.25E+00	3.13E-01	1.89E+01	0.01%	0.01%
Cadmium	0.00E+00	mg/L	0.0E+00	mg/kg	2.43E+04	mg/kg	NA	NA	1.90E+02	2.30E+01	7.00E+01	7.00E+01	0.00E+00	0.00E+00	3.43E+02	NA	NA	0.00E+00	3.29E+05	0.00E+00	0.00E+00	3.29E+05	4	1.00E+00	2.50E-01	1.32E+06	1.00E+01	2.50E+00	1.32E+05	99.34%	97.64%
Chromium	0.00E+00	mg/L	0.0E+00	mg/kg	1.82E+03	mg/kg	NA	NA	1.10E+01	4.80E-01	8.00E-01	8.00E-01	0.00E+00	0.00E+00	2.57E+01	NA	NA	0.00E+00	5.14E+02	0.00E+00	0.00E+00	5.40E+02	4	2.74E+03	6.84E+02	7.89E-01	1.37E+04	3.42E+03	1.58E-01	0.00%	0.00%
Copper	0.00E+00	mg/L	0.0E+00	mg/kg	6.77E+02	mg/kg	NA	NA	5.50E+00	7.40E+00	1.40E+00	1.40E+00	0.00E+00	0.00E+00	9.56E+00	NA	NA	0.00E+00	2.95E+03	0.00E+00	0.00E+00	2.96E+03	8	1.17E+01	1.46E+00	2.02E+03	1.51E+01	1.89E+00	1.57E+03	0.15%	1.16%
Cyanide	0.00E+00	mg/L	0.0E+00	mg/kg	1.48E+01	mg/kg	NA	NA	3.20E+00	2.70E+00	8.30E-01	8.30E-01	0.00E+00	0.00E+00	2.09E-01	NA	NA	0.00E+00	2.35E+01	0.00E+00	0.00E+00	2.37E+01	4	6.87E+01	1.72E+01	1.38E+00	3.44E+02	8.60E+01	2.76E-01	0.00%	0.00%
Iron	0.00E+00	mg/L	0.0E+00	mg/kg	5.14E+04	mg/kg	NA	NA	1.00E-01	4.00E-03	3.10E-02	3.10E-02	0.00E+00	0.00E+00	7.26E+02	NA	NA	0.00E+00	1.21E+02	0.00E+00	0.00E+00	8.47E+02	8	NA	NA	NA	NA	NA	NA	NA	NA
Lead	0.00E+00	mg/L	0.0E+00	mg/kg	1.41E+03	mg/kg	NA	NA	2.28E+02	1.10E+01	2.70E+00	2.70E+00	0.00E+00	0.00E+00	1.99E+01	NA	NA	0.00E+00	9.12E+03	0.00E+00	0.00E+00	9.14E+03	4	8.00E+00	2.00E+00	4.57E+03	8.00E+01	2.00E+01	4.57E+02	0.34%	0.34%
Mercury	0.00E+00	mg/L	0.0E+00	mg/kg	5.30E-01	mg/kg	NA	NA	3.30E+01	1.20E+01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	7.48E-03	NA	NA	0.00E+00	3.74E+00	0.00E+00	0.00E+00	3.75E+00	8	1.00E+00	1.25E-01	3.00E+01	5.00E+00	6.25E-01	6.00E+00	0.00%	0.00%
Nickel	0.00E+00	mg/L	0.0E+00	mg/kg	3.26E+01	mg/kg	NA	NA	7.80E+00	2.20E+01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	4.60E-01	NA	NA	0.00E+00	4.22E+02	0.00E+00	0.00E+00	4.22E+02	4	4.00E+01	1.00E+01	4.22E+01	8.00E+01	2.00E+01	2.11E+01	0.00%	0.02%
Selenium	0.00E+00	mg/L	0.0E+00	mg/kg	1.10E+00	mg/kg	NA	NA	1.40E+01	7.70E+01	1.80E+00	1.80E+00	0.00E+00	0.00E+00	1.55E-02	NA	NA	0.00E+00	4.98E+01	0.00E+00	0.00E+00	4.98E+01	4	2.00E-01	5.00E-02	9.97E+02	3.00E-01	7.50E-02	6.65E+02	0.08%	0.49%
Silver	0.00E+00	mg/L	0.0E+00	mg/kg	3.60E+01	mg/kg	NA	NA	1.95E+01	1.50E-01	8.30E-01	8.30E-01	0.00E+00	0.00E+00	5.08E-01	NA	NA	0.00E+00	3.18E+00	0.00E+00	0.00E+00	3.68E+00	4	2.22E+01	5.55E+00	6.64E-01	2.22E+02	5.55E+01	6.64E-02	0.00%	0.00%
Zinc	0.00E+00	mg/L	0.0E+00	mg/kg	1.78E+03	mg/kg	NA	NA	5.00E+01	3.40E+01	1.60E+01	1.60E+01	0.00E+00	0.00E+00	2.51E+01	NA	NA	0.00E+00	3.56E+04	0.00E+00	0.00E+00	3.56E+04	4	1.60E+02	4.00E+01	8.91E+02	3.20E+02	8.00E+01	4.45E+02	0.07%	0.33%
4,4'-DDT	0.00E+00	mg/L	0.0E+00	mg/kg	2.18E-02	mg/kg	NA	NA	6.70E+01	8.00E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	3.08E-04	NA	NA	0.00E+00	1.03E-03	0.00E+00	0.00E+00	1.33E-03	4	8.00E-01	2.00E-01	6.67E-03	4.00E+00	1.00E+00	1.33E-03	0.00%	0.00%
																						Hazard Index (Total EEQ):			1.3E+06			1.3E+05	100.00%	100.00%

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x \, Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
Tier 1 = Max EEQ using max EPC, max BAF/BCF, max Intake Rates, min BW, and FHR =1.
Tier 2 = EEQ using 95% EPC, non-max BAF/BCF, avg Intake Rates, avg BW and calculated FHR.
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EEQ = Ecological Effects Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
PDE = Predicted Daily Exposure
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box): [n] See appropriate text tables for equations.
If BAF/BCF regression equation produced Tier 2 value exceeding maximum Tier 1 BAF/BCF value, Tier 1 value used a default.
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Plant diet fraction =	1	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.00024	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.01	kg/d
Body weight =	0.017	kg
Home range =	0.089	acres
Water intake rate =	0.007	L/d
Site Area =	0.94	acres
Frac. home range (FHR) =	1.00E+00	unitless

Table F-9
Tier 2 Chemicals of Potential Ecological Concern EEQs and Hazard Indices for Meadow Voles at Building 4343

Hazard Estimate - Tier 2
Meadow Vole

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Soil Exposure Point Concentration	Units	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Plant BAF	Mammal BAF	Bird BAF	PDE Surface Water	PDE Sediment	PDE Soil	PDE Fish	PDE Aq. Invert.	PDE Terr. Invert.	PDE Plants	PDE Mammals	PDE Birds	Total PDE	Chemical-Specific Toxicity Value UF	NOAEL	Adjusted NOAEL	EEQ N	LOAEL	Adjusted LOAEL	EEQ L	Percent Contribution to EEQ N	Percent Contribution to EEQ L
							---------- unitless ----------						mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d			
Antimony	0.00E+00	mg/L	0.0E+00	mg/kg	3.89E+00	mg/kg	NA	NA	1.20E+00	3.70E-02	2.70E-01	2.70E-01	0.00E+00	0.00E+00	2.00E-02	NA	NA	0.00E+00	3.11E-02	0.00E+00	0.00E+00	5.11E-02	4	1.25E-01	3.13E-02	1.64E+00	1.25E+00	3.13E-01	1.64E-01	0.25%	0.25%
Cadmium	0.00E+00	mg/L	0.0E+00	mg/kg	2.43E+04	mg/kg	NA	NA	1.78E-01	6.58E-03	4.00E+00	4.00E+00	0.00E+00	0.00E+00	1.25E+02	NA	NA	0.00E+00	3.46E+01	0.00E+00	0.00E+00	1.59E+02	4	1.00E+00	2.50E-01	6.37E+02	1.00E+01	2.50E+00	6.37E+01	99.05%	95.98%
Chromium	0.00E+00	mg/L	0.0E+00	mg/kg	2.23E+02	mg/kg	NA	NA	3.20E+00	4.10E-02	3.30E-01	3.30E-01	0.00E+00	0.00E+00	1.15E+00	NA	NA	0.00E+00	1.98E+00	0.00E+00	0.00E+00	3.12E+00	4	2.74E+03	6.84E+02	4.56E-03	1.37E+04	3.42E+03	9.12E-04	0.00%	0.00%
Copper	0.00E+00	mg/L	0.0E+00	mg/kg	8.50E+01	mg/kg	NA	NA	2.07E-01	1.30E-01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	4.36E-01	NA	NA	0.00E+00	2.39E+00	0.00E+00	0.00E+00	2.83E+00	8	1.17E+01	1.46E+00	1.93E+00	1.51E+01	1.89E+00	1.50E+00	0.30%	2.25%
Cyanide	0.00E+00	mg/L	0.0E+00	mg/kg	3.44E+00	mg/kg	NA	NA	1.20E+00	1.60E+00	2.70E-01	2.70E-01	0.00E+00	0.00E+00	1.77E-02	NA	NA	0.00E+00	1.19E+00	0.00E+00	0.00E+00	1.21E+00	4	6.87E+01	1.72E+01	7.03E-02	3.44E+02	8.60E+01	1.40E-02	0.01%	0.02%
Iron	0.00E+00	mg/L	0.0E+00	mg/kg	3.42E+04	mg/kg	NA	NA	7.80E-02	4.00E-03	1.70E-02	1.70E-02	0.00E+00	0.00E+00	1.76E+02	NA	NA	0.00E+00	2.96E+01	0.00E+00	0.00E+00	2.05E+02	8	NA	NA	NA	NA	NA	NA	NA	NA
Lead	0.00E+00	mg/L	0.0E+00	mg/kg	1.33E+02	mg/kg	NA	NA	3.20E-01	3.08E-02	2.90E-01	2.90E-01	0.00E+00	0.00E+00	6.83E-01	NA	NA	0.00E+00	8.84E-01	0.00E+00	0.00E+00	1.57E+00	4	8.00E+00	2.00E+00	7.84E-01	8.00E+01	2.00E+01	7.84E-02	0.12%	0.12%
Mercury	0.00E+00	mg/L	0.0E+00	mg/kg	1.26E-01	mg/kg	NA	NA	4.33E+00	9.54E-01	1.90E-01	1.90E-01	0.00E+00	0.00E+00	6.47E-04	NA	NA	0.00E+00	2.60E-02	0.00E+00	0.00E+00	2.66E-02	8	1.00E+00	1.25E-01	2.13E-01	5.00E+00	6.25E-01	4.26E-02	0.03%	0.06%
Nickel	0.00E+00	mg/L	0.0E+00	mg/kg	1.16E+01	mg/kg	NA	NA	4.70E+00	5.89E-02	5.90E-01	5.90E-01	0.00E+00	0.00E+00	5.96E-02	NA	NA	0.00E+00	1.48E-01	0.00E+00	0.00E+00	2.07E-01	4	4.00E+01	1.00E+01	2.07E-02	8.00E+01	2.00E+01	1.04E-02	0.00%	0.02%
Selenium	0.00E+00	mg/L	0.0E+00	mg/kg	4.29E-01	mg/kg	NA	NA	1.17E+00	4.66E-01	1.20E+00	1.20E+00	0.00E+00	0.00E+00	2.20E-03	NA	NA	0.00E+00	4.32E-02	0.00E+00	0.00E+00	4.54E-02	4	2.00E-01	5.00E-02	9.08E-01	3.00E-01	7.50E-02	6.05E-01	0.14%	0.91%
Silver	0.00E+00	mg/L	0.0E+00	mg/kg	3.08E+00	mg/kg	NA	NA	1.50E+01	4.00E-02	2.70E-01	2.70E-01	0.00E+00	0.00E+00	1.58E-02	NA	NA	0.00E+00	2.66E-02	0.00E+00	0.00E+00	4.25E-02	4	2.22E+01	5.55E+00	7.65E-03	2.22E+02	5.55E+01	7.65E-04	0.00%	0.00%
Zinc	0.00E+00	mg/L	0.0E+00	mg/kg	1.89E+02	mg/kg	NA	NA	2.53E+00	4.84E-01	2.70E+00	2.70E+00	0.00E+00	0.00E+00	9.71E-01	NA	NA	0.00E+00	1.98E+01	0.00E+00	0.00E+00	2.07E+01	4	1.60E+02	4.00E+01	5.18E-01	3.20E+02	8.00E+01	2.59E-01	0.08%	0.39%
4,4'-DDT	0.00E+00	mg/L	0.0E+00	mg/kg	2.18E-02	mg/kg	NA	NA	5.50E+01	2.80E-02	5.00E-01	5.00E-01	0.00E+00	0.00E+00	0.00011195	NA	NA	0.00E+00	1.32E-04	0.00E+00	0.00E+00	2.44E-04	4	8.00E-01	2.00E-01	1.22E-03	4.00E+00	1.00E+00	2.44E-04		
																						Hazard Index (Total EEQ):			6.4E+02			6.6E+01	100.00%	100.00%

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
Tier 1 = Max EEQ using max EPC, max BAF/BCF, max Intake Rates, min BW, and FHR =1.
Tier 2 = EEQ using 95% EPC, non-max BAF/BCF, avg Intake Rates, avg BW and calculated FHR.
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EEQ = Ecological Effects Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
PDE = Predicted Daily Exposure
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box): n See appropriate text tables for equations.
If BAF/BCF regression equation produced Tier 2 value exceeding maximum Tier 1 BAF/BCF value, Tier 1 value used as default.
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Plant diet fraction =	1	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.00019	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.008	kg/d
Body weight =	0.037	kg
Home range =	0.089	acres
Water intake rate =	0.0051	L/d
Site Area =	0.94	acres
Frac. home range (FHR) =	1.00E+00	unitless

Table F-10
Tier 1 Chemicals of Potential Ecological Concern EEQs and Hazard Indices for Short-tailed Shrews at Building 4343

Hazard Estimate - Tier 1
Short-tailed Shrew

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Soil Exposure Point Concentration	Units	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Plant BAF	Mammal BAF	Bird BAF	PDE Surface Water	PDE Sediment	PDE Soil	PDE Fish	PDE Aq. Invert.	PDE Terr. Invert.	PDE Plants	PDE Mammals	PDE Birds	Total PDE	Chemical-Specific Toxicity Value UF	NOAEL	Adjusted NOAEL	EEQ N	LOAEL	Adjusted LOAEL	EEQ L	Percent Contribution to EEQ N	Percent Contribution to EEQ L
							---------- unitless ----------						mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d			
Antimony	0.00E+00	mg/L	0.0E+00	mg/kg	4.12E+01	mg/kg	NA	NA	3.20E+00	2.20E-01	8.30E-01	8.30E-01	0.00E+00	0.00E+00	1.02E+00	NA	NA	3.16E+01	0.00E+00	0.00E+00	0.00E+00	3.27E+01	8	1.25E-01	1.56E-02	2.09E+03	1.25E+00	1.56E-01	2.09E+02	0.02%	0.02%
Cadmium	0.00E+00	mg/L	0.0E+00	mg/kg	2.43E+04	mg/kg	NA	NA	1.90E+02	2.30E+01	7.00E+01	7.00E+01	0.00E+00	0.00E+00	6.03E+02	NA	NA	1.11E+06	0.00E+00	0.00E+00	0.00E+00	1.11E+06	8	1.00E+00	1.25E-01	8.87E+06	1.00E+01	1.25E+00	8.87E+05	99.09%	98.99%
Chromium	0.00E+00	mg/L	0.0E+00	mg/kg	1.82E+03	mg/kg	NA	NA	1.10E+01	4.80E-01	8.00E-01	8.00E-01	0.00E+00	0.00E+00	4.51E+01	NA	NA	4.80E+03	0.00E+00	0.00E+00	0.00E+00	4.85E+03	8	2.74E+03	3.42E+02	1.42E+01	1.37E+04	1.71E+03	2.83E+00	0.00%	0.00%
Copper	0.00E+00	mg/L	0.0E+00	mg/kg	6.77E+02	mg/kg	NA	NA	5.50E+00	7.40E+00	1.40E+00	1.40E+00	0.00E+00	0.00E+00	1.68E+01	NA	NA	8.94E+02	0.00E+00	0.00E+00	0.00E+00	9.10E+02	8	1.17E+01	1.46E+00	6.23E+02	1.51E+01	1.89E+00	4.82E+02	0.01%	0.05%
Cyanide	0.00E+00	mg/L	0.0E+00	mg/kg	1.48E+01	mg/kg	NA	NA	3.20E+00	2.70E+00	8.30E-01	8.30E-01	0.00E+00	0.00E+00	3.67E-01	NA	NA	1.14E+01	0.00E+00	0.00E+00	0.00E+00	1.17E+01	8	6.87E+01	8.59E+00	1.37E+00	3.44E+02	4.30E+01	2.73E-01	0.00%	0.00%
Iron	0.00E+00	mg/L	0.0E+00	mg/kg	5.14E+04	mg/kg	NA	NA	1.00E-01	4.00E-03	3.10E-02	3.10E-02	0.00E+00	0.00E+00	1.27E+03	NA	NA	1.23E+03	0.00E+00	0.00E+00	0.00E+00	2.51E+03	8	NA	NA	NA	NA	NA	NA	NA	NA
Lead	0.00E+00	mg/L	0.0E+00	mg/kg	1.41E+03	mg/kg	NA	NA	2.28E+02	1.10E+01	2.70E+00	2.70E+00	0.00E+00	0.00E+00	3.50E+01	NA	NA	7.72E+04	0.00E+00	0.00E+00	0.00E+00	7.72E+04	8	8.00E+00	1.00E+00	7.72E+04	8.00E+01	1.00E+01	7.72E+03	0.86%	0.86%
Mercury	0.00E+00	mg/L	0.0E+00	mg/kg	5.30E-01	mg/kg	NA	NA	3.30E+01	1.20E+01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	1.31E-02	NA	NA	4.20E+00	0.00E+00	0.00E+00	0.00E+00	4.21E+00	8	1.00E+00	1.25E-01	3.37E+01	5.00E+00	6.25E-01	6.74E+00	0.00%	0.00%
Nickel	0.00E+00	mg/L	0.0E+00	mg/kg	3.26E+01	mg/kg	NA	NA	7.80E+00	2.20E+01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	8.08E-01	NA	NA	6.10E+01	0.00E+00	0.00E+00	0.00E+00	6.18E+01	8	4.00E+01	5.00E+00	1.24E+01	8.00E+01	1.00E+01	6.18E+00	0.00%	0.00%
Selenium	0.00E+00	mg/L	0.0E+00	mg/kg	1.10E+00	mg/kg	NA	NA	1.40E+01	7.70E+01	1.80E+00	1.80E+00	0.00E+00	0.00E+00	2.73E-02	NA	NA	3.70E+00	0.00E+00	0.00E+00	0.00E+00	3.72E+00	8	2.00E-01	2.50E-02	1.49E+02	3.00E-01	3.75E-02	9.93E+01	0.00%	0.01%
Silver	0.00E+00	mg/L	0.0E+00	mg/kg	3.60E+01	mg/kg	NA	NA	1.95E+01	1.50E-01	8.30E-01	8.30E-01	0.00E+00	0.00E+00	8.93E-01	NA	NA	1.68E+02	0.00E+00	0.00E+00	0.00E+00	1.69E+02	8	2.22E+01	2.78E+00	6.10E+01	2.22E+02	2.78E+01	6.10E+00	0.00%	0.00%
Zinc	0.00E+00	mg/L	0.0E+00	mg/kg	1.78E+03	mg/kg	NA	NA	5.00E+01	3.40E+01	1.60E+01	1.60E+01	0.00E+00	0.00E+00	4.41E+01	NA	NA	2.14E+04	0.00E+00	0.00E+00	0.00E+00	2.14E+04	8	1.60E+02	2.00E+01	1.07E+03	3.20E+02	4.00E+01	5.35E+02	0.01%	0.06%
4,4'-DDT	0.00E+00	mg/L	0.0E+00	mg/kg	2.18E-02	mg/kg	NA	NA	6.70E+01	8.00E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	5.41E-04	NA	NA	3.51E-01	0.00E+00	0.00E+00	0.00E+00	3.51E-01	8	8.00E-01	1.00E-01	3.51E+00	4.00E+00	5.00E-01	7.02E-01	0.00%	0.00%
																						Hazard Index (Total EEQ):			9.0E+06			9.0E+05	100.00%	100.00%

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
Tier 1 = Max EEQ using max EPC, max BAF/BCF, max Intake Rates, min BW, and FHR =1.
Tier 2 = EEQ using 95% EPC, non-max BAF/BCF, avg Intake Rates, avg BW and calculated FHR.
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EEQ = Ecological Effects Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
PDE = Predicted Daily Exposure
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box): n See appropriate text tables for equations.
If BAF/BCF regression equation produced Tier 2 value exceeding maximum Tier 1 BAF/BCF value, Tier 1 value used a default.
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Plant diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	1	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.00031	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.003	kg/d
Body weight =	0.0125	kg
Home range =	0.96	acres
Water intake rate =	0.0033	L/d
Site Area =	0.94	acres
Frac. home range (FHR) =	1.00E+00	unitless

Table F-11
Tier 2 Chemicals of Potential Ecological Concern EEQs and Hazard Indices for Short-tailed Shrews at Building 4343

Hazard Estimate - Tier 2
Short-tailed Shrew

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Soil Exposure Point Concentration	Units	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Plant BAF	Mammal BAF	Bird BAF	PDE Surface Water	PDE Sediment	PDE Soil	PDE Fish	PDE Aq. Invert.	PDE Terr. Invert.	PDE Plants	PDE Mammals	PDE Birds	Total PDE	Chemical-Specific Toxicity Value UF	NOAEL	Adjusted NOAEL	EEQ N	LOAEL	Adjusted LOAEL	EEQ L	Percent Contribution to EEQ N	Percent Contribution to EEQ L
							---------- unitless ----------						mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d			
Antimony	0.00E+00	mg/L	0.0E+00	mg/kg	3.89E+00	mg/kg	NA	NA	1.20E+00	3.70E-02	2.70E-01	2.70E-01	0.00E+00	0.00E+00	5.84E-02	NA	NA	6.70E-01	0.00E+00	0.00E+00	0.00E+00	7.29E-01	8	1.25E-01	1.56E-02	4.66E+01	1.25E+00	1.56E-01	4.66E+00	0.59%	0.58%
Cadmium	0.00E+00	mg/L	0.0E+00	mg/kg	2.43E+04	mg/kg	NA	NA	1.78E-01	6.58E-03	4.00E+00	4.00E+00	0.00E+00	0.00E+00	3.65E+02	NA	NA	6.22E+02	0.00E+00	0.00E+00	0.00E+00	9.87E+02	8	1.00E+00	1.25E-01	7.90E+03	1.00E+01	1.25E+00	7.90E+02	99.11%	98.39%
Chromium	0.00E+00	mg/L	0.0E+00	mg/kg	2.23E+02	mg/kg	NA	NA	3.20E+00	4.10E-02	3.30E-01	3.30E-01	0.00E+00	0.00E+00	3.35E+00	NA	NA	1.02E+02	0.00E+00	0.00E+00	0.00E+00	1.06E+02	8	2.74E+03	3.42E+02	3.09E-01	1.37E+04	1.71E+03	6.18E-02	0.00%	0.01%
Copper	0.00E+00	mg/L	0.0E+00	mg/kg	8.50E+01	mg/kg	NA	NA	2.07E-01	1.30E-01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	1.28E+00	NA	NA	2.52E+00	0.00E+00	0.00E+00	0.00E+00	3.80E+00	8	1.17E+01	1.46E+00	2.60E+00	1.51E+01	1.89E+00	2.01E+00	0.03%	0.25%
Cyanide	0.00E+00	mg/L	0.0E+00	mg/kg	3.44E+00	mg/kg	NA	NA	1.20E+00	1.60E+00	2.70E-01	2.70E-01	0.00E+00	0.00E+00	5.16E-02	NA	NA	5.93E-01	0.00E+00	0.00E+00	0.00E+00	6.44E-01	8	6.87E+01	8.59E+00	7.50E-02	3.44E+02	4.30E+01	1.50E-02	0.00%	0.00%
Iron	0.00E+00	mg/L	0.0E+00	mg/kg	3.42E+04	mg/kg	NA	NA	7.80E-02	4.00E-03	1.70E-02	1.70E-02	0.00E+00	0.00E+00	5.13E+02	NA	NA	3.83E+02	0.00E+00	0.00E+00	0.00E+00	8.97E+02	8	NA	NA	NA	NA	NA	NA	NA	NA
Lead	0.00E+00	mg/L	0.0E+00	mg/kg	1.33E+02	mg/kg	NA	NA	3.20E-01	3.08E-02	2.90E-01	2.90E-01	0.00E+00	0.00E+00	2.00E+00	NA	NA	6.11E+00	0.00E+00	0.00E+00	0.00E+00	8.11E+00	8	8.00E+00	1.00E+00	8.11E+00	8.00E+01	1.00E+01	8.11E-01	0.10%	0.10%
Mercury	0.00E+00	mg/L	0.0E+00	mg/kg	1.26E-01	mg/kg	NA	NA	4.33E+00	9.54E-01	1.90E-01	1.90E-01	0.00E+00	0.00E+00	1.89E-03	NA	NA	7.84E-02	0.00E+00	0.00E+00	0.00E+00	8.03E-02	8	1.00E+00	1.25E-01	6.42E-01	5.00E+00	6.25E-01	1.28E-01	0.01%	0.02%
Nickel	0.00E+00	mg/L	0.0E+00	mg/kg	1.16E+01	mg/kg	NA	NA	4.70E+00	5.89E-02	5.90E-01	5.90E-01	0.00E+00	0.00E+00	1.74E-01	NA	NA	7.83E+00	0.00E+00	0.00E+00	0.00E+00	8.00E+00	8	4.00E+01	5.00E+00	1.60E+00	8.00E+01	1.00E+01	8.00E-01	0.02%	0.10%
Selenium	0.00E+00	mg/L	0.0E+00	mg/kg	4.29E-01	mg/kg	NA	NA	1.17E+00	4.66E-01	1.20E+00	1.20E+00	0.00E+00	0.00E+00	6.44E-03	NA	NA	7.18E-02	0.00E+00	0.00E+00	0.00E+00	7.83E-02	8	2.00E-01	2.50E-02	3.13E+00	3.00E-01	3.75E-02	2.09E+00	0.04%	0.26%
Silver	0.00E+00	mg/L	0.0E+00	mg/kg	3.08E+00	mg/kg	NA	NA	1.50E+01	4.00E-02	2.70E-01	2.70E-01	0.00E+00	0.00E+00	4.62E-02	NA	NA	6.63E+00	0.00E+00	0.00E+00	0.00E+00	6.68E+00	8	2.22E+01	2.78E+00	2.41E+00	2.22E+02	2.78E+01	2.41E-01	0.03%	0.03%
Zinc	0.00E+00	mg/L	0.0E+00	mg/kg	1.89E+02	mg/kg	NA	NA	2.53E+00	4.84E-01	2.70E+00	2.70E+00	0.00E+00	0.00E+00	2.84E+00	NA	NA	6.87E+01	0.00E+00	0.00E+00	0.00E+00	7.15E+01	8	1.60E+02	2.00E+01	3.57E+00	3.20E+02	4.00E+01	1.79E+00	0.04%	0.22%
4,4'-DDT	0.00E+00	mg/L	0.0E+00	mg/kg	2.18E-02	mg/kg	NA	NA	5.50E+01	2.80E-02	5.00E-01	5.00E-01	0.00E+00	0.00E+00	0.0003273	NA	NA	1.72E-01	0.00E+00	0.00E+00	0.00E+00	1.73E-01	8	8.00E-01	1.00E-01	1.73E+00	4.00E+00	5.00E-01	3.45E-01	0.02%	0.04%
																						Hazard Index (Total EEQ):			8.0E+03			8.0E+02	100.00%	100.00%

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x \, Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
Tier 1 = Max EEQ using max EPC, max BAF/BCF, max Intake Rates, min BW, and FHR =1.
Tier 2 = EEQ using 95% EPC, non-max BAF/BCF, avg Intake Rates, avg BW and calculated FHR.
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EEQ = Ecological Effects Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
PDE = Predicted Daily Exposure
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box): n See appropriate text tables for equations.
If BAF/BCF regression equation produced Tier 2 value exceeding maximum Tier 1 BAF/BCF value, Tier 1 value used as default.
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Plant diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	1	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.00023	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.0022	kg/d
Body weight =	0.015	kg
Home range =	0.96	acres
Water intake rate =	0.0023	L/d
Site Area =	0.94	acres
Frac. home range (FHR) =	9.79E-01	unitless

Table F-12
Tier 1 Chemicals of Potential Ecological Concern EEQs and Hazard Indices for American Robins at Building 4343

Hazard Estimate - Tier 1
American Robin

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Soil Exposure Point Concentration	Units	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Plant BAF	Mammal BAF	Bird BAF	PDE Surface Water	PDE Sediment	PDE Soil	PDE Fish	PDE Aq. Invert.	PDE Terr. Invert.	PDE Plants	PDE Mammals	PDE Birds	Total PDE	Chemical-Specific Toxicity Value UF	NOAEL	Adjusted NOAEL	EEQ N	LOAEL	Adjusted LOAEL	EEQ L	Percent Contribution to EEQ N	Percent Contribution to EEQ L
							---------- unitless ----------						mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d			
Antimony	0.00E+00	mg/L	0.0E+00	mg/kg	4.12E+01	mg/kg	NA	NA	3.20E+00	2.20E-01	8.30E-01	8.30E-01	0.00E+00	0.00E+00	5.19E-01	NA	NA	1.58E+01	1.77E+00	0.00E+00	0.00E+00	1.81E+01	8	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	0.00E+00	mg/L	0.0E+00	mg/kg	2.43E+04	mg/kg	NA	NA	1.90E+02	2.30E+01	7.00E+01	7.00E+01	0.00E+00	0.00E+00	3.06E+02	NA	NA	5.53E+05	1.09E+05	0.00E+00	0.00E+00	6.62E+05	8	1.45E+00	1.81E-01	3.65E+06	2.00E+01	2.50E+00	2.65E+05	96.80%	94.77%
Chromium	0.00E+00	mg/L	0.0E+00	mg/kg	1.82E+03	mg/kg	NA	NA	1.10E+01	4.80E-01	8.00E-01	8.00E-01	0.00E+00	0.00E+00	2.29E+01	NA	NA	2.40E+03	1.71E+02	0.00E+00	0.00E+00	2.59E+03	8	1.00E+00	1.25E-01	2.07E+04	5.00E+00	6.25E-01	4.14E+03	0.55%	1.48%
Copper	0.00E+00	mg/L	0.0E+00	mg/kg	6.77E+02	mg/kg	NA	NA	5.50E+00	7.40E+00	1.40E+00	1.40E+00	0.00E+00	0.00E+00	8.53E+00	NA	NA	4.46E+02	9.78E+02	0.00E+00	0.00E+00	1.43E+03	8	4.70E+01	5.88E+00	2.44E+02	6.20E+01	7.75E+00	1.85E+02	0.01%	0.07%
Cyanide	0.00E+00	mg/L	0.0E+00	mg/kg	1.48E+01	mg/kg	NA	NA	3.20E+00	2.70E+00	8.30E-01	8.30E-01	0.00E+00	0.00E+00	1.86E-01	NA	NA	5.67E+00	7.80E+00	0.00E+00	0.00E+00	1.37E+01	8	NA	NA	NA	NA	NA	NA	NA	NA
Iron	0.00E+00	mg/L	0.0E+00	mg/kg	5.14E+04	mg/kg	NA	NA	1.00E-01	4.00E-03	3.10E-02	3.10E-02	0.00E+00	0.00E+00	6.48E+02	NA	NA	6.15E+02	4.01E+01	0.00E+00	0.00E+00	1.30E+03	8	NA	NA	NA	NA	NA	NA	NA	NA
Lead	0.00E+00	mg/L	0.0E+00	mg/kg	1.41E+03	mg/kg	NA	NA	2.28E+02	1.10E+01	2.70E+00	2.70E+00	0.00E+00	0.00E+00	1.78E+01	NA	NA	3.85E+04	3.03E+03	0.00E+00	0.00E+00	4.15E+04	8	3.85E+00	4.81E-01	8.63E+04	3.85E+01	4.81E+00	8.63E+03	2.29%	3.09%
Mercury	0.00E+00	mg/L	0.0E+00	mg/kg	5.30E-01	mg/kg	NA	NA	3.30E+01	1.20E+01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	6.68E-03	NA	NA	2.09E+00	1.24E+00	0.00E+00	0.00E+00	3.34E+00	8	4.50E-01	5.63E-02	5.94E+01	9.00E-01	1.13E-01	2.97E+01	0.00%	0.01%
Nickel	0.00E+00	mg/L	0.0E+00	mg/kg	3.26E+01	mg/kg	NA	NA	7.80E+00	2.20E+01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	4.11E-01	NA	NA	3.04E+01	1.40E+02	0.00E+00	0.00E+00	1.71E+02	8	7.74E+01	9.68E+00	1.77E+01	1.07E+02	1.34E+01	1.28E+01	0.00%	0.00%
Selenium	0.00E+00	mg/L	0.0E+00	mg/kg	1.10E+00	mg/kg	NA	NA	1.40E+01	7.70E+01	1.80E+00	1.80E+00	0.00E+00	0.00E+00	1.39E-02	NA	NA	1.84E+00	1.65E+01	0.00E+00	0.00E+00	1.84E+01	8	5.00E-01	6.25E-02	2.94E+02	1.00E+00	1.25E-01	1.47E+02	0.01%	0.05%
Silver	0.00E+00	mg/L	0.0E+00	mg/kg	3.60E+01	mg/kg	NA	NA	1.95E+01	1.50E-01	8.30E-01	8.30E-01	0.00E+00	0.00E+00	4.54E-01	NA	NA	8.40E+01	1.05E+00	0.00E+00	0.00E+00	8.55E+01	8	2.67E+00	3.34E-01	2.56E+02	1.33E+01	1.66E+00	5.14E+01	0.01%	0.02%
Zinc	0.00E+00	mg/L	0.0E+00	mg/kg	1.78E+03	mg/kg	NA	NA	5.00E+01	3.40E+01	1.60E+01	1.60E+01	0.00E+00	0.00E+00	2.24E+01	NA	NA	1.07E+04	1.18E+04	0.00E+00	0.00E+00	2.25E+04	8	1.45E+01	1.81E+00	1.24E+04	1.31E+02	1.64E+01	1.37E+03	0.33%	0.49%
4,4'-DDT	0.00E+00	mg/L	0.0E+00	mg/kg	2.18E-02	mg/kg	NA	NA	6.70E+01	8.00E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	2.75E-04	NA	NA	1.75E-01	3.41E-04	0.00E+00	0.00E+00	1.75E-01	8	2.80E-03	3.50E-04	5.01E+02	2.80E-02	3.50E-03	5.01E+01	0.01%	0.02%
																						Hazard Index (Total EEQ):			3.8E+06			2.8E+05	100.00%	100.00%

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
Tier 1 = Max EEQ using max EPC, max BAF/BCF, max Intake Rates, min BW, and FHR =1.
Tier 2 = EEQ using 95% EPC, non-max BAF/BCF, avg Intake Rates, avg BW and calculated FHR.
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EEQ = Ecological Effects Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
PDE = Predicted Daily Exposure
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box): n See appropriate text tables for equations.
If BAF/BCF regression equation produced Tier 2 value exceeding maximum Tier 1 BAF/BCF value, Tier 1 value used a default.
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Plant diet fraction =	0.62	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0.38	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.0008	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.02	kg/d
Body weight =	0.0635	kg
Home range =	1.2	acres
Water intake rate =	0.013	L/d
Site Area =	0.94	acres
Frac. home range (FHR) =	1.00E+00	unitless

Table F-13
Tier 2 Chemicals of Potential Ecological Concern EEQs and Hazard Indices for American Robins at Building 4343

Hazard Estimate - Tier 2
American Robin

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Soil Exposure Point Concentration	Units	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Plant BAF	Mammal BAF	Bird BAF	PDE Surface Water	PDE Sediment	PDE Soil	PDE Fish	PDE Aq. Invert.	PDE Terr. Invert.	PDE Plants	PDE Mammals	PDE Birds	Total PDE	Chemical-Specific Toxicity Value UF	NOAEL	Adjusted NOAEL	EEQ N	LOAEL	Adjusted LOAEL	EEQ L	Percent Contribution to EEQ N	Percent Contribution to EEQ L
							---------- unitless ----------						mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d			
Antimony	0.00E+00	mg/L	0.0E+00	mg/kg	3.89E+00	mg/kg	NA	NA	1.20E+00	3.70E-02	2.70E-01	2.70E-01	0.00E+00	0.00E+00	2.52E-02	NA	NA	2.88E-01	1.45E-02	0.00E+00	0.00E+00	3.27E-01	8	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	0.00E+00	mg/L	0.0E+00	mg/kg	2.43E+04	mg/kg	NA	NA	1.78E-01	6.58E-03	4.00E+00	4.00E+00	0.00E+00	0.00E+00	1.58E+02	NA	NA	2.67E+02	1.61E+01	0.00E+00	0.00E+00	4.41E+02	8	1.45E+00	1.81E-01	2.43E+03	2.00E+01	2.50E+00	1.76E+02	79.59%	63.40%
Chromium	0.00E+00	mg/L	0.0E+00	mg/kg	2.23E+02	mg/kg	NA	NA	3.20E+00	4.10E-02	3.30E-01	3.30E-01	0.00E+00	0.00E+00	1.45E+00	NA	NA	4.40E+01	9.19E-01	0.00E+00	0.00E+00	4.63E+01	8	1.00E+00	1.25E-01	3.71E+02	5.00E+00	6.25E-01	7.41E+01	12.13%	26.67%
Copper	0.00E+00	mg/L	0.0E+00	mg/kg	8.50E+01	mg/kg	NA	NA	2.07E-01	1.30E-01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	5.51E-01	NA	NA	1.08E+00	1.11E+00	0.00E+00	0.00E+00	2.74E+00	8	4.70E+01	5.88E+00	4.67E-01	6.20E+01	7.75E+00	3.54E-01	0.02%	0.13%
Cyanide	0.00E+00	mg/L	0.0E+00	mg/kg	3.44E+00	mg/kg	NA	NA	1.20E+00	1.60E+00	2.70E-01	2.70E-01	0.00E+00	0.00E+00	2.23E-02	NA	NA	2.54E-01	5.53E-01	0.00E+00	0.00E+00	8.30E-01	8	NA	NA	NA	NA	NA	NA	NA	NA
Iron	0.00E+00	mg/L	0.0E+00	mg/kg	3.42E+04	mg/kg	NA	NA	7.80E-02	4.00E-03	1.70E-02	1.70E-02	0.00E+00	0.00E+00	2.22E+02	NA	NA	1.64E+02	1.38E+01	0.00E+00	0.00E+00	4.00E+02	8	NA	NA	NA	NA	NA	NA	NA	NA
Lead	0.00E+00	mg/L	0.0E+00	mg/kg	1.33E+02	mg/kg	NA	NA	3.20E-01	3.08E-02	2.90E-01	2.90E-01	0.00E+00	0.00E+00	8.63E-01	NA	NA	2.62E+00	4.11E-01	0.00E+00	0.00E+00	3.90E+00	8	3.85E+00	4.81E-01	8.10E+00	3.85E+01	4.81E+00	8.10E-01	0.27%	0.29%
Mercury	0.00E+00	mg/L	0.0E+00	mg/kg	1.26E-01	mg/kg	NA	NA	4.33E+00	9.54E-01	1.90E-01	1.90E-01	0.00E+00	0.00E+00	8.17E-04	NA	NA	3.36E-02	1.21E-02	0.00E+00	0.00E+00	4.65E-02	8	4.50E-01	5.63E-02	8.27E-01	9.00E-01	1.13E-01	4.14E-01	0.03%	0.15%
Nickel	0.00E+00	mg/L	0.0E+00	mg/kg	1.16E+01	mg/kg	NA	NA	4.70E+00	5.89E-02	5.90E-01	5.90E-01	0.00E+00	0.00E+00	7.52E-02	NA	NA	3.36E+00	6.86E-02	0.00E+00	0.00E+00	3.50E+00	8	7.74E+01	9.68E+00	3.62E-01	1.07E+02	1.34E+01	2.62E-01	0.01%	0.09%
Selenium	0.00E+00	mg/L	0.0E+00	mg/kg	4.29E-01	mg/kg	NA	NA	1.17E+00	4.66E-01	1.20E+00	1.20E+00	0.00E+00	0.00E+00	2.78E-03	NA	NA	3.08E-02	2.01E-02	0.00E+00	0.00E+00	5.37E-02	8	5.00E-01	6.25E-02	8.59E-01	1.00E+00	1.25E-01	4.29E-01	0.03%	0.15%
Silver	0.00E+00	mg/L	0.0E+00	mg/kg	3.08E+00	mg/kg	NA	NA	1.50E+01	4.00E-02	2.70E-01	2.70E-01	0.00E+00	0.00E+00	2.00E-02	NA	NA	2.85E+00	1.24E-02	0.00E+00	0.00E+00	2.88E+00	8	2.67E+00	3.34E-01	8.63E+00	1.33E+01	1.66E+00	1.73E+00	0.28%	0.62%
Zinc	0.00E+00	mg/L	0.0E+00	mg/kg	1.89E+02	mg/kg	NA	NA	2.53E+00	4.84E-01	2.70E+00	2.70E+00	0.00E+00	0.00E+00	1.23E+00	NA	NA	2.95E+01	9.19E+00	0.00E+00	0.00E+00	3.99E+01	8	1.45E+01	1.81E+00	2.20E+01	1.31E+02	1.64E+01	2.43E+00	0.72%	0.88%
4,4'-DDT	0.00E+00	mg/L	0.0E+00	mg/kg	2.18E-02	mg/kg	NA	NA	5.50E+01	2.80E-02	5.00E-01	5.00E-01	0.00E+00	0.00E+00	0.00014139	NA	NA	7.39E-02	6.14E-05	0.00E+00	0.00E+00	7.41E-02	8	2.80E-03	3.50E-04	2.12E+02	2.80E-02	3.50E-03	2.12E+01	6.93%	7.61%
																							Hazard Index (Total EEQ):			3.1E+03			2.8E+02	100.00%	100.00%

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x \, Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
Tier 1 = Max EEQ using max EPC, max BAF/BCF, max Intake Rates, min BW, and FHR =1.
Tier 2 = EEQ using 95% EPC, non-max BAF/BCF, avg Intake Rates, avg BW and calculated FHR.
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EEQ = Ecological Effects Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
PDE = Predicted Daily Exposure
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box): n See appropriate text tables for equations.
If BAF/BCF regression equation produced Tier 2 value exceeding maximum Tier 1 BAF/BCF value, Tier 1 value used as default.
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Plant diet fraction =	0.62	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0.38	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.00064	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.016	kg/d
Body weight =	0.0773	kg
Home range =	1.2	acres
Water intake rate =	0.011	L/d
Site Area =	0.94	acres
Frac. home range (FHR) =	7.83E-01	unitless

Table F-14
Tier 1 Chemicals of Potential Ecological Concern EEQs and Hazard Indices for Red-Tailed Hawks at Building 4343

Hazard Estimate - Tier 1
Red-Tailed Hawk

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Soil Exposure Point Concentration	Units	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Plant BAF	Mammal BAF	Bird BAF	PDE Surface Water	PDE Sediment	PDE Soil	PDE Fish	PDE Aq. Invert.	PDE Terr. Invert.	PDE Plants	PDE Mammals	PDE Birds	Total PDE	Chemical-Specific Toxicity Value UF	NOAEL	Adjusted NOAEL	EEQ N	LOAEL	Adjusted LOAEL	EEQ L	Percent Contribution to EEQ N	Percent Contribution to EEQ L
							---------- unitless ----------						mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d			
Antimony	0.00E+00	mg/L	0.0E+00	mg/kg	4.12E+01	mg/kg	NA	NA	3.20E+00	2.20E-01	8.30E-01	8.30E-01	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	1.71E+00	5.40E-01	2.25E+00	8	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	0.00E+00	mg/L	0.0E+00	mg/kg	2.43E+04	mg/kg	NA	NA	1.90E+02	2.30E+01	7.00E+01	7.00E+01	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	8.51E+04	2.69E+04	1.12E+05	8	1.45E+00	1.81E-01	6.18E+05	2.00E+01	2.50E+00	4.48E+04	99.62%	99.27%
Chromium	0.00E+00	mg/L	0.0E+00	mg/kg	1.82E+03	mg/kg	NA	NA	1.10E+01	4.80E-01	8.00E-01	8.00E-01	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	7.28E+01	2.30E+01	9.58E+01	8	1.00E+00	1.25E-01	7.67E+02	5.00E+00	6.25E-01	1.53E+02	0.12%	0.34%
Copper	0.00E+00	mg/L	0.0E+00	mg/kg	6.77E+02	mg/kg	NA	NA	5.50E+00	7.40E+00	1.40E+00	1.40E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	4.74E+01	1.50E+01	6.24E+01	8	4.70E+01	5.88E+00	1.06E+01	6.20E+01	7.75E+00	8.05E+00	0.00%	0.02%
Cyanide	0.00E+00	mg/L	0.0E+00	mg/kg	1.48E+01	mg/kg	NA	NA	3.20E+00	2.70E+00	8.30E-01	8.30E-01	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	6.15E-01	1.94E-01	8.09E-01	8	NA	NA	NA	NA	NA	NA	NA	NA
Iron	0.00E+00	mg/L	0.0E+00	mg/kg	5.14E+04	mg/kg	NA	NA	1.00E-01	4.00E-03	3.10E-02	3.10E-02	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	7.97E+01	2.52E+01	1.05E+02	8	NA	NA	NA	NA	NA	NA	NA	NA
Lead	0.00E+00	mg/L	0.0E+00	mg/kg	1.41E+03	mg/kg	NA	NA	2.28E+02	1.10E+01	2.70E+00	2.70E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	1.90E+02	6.01E+01	2.51E+02	8	3.85E+00	4.81E-01	5.21E+02	3.85E+01	4.81E+00	5.21E+01	0.08%	0.12%
Mercury	0.00E+00	mg/L	0.0E+00	mg/kg	5.30E-01	mg/kg	NA	NA	3.30E+01	1.20E+01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	2.92E-02	9.21E-03	3.84E-02	8	4.50E-01	5.63E-02	6.82E-01	9.00E-01	1.13E-01	3.41E-01	0.00%	0.00%
Nickel	0.00E+00	mg/L	0.0E+00	mg/kg	3.26E+01	mg/kg	NA	NA	7.80E+00	2.20E+01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	1.79E+00	5.67E-01	2.36E+00	8	7.74E+01	9.68E+00	2.44E-01	1.07E+02	1.34E+01	1.77E-01	0.00%	0.00%
Selenium	0.00E+00	mg/L	0.0E+00	mg/kg	1.10E+00	mg/kg	NA	NA	1.40E+01	7.70E+01	1.80E+00	1.80E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	9.91E-02	3.13E-02	1.30E-01	8	5.00E-01	6.25E-02	2.09E+00	1.00E+00	1.25E-01	1.04E+00	0.00%	0.00%
Silver	0.00E+00	mg/L	0.0E+00	mg/kg	3.60E+01	mg/kg	NA	NA	1.95E+01	1.50E-01	8.30E-01	8.30E-01	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	1.49E+00	4.72E-01	1.97E+00	8	2.67E+00	3.34E-01	5.89E+00	1.33E+01	1.66E+00	1.18E+00	0.00%	0.00%
Zinc	0.00E+00	mg/L	0.0E+00	mg/kg	1.78E+03	mg/kg	NA	NA	5.00E+01	3.40E+01	1.60E+01	1.60E+01	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	1.42E+03	4.50E+02	1.87E+03	8	1.45E+01	1.81E+00	1.03E+03	1.31E+02	1.64E+01	1.14E+02	0.17%	0.25%
4,4'-DDT	0.00E+00	mg/L	0.0E+00	mg/kg	2.18E-02	mg/kg	NA	NA	6.70E+01	8.00E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	1.09E-03	3.44E-04	1.44E-03	8	2.80E-03	3.50E-04	4.10E+00	2.80E-02	3.50E-03	4.10E-01	0.00%	0.00%
																						Hazard Index (Total EEQ):			6.2E+05			4.5E+04	100.00%	100.00%

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x \, Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
Tier 1 = Max EEQ using max EPC, max BAF/BCF, max Intake Rates, min BW, and FHR =1.
Tier 2 = EEQ using 95% EPC, non-max BAF/BCF, avg Intake Rates, avg BW and calculated FHR.
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EEQ = Ecological Effects Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
PDE = Predicted Daily Exposure
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box): n See appropriate text tables for equations.
If BAF/BCF regression equation produced Tier 2 value exceeding maximum Tier 1 BAF/BCF value, Tier 1 value used a default.
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Plant diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0	unitless
Mammal diet fraction =	0.76	unitless
Bird diet fraction =	0.24	unitless
Soil ingestion rate =	0	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.063	kg/d
Body weight =	0.957	kg
Home range =	2081	acres
Water intake rate =	0.068	L/d
Site Area =	0.94	acres
Frac. home range (FHR) =	1.00E+00	unitless

Table F-15
Tier 2 Chemicals of Potential Ecological Concern EEQs and Hazard Indices for Red-Tailed Hawks at Building 4343

Hazard Estimate - Tier 2
Red-Tailed Hawk

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Soil Exposure Point Concentration	Units	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Plant BAF	Mammal BAF	Bird BAF	PDE Surface Water	PDE Sediment	PDE Soil	PDE Fish	PDE Aq. Invert.	PDE Terr. Invert.	PDE Plants	PDE Mammals	PDE Birds	Total PDE	Chemical-Specific Toxicity Value UF	NOAEL	Adjusted NOAEL	EEQ N	LOAEL	Adjusted LOAEL	EEQ L	Percent Contribution to EEQ N	Percent Contribution to EEQ L
							---------- unitless ----------						mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d			
Antimony	0.00E+00	mg/L	0.0E+00	mg/kg	3.89E+00	mg/kg	NA	NA	1.20E+00	3.70E-02	2.70E-01	2.70E-01	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	1.88E-05	5.92E-06	2.47E-05	8	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	0.00E+00	mg/L	0.0E+00	mg/kg	2.43E+04	mg/kg	NA	NA	1.78E-01	6.58E-03	4.00E+00	4.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	1.74E+00	5.48E-01	2.28E+00	8	1.45E+00	1.81E-01	1.26E+01	2.00E+01	2.50E+00	9.14E-01	99.81%	99.55%
Chromium	0.00E+00	mg/L	0.0E+00	mg/kg	2.23E+02	mg/kg	NA	NA	3.20E+00	4.10E-02	3.30E-01	3.30E-01	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	1.31E-03	4.15E-04	1.73E-03	8	1.00E+00	1.25E-01	1.38E-02	5.00E+00	6.25E-01	2.77E-03	0.11%	0.30%
Copper	0.00E+00	mg/L	0.0E+00	mg/kg	8.50E+01	mg/kg	NA	NA	2.07E-01	1.30E-01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	1.67E-03	5.27E-04	2.20E-03	8	4.70E+01	5.88E+00	3.74E-04	6.20E+01	7.75E+00	2.84E-04	0.00%	0.03%
Cyanide	0.00E+00	mg/L	0.0E+00	mg/kg	3.44E+00	mg/kg	NA	NA	1.20E+00	1.60E+00	2.70E-01	2.70E-01	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	1.66E-05	5.24E-06	2.18E-05	8	NA	NA	NA	NA	NA	NA	NA	NA
Iron	0.00E+00	mg/L	0.0E+00	mg/kg	3.42E+04	mg/kg	NA	NA	7.80E-02	4.00E-03	1.70E-02	1.70E-02	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	1.04E-02	3.28E-03	1.37E-02	8	NA	NA	NA	NA	NA	NA	NA	NA
Lead	0.00E+00	mg/L	0.0E+00	mg/kg	1.33E+02	mg/kg	NA	NA	3.20E-01	3.08E-02	2.90E-01	2.90E-01	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	6.89E-04	2.18E-04	9.06E-04	8	3.85E+00	4.81E-01	1.88E-03	3.85E+01	4.81E+00	1.88E-04	0.01%	0.02%
Mercury	0.00E+00	mg/L	0.0E+00	mg/kg	1.26E-01	mg/kg	NA	NA	4.33E+00	9.54E-01	1.90E-01	1.90E-01	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	4.28E-07	1.35E-07	5.63E-07	8	4.50E-01	5.63E-02	1.00E-05	9.00E-01	1.13E-01	5.00E-06	0.00%	0.00%
Nickel	0.00E+00	mg/L	0.0E+00	mg/kg	1.16E+01	mg/kg	NA	NA	4.70E+00	5.89E-02	5.90E-01	5.90E-01	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	1.22E-04	3.86E-05	1.61E-04	8	7.74E+01	9.68E+00	1.66E-05	1.07E+02	1.34E+01	1.20E-05	0.00%	0.00%
Selenium	0.00E+00	mg/L	0.0E+00	mg/kg	4.29E-01	mg/kg	NA	NA	1.17E+00	4.66E-01	1.20E+00	1.20E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	9.19E-06	2.90E-06	1.21E-05	8	5.00E-01	6.25E-02	1.94E-04	1.00E+00	1.25E-01	9.68E-05	0.00%	0.01%
Silver	0.00E+00	mg/L	0.0E+00	mg/kg	3.08E+00	mg/kg	NA	NA	1.50E+01	4.00E-02	2.70E-01	2.70E-01	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	1.49E-05	4.69E-06	1.95E-05	8	2.67E+00	3.34E-01	5.86E-05	1.33E+01	1.66E+00	1.18E-05	0.00%	0.00%
Zinc	0.00E+00	mg/L	0.0E+00	mg/kg	1.89E+02	mg/kg	NA	NA	2.53E+00	4.84E-01	2.70E+00	2.70E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	9.11E-03	2.88E-03	1.20E-02	8	1.45E+01	1.81E+00	6.62E-03	1.31E+02	1.64E+01	7.32E-04	0.05%	0.08%
4,4'-DDT	0.00E+00	mg/L	0.0E+00	mg/kg	2.18E-02	mg/kg	NA	NA	5.50E+01	2.80E-02	5.00E-01	5.00E-01	0.00E+00	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	1.95E-07	6.15E-08	2.56E-07	8	2.80E-03	3.50E-04	7.32E-04	2.80E-02	3.50E-03	7.32E-05	0.01%	0.01%
																						Hazard Index (Total EEQ):			1.3E+01			9.2E-01	100.00%	100.00%

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
Tier 1 = Max EEQ using max EPC, max BAF/BCF, max Intake Rates, min BW, and FHR =1.
Tier 2 = EEQ using 95% EPC, non-max BAF/BCF, avg Intake Rates, avg BW and calculated FHR.
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EEQ = Ecological Effects Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
PDE = Predicted Daily Exposure
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box): n See appropriate text tables for equations.
If BAF/BCF regression equation produced Tier 2 value exceeding maximum Tier 1 BAF/BCF value, Tier 1 value used as default.
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Plant diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0	unitless
Mammal diet fraction =	0.76	unitless
Bird diet fraction =	0.24	unitless
Soil ingestion rate =	0	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.059	kg/d
Body weight =	1.134	kg
Home range =	2081	acres
Water intake rate =	0.064	L/d
Site Area =	0.94	acres
Frac. home range (FHR) =	4.52E-04	unitless

Table F-16
Tier 1 Chemicals of Potential Ecological Concern EEQs and Hazard Indices for Red Foxes at Building 4343

Hazard Estimate - Tier 1
Red Fox

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Soil Exposure Point Concentration	Units	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Plant BAF	Mammal BAF	Bird BAF	PDE Surface Water	PDE Sediment	PDE Soil	PDE Fish	PDE Aq. Invert.	PDE Terr. Invert.	PDE Plants	PDE Mammals	PDE Birds	Total PDE	Chemical-Specific Toxicity Value UF	NOAEL	Adjusted NOAEL		LOAEL	Adjusted LOAEL		Percent Contribution to	Percent Contribution to
							---------- unitless ----------						mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d	EEQ N	mg/kg-d	mg/kg-d	EEQ L	EEQ N	EEQ L
Antimony	0.00E+00	mg/L	0.0E+00	mg/kg	4.12E+01	mg/kg	NA	NA	3.20E+00	2.20E-01	8.30E-01	8.30E-01	0.00E+00	0.00E+00	1.33E-01	NA	NA	6.08E-01	1.78E-01	2.56E+00	5.52E-01	4.03E+00	8	1.25E-01	1.56E-02	2.58E+02	1.25E+00	1.56E-01	2.58E+01	0.02%	0.02%
Cadmium	0.00E+00	mg/L	0.0E+00	mg/kg	2.43E+04	mg/kg	NA	NA	1.90E+02	2.30E+01	7.00E+01	7.00E+01	0.00E+00	0.00E+00	7.83E+01	NA	NA	2.13E+04	1.10E+04	1.27E+05	2.74E+04	1.87E+05	8	1.00E+00	1.25E-01	1.50E+06	1.00E+01	1.25E+00	1.50E+05	99.81%	99.66%
Chromium	0.00E+00	mg/L	0.0E+00	mg/kg	1.82E+03	mg/kg	NA	NA	1.10E+01	4.80E-01	8.00E-01	8.00E-01	0.00E+00	0.00E+00	5.86E+00	NA	NA	9.23E+01	1.71E+01	1.09E+02	2.35E+01	2.48E+02	8	2.74E+03	3.42E+02	7.24E-01	1.37E+04	1.71E+03	1.45E-01	0.00%	0.00%
Copper	0.00E+00	mg/L	0.0E+00	mg/kg	6.77E+02	mg/kg	NA	NA	5.50E+00	7.40E+00	1.40E+00	1.40E+00	0.00E+00	0.00E+00	2.18E+00	NA	NA	1.72E+01	9.82E+01	7.10E+01	1.53E+01	2.04E+02	8	1.17E+01	1.46E+00	1.39E+02	1.51E+01	1.89E+00	1.08E+02	0.01%	0.07%
Cyanide	0.00E+00	mg/L	0.0E+00	mg/kg	1.48E+01	mg/kg	NA	NA	3.20E+00	2.70E+00	8.30E-01	8.30E-01	0.00E+00	0.00E+00	4.77E-02	NA	NA	2.18E-01	7.83E-01	9.20E-01	1.98E-01	2.17E+00	8	6.87E+01	8.59E+00	2.52E-01	3.44E+02	4.30E+01	5.04E-02	0.00%	0.00%
Iron	0.00E+00	mg/L	0.0E+00	mg/kg	5.14E+04	mg/kg	NA	NA	1.00E-01	4.00E-03	3.10E-02	3.10E-02	0.00E+00	0.00E+00	1.66E+02	NA	NA	2.37E+01	4.03E+00	1.19E+02	2.57E+01	3.38E+02	8	NA	NA	NA	NA	NA	NA	NA	NA
Lead	0.00E+00	mg/L	0.0E+00	mg/kg	1.41E+03	mg/kg	NA	NA	2.28E+02	1.10E+01	2.70E+00	2.70E+00	0.00E+00	0.00E+00	4.54E+00	NA	NA	1.48E+03	3.04E+02	2.85E+02	6.14E+01	2.14E+03	8	8.00E+00	1.00E+00	2.14E+03	8.00E+01	1.00E+01	2.14E+02	0.14%	0.14%
Mercury	0.00E+00	mg/L	0.0E+00	mg/kg	5.30E-01	mg/kg	NA	NA	3.30E+01	1.20E+01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	1.71E-03	NA	NA	8.06E-02	1.25E-01	4.37E-02	9.41E-03	2.60E-01	8	1.00E+00	1.25E-01	2.08E+00	5.00E+00	6.25E-01	4.16E-01	0.00%	0.00%
Nickel	0.00E+00	mg/L	0.0E+00	mg/kg	3.26E+01	mg/kg	NA	NA	7.80E+00	2.20E+01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	1.05E-01	NA	NA	1.17E+00	1.41E+01	2.69E+00	5.79E-01	1.86E+01	8	4.00E+01	5.00E+00	3.72E+00	8.00E+01	1.00E+01	1.86E+00	0.00%	0.00%
Selenium	0.00E+00	mg/L	0.0E+00	mg/kg	1.10E+00	mg/kg	NA	NA	1.40E+01	7.70E+01	1.80E+00	1.80E+00	0.00E+00	0.00E+00	3.54E-03	NA	NA	7.10E-02	1.66E+00	1.48E-01	3.19E-02	1.91E+00	8	2.00E-01	2.50E-02	7.66E+01	3.00E-01	3.75E-02	5.10E+01	0.01%	0.03%
Silver	0.00E+00	mg/L	0.0E+00	mg/kg	3.60E+01	mg/kg	NA	NA	1.95E+01	1.50E-01	8.30E-01	8.30E-01	0.00E+00	0.00E+00	1.16E-01	NA	NA	3.24E+00	1.06E-01	2.24E+00	4.82E-01	6.18E+00	8	2.22E+01	2.78E+00	2.23E+00	2.22E+02	2.78E+01	2.23E-01	0.00%	0.00%
Zinc	0.00E+00	mg/L	0.0E+00	mg/kg	1.78E+03	mg/kg	NA	NA	5.00E+01	3.40E+01	1.60E+01	1.60E+01	0.00E+00	0.00E+00	5.73E+00	NA	NA	4.10E+02	1.19E+03	2.13E+03	4.60E+02	4.19E+03	8	1.60E+02	2.00E+01	2.10E+02	3.20E+02	4.00E+01	1.05E+02	0.01%	0.07%
4,4'-DDT	0.00E+00	mg/L	0.0E+00	mg/kg	2.18E-02	mg/kg	NA	NA	6.70E+01	8.00E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	7.02E-05	NA	NA	6.73E-03	3.42E-05	1.63E-03	3.52E-04	8.82E-03	8	8.00E-01	1.00E-01	8.82E-02	4.00E+00	5.00E-01	1.76E-02	0.00%	0.00%
																						Hazard Index (Total EEQ):			1.5E+06			1.5E+05	100.00%	100.00%

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x \, Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
Tier 1 = Max EEQ using max EPC, max BAF/BCF, max Intake Rates, min BW, and FHR =1.
Tier 2 = EEQ using 95% EPC, non-max BAF/BCF, avg Intake Rates, avg BW and calculated FHR.
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EEQ = Ecological Effects Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
PDE = Predicted Daily Exposure
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box): [n] See appropriate text tables for equations.
If BAF/BCF regression equation produced Tier 2 value exceeding maximum Tier 1 BAF/BCF value, Tier 1 value used a default.
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/UF
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Plant diet fraction =	0.17	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0.04	unitless
Mammal diet fraction =	0.65	unitless
Bird diet fraction =	0.14	unitless
Soil ingestion rate =	0.0095	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.34	kg/d
Body weight =	2.95	kg
Home range =	2204	acres
Water intake rate =	0.57	L/d
Site Area =	0.94	acres
Frac. home range (FHR) =	1.00E+00	unitless

Table F-17
Tier 2 Chemicals of Potential Ecological Concern EEQs and Hazard Indices for Red Foxes at Building 4343

Hazard Estimate - Tier 2
Red Fox

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Soil Exposure Point Concentration	Units	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Plant BAF	Mammal BAF	Bird BAF	PDE Surface Water	PDE Sediment	PDE Soil	PDE Fish	PDE Aq. Invert.	PDE Terr. Invert.	PDE Plants	PDE Mammals	PDE Birds	Total PDE	Chemical-Specific Toxicity Value UF	NOAEL	Adjusted NOAEL	EEQ N	LOAEL	Adjusted LOAEL	EEQ L	Percent Contribution to EEQ N	Percent Contribution to EEQ L
							---------- unitless ----------						mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d		mg/kg-d	mg/kg-d			
Antimony	0.00E+00	mg/L	0.0E+00	mg/kg	3.89E+00	mg/kg	NA	NA	1.20E+00	3.70E-02	2.70E-01	2.70E-01	0.00E+00	0.00E+00	2.45E-06	NA	NA	4.22E-06	5.53E-07	1.54E-05	3.32E-06	2.60E-05	8	1.25E-01	1.56E-02	1.66E-03	1.25E+00	1.56E-01	1.66E-04	0.01%	0.01%
Cadmium	0.00E+00	mg/L	0.0E+00	mg/kg	2.43E+04	mg/kg	NA	NA	1.78E-01	6.58E-03	4.00E+00	4.00E+00	0.00E+00	0.00E+00	1.53E-02	NA	NA	3.92E-03	6.14E-04	1.43E+00	3.07E-01	1.75E+00	8	1.00E+00	1.25E-01	1.40E+01	1.00E+01	1.25E+00	1.40E+00	99.97%	99.88%
Chromium	0.00E+00	mg/L	0.0E+00	mg/kg	2.23E+02	mg/kg	NA	NA	3.20E+00	4.10E-02	3.30E-01	3.30E-01	0.00E+00	0.00E+00	1.41E-04	NA	NA	6.45E-04	3.51E-05	1.08E-03	2.33E-04	2.13E-03	8	2.74E+03	3.42E+02	6.24E-06	1.37E+04	1.71E+03	1.25E-06	0.00%	0.00%
Copper	0.00E+00	mg/L	0.0E+00	mg/kg	8.50E+01	mg/kg	NA	NA	2.07E-01	1.30E-01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	5.36E-05	NA	NA	1.59E-05	4.25E-05	1.37E-03	2.96E-04	1.78E-03	8	1.17E+01	1.46E+00	1.22E-03	1.51E+01	1.89E+00	9.44E-04	0.01%	0.07%
Cyanide	0.00E+00	mg/L	0.0E+00	mg/kg	3.44E+00	mg/kg	NA	NA	1.20E+00	1.60E+00	2.70E-01	2.70E-01	0.00E+00	0.00E+00	2.17E-06	NA	NA	3.73E-06	2.11E-05	1.36E-05	2.94E-06	4.36E-05	8	6.87E+01	8.59E+00	5.08E-06	3.44E+02	4.30E+01	1.01E-06	0.00%	0.00%
Iron	0.00E+00	mg/L	0.0E+00	mg/kg	3.42E+04	mg/kg	NA	NA	7.80E-02	4.00E-03	1.70E-02	1.70E-02	0.00E+00	0.00E+00	2.16E-02	NA	NA	2.41E-03	5.25E-04	8.54E-03	1.84E-03	3.49E-02	8	NA	NA	NA	NA	NA	NA	NA	NA
Lead	0.00E+00	mg/L	0.0E+00	mg/kg	1.33E+02	mg/kg	NA	NA	3.20E-01	3.08E-02	2.90E-01	2.90E-01	0.00E+00	0.00E+00	8.39E-05	NA	NA	3.85E-05	1.57E-05	5.66E-04	1.22E-04	8.27E-04	8	8.00E+00	1.00E+00	8.27E-04	8.00E+01	1.00E+01	8.27E-05	0.01%	0.01%
Mercury	0.00E+00	mg/L	0.0E+00	mg/kg	1.26E-01	mg/kg	NA	NA	4.33E+00	9.54E-01	1.90E-01	1.90E-01	0.00E+00	0.00E+00	7.95E-08	NA	NA	4.93E-07	4.62E-07	3.52E-07	7.57E-08	1.46E-06	8	1.00E+00	1.25E-01	1.17E-05	5.00E+00	6.25E-01	2.34E-06	0.00%	0.00%
Nickel	0.00E+00	mg/L	0.0E+00	mg/kg	1.16E+01	mg/kg	NA	NA	4.70E+00	5.89E-02	5.90E-01	5.90E-01	0.00E+00	0.00E+00	7.32E-06	NA	NA	4.93E-05	2.62E-06	1.01E-04	2.17E-05	1.81E-04	8	4.00E+01	5.00E+00	3.63E-05	8.00E+01	1.00E+01	1.81E-05	0.00%	0.00%
Selenium	0.00E+00	mg/L	0.0E+00	mg/kg	4.29E-01	mg/kg	NA	NA	1.17E+00	4.66E-01	1.20E+00	1.20E+00	0.00E+00	0.00E+00	2.71E-07	NA	NA	4.52E-07	7.67E-07	7.56E-06	1.63E-06	1.07E-05	8	2.00E-01	2.50E-02	4.27E-04	3.00E-01	3.75E-02	2.85E-04	0.00%	0.02%
Silver	0.00E+00	mg/L	0.0E+00	mg/kg	3.08E+00	mg/kg	NA	NA	1.50E+01	4.00E-02	2.70E-01	2.70E-01	0.00E+00	0.00E+00	1.94E-06	NA	NA	4.18E-05	4.73E-07	1.22E-05	2.63E-06	5.90E-05	8	2.22E+01	2.78E+00	2.13E-05	2.22E+02	2.78E+01	2.13E-06	0.00%	0.00%
Zinc	0.00E+00	mg/L	0.0E+00	mg/kg	1.89E+02	mg/kg	NA	NA	2.53E+00	4.84E-01	2.70E+00	2.70E+00	0.00E+00	0.00E+00	1.19E-04	NA	NA	4.32E-04	3.51E-04	7.49E-03	1.61E-03	1.00E-02	8	1.60E+02	2.00E+01	5.01E-04	3.20E+02	4.00E+01	2.50E-04	0.00%	0.02%
4,4'-DDT	0.00E+00	mg/L	0.0E+00	mg/kg	2.18E-02	mg/kg	NA	NA	5.50E+01	2.80E-02	5.00E-01	5.00E-01	0.00E+00	0.00E+00	1.3751E-08	NA	NA	1.08E-06	2.34E-09	1.60E-07	3.45E-08	1.29E-06	8	8.00E-01	1.00E-01	1.29E-05	4.00E+00	5.00E-01	2.59E-06	0.00%	0.00%
																							Hazard Index (Total EEQ):			1.4E+01			1.4E+00	100.00%	100.00%

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x \, Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L
BW = Body Weight

Notes:
Tier 1 = Max EEQ using max EPC, max BAF/BCF, max Intake Rates, min BW, and FHR =1
Tier 2 = EEQ using 95% EPC, non-max BAF/BCF, avg Intake Rates, avg BW and calculated FHR
BAF = Bioaccumulation Factor (may be BCF if this is the only value available
EEQ = Ecological Effects Quotient
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Leve
NOAEL = No Observed Adverse Effect Leve
NA = Not applicable/Not available
PDE = Predicted Daily Exposure
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor
Some BAF (or BCF) values based on media regression equations (value in box) n See appropriate text tables for equations.
If BAF/BCF regression equation produced Tier 2 value exceeding maximum Tier 1 BAF/BCF value, Tier 1 value used as defau
LOAEL and NOAEL values from appropriate toxicity summary tables in the text
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or NOAEL = LOAEL/UF or NOAEL/U
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this mediu
Receptor diet data and home range data from appropriate text table
Exposure point concentrations (EPCs) from appropriate text tables

Species-Specific Factors

Plant diet fraction =	0.17	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0.04	unitless
Mammal diet fraction =	0.65	unitless
Bird diet fraction =	0.14	unitless
Soil ingestion rate =	0.0067	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.24	kg/d
Body weight =	4.53	kg
Home range =	2204	acres
Water intake rate =	0.39	L/d
Site Area =	0.94	acres
Frac. home range (FHR) =	4.26E-04	unitless

Table F-18
Comparison of Maximum Detection Limits in Surface Soil with Ecological Screening Values
Building 4343

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

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (3)	Region III BTAG Screening Levels	Max ND Greater than Screening Criteria (Y/N)
Surface Soil (0 - 2 feet)	99-35-4	1,3,5-Trinitrobenzene			mg/kg		0/2	1.00E-01 - 1.00E-01	1.00E-01	N/A	3.76E-01	NVA	No
	99-65-0	1,3-Dinitrobenzene			mg/kg		0/2	1.00E-01 - 1.00E-01	1.00E-01	N/A	6.55E-01	NVA	No
	118-96-7	2,4,6-Trinitrotoluene			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	7.00E-01	NVA	No
	35572-78-2	2-amino-4,6-Dinitrotoluene			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	5.30E+00	NVA	No
	88-72-2	2-Nitrotoluene			mg/kg		0/2	4.00E-01 - 4.00E-01	4.00E-01	N/A	4.10E+00	NVA	No
	99-08-1	3-Nitrotoluene			mg/kg		0/2	4.00E-01 - 4.00E-01	4.00E-01	N/A	5.30E+00	NVA	No
	19406-51-0	4-amino-2,6-Dinitrotoluene			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	3.60E+00	NVA	No
	99-99-0	4-Nitrotoluene			mg/kg		0/2	4.00E-01 - 4.00E-01	4.00E-01	N/A	9.40E+00	NVA	No
	100-51-6	Benzyl alcohol			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	6.58E+01	NVA	No
	156-59-2	cis-1,2-Dichloroethene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	7.84E-01	3.00E-01	No
	121-82-4	Cyclonite (RDX)			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	5.80E+00	NVA	No
	2691-41-0	HMX			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	4.30E+01	NVA	No
	55-63-0	Nitroglycerin			mg/kg		0/2	3.12E-01 - 3.28E-01	3.28E-01	N/A	1.50E+02	NVA	No
	95-47-6	o-Xylene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.00E+01	1.00E-01	No
	78-11-5	Pentaerythritol tetranitrate (PETN)			mg/kg		0/2	3.12E-01 - 3.28E-01	3.28E-01	N/A	1.40E+04	NVA	No
	110-86-1	Pyridine			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	1.03E+00	NVA	No
	479-45-8	Tetryl			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	2.00E+00	NVA	No
	156-60-5	trans-1,2-Dichloroethene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	7.84E-01	3.00E-01	No
	93-76-5	2,4,5-T			mg/kg		0/2	1.04E-01 - 1.09E-01	1.09E-01	N/A	5.96E-01	NVA	No
	93-72-1	**2,4,5-TP (Silvex)**			**mg/kg**		**0/2**	**1.04E-01 - 1.09E-01**	**1.09E-01**	**N/A**	**1.09E-01**	**NVA**	**Yes**
	94-75-7	**2,4-D**			**mg/kg**		**0/2**	**2.08E-01 - 2.19E-01**	**2.19E-01**	**N/A**	**2.73E-02**	**NVA**	**Yes**
	94-82-6	2,4-DB			mg/kg		0/2	1.04E+00 - 1.09E+00	1.09E+00	N/A	NVA	NVA	No
	72-55-9	4,4'-DDE			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	5.96E-01	1.00E-01	No
	309-00-2	Aldrin			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	3.32E-03	1.00E-01	No
	319-84-6	alpha-BHC			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	9.94E-02	NVA	No
	5103-71-9	alpha-Chlordane			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	2.24E-01	1.00E-01	No
	319-85-7	beta-BHC			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	3.98E-03	NVA	No
	75-99-0	Dalapon			mg/kg		0/2	1.04E+00 - 1.09E+00	1.09E+00	N/A	NVA	NVA	No
	319-86-8	delta-BHC			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	9.94E+00	NVA	No
	1918-00-9	Dicamba			mg/kg		0/2	2.08E-01 - 2.19E-01	2.19E-01	N/A	NVA	NVA	No
	120-36-5	Dichloroprop			mg/kg		0/2	2.08E-01 - 2.19E-01	2.19E-01	N/A	NVA	NVA	No
	60-57-1	Dieldrin			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	1.10E-02	1.00E-01	No
	959-98-8	Endosulfan I			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	1.19E-01	NVA	No
	1031-07-8	Endosulfan sulfate			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	3.58E-02	NVA	No
	53494-70-5	Endrin ketone			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	NVA	NVA	No
	58-89-9	gamma-BHC (Lindane)			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	5.00E-03	1.00E-01	No
	5103-74-2	gamma-Chlordane			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	2.24E-01	1.00E-01	No
	76-44-8	Heptachlor			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	5.98E-03	NVA	No
	1024-57-3	Heptachlor epoxide			mg/kg		0/2	7.00E-04 - 7.00E-04	7.00E-04	N/A	1.52E-01	1.00E-01	No
	94-74-6	MCPA			mg/kg		0/4	1.04E+02 - 1.09E+02	1.09E+02	N/A	NVA	NVA	No
	93-65-2	MCPP			mg/kg		0/2	1.04E+02 - 1.09E+02	1.09E+02	N/A	NVA	NVA	No
	8001-35-2	Toxaphene			mg/kg		0/2	3.46E-02 - 3.64E-02	3.64E-02	N/A	1.19E-01	NVA	No
	12674-11-2	Aroclor 1016			mg/kg		0/4	3.46E-02 - 3.89E-02	3.89E-02	N/A	3.71E-01	1.00E-01	No
	11104-28-2	Aroclor 1221			mg/kg		0/4	6.93E-02 - 7.79E-02	7.79E-02	N/A	3.71E-01	1.00E-01	No
	11141-16-5	Aroclor 1232			mg/kg		0/4	3.46E-02 - 3.89E-02	3.89E-02	N/A	3.71E-01	1.00E-01	No
	53469-21-9	Aroclor 1242			mg/kg		0/4	3.46E-02 - 3.89E-02	3.89E-02	N/A	3.71E-01	1.00E-01	No

Table F-18
Comparison of Maximum Detection Limits in Surface Soil with Ecological Screening Values
Building 4343

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

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (3)	Region III BTAG Screening Levels	Max ND Greater than Screening Criteria (Y/N)
	12672-29-6	Aroclor 1248			mg/kg		0/4	3.46E-02 - 3.89E-02	3.89E-02	N/A	3.71E-01	1.00E-01	No
	11096-82-5	Aroclor 1260			mg/kg		0/4	3.46E-02 - 3.89E-02	3.89E-02	N/A	3.71E-01	1.00E-01	No
	131-11-3	Dimethylphthalate			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	7.34E+02	NVA	No
	120-82-1	**1,2,4-Trichlorobenzene**			**mg/kg**		**0/2**	**1.70E-01 - 1.80E-01**	**1.80E-01**	**N/A**	**2.00E+01**	**1.00E-01**	**Yes**
	95-50-1	**1,2-Dichlorobenzene**			**mg/kg**		**0/2**	**1.70E-01 - 1.80E-01**	**1.80E-01**	**N/A**	**2.96E+00**	**1.00E-01**	**Yes**
	541-73-1	1,3-Dichlorobenzene			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	3.77E+01	NVA	No
	106-46-7	**1,4-Dichlorobenzene**			**mg/kg**		**0/2**	**1.70E-01 - 1.80E-01**	**1.80E-01**	**N/A**	**2.00E+01**	**1.00E-01**	**Yes**
	95-95-4	**2,4,5-Trichlorophenol**			**mg/kg**		**0/2**	**1.70E-01 - 1.80E-01**	**1.80E-01**	**N/A**	**9.00E+00**	**1.00E-01**	**Yes**
	88-06-2	**2,4,6-Trichlorophenol**			**mg/kg**		**0/2**	**1.70E-01 - 1.80E-01**	**1.80E-01**	**N/A**	**4.00E+00**	**1.00E-01**	**Yes**
	120-83-2	**2,4-Dichlorophenol**			**mg/kg**		**0/2**	**1.70E-01 - 1.80E-01**	**1.80E-01**	**N/A**	**8.75E+01**	**1.00E-01**	**Yes**
	105-67-9	**2,4-Dimethylphenol**			**mg/kg**		**0/2**	**1.70E-01 - 1.80E-01**	**1.80E-01**	**N/A**	**1.00E-02**	**1.00E-01**	**Yes**
	51-28-5	**2,4-Dinitrophenol**			**mg/kg**		**0/2**	**8.70E-01 - 9.10E-01**	**9.10E-01**	**N/A**	**2.00E+01**	**1.00E-01**	**Yes**
	121-14-2	2,4-Dinitrotoluene			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	1.28E+00	NVA	No
	606-20-2	**2,6-Dinitrotoluene**			**mg/kg**		**0/2**	**2.00E-01 - 2.00E-01**	**2.00E-01**	**N/A**	**3.28E-02**	**NVA**	**Yes**
	91-58-7	**2-Chloronaphthalene**			**mg/kg**		**0/2**	**1.70E-01 - 1.80E-01**	**1.80E-01**	**N/A**	**1.22E-02**	**NVA**	**Yes**
	95-57-8	**2-Chlorophenol**			**mg/kg**		**0/2**	**1.70E-01 - 1.80E-01**	**1.80E-01**	**N/A**	**2.43E-01**	**1.00E-01**	**Yes**
	88-74-4	2-Nitroaniline			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	7.41E+01	NVA	No
	88-75-5	2-Nitrophenol			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	1.60E+00	NVA	No
	88-85-7	**2-sec-butyl-4,6-dinitrophenol**			**mg/kg**		**0/2**	**2.08E-01 - 2.19E-01**	**2.19E-01**	**N/A**	**2.18E-02**	**NVA**	**Yes**
	91-94-1	3,3'-Dichlorobenzidine			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	6.46E-01	NVA	No
	99-09-2	3-Nitroaniline			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	3.16E+00	NVA	No
	534-52-1	**4,6-Dinitro-o-cresol**			**mg/kg**		**0/2**	**8.70E-01 - 9.10E-01**	**9.10E-01**	**N/A**	**1.44E-01**	**NVA**	**Yes**
	100-01-6	4-Nitroaniline			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	2.19E+01	NVA	No
	100-02-7	**4-Nitrophenol**			**mg/kg**		**0/2**	**8.70E-01 - 9.10E-01**	**9.10E-01**	**N/A**	**7.00E+00**	**1.00E-01**	**Yes**
	83-32-9	Acenaphthene			mg/kg		0/1	1.90E-03 - 1.90E-03	1.90E-03	N/A	2.00E+01	1.00E-01	No
	65-85-0	Benzoic Acid			mg/kg		0/2	8.70E-01 - 9.10E-01	9.10E-01	N/A	7.30E+00	NVA	No
	111-91-1	bis(2-Chloroethoxy)methane			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	3.02E-01	NVA	No
	111-44-4	bis(2-Chloroethyl)ether			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	2.37E+01	NVA	No
	108-60-1	bis(2-Chloroisopropyl)ether			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	1.99E+01	NVA	No
	117-81-7	bis(2-Ethylhexyl) phthalate			mg/kg		0/2	5.30E-02 - 5.50E-02	5.50E-02	N/A	9.26E-01	NVA	No
	85-68-7	Butyl benzyl phthalate			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	2.39E-01	NVA	No
	86-74-8	Carbazole			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	NVA	NVA	No
	84-74-2	Di-n-butyl phthalate			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	2.00E+02	NVA	No
	117-84-0	Di-n-octyl phthalate			mg/kg		0/2	5.10E-02 - 1.70E-01	1.70E-01	N/A	7.09E+02	NVA	No
	132-64-9	Dibenzofuran			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	6.10E+00	NVA	No
	84-66-2	Diethyl phthalate			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	1.00E+02	NVA	No
	118-74-1	Hexachlorobenzene			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	1.99E-01	NVA	No
	87-68-3	**Hexachlorobutadiene**			**mg/kg**		**0/2**	**1.70E-01 - 1.80E-01**	**1.80E-01**	**N/A**	**3.98E-02**	**NVA**	**Yes**
	77-47-4	Hexachlorocyclopentadiene			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	1.00E+01	NVA	No
	67-72-1	Hexachloroethane			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	5.96E-01	NVA	No
	78-59-1	Isophorone			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	1.39E+02	NVA	No
	621-64-7	n-Nitroso-di-n-propylamine			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	5.44E-01	NVA	No
	86-30-6	n-Nitrosodiphenylamine			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	5.45E-01	NVA	No
	98-95-3	Nitrobenzene			mg/kg		0/2	2.00E-01 - 2.00E-01	2.00E-01	N/A	1.31E+00	NVA	No

Table F-18
Comparison of Maximum Detection Limits in Surface Soil with Ecological Screening Values
Building 4343

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

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (2)	Screening Toxicity Value (3)	Region III BTAG Screening Levels	Max ND Greater than Screening Criteria (Y/N)
	95-48-7	**o-Cresol**			**mg/kg**		**0/2**	**1.70E-01 - 1.80E-01**	**1.80E-01**	**N/A**	**4.04E+01**	**1.00E-01**	**Yes**
	59-50-7	p-Chloro-m-cresol			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	7.95E+00	NVA	No
	106-47-8	p-Chloroaniline			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	1.10E+00	NVA	No
	106-44-5	**p-Cresol**			**mg/kg**		**0/2**	**1.70E-01 - 1.80E-01**	**1.80E-01**	**N/A**	**1.63E+02**	**1.00E-01**	**Yes**
	87-86-5	**Pentachlorophenol**			**mg/kg**		**0/2**	**8.70E-01 - 9.10E-01**	**9.10E-01**	**N/A**	**3.00E+00**	**1.00E-01**	**Yes**
	108-95-2	**Phenol**			**mg/kg**		**0/2**	**1.70E-01 - 1.80E-01**	**1.80E-01**	**N/A**	**3.00E+01**	**1.00E-01**	**Yes**
	71-55-6	1,1,1-Trichloroethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	2.98E+01	3.00E-01	No
	79-34-5	1,1,2,2-Tetrachloroethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.27E-01	3.00E-01	No
	79-00-5	1,1,2-Trichloroethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	2.86E+01	3.00E-01	No
	75-34-3	1,1-Dichloroethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	2.01E+01	3.00E-01	No
	75-35-4	1,1-Dichloroethene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	8.28E+00	NVA	No
	107-06-2	1,2-Dichloroethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	2.12E+01	8.70E+02	No
	78-87-5	1,2-Dichloropropane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	3.27E+01	NVA	No
	78-93-3	2-Butanone			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	8.96E+01	NVA	No
	591-78-6	2-Hexanone			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.26E+01	NVA	No
	101-55-3	4-Bromophenyl phenylether			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	NVA	NVA	No
	7005-72-3	4-Chlorophenyl phenylether			mg/kg		0/2	1.70E-01 - 1.80E-01	1.80E-01	N/A	NVA	NVA	No
	108-10-1	4-Methyl-2-pentanone			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	4.43E+02	1.00E+02	No
	67-64-1	Acetone			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	2.50E+00	NVA	No
	71-43-2	Benzene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	2.55E-01	1.00E-01	No
	75-27-4	Bromodichloromethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	5.40E-01	4.50E+02	No
	74-83-9	Bromomethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	2.35E-01	NVA	No
	75-15-0	Carbon disulfide			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	9.41E-02	NVA	No
	56-23-5	Carbon tetrachloride			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	2.98E+00	3.00E-01	No
	108-90-7	Chlorobenzene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	4.00E+01	1.00E-01	No
	75-00-3	Chloroethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	NVA	NVA	No
	74-87-3	Chloromethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.04E+01	NVA	No
	10061-01-5	cis-1,3-Dichloro-1-propene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	3.98E-01	3.00E-01	No
	124-48-1	Dibromochloromethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	2.05E+00	NVA	No
	100-41-4	Ethylbenzene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	5.16E+00	1.00E-01	No
	75-09-2	Methylene chloride			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	4.05E+00	3.00E-01	No
	100-42-5	Styrene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	3.00E+02	1.00E-01	No
	127-18-4	Tetrachloroethene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	9.92E+00	3.00E-01	No
	108-88-3	Toluene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	2.00E+02	1.00E-01	No
	10061-02-6	trans-1,3-Dichloropropene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	3.98E-01	3.00E-01	No
	75-25-2	Tribromomethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.59E+01	1.15E+03	No
	79-01-6	Trichloroethene			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.24E+01	3.00E-01	No
	67-66-3	Trichloromethane			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	1.19E+00	3.00E-01	No
	75-01-4	Vinyl Chloride			mg/kg		0/2	4.70E-03 - 4.90E-03	4.90E-03	N/A	6.46E-01	3.00E-01	No
	1330-20-7	Xylenes (total)			mg/kg		0/2	9.40E-03 - 9.80E-03	9.80E-03	N/A	1.00E+01	1.00E-01	No

(1) Maximum non-detect limit value used for screening.
(2) No Background values were utilized in this screening assessment.
(3) Screening toxicity values from USEPA SSLs (2000); Efroymson et al., PRGs (1997); and USEPA Region V EDQLs (1999); and other sources. See text for derivation. Region III BTAG Screening Levels have also been utilized.

Definitions: N/A = Not Applicable or Not Available
NVA = No Value Available

Table F-19
Selection of Ecological Soil Screening Toxicity Values, for Food Chain Exposure, for Non-Detect Constituents, Building 4343

Parameter	Ecological Soil Screening Levels[a] (mg/kg)	Ecological Preliminary Remediation Goals[b] (mg/kg)	Ecological Data Quality Levels[c] (mg/kg)	Other Ecological Soil Screening Levels[d] (mg/kg)	Selected Ecological Screening Toxicity Value[e] (mg/kg)
1,1,1-Trichloroethane	NVA	NVA	29.8	--	29.8
1,1,2,2-Tetrachloroethane	NVA	NVA	0.12722	--	0.12722
1,1,2-Trichloroethane	NVA	NVA	28.6	--	28.6
1,1-Dichloroethane	NVA	NVA	20.1	--	20.1
1,1-Dichloroethene	NVA	NVA	8.28	--	8.28
1,2,4-Trichlorobenzene	NVA	$20_{(earthworm)}$	11.1	--	20
1,2-Dichlorobenzene	NVA	NVA	2.96	--	2.96
1,2-Dichloroethane	NVA	NVA	21.2	--	21.2
1,2-Dichloropropane	NVA	NVA	32.7	--	32.7
1,3,5-Trinitrobenzene	NVA	NVA	0.37615	--	0.37615
1,3-Dichlorobenzene	NVA	NVA	37.7	--	37.7
1,3-Dinitrobenzene	NVA	NVA	0.6547	--	0.6547
1,4-Dichlorobenzene	NVA	$20_{(earthworm)}$	0.54559	--	20
2,4,5-T	NVA	NVA	0.59634	--	0.59634
2,4,5-TP (Silvex)	NVA	NVA	0.1088	--	0.1088
2,4,5-Trichlorophenol	NVA	$9_{(earthworm)}$	14.1	--	9
2,4,6-Trichlorophenol	NVA	$4_{(plant)}$	9.94	--	4
2,4,6-Trinitrotoluene	NVA	NVA	NVA	0.7[f]	0.7
2,4-D	NVA	NVA	0.02725	--	0.02725
2,4-DB	NVA	NVA	NVA	NVA	NVA
2,4-Dichlorophenol	NVA	NVA	87.5	--	87.5
2,4-Dimethylphenol	NVA	NVA	0.01	--	0.01
2,4-Dinitrophenol	NVA	$20_{(plant)}$	0.06086	--	20
2,4-Dinitrotoluene	NVA	NVA	1.28	--	1.28
2,6-Dinitrotoluene	NVA	NVA	0.03283	--	0.03283
2-amino-4,6-Dinitrotoluene	NVA	NVA	NVA	5.3	5.3
2-Butanone	NVA	NVA	89.6	--	89.6
2-Chloronaphthalene	NVA	NVA	0.01218	--	0.01218
2-Chlorophenol	NVA	NVA	0.24266	--	0.24266
2-Hexanone	NVA	NVA	12.6	--	12.6
2-Nitroaniline	NVA	NVA	74.1	--	74.1
2-Nitrophenol	NVA	NVA	1.6	--	1.6
2-Nitrotoluene	NVA	NVA	NVA	4.1	4.1
2-sec-butyl-4,6-dinitrophenol	NVA	NVA	0.0218	--	0.0218
3,3'-Dichlorobenzidine	NVA	NVA	0.64636	--	0.64636
3-Nitroaniline	NVA	NVA	3.16	--	3.16
3-Nitrotoluene	NVA	NVA	NVA	5.3[f]	5.3
4,4'-DDE	NVA	NVA	0.59587	--	0.59587
4,6-Dinitro-o-cresol	NVA	NVA	0.14408	--	0.14408
4-amino-2,6-Dinitrotoluene	NVA	NVA	NVA	3.6[f]	3.6
4-Bromophenyl phenylether	NVA	NVA	NVA	NVA	NVA
4-Chlorophenyl phenylether	NVA	NVA	NVA	NVA	NVA
4-Methyl-2-pentanone	NVA	NVA	443	--	443
4-Nitroaniline	NVA	NVA	21.9	--	21.9
4-Nitrophenol	NVA	$7_{(earthworm)}$	5.12	--	7
4-Nitrotoluene	NVA	NVA	NVA	9.4	9.4
Acenaphthene	NVA	$20_{(plant)}$	682	--	20
Acetone	NVA	NVA	2.5	--	2.5
Aldrin	NVA	NVA	0.00332	--	0.00332
alpha-BHC	NVA	NVA	0.09939	--	0.09939
alpha-Chlordane	NVA	NVA	0.224	--	0.224
Aroclor 1016	NVA	$0.371_{(mammal)}$	0.000332	--	0.371
Aroclor 1221	NVA	$0.371_{(mammal)}$	0.000332	--	0.371
Aroclor 1232	NVA	$0.371_{(mammal)}$	0.000332	--	0.371

Table F-19
Selection of Ecological Soil Screening Toxicity Values, for Food Chain Exposure, for Non-Detect Constituents, Building 4343

Parameter	Ecological Soil Screening Levels[a] (mg/kg)	Ecological Preliminary Remediation Goals[b] (mg/kg)	Ecological Data Quality Levels[c] (mg/kg)	Other Ecological Soil Screening Levels[d] (mg/kg)	Selected Ecological Screening Toxicity Value[e] (mg/kg)
Aroclor 1242	NVA	$0.371_{(mammal)}$	0.000332	--	0.371
Aroclor 1248	NVA	$0.371_{(mammal)}$	0.000332	--	0.371
Aroclor 1260	NVA	$0.371_{(mammal)}$	0.000332	--	0.371
Benzene	NVA	NVA	0.25462	--	0.25462
Benzoic acid	NVA	NVA	NVA	7.3[f]	7.3
Benzyl alcohol	NVA	NVA	65.8	--	65.8
beta-BHC	NVA	NVA	0.00398	--	0.00398
bis(2-Chloroethoxy)methane	NVA	NVA	0.30209	--	0.30209
bis(2-Chloroethyl)ether	NVA	NVA	23.7	--	23.7
bis(2-Chloroisopropyl)ether	NVA	NVA	19.9	--	19.9
bis(2-Ethylhexyl) phthalate	NVA	NVA	0.92594	--	0.92594
Bromodichloromethane	NVA	NVA	0.53978	--	0.53978
Bromomethane	NVA	NVA	0.23516	--	0.23516
Butyl benzyl phthalate	NVA	NVA	0.23889	--	0.23889
Carbazole	NVA	NVA	NVA	NVA	NVA
Carbon disulfide	NVA	NVA	0.09412	--	0.09412
Carbon tetrachloride	NVA	NVA	2.98	--	2.98
Chlorobenzene	NVA	$40_{(earthworm)}$	13.1	--	40
Chloroethane	NVA	NVA	NVA	NVA	NVA
Chloromethane	NVA	NVA	10.4	--	10.4
cis-1,2-Dichloroethene	NVA	NVA	0.78373	--	0.78373
cis-1,3-Dichloro-1-propene	NVA	NVA	0.39786	--	0.39786
Cyclonite (RDX)	$5.8_{(mammal)}$	NVA	NVA	--	5.8
Dalapon	NVA	NVA	NVA	NVA	NVA
delta-BHC	NVA	NVA	9.94	--	9.94
Dibenzofuran	NVA	NVA	NVA	6.1[f]	6.1
Dibromochloromethane	NVA	NVA	2.05	--	2.05
Dicamba	NVA	NVA	NVA	NVA	NVA
Dichloroprop	NVA	NVA	NVA	NVA	NVA
Dieldrin	$0.011_{(bird)}$	NVA	0.00238	--	0.011
Diethyl phthalate	NVA	$100_{(plant)}$	24.8	--	100
Dimethyl phthalate	NVA	NVA	734	--	734
Di-n-butyl phthalate	NVA	$200_{(plant)}$	0.14979	--	200
Di-n-octyl phthalate	NVA	NVA	709	--	709
Endosulfan I	NVA	NVA	0.11927	--	0.11927
Endosulfan sulfate	NVA	NVA	0.03578	--	0.03578
Endrin ketone	NVA	NVA	NVA	NVA	NVA
Ethylbenzene	NVA	NVA	5.16	--	5.16
gamma-BHC (Lindane)	NVA	NVA	0.005	--	0.005
gamma-Chlordane	NVA	NVA	0.224	--	0.224
Heptachlor	NVA	NVA	0.00598	--	0.00598
Heptachlor epoxide	NVA	NVA	0.15188	--	0.15188
Hexachlorobenzene	NVA	NVA	0.19878	--	0.19878
Hexachlorobutadiene	NVA	NVA	0.03976	--	0.03976
Hexachlorocyclopentadiene	NVA	$10_{(plant)}$	0.75537	--	10
Hexachloroethane	NVA	NVA	0.59634	--	0.59634
HMX	NVA	NVA	NVA	43	43
Isophorone	NVA	NVA	139	--	139
MCPA	NVA	NVA	NVA	NVA	NVA
MCPP	NVA	NVA	NVA	NVA	NVA
Methylene chloride	NVA	NVA	4.05	--	4.05
Nitrobenzene	NVA	NVA	1.31	--	1.31
Nitroglycerin	NVA	NVA	NVA	150[f]	150
n-Nitroso-di-n-propylamine	NVA	NVA	0.54368	--	0.54368
n-Nitrosodiphenylamine	NVA	NVA	0.54514	--	0.54514

Table F-19
Selection of Ecological Soil Screening Toxicity Values, for Food Chain Exposure, for Non-Detect Constituents, Building 4343

Parameter	Ecological Soil Screening Levels[a] (mg/kg)	Ecological Preliminary Remediation Goals[b] (mg/kg)	Ecological Data Quality Levels[c] (mg/kg)	Other Ecological Soil Screening Levels[d] (mg/kg)	Selected Ecological Screening Toxicity Value[e] (mg/kg)
o-Cresol	NVA	NVA	40.4	--	40.4
o-Xylene	NVA	NVA	10	--	10
p-Chloroaniline	NVA	NVA	1.1	--	1.1
p-Chloro-m-cresol	NVA	NVA	7.95	--	7.95
p-Cresol	NVA	NVA	163	--	163
Pentachlorophenol	NVA	$3_{(plant)}$	0.11927	--	3
Pentaerythritol tetranitrate (PETN)	NVA	NVA	NVA	14,000[f]	14,000
Phenol	NVA	$30_{(earthworm)}$	120	--	30
Pyridine	NVA	NVA	1.03	--	1.03
Styrene	NVA	$300_{(plant)}$	4.69	--	300
Tetrachloroethene	NVA	NVA	9.92	--	9.92
Tetryl	NVA	NVA	NVA	2	2
Toluene	NVA	$200_{(plant)}$	5.45	--	200
Toxaphene	NVA	NVA	0.11927	--	0.11927
trans-1,2-Dichloroethene	NVA	NVA	0.78373	--	0.78373
trans-1,3-Dichloropropene	NVA	NVA	0.39786	--	0.39786
Tribromomethane	NVA	NVA	15.9	--	15.9
Trichloroethene	NVA	NVA	12.4	--	12.4
Trichloromethane	NVA	NVA	1.19	--	1.19
Vinyl Chloride	NVA	NVA	0.64614	--	0.64614
Xylenes (total)	NVA	NVA	10	--	10

a Ecological Soil Screening Level Guidance, USEPA, July 2000, Draft.
b Preliminary Remediation Goals for Ecological Endpoints, R. A. Efroymson, et. al., August 1997.
c Ecological Data Quality Levels, USEPA Region 5, October 1999.
d
e The following hierarchy was utilized to select the final Ecological Screening Toxicity Values for this assessment:
1. The lower value of either the Ecological Soil Screening Level Guidance or the Preliminary Remediation Goals for Ecological Endpoints.
2. Ecological Data Quality Levels, USEPA Region 5

f Value is from Los Alamos
NVA = No Value Available

Appendix G
Correspondence

This Appendix Contains:

Appendix G-1 UST Closure Report
Appendix G-2 Letter of Discovery

Appendix G-1
UST Closure Report

98-130

Pack
ENV file
Olsen

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

James S. Gilmore, III
Governor

John Paul Woodley, Jr.
Secretary of Natural Resources

West Central Regional Office
3019 Peters Creek Road, Roanoke, Virginia 24019
Telephone (540) 562-6700, Fax (540) 526-6725
http://www.deq.state.va.us

Dennis H. Treacy
Director

Thomas L. Henderson
Regional Director

August 24, 1998

Mr. Robert Richardson
Environmental Affairs
Radford Army Ammunition Plant
P.O. Box 1
Radford, VA 24141

RE: Underground Storage Tank (UST) Closure Assessment Review for: One 500 Gallon Gasoline UST at Building Account 4343, Radford Army Ammunition Plant, Peppers Ferry Road (Rt. 114), Montgomery County, Virginia, FAC. I.D. No. 2-000051

Dear Mr. Richardson:

The staff has completed a review of the site assessment that was performed at your Underground Storage Tank closure, as required by Section 7.3 of the Virginia Underground Storage Tanks; Technical Standards and Corrective Action Requirements (9 VAC 25-580-10 et seq.). Based on the information provided, it appears that site conditions do not warrant further action at this time. However, if significant environmental contamination associated with this facility is detected in the future, further environmental investigations and corrective action may be required.

If you have questions regarding Virginia's UST program, our office will be glad to assist.

Sincerely,

Ken Chapman
Senior Geologist

cc. UST Closure File 2-000051
C. Bruce Davidson, DEQ-WCRO

ALLIANT TECHSYSTEMS

Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

July 28, 1998

98-815-159

Ms. Amy Harshman
DEQ UST Program
Department of Environmental Quality
P.O. Box 10009
Richmond, VA 23240-0009

Subject: (1) Initial Abatement Measures and Site Check Reports for Building Accounts 8106-1 & 8106-2 (PC-98-1156) and 4736 (PC-98-1157)
(2) UST Closure Documentation; UST Building Accounts 8106-1, 8106-2, 4736, 906-13, and 4343
Radford Army Ammunition Plant, Pulaski County, VA;
Facility I.D. No. 2-000051

References: (1) Attached DEQ-WCRO Letter from Mr. Ken Chapman, dated July 1, 1998, Request for Initial Abatement Measures Reports on 8106 and 4736
(2) Enclosed UST Closure Report from Environmental Directions, Inc., dated July 17, 1998 for Building Accounts 8106-1, 8106-2, 4736, 906-13, and 4343

Dear Ms. Harshman:

Enclosed, please find the Initial Abatement Measures and Site Check Reports for Building Accounts 8106-1, 8106-2, and 4736 as requested by Mr. Ken Chapman of the West Central Regional DEQ Office in the above referenced letter. Also included herein, are supporting UST Closure documentation for the five USTs (Buildings 8106-1, 8106-2, 4736, 906-13, and 4343) that were removed in June 1998.

Building 8106 is located at the Radford Army Ammunition Plant's New River Storage Unit in Dublin, VA (Pulaski County). The site was formerly a fueling station and contained a 2,000 gallon gasoline UST (8106-1), and a 1,000 gallon diesel UST (8106-2). The tanks have been in temporary closure status since July 1993, and were removed from the ground in June 1998. Soil contamination was evident during tank removal activities and DEQ-WCRO was notified on June 18, 1998. Mr. Chapman then assigned PC No. 98-1156, and forwarded the request to submit this report.

Building 4736 is located in the Horseshoe Area (Pulaski County) portion of the main Radford plant in the Rocket Manufacturing Area. The site was formerly a fueling station and contained a 2,000 gallon gasoline UST. The tank has been in temporary closure status since December 1993, and was removed from the ground in June 1998. Soil contamination was evident during tank removal activities and DEQ-WCRO was notified on June 18, 1998. Mr. Chapman then assigned PC No. 98-1157, and forwarded the request to submit this report.

Closure documentation for all 5 USTs is included within the enclosed Tank Closure Report by Environmental Directions. If there are any questions or comments concerning the enclosed information, please call Mr. Jeff Pack at (540) 639-8369, or FAX at (540) 639-7214.

Very truly yours,

C. A. Jake

C. A. Jake, Supervisor
Environmental

JSPack:V:\815-158
Attachments

cc: Mr. Ken R. Chapman, Senior Geologist
Virginia Department of Environmental Quality
West Central Regional Office
3019 Peters Creek Road
Roanoke, VA 24019

Coordination:

M. L. Griffith

R. L. Richardson

bc: Administrative File
D. W. Shead - MN11-2143
C. A. Jake
M. J. Sullivan
J. S. Pack
M. A. Lee
R. L. Richardson (ACO)
S. J. Barker (ACO)
Env. File

Tank Closure Report

Alliant Techsystems, Inc.
Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, VA 24141
(Sites located in Radford and Dublin)

Prepared for:

Mike Lee
Project Engineer
Alliant Techsystems, Inc.
Radford Army Ammunition Plant

Prepared by:

Rondel F. Mitchell
Environmental Directions, Inc.
2727 Plantation Road
Roanoke, VA 24012
(540) 362-9447

July 17, 1998

EDI Project Number: 100301

Table of Contents

Closure Assessment
a. Site Maps
b. Photos
c. Closure Report

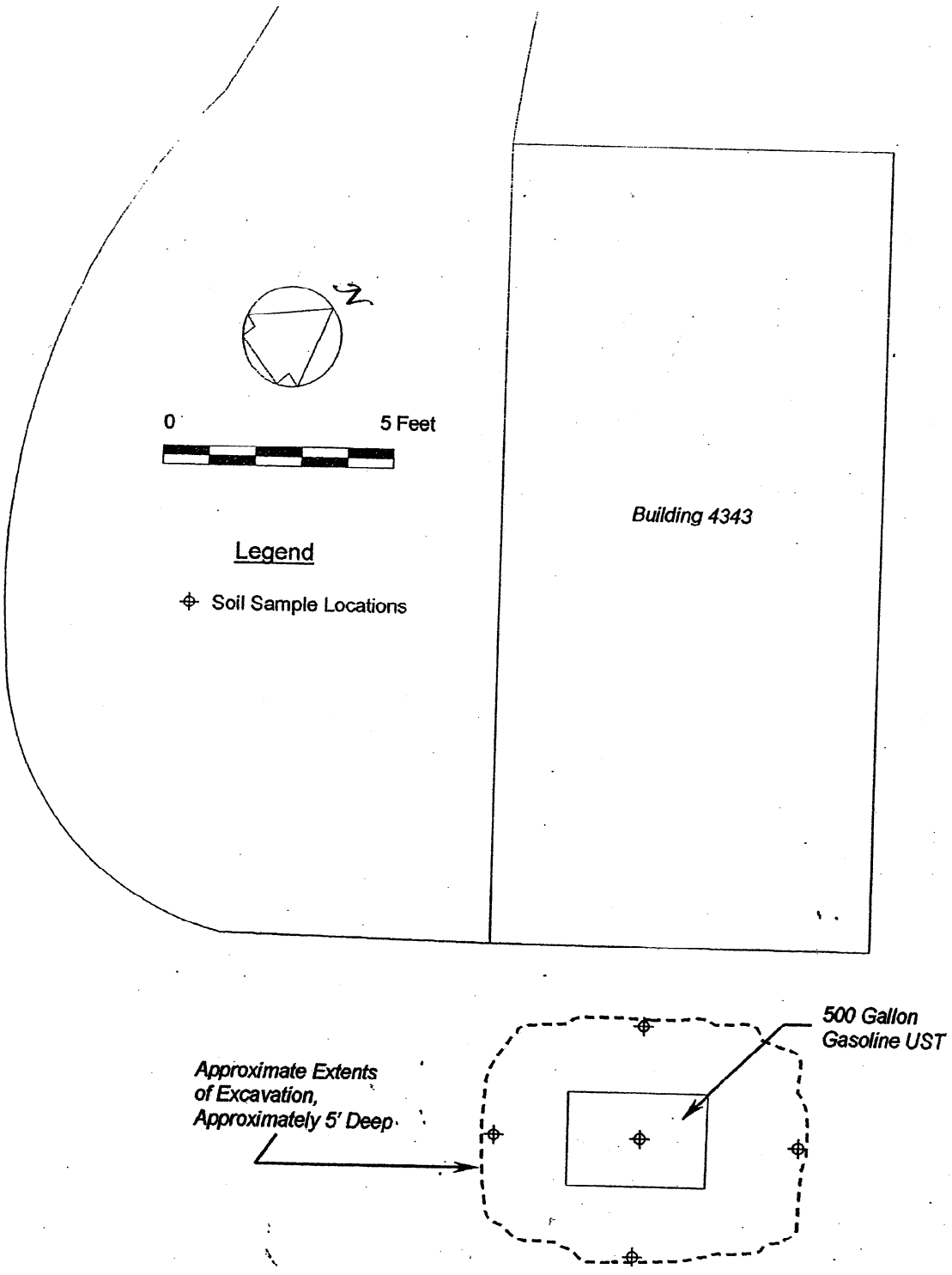
I. Form 7530-1

II. Laboratory Analysis and Chain of Custody

III. Inspection Permit

Closure Assessment

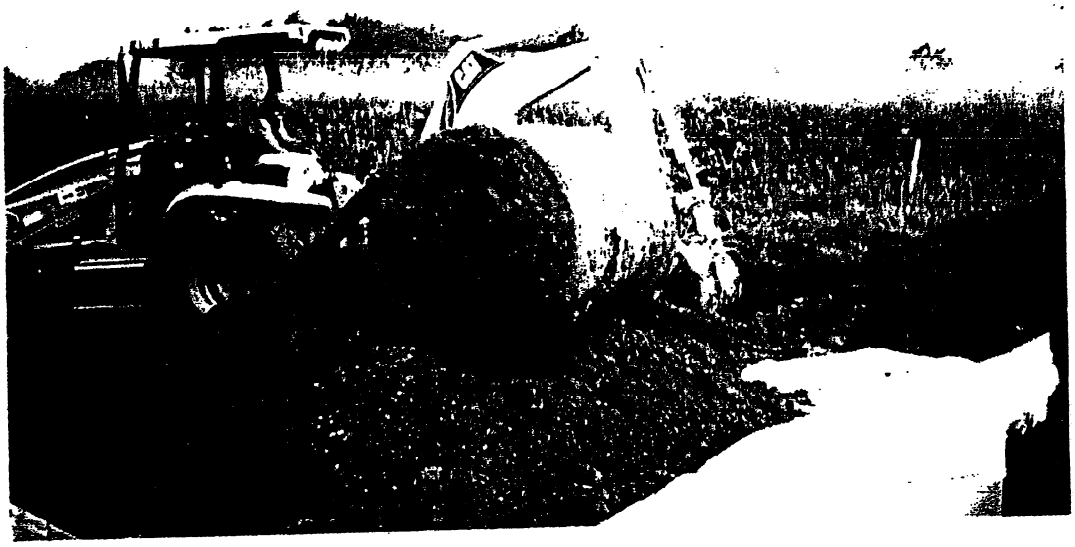
a. Site Maps
b. Photos
c. Closure Report



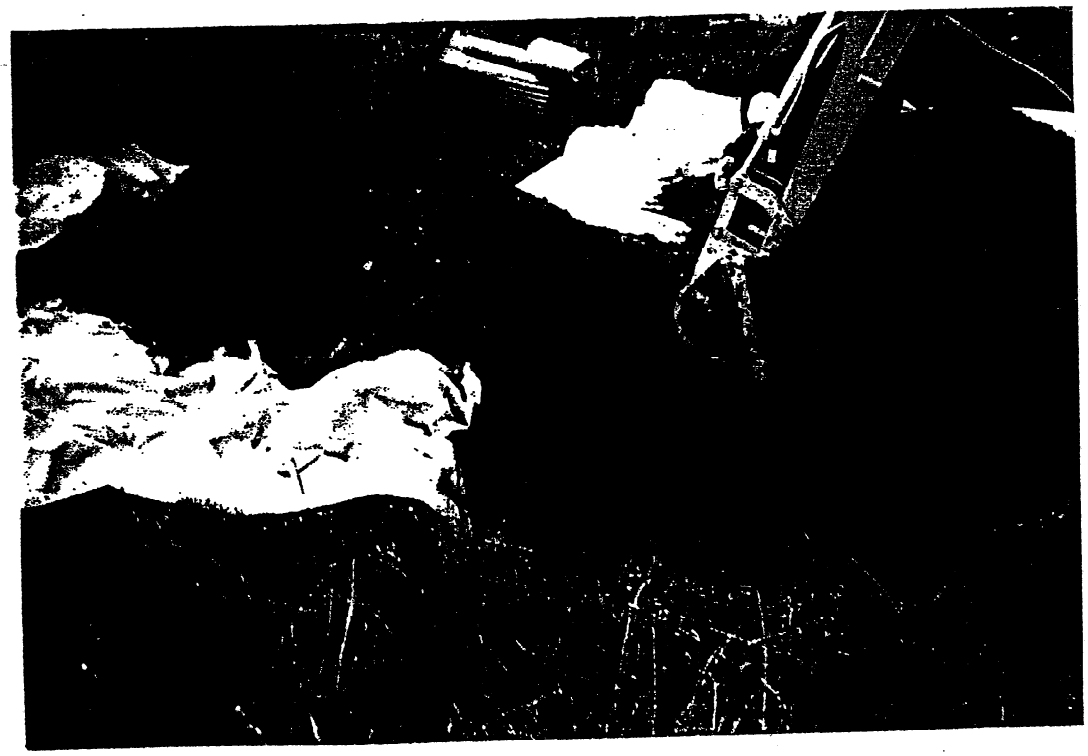
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Site 2

ENVIRONMENTAL
DIRECTIONS
INCORPORATED



Photograph Site 2: Tank Removal



Photograph Site 2: Tank Pit After Excavation

Closure Assessment

Environmental Directions, Inc. (EDI) was contracted by Alliant Techsystems for removal and closure of five UST's from the Radford Army Ammunition Plant New River Storage Unit (Dudlin) and the Main Radford Facility (Radford). Three tanks were removed from the Radford Facility, herein referred to as Sites 1, 2, and 3. Two tanks were removed from the Dublin Facility, herein referred to as Site 4. Site 1 contained a 2000 gallon gasoline UST, while Site 2 contained a 550 gallon gasoline UST, and Site 3 contained a 500 gallon diesel UST. Site 4 contained one 2000 gallon gasoline UST and a 1000 gallon diesel UST. All tanks were cleaned on site and tanks were disposed of by Jarrett Contractors, Inc.

Following is a summary of tank removal and closure activities for each tank site:

Site 1:

Site 1 was located at the Radford Facility, adjacent to Building 4736, and was used as a former vehicle fueling area. The tank was covered by asphalt and concrete. On June 12, 1998, EDI removed the 2000 gallon gasoline tank and approximately 20 tons of soil around the tank. The tank was cleaned on-site and properly disposed of off-site. After the tank was removed, visible soil staining and product was observed. At the direction of the Alliant Engineer, EDI overexcavated the tank pit area on June 18, 1998. Approximately 50 additional tons of contaminated soil was removed, stockpiled, and secured with plastic on site. During the overexcavation flowing water was observed entering the tank pit and excavation was halted. Due to the visible product in the tank pit, no sample was collected from under the tank. A composite sample was collected from the four walls of the excavation and submitted to CT&E Environmental Services Laboratory (CT&E) for TPH-DRO, TPH-GRO, TPH 418.1, BTEX, and TCLP 8 RCRA Metals analysis. See Appendix II. Analytical results from this sample were reported as TPH-DRO as (380 mg/kg), TPH-GRO (0.90 mg/kg), TPH 418.1 (320 mg/kg), total xylenes (0.21 mg/kg), and barium (2.5 mg/kg). All other sample analyses from this site were non-detect. The site has been secured and EDI is awaiting direction from the Alliant Engineer to continue overexcavation or backfill tank pit area and remove contaminated soils. In addition, analytical from the stockpiled soil at this site can be found in Appendix II.

Site 2:

Site 2 was located at the Radford facility, behind Building 4343, and was used as a storage tank for a generator in the former Pump House. On June 11, 1998, EDI removed the 550 gallon gasoline tank and approximately 7 tons of soil. The tank was cleaned on-site and properly disposed of off-site. OVA readings from the soil under the tank and from the tank walls was slightly above background readings. A sample was collected from each wall of the excavation and from under the tank. These samples were submitted to CT&E for TPH-DRO, TPH-GRO, TPH 418.1, and BTEX analysis. See Appendix II. All samples were non-detect. In addition, analytical results from the stockpiled soil at this site can be found in Appendix II.

otification for Underground Storage Tanks

STATE USE ONLY
ID NUMBER
DATE RECEIVED
A. NEW
B. AMENDED
C. ENTERED INTO UST-DMS
D. Comments:

tate Agency Name and Address
)EQ-Water - UST Program

P. O. Box No. 10009
Richmond, VA 23240-0009

TYPE OF NOTIFICATION

A. NEW FACILITY ☐ B. AMENDED ☒ C. CLOSURE

2 No. of tanks at facility 4 No. of continuation sheets attached

INSTRUCTIONS

Please type or print in ink all items except "signature" in section VIII. This form must e completed for each location containing underground storage tanks. If more than e (5) tanks are owned at this location, photocopy pages 3, 4 and 5, and staple continuation sheets to the form.

GENERAL INFORMATION

Notification is required by Virginia law for all underground storage tanks that have n used to store regulated substances and were in the ground as of May 8, 1986, that are brought into use after May 8, 1986. The information requested is required §62.1-44.34:9.6 & 7 of the Virginia State Water Control Law, Article 9.

The primary purpose of this notification program is to locate and evaluate underground age tanks that store or have stored petroleum or hazardous substances. It is expected l the information you provide will be based on reasonable available records, or in the ence of such records, your knowledge, belief, or recollection.

Who Must Notify?

A. Virginia State Water Control Law Article 9 § 62.1-44.34:9.6 & 7, requires that unless noted, owners of underground storage tanks that store regulated substances must notify State Water Control Board of the existence of their tanks. Owner means:

1) in the case of an underground storage tank in use on November 8, 1984, or brought use after that date, any person who owns an underground storage tank used for the rage, use or dispensing of regulated substances, and

2) in the case of any underground storage tank in use before November 8, 1984; but no ger in use after that date, any person who owned such tank immediately before the discontinuation of its use, and

B. Owners of property who have actual knowledge of underground storage tanks on such operty that were taken out of service before January 1, 1974, yet still in the ground.

What UST's Must Be Notified? Underground storage tank or "UST" means any one combination of tanks (including underground pipes connected thereto) that is used to con- accumulation of regulated substances, and the volume of which (including the volume ground pipes connected thereto) is 10% or more beneath the surface of the ground.

hat UST's Are Excluded From Notification Requirements?

1. Farm or residential tank of 1,100 gallons or less capacity used for storing motor fuel for noncommercial purposes;
2. Tank used for storing heating oil for consumption on the premises where stored,
3. Septic tank;
4. Pipeline facility (including gathering lines) regulated under:
   a. The Natural Gas Pipeline Safety Act of 1968 (49 U.S.C. App. 1671, et seq.), or
   b. The Hazardous Liquid Pipeline Safety Act of 1979 (49 U.S.C. App. 2001, et seq.), or
   c. Which is an intrastate pipeline facility regulated under state laws comparable to the provisions of the law referred to in subdivisions 4.a or 4.b of this definition;
5. Surface impoundment, pit, pond, or lagoon;
6. Storm-water or wastewater collection system;
7. Flow-through process tank;
8. Liquid trap or associated gathering lines directly related to oil or gas production and gathering operations; or
9. Storage tank situated in an underground area (such as a basement, cellar, mineworking, drift, shaft, or tunnel) if the storage tank is situated upon or above the surface of the floor.

The Following Need Not Notify, But May Be Regulated.

10. Wastewater treatment tank systems;
11. Any UST systems containing radioactive material that are regulated under the Atomic Energy Act of 1954 (42 USC 2011 and following);
12. Any UST system that is part of an emergency generator system at nuclear power generation facilities regulated by the Nuclear Regulatory Commission under 10 CFR Part 50, Appendix A;
13. Airport hydrant fuel distribution systems; and
14. UST systems with field-constructed tanks

What Substances Are Covered? "Regulated substance" means an element, compound, mixture, solution, or substance that, when released into the environment, may present substantial danger to the public health or welfare, or the environment. The term "regulated substance" includes:

1. Any substance defined in § 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, but not any substance regulated as a hazardous waste under subtitle C of the Resource Conservation and Recovery Act (RCRA) of 1976; and
2. Petroleum, including crude oil or any fraction thereof, that is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute). The term "regulated substance" includes but is not limited to petroleum and petroleum-based substances comprised of a complex blend of hydrocarbons derived from crude oil through processes of separation, conversion, upgrading, and finishing, such as motor fuels, jet fuels, distillate fuel oils, residual fuel oils, lubricants, petroleum solvents, and used oils.

When to Notify?

A. Any owner who brings an underground storage tank system into use must within 30 days of bringing such tank into use, submit a notice of existence of such tank system to the board. Any change in: ownership; tank status (e.g., temporarily / permanently closed out); tank/piping systems (e.g., upgrades such as addition of corrosion protection, internal lining, release detection); substance stored (e.g., change from petroleum to hazardous substance) requires the UST owner to submit an amended notification form within 30 days after such change/upgrade occurs or is brought into use. Owners may provide notice for several tanks using one notification form, but owners with tanks located at more than one place of operation must file a separate notification form for each separate place of operation.

Under Virginia UST notification requirements effective July 1, 1987, owners of property who have actual knowledge of underground storage tanks on such property that were taken out of service before January 1, 1974, yet still in the ground, must notify the board on the notification form.

Notices required to be submitted must provide all of the information in Sections I through IX of this form (Section X as required) for each tank for which notice must be given. Notices for tanks installed after December 22, 1988, must also provide all of the information in Section XI of this form for each tank for which notice must be given.

B. All owners and operators of new UST systems must certify in the notification form compliance with the following requirements of Virginia Regulation 9 VAC 25-580-10, et seq.

1. Installation of tanks and piping under subsection E of § 2.1;
2. Cathodic protection of steel tanks and piping under subsections A and B of § 2.1;
3. Release detection under §§ 4.2. and 4.3.
4. Financial responsibility under Virginia Regulation 9 VAC 25-590-10, et seq.

C. All owners and operators of new UST systems must ensure that the installer certifies in the notification form that the methods used to install the tanks and piping comply with the requirements in subsection D of § 2.1 of 9 VAC 25-580-10, et seq.

D. Beginning October 24, 1988, any person who sells a tank intended to be used as an underground storage tank must notify the purchaser of such tank of the owner's notification obligations under subsection A of this section. The statement provided in Appendix II of 9 VAC 25-590-10 may be used to comply with this requirement.

I. OWNERSHIP OF TANK(S)

UNITED STATES ARMY
Owner Name (Corporation, Individual, Public Agency, or Other Entity)

RADFORD ARMY AMMUNITION PLANT
Street Address

RT. 114, P.O. BOX 1

RADFORD VA 24141
City State ZIP Code

PULASKI / MONTGOMERY
County

(540) 639-8369
Phone Number (Include Area Code)

II. LOCATION OF TANK(S)

If known, give the geographic location of tank(s) by degrees, minutes, and seconds. Example Lat 42, 36, 12N Long. 85, 24, 17W

Latitude 37°10'19" Longitude 80°31'17"

(If same as Section I, mark box here) ☐

Facility or Company Site Identifier, as applicable

Street Address (P. O. Box not acceptable)

City State ZIP Code

County Municipality

III. TYPE OF OWNER

Federal Government ☐ Commercial
State Government ☐ Private
Local Government

IV. INDIAN LANDS

Tanks are located on land within an Indian Reservation or on other trust lands. ☐

Tanks are owned by Native American nation, tribe, or individual. ☐

Tribe or Nation: _____

V. TYPE OF FACILITY

ect the Appropriate Facility Description:

___ Gas Station/Convenience Store	___ State Government	___ Contractor
___ Petroleum Distributor	___ Railroad	___ Trucking/Transport
___ Air Taxi (Airline)	___ Federal - Non-Military	___ Utilities
___ Aircraft Owner	X Federal - Military	___ Residential
___ Auto Dealership	___ Commercial	___ Farm
___ Local Government	___ Industrial	___ Other (Explain) _____

VI. CONTACT PERSON IN CHARGE OF TANKS

me (Print)	Job Title	Mailing Address	Phone Number (Include Area Code)
FF S. PACK	ENVIRONMENTAL ENGINEER	ALLIANT TECHSYSTEMS, INC. RADFORD ARMY AMMUNITION PLANT P.O. BOX 1 RADFORD, VA 24141	(540) 639 -8369

VII. FINANCIAL RESPONSIBILITY

I have met the financial responsibility requirements in accordance with VR680-13-03 utilizing the following method(s).

ark All that Apply

X Self Insurance	☐ Guarantee	☐ Virginia Underground Petroleum Storage Tank Fund
☐ Commercial Insurance	☐ Surety Bond	☐ Trust Fund
☐ Risk Retention Group	☐ Letter of Credit	☐ Other Method Allowed (Specify)

_____

VIII. CERTIFICATION (Read and sign after completing all sections)

certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached ocuments, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the ubmitted information is true, accurate, and complete. *(To be signed by either the owner or the owner's authorized representative)*

ame and official title of owner (Print)	Signature	Date Signed
TC ARMANDO LOPEZ, JR. O. MING OFFICER	Albert J. Starostanko Executive Officer, CPT OD	29 Jun 98
am: l official title of wner's authorized representative (Print) ENNETH D. DOLPH ESIDENT MANAGER	Signature	Date Signed 29 Jun 98.

IX. DESCRIPTION OF UNDERGROUND STORAGE TANKS (Complete for each tank at this location.)

k Identification Number	Tank No. 8106-1	Tank No. 8106-2	Tank No. 4343	Tank No. 906-13	Tank No. 4736
Status of Tank (Mark only one) — Currently in Use					
Temporarily Out of Use (Rememoer to fill out section X)					
Permanently Out of Use (Rememoer to fill out section X)	X	X	X	X	X
Amendment of Information					
Date of Installation (mo./year)	1959	1959	1941	1980	1979
Estimated Total Capacity (gallons)	2,000	1,000	550	500	2,000
Tank Material of Construction (Mark all that apply)					
Asonait Coated or Bare Steel	X	X	X	X	X
Cathodically Protected Steel					
Epoxy Coated Steel					
Composite (Steel with Fiberglass)					
Fiberglass Reinforced Plastic					
Lined Interior					
Double Walled					
Polyethylene Tank Jacket					
Concrete					
Excavation Liner					
Unknown					
Other (Please specify)					
Has tank been repaired?	No	No	No	No	No
Piping Material of Construction (Mark all that apply) - Bare Steel	X	X	X		X
Galvanized Steel				X	
Fiberglass Reinforced Plastic					
Copper					
Cathodically Protected					
Double Walled					
Secondary Containment					
Unknown					
Other (Please specify)					
Has piping been repaired?	No	No	No	No	No
Piping (Type) (Mark only one)					
Suction: no valve at tank	X	X	X (glass)	X	X
Suction: valve at tank					
Pressure					
Gravity Fed			X		

nk Identification Number	Tank No. 8106-1	Tank No. 8106-2	Tank No. 4343	Tank No. 906-13	Tank No 4736
Substance Currently or Last Stored In Greatest Quantity by Volume					
Gasoline	X		X		X
Diesel		X		X	
Gasohol					
Kerosene					
Heating Oil					
Used Oil					
Other (Please specify)					
Hazardous Substance					
CERCLA name and/or					
CAS Number					
Mixture of Substances					
Please specify					

X TANKS OUT OF USE, OR CHANGE IN SERVICE

1. [ ] sing of Tank					
Estimated date last used (mo./day/year)	7/1/93	7/1/93	1956	7/14/95	12/2/93
B. Estimate date tank closed (mo./day/year)	7/1/93	7/1/93	1956	7/14/95	12/2/93
C. Tank was removed from ground	6/14/98 X	6/14/98 X	6/12/98 X	6/12/98 X	6/15/98 X
D. Tank was closed in ground					
E. Tank filled with inert material					
Describe					
F. Change in service					
[ ] osure Assessment Completed (Site Map and Soil Sampling Results must be submitted with this form.)	X	X	X	X	X
3. Evidence of a leak detected	YES	YES	No	No	YES

nk Identification Number	Tank No. 8106-1	Tank No. 8106-2	Tank No. 4343	Tank No. 9063	Tank No. 4736
Installation					
A. Installer certified by tank and piping manufacturers					
B. Installation inspected by a registered engineer					
C. Manufacturer's installation check-lists have been completed					
D. Obtained certificate of use issued by local permitting official					
E. Another method allowed by State Water Control Board. (Please specify)					

Release Detection (Mark all that apply)	TANK	PIPING	TANK	PIPING	TANK	PIPING	TANK	PIPING	TANK	PIPING
A. Manual tank gauging										
B. Tank tightness testing										
C. Inventory controls										
D. Automatic gauging										
E. Vapor monitoring										
F. Groundwater monitoring										
G. Interstitial monitoring, double walled tank and/or piping										
H. Interstitial monitoring/secondary containment										
I. Automatic line leak detectors										
J. Line tightness testing										
K. Other method allowed by State Water Control Board. (Please specify)										

I. Spill and Overfill Protection					
A. Overfill device installed					
B. Spill device installed					

OATH: I certify the information concerning installation that is provided in section XI is true to the best of my belief and knowledge

Installer: _____ _____ _____

Name Signature Date

_____ _____

Position Company

Laboratory Analysis and Chain of Custody - Site 2

CT&E Env[illegible]vices
1258 Greenbrier Street
Charleston, WV 25311
Rex Kuhl 304-346-0725

Chain of Custody

Instructions on back of this document

ENVIRONMENTAL DIRECTIONS, INC.
2727 PLANTATION RD.
ROANOKE VA 24012
540-362-5636

Section 1
Client Environmental Directions, Inc.
Address P O Box 7569
Roanoke, VA 24019-0569
Phone 540-362-5636 FAX: 540-362-9447

Project Name and/or Number 100301
Purchase Order No 1721 required
Project Manager Greg Whitt
Sampler(s): GW

Section 5 (check one)
TURNAROUND TIME REQUESTED
Normal 5 ~~working~~ days ✓
3 day RUSH
48 hr RUSH
24 hr RUSH

6-744-1/16

Section 2 SAMPLE ID	LOCATION/DEPTH	MATRIX	COLLECTION DATE TIME	Grab/ Comp	CONTAINER TYPE & #	PRESERVED WITH	ANALYSES REQUIRED	EDI LAB #
002	Tank1 West Wall Comp	soil			12-4oz		TPH 8015, 5030/8020A, TPH 418.1, TCLP Pb	
003	Tank1&2 N Wall Comp							
006	Tank2 E Wall							
031	Tank1&2 S wall over excav comp							
029	Tank1&2 Pit bottom comp							
012	N Wall Bldg 4343 500gl Diesel				1-4oz			
013	S							
014	E							
015	W							
016	under tank							
018	N				8-4oz			
019	S wall of exc. Bldg 906-13 500gal							
020	E							
021	W							
022	Under Tank							
024	4 wall exc-comp Bldg 4736 2Kgal						TCLP Metals (8)	

SECTION 3:

Relinquished by:	Date/Time	Received by:	Date/Time	Received by EDI Lab:	Date/Time	Temp.	pH	Seal	Condition
Karen Vaught	6-22-98	UPS NDA	6-22-98	A Rhodes	6-23-98 0931	19°C			
Relinquished by:	**Date/Time**	**Received by:**	**Date/Time**	**Shipper:**	**Waybill No.**				

SECTION 4:
Remarks

CT&E Environmental Services Inc.

Laboratory Division

Laboratory Analysis Report

Greg Whitt
ENVIRONMENTAL DIRECTIONS, INC

012 N WALL BLDG 4343 500 GL DIES
ENVIRONMENTAL DIRECTIONS

Sampled by CLIENT
PO # 1721

Laboratory Number 298-06-0744-006

Date Received 06/23/98

Client Reference 100301

Respectfully Submitted:

Y. M. Wright

063098 1640

ANALYSIS FOR REQUESTED PARAMETERS
ALL RESULTS ARE ON AN AS RECEIVED BASIS

ANALYZED PARAMETER	CAS NO.	RESULT	LOQ	UNITS	METHOD	DATE/TIME/ANALYST
Total Petroleum Hydrocarbon (Infrared)		ND	40	mg/Kg	EPA418.1M	06/25/98 10:00 TB

ND: Not detected at a concentration greater than the LOQ - Limit of Quantitation.

Method Reference TPH: Method EPA 418.1 modified for soil.

4665 Paris Street, Suite 200-B, **Denver, CO 80239** – Tel: (303) 373-4847 Fax: (303) 373-4884
1258 Greenbrier Street, **Charleston, WV 25311-1002** – (304) 346-0725 Fax: (304) 346-0761
5712 Erdman Ave., **Baltimore, MD 21205-3598** – Tel: (410) 483-2200 Fax: (410) 483-2206
4440 Glen Este-Withamsville Road, Suite 900, **Cincinnati, OH 45245-1331** – Tel: (513) 752-9696 Fax: (513) 752-2614

CT&E Environmental Services Inc.

Laboratory Division

Laboratory Analysis Report

Greg Whitt
ENVIRONMENTAL DIRECTIONS, INC

012 N WALL BLDG 4343 500 GL DIES
ENVIRONMENTAL DIRECTIONS

Sampled by CLIENT
PO # 1721

Laboratory Number 298-06-0744-006

Date Received 06/23/98

Client Reference 100301

Respectfully Submitted:

Y.M. Wright

063098 1640

ANALYSIS FOR REQUESTED PARAMETERS
ALL RESULTS ARE ON AN AS RECEIVED BASIS

ANALYZED PARAMETER	CAS NO.	RESULT	LOQ	UNITS	METHOD	DATE/TIME/ANALYST
Diesel Range Organics (DRO)		ND	2.0	mg/kg	SW8015	06/24/98 20:23 TEP
SURROGATE RECOVERY						
o-Terphenyl<SURROGATE>		68	---	% REC	SW8015	06/24/98 20:23 TEP

ND: Not detected at a concentration greater than the LOQ - Limit of Quantitation.

Method Reference: USEPA: Test Methods For Evaluating Solid Waste; SW-846, 3rd Edition; Nov 1986.

4665 Paris Street, Suite 200-B, Denver, CO 80239 – Tel: (303) 373-4847 Fax: (303) 373-4884
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CT&E Environmental Services Inc.

Laboratory Division

Laboratory Analysis Report

Greg Whitt
ENVIRONMENTAL DIRECTIONS, INC

Laboratory Number 298-06-0744-006 Respectfully Submitted:

012 N WALL BLDG 4343 500 GL DIES
ENVIRONMENTAL DIRECTIONS

Date Received 06/23/98

Y. M. Wright

063098 1640

Sampled by CLIENT
PO # 1721

Client Reference 100301

ANALYSIS FOR REQUESTED PARAMETERS
ALL RESULTS ARE ON AN AS RECEIVED BASIS

ANALYZED PARAMETER	CAS NO.	RESULT	LOQ	UNITS	METHOD	DATE/TIME/ANALYST
Gasoline Range Organics (GRO)		ND	0.50	mg/kg	SW8015	06/23/98 17:43 PAC
SURROGATE RECOVERY						
a,a,a-Trifluorotoluene<SURROGATE>		88	------	% REC	SW8015	06/23/98 17:43 PAC
BTEX:						
Benzene	71-43-2	ND	0.025	mg/kg	SW8021	06/23/98 17:43 PAC
Toluene	108-88-3	ND	0.025	mg/kg	SW8021	06/23/98 17:43 PAC
Ethylbenzene	100-41-4	ND	0.025	mg/kg	SW8021	06/23/98 17:43 PAC
Total Xylenes	1330-20-7	ND	0.025	mg/kg	SW8021	06/23/98 17:43 PAC
SURROGATE RECOVERY						
a,a,a-Trifluorotoluene<SURROGATE>		102	------	% REC	SW8021	06/23/98 17:43 PAC

ND: Not detected at a concentration greater than the LOQ - Limit of Quantitation.

Method Reference: USEPA: Test Methods For Evaluating Solid Waste; SW-846, 3rd Edition; Nov 1986.

4665 Paris Street, Suite 200-B, **Denver, CO 80239** – Tel: (303) 373-4847 Fax: (303) 373-4884
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CT&E Environmental Services Inc.

Laboratory Division

Laboratory Analysis Report

Greg Whitt
ENVIRONMENTAL DIRECTIONS, INC

013 S WALL BLDG 4343 500 GL DIES
ENVIRONMENTAL DIRECTIONS

Sampled by CLIENT
PO # 1721

Laboratory Number 298-06-0744-007 Respectfully Submitted:

Y. M. Wright

063098 1640

Date Received 06/23/98

Client Reference 100301

ANALYSIS FOR REQUESTED PARAMETERS
ALL RESULTS ARE ON AN AS RECEIVED BASIS

ANALYZED PARAMETER	CAS NO.	RESULT	LOQ	UNITS	METHOD	DATE/TIME/ANALYST
Total Petroleum Hydrocarbon (Infrared)		ND	40	mg/Kg	EPA418.1M	06/25/98 10:00 TB

ND: Not detected at a concentration greater than the LOQ - Limit of Quantitation.

Method Reference TPH: Method EPA 418.1 modified for soil.

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CT&E Environmental Services Inc.

Laboratory Division

Laboratory Analysis Report

Greg Whitt
ENVIRONMENTAL DIRECTIONS, INC

Laboratory Number 298-06-0744-007 Respectfully Submitted:

013 S WALL BLDG 4343 500 GL DIES
ENVIRONMENTAL DIRECTIONS

Date Received 06/23/98

Y.M. Wright

063098 1640

Sampled by CLIENT
PO # 1721

Client Reference 100301

ANALYSIS FOR REQUESTED PARAMETERS
ALL RESULTS ARE ON AN AS RECEIVED BASIS

ANALYZED PARAMETER	CAS NO.	RESULT	LOQ	UNITS	METHOD	DATE/TIME/ANALYST
Diesel Range Organics (DRO)		ND	2.0	mg/kg	SW8015	06/24/98 20:57 TEP
SURROGATE RECOVERY						
o-Terphenyl<SURROGATE>		61	---	% REC	SW8015	06/24/98 20:57 TEP

ND: Not detected at a concentration greater than the LOQ - Limit of Quantitation.

Method Reference: USEPA: Test Methods For Evaluating Solid Waste; SW-846, 3rd Edition; Nov 1986.

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CT&E Environmental Services Inc.

Laboratory Division

Laboratory Analysis Report

Laboratory Number 298-06-0744-007 Respectfully Submitted:

Greg Whitt
ENVIRONMENTAL DIRECTIONS, INC

013 S WALL BLDG 4343 500 GL DIES
ENVIRONMENTAL DIRECTIONS

Date Received 06/23/98

Y. M. Wright
063098 1640

Sampled by CLIENT
PO # 1721

Client Reference 100301

ANALYSIS FOR REQUESTED PARAMETERS
ALL RESULTS ARE ON AN AS RECEIVED BASIS

ANALYZED PARAMETER	CAS NO.	RESULT	LOQ	UNITS	METHOD	DATE/TIME/ANALYST
Gasoline Range Organics (GRO)		ND	0.50	mg/kg	SW8015	06/23/98 21:38 PAC
SURROGATE RECOVERY a,a,a-Trifluorotoluene<SURROGATE>		91	------	% REC	SW8015	06/23/98 21:38 PAC
BTEX:						
Benzene	71-43-2	ND	0.025	mg/kg	SW8021	06/23/98 21:38 PAC
Toluene	108-88-3	ND	0.025	mg/kg	SW8021	06/23/98 21:38 PAC
Ethylbenzene	100-41-4	ND	0.025	mg/kg	SW8021	06/23/98 21:38 PAC
Total Xylenes	1330-20-7	ND	0.025	mg/kg	SW8021	06/23/98 21:38 PAC
SURROGATE RECOVERY a,a,a-Trifluorotoluene<SURROGATE>		102	------	% REC	SW8021	06/23/98 21:38 PAC

ND: Not detected at a concentration greater than the LOQ - Limit of Quantitation.

Method Reference: USEPA: Test Methods For Evaluating Solid Waste; SW-846, 3rd Edition; Nov 1986.

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CT&E Environmental Services Inc.

Laboratory Division

Laboratory Analysis Report

Greg Whitt
ENVIRONMENTAL DIRECTIONS, INC

Laboratory Number 298-06-0744-008 Respectfully Submitted:

Y. M. Wright

014 E WALL BLDG 4343 500 GL DIES
ENVIRONMENTAL DIRECTIONS

Date Received 06/23/98

063098 1640

Sampled by CLIENT
PO # 1721

Client Reference 100301

ANALYSIS FOR REQUESTED PARAMETERS
ALL RESULTS ARE ON AN AS RECEIVED BASIS

ANALYZED PARAMETER	CAS NO.	RESULT	LOQ	UNITS	METHOD	DATE/TIME/ANALYST
Total Petroleum Hydrocarbon (Infrared)		ND	40	mg/Kg	EPA418.1M	06/25/98 10:00 TB

ND: Not detected at a concentration greater than the LOQ - Limit of Quantitation.

Method Reference TPH: Method EPA 418.1 modified for soil.

4665 Paris Street, Suite 200-B, **Denver, CO 80239** – Tel: (303) 373-4847 Fax: (303) 373-4884
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F-704

CT&E Environmental Services Inc.
Laboratory Division

Laboratory Analysis Report

Greg Whitt
ENVIRONMENTAL DIRECTIONS, INC

014 E WALL BLDG 4343 500 GL DIES
ENVIRONMENTAL DIRECTIONS

Sampled by CLIENT
PO # 1721

Laboratory Number 298-06-0744-008 Respectfully Submitted:

Y. M. Wright
063098 1640

Date Received 06/23/98

Client Reference 100301

ANALYSIS FOR REQUESTED PARAMETERS
ALL RESULTS ARE ON AN AS RECEIVED BASIS

ANALYZED PARAMETER	CAS NO.	RESULT	LOQ	UNITS	METHOD	DATE/TIME/ANALYST
Diesel Range Organics (DRO)		ND	2.0	mg/kg	SW8015	06/24/98 21:31 TEP
SURROGATE RECOVERY						
o-Terphenyl<SURROGATE>		65	---	% REC	SW8015	06/24/98 21:31 TEP

ND: Not detected at a concentration greater than the LOQ - Limit of Quantitation.

Method Reference: USEPA: Test Methods For Evaluating Solid Waste; SW-846, 3rd Edition; Nov 1986.

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CT&E Environmental Services Inc.

Laboratory Division

Laboratory Analysis Report

Greg Whitt
ENVIRONMENTAL DIRECTIONS, INC

014 E WALL BLDG 4343 500 GL DIES
ENVIRONMENTAL DIRECTIONS

Sampled by CLIENT
PO # 1721

Laboratory Number 298-06-0744-008 Respectfully Submitted:

Y. M. Wright

063098 1640

Date Received 06/23/98

Client Reference 100301

ANALYSIS FOR REQUESTED PARAMETERS
ALL RESULTS ARE ON AN AS RECEIVED BASIS

PARAMETER	CAS NO.	RESULT	LOQ	UNITS	METHOD	ANALYZED DATE/TIME/ANALYST
Gasoline Range Organics (GRO)		ND	0.50	mg/kg	SW8015	06/23/98 22:02 PAC
SURROGATE RECOVERY						
a,a,a-Trifluorotoluene<SURROGATE>		82	------	% REC	SW8015	06/23/98 22:02 PAC
BTEX:						
Benzene	71-43-2	ND	0.025	mg/kg	SW8021	06/23/98 22:02 PAC
Toluene	108-88-3	ND	0.025	mg/kg	SW8021	06/23/98 22:02 PAC
Ethylbenzene	100-41-4	ND	0.025	mg/kg	SW8021	06/23/98 22:02 PAC
Total Xylenes	1330-20-7	ND	0.025	mg/kg	SW8021	06/23/98 22:02 PAC
SURROGATE RECOVERY						
a,a,a-Trifluorotoluene<SURROGATE>		100	------	% REC	SW8021	06/23/98 22:02 PAC

ND: Not detected at a concentration greater than the LOQ - Limit of Quantitation.

Method Reference: USEPA: Test Methods For Evaluating Solid Waste; SW-846, 3rd Edition; Nov 1986.

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4440 Glen Este-Withamsville Road, Suite 900, **Cincinnati, OH 45245-1331** – Tel: (513) 752-9696 Fax: (513) 752-2614

CT&E Environmental Services Inc.

Laboratory Division

Laboratory Analysis Report

Greg Whitt
ENVIRONMENTAL DIRECTIONS, INC

015 W WALL BLDG 4343 500 GL DIES
ENVIRONMENTAL DIRECTIONS

Sampled by CLIENT
PO # 1721

Laboratory Number 298-06-0744-009 Respectfully Submitted:

Y. M. Wright

063098 1640

Date Received 06/23/98

Client Reference 100301

ANALYSIS FOR REQUESTED PARAMETERS
ALL RESULTS ARE ON AN AS RECEIVED BASIS

ANALYZED PARAMETER	CAS NO.	RESULT	LOQ	UNITS	METHOD	DATE/TIME/ANALYST
Total Petroleum Hydrocarbon (Infrared)		ND	40	mg/Kg	EPA418.1M	06/25/98 10:00 TB

ND: Not detected at a concentration greater than the LOQ - Limit of Quantitation.

Method Reference TPH: Method EPA 418.1 modified for soil.

4665 Paris Street, Suite 200-B, **Denver, CO 80239** – Tel: (303) 373-4847 Fax: (303) 373-4884
1258 Greenbrier Street, **Charleston, WV 25311-1002** – (304) 346-0725 Fax: (304) 346-0761
5712 Erdman Ave., **Baltimore, MD 21205-3598** – Tel: (410) 483-2200 Fax: (410) 483-2206
4440 Glen Este-Withamsville Road, Suite 900, **Cincinnati, OH 45245-1331** – Tel: (513) 752-9696 Fax: (513) 752-2614

CT&E Environmental Services Inc.

Laboratory Division

Laboratory Analysis Report

Greg Whitt
ENVIRONMENTAL DIRECTIONS, INC

015 W WALL BLDG 4343 500 GL DIES
ENVIRONMENTAL DIRECTIONS

Sampled by CLIENT
PO # 1721

Laboratory Number 298-06-0744-009 Respectfully Submitted:

Date Received 06/23/98

063098 1640

Client Reference 100301

ANALYSIS FOR REQUESTED PARAMETERS
ALL RESULTS ARE ON AN AS RECEIVED BASIS

ANALYZED PARAMETER	CAS NO.	RESULT	LOQ	UNITS	METHOD	DATE/TIME/ANALYST
Diesel Range Organics (DRO)		ND	2.0	mg/kg	SW8015	06/24/98 22:05 TEP
SURROGATE RECOVERY						
o-Terphenyl<SURROGATE>		55	---	% REC	SW8015	06/24/98 22:05 TEP

ND: Not detected at a concentration greater than the LOQ - Limit of Quantitation.

Method Reference: USEPA: Test Methods For Evaluating Solid Waste; SW-846, 3rd Edition; Nov 1986.

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CT&E Environmental Services Inc.

Laboratory Division

Laboratory Analysis Report

Greg Whitt
ENVIRONMENTAL DIRECTIONS, INC

Laboratory Number 298-06-0744-009 Respectfully Submitted:

015 W WALL BLDG 4343 500 GL DIES
ENVIRONMENTAL DIRECTIONS

Date Received 06/23/98

063098 1640

Sampled by CLIENT
PO # 1721

Client Reference 100301

ANALYSIS FOR REQUESTED PARAMETERS
ALL RESULTS ARE ON AN AS RECEIVED BASIS

ANALYZED PARAMETER	CAS NO.	RESULT	LOQ	UNITS	METHOD	DATE/TIME/ANALYST
Gasoline Range Organics (GRO)		ND	0.50	mg/kg	SW8015	06/23/98 22:25 PAC
SURROGATE RECOVERY						
a,a,a-Trifluorotoluene<SURROGATE>		90	------	% REC	SW8015	06/23/98 22:25 PAC
BTEX:						
Benzene	71-43-2	ND	0.025	mg/kg	SW8021	06/23/98 22:25 PAC
Toluene	108-88-3	ND	0.025	mg/kg	SW8021	06/23/98 22:25 PAC
Ethylbenzene	100-41-4	ND	0.025	mg/kg	SW8021	06/23/98 22:25 PAC
Total Xylenes	1330-20-7	ND	0.025	mg/kg	SW8021	06/23/98 22:25 PAC
SURROGATE RECOVERY						
a,a,a-Trifluorotoluene<SURROGATE>		103	------	% REC	SW8021	06/23/98 22:25 PAC

ND: Not detected at a concentration greater than the LOQ - Limit of Quantitation.

Method Reference: USEPA: Test Methods For Evaluating Solid Waste; SW-846, 3rd Edition; Nov 1986.

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CT&E Environmental Services Inc.

Laboratory Division

Laboratory Analysis Report

Greg Whitt
ENVIRONMENTAL DIRECTIONS, INC

Laboratory Number 298-06-0744-010 Respectfully Submitted:

016 UNDER TANK BLDG 4343 500 GL DIES
ENVIRONMENTAL DIRECTIONS

Date Received 06/23/98

T. M. Wright

063098 1640

Sampled by CLIENT
PO # 1721

Client Reference 100301

ANALYSIS FOR REQUESTED PARAMETERS
ALL RESULTS ARE ON AN AS RECEIVED BASIS

ANALYZED PARAMETER	CAS NO.	RESULT	LOQ	UNITS	METHOD	DATE/TIME/ANALYST
Total Petroleum Hydrocarbon (Infrared)		ND	40	mg/Kg	EPA418.1M	06/25/98 10:00 TB

ND: Not detected at a concentration greater than the LOQ - Limit of Quantitation.

Method Reference TPH: Method EPA 418.1 modified for soil.

4665 Paris Street, Suite 200-B, Denver, CO 80239 – Tel: (303) 373-4847 Fax: (303) 373-4884
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CT&E Environmental Services Inc.

Laboratory Division

Laboratory Analysis Report

Greg Whitt
ENVIRONMENTAL DIRECTIONS, INC

016 UNDER TANK BLDG 4343 500 GL DIES
ENVIRONMENTAL DIRECTIONS

Sampled by CLIENT
PO # 1721

Laboratory Number 298-06-0744-010

Date Received 06/23/98

Client Reference 100301

Respectfully Submitted:

J. M. Wright

063098 1640

ANALYSIS FOR REQUESTED PARAMETERS
ALL RESULTS ARE ON AN AS RECEIVED BASIS

ANALYZED PARAMETER	CAS NO.	RESULT	LOQ	UNITS	METHOD	DATE/TIME/ANALYST
Diesel Range Organics (DRO)		ND	2.0	mg/kg	SW8015	06/24/98 22:39 TEP
SURROGATE RECOVERY o-Terphenyl<SURROGATE>		59	---	% REC	SW8015	06/24/98 22:39 TEP

ND: Not detected at a concentration greater than the LOQ - Limit of Quantitation.

Method Reference: USEPA: Test Methods For Evaluating Solid Waste; SW-846, 3rd Edition; Nov 1986.

4665 Paris Street, Suite 200-B, Denver, CO 80239 – Tel: (303) 373-4847 Fax: (303) 373-4884
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CT&E Environmental Services Inc.

Laboratory Division

Laboratory Analysis Report

Greg Whitt
ENVIRONMENTAL DIRECTIONS, INC

Laboratory Number 298-06-0744-010 Respectfully Submitted:

J. M. Wright

016 UNDER TANK BLDG 4343 500 GL DIES
ENVIRONMENTAL DIRECTIONS

Date Received 06/23/98

063098 1640

Sampled by CLIENT
PO # 1721

Client Reference 100301

ANALYSIS FOR REQUESTED PARAMETERS
ALL RESULTS ARE ON AN AS RECEIVED BASIS

ANALYZED PARAMETER	CAS NO.	RESULT	LOQ	UNITS	METHOD	DATE/TIME/ANALYST
Gasoline Range Organics (GRO)		ND	0.50	mg/kg	SW8015	06/23/98 22:49 PAC
SURROGATE RECOVERY						
a,a,a-Trifluorotoluene<SURROGATE>		90	------	% REC	SW8015	06/23/98 22:49 PAC
BTEX:						
Benzene	71-43-2	ND	0.025	mg/kg	SW8021	06/23/98 22:49 PAC
Toluene	108-88-3	ND	0.025	mg/kg	SW8021	06/23/98 22:49 PAC
Ethylbenzene	100-41-4	ND	0.025	mg/kg	SW8021	06/23/98 22:49 PAC
Total Xylenes	1330-20-7	ND	0.025	mg/kg	SW8021	06/23/98 22:49 PAC
SURROGATE RECOVERY						
a,a,a-Trifluorotoluene<SURROGATE>		102	------	% REC	SW8021	06/23/98 22:49 PAC

ND: Not detected at a concentration greater than the LOQ - Limit of Quantitation.

Method Reference: USEPA: Test Methods For Evaluating Solid Waste; SW-846, 3rd Edition; Nov 1986.

4665 Paris Street, Suite 200-B, Denver, CO 80239 – Tel: (303) 373-4847 Fax: (303) 373-4884
1258 Greenbrier Street, Charleston, WV 25311-1002 – (304) 346-0725 Fax: (304) 346-0761
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4440 Glen Este-Withamsville Road, Suite 900, Cincinnati, OH 45245-1331 – Tel: (513) 752-9696 Fax: (513) 752-2614

Appendix G-2
Letter of Discovery

ALLIANT TECHSYSTEMS

Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

April 4, 1998

98-815-083

U.S. Environmental Protection Agency
Region III
841 Chestnut Building
Philadelphia, PA 19109-4431

Attention: Ms. Mary Beck, 3WC23

Re: Notification of Newly Discovered Area of Concern,
Building 4343,
Radford Army Ammunition Plant, Radford, VA
EPA ID # VA1 210 02 0730

Dear Ms. Beck:

As discussed at our meeting on Tuesday, March 10, 1998, a new Area of Concern has been located at Radford Army Ammunition Plant (RFAAP). Building 4343, Cadmium Plating House, located in the Pilot B Area of the Rocket Manufacturing Area in the Horseshoe Section of RFAAP Main Plant has had soil samples taken that indicate elevated levels of cadmium.

The enclosed drawings indicate that Building 4343, was originally designated as the Fire Water Pump House. The building was used to house a five inch one stage, 500 gallon per minute gasoline powered pump that pumped fire water into storage tanks that were located directly east of Building 4343 (Drawings 6929-3371, 6929-3367, 6929-3368 and GBF 1693). A 550 gallon underground tank was used to store the gasoline for the pump (Drawing 6929-3369). This storage tank was located approximately 40 feet south of Building 4343 (Drawing 6929-3371). The storage tank is slated for removal before December 22, 1998.

Building 4343, was converted for cadmium plating operations in 1956, as indicated in the enclosed drawings. The pump and pump engine were removed and floor sumps were filled to level. Cadmium plating baths, a drying cabinet, and a exterior lead catch tank were installed (Drawing 6929-3370). In 1957 an exhaust system was installed (drawing HRP-37-5722). The Cadmium Plating House was used to plate NIKE Ignitor Grains with cadmium.

Samples were taken around Building 4343 These indicated elevated levels of cadmium in soil. Sample locations and laboratory results are enclosed.

Sample ID	TCLP for Cadmium in mg/l
4343-01-SVR	14.05
4343-02-SVR	2.85
4343-03-SVR	0.59
4343-04-SVR	1.34
4343-05-SVR	36.80

Building 4343 has been added to the Defense Environmental Tracking System. This site received a rating of 1A, the highest priority. The site will be prioritized for funding in Calendar Year 1998 followed by further site assessment.

Please, accept this letter without certification. The proper certification and distribution will follow next week. If you have any concerns or comments, please coordinate them with myself, Jerry Redder of my staff at (540)639-7536 or Rob Davie, Radford ACO staff at (540)639-7612.

Sincerely,

C.A. Jake, Supervisor
Environmental Affairs

Enclosure

cc w/o enclosure: Devlin Harris, DEQ
Rob Thomson, EPA
Leslie Romanchik, DEQ
Todd Beckwith, AEC
Susan Marker, IOC
D. W. Shead, ATK

Coordination: R. N. Davie

M. L. Griffith

bc w/o enclosure: Administrative File
M. L. Griffith
J. J. Redder
A. E. Olsen
R. N. Davie
Env. File

Concerning the following Document submitted April 7, 1997:

Notification of Newly Discovered Area of Concern, Building 4343

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: Armando Lopez
TITLE: LTC, CM, Commanding
Radford AAP

SIGNATURE:
PRINTED NAME: Ken Dolph
TITLE: Resident Manager
Alliant Techsystems Inc.

Appendix H
Remedial Goal Calculation Details

REMEDIAL GOAL CALCULATION DETAILS

Remediation goals (RGs) were developed for cadmium in soil at Building 4343. These goals were derived for three commercial/industrial scenarios (maintenance worker, excavation worker, and industrial worker) and two resident scenarios (adult and child). For each scenario, RGs were calculated at target hazard index (HI) values of 1.0, 0.5, and 0.1.

By specifying the target HI, the RGs were back-calculated by re-arranging the risk and hazard calculations described in *Section 6.2.3*. Because levels of cadmium in soil resulted in exceedances of the HI, the RGs were based on calculations for noncarcinogenic effects, as follows:

$$RG = \frac{THI \ x \ BW \ x \ AT \ x 10^{6} \ mg/kg}{EF \ x \ ED \ x \ FI \left[A + B + C\right]}$$

where:

RG = remediation goal (mg/kg)
THI = target hazard index (unitless)
BW = body weight (kg)
AT = averaging time (days)
EF = exposure frequency (days/year)
ED = exposure duration (years)
FI = fraction ingested (unitless)

A – Ingestion Pathway

$A = (1/RfD_{oral})\ (IR_{oral})$

where:

RfD_{oral} = oral Reference Dose (mg/kg-day)
IR_{oral} = ingestion rate (mg/day)

B – Dermal Absorption Pathway

$B = (1/RfD_{dermal})\ (SA)\ (SSAF)\ (DABS)$

where:

RfD_{dermal} = oral Reference Dose, adjusted by oral absorption factor (mg/kg-day)
SA = skin surface area (cm^2)
SSAF = soil to skin adherence factor (mg/cm^2-day)
DABS = dermal absorption factor

C – Inhalation Pathway

$C = (CSF_{inhl})\ (IR_{inhl})\ (1/_{VF})\ (1/_{PEF})(10^6\ mg/kg)$

where:

RfD_{inhl}	=	inhalation Reference Dose (mg/kg-day)
IR_{inhl}	=	inhalation rate (m^3/day)
VF	=	volatilization factor (m^3/day)
PEF	=	particulate emission factor (m^3/day)

To be consistent with the exposure parameters that were used in the risk and hazard calculations in *Section 6.0*, the same parameters were applied in derivation of RGs. The exposure parameters for the maintenance worker, excavation worker, adult resident, and child resident are summarized in **Appendix E-1, Tables E-5 through E-8**.

For purposes of the CMS, an additional commercial/industrial receptor was added to the scenarios used in the HHRA. An industrial outdoor worker was included to account for standard commercial/industrial exposures. The exposure parameters for this receptor are similar to those used for the maintenance worker except that the exposure frequency of 225 days/year is used rather than the more limited exposure frequency of 50 days/year.

As stated, these RGs are based on HIs for noncarcinogenic effects. Although cadmium is carcinogenic by the inhalation pathway, resulting risk estimates in the HHRA for cadmium were within or below the risk range. The RGs calculated for the noncarcinogenic effects are more conservative and, therefore, would be protective of carcinogenic effects.

Appendix I
National Environmental Policy Act Compliance Evaluation

Appendix I

Compliance With NEPA Requirements
Building 4343

Environmental Consideration (i.e., Attributes)	**Alternative One: No** Further Action	**Alternative Two:** Excavation with Waste in Place, Off-site Disposal, Removal of Sumps, Demolition of Building 4343, and Land Use Controls	**Alternative Three:** Excavation for Clean Close Out, Off-site Disposal, and Removal of Sumps, Demolition of Building 4343	**Alternative Four**: Stabilization, Removal of Sumps, Demolition of Building 4343, and Land Use Controls
Ecology – Impact on Wetlands	No wetlands identified at Building 4343. No impact to wetlands.	No wetlands identified at Building 4343. No impact to wetlands.	No wetlands identified at Building 4343. No impact to wetlands.	No wetlands identified at Building 4343. No impact to wetlands.
Ecology – Impact on Endangered and/or Threatened Species	No endangered and/or threatened species affected.	While not observed during site reconnaissance, several threatened and endangered species have been found within the grassland community type at RFAAP. Some habitat may be disturbed during excavation activities in the excavation area. The area affected is minimal compared to overall site. Therefore, effects are expected to be minimal.	While not observed during site reconnaissance, several threatened and endangered species have been found within the grassland community type at RFAAP. Some habitat may be disturbed during excavation activities in the excavation area. The area affected is minimal compared to overall site. Therefore, effects are expected to be minimal.	While not observed during site reconnaissance, several threatened and endangered species have been found within the grassland community type at RFAAP. Some habitat may be disturbed during excavation activities in the excavation area. The area affected is minimal compared to overall site. Therefore, effects are expected to be minimal.
Ecology – Impact on Vegetation	No impact.	Vegetation will be removed during excavation activities. No impact otherwise.	Vegetation will be removed during excavation activities. No impact otherwise.	Vegetation will be removed during excavation activities. No impact otherwise.
Archeological	None present in the Building 4343 area.	None present in the Building 4343 area.	None present in the Building 4343 area.	None present in the Building 4343 area.
Noise	None.	Slight increase in noise levels (dB) due to excavation activities. Increases will not be significant.	Slight increase in noise levels (dB) due to excavation activities. Increases will not be significant.	Slight increase in noise levels (dB) due to excavation and stabilization activities. Increases will not be significant.
Water – surface water, groundwater	No impact to surface water or groundwater.	Contaminants would be removed from surface and subsurface soil. Therefore, no migration of contaminants to groundwater will occur. Erosion control measures will be employed to prevent impacts to surface water bodies.	Contaminants would be removed from surface and subsurface soil. Therefore, no migration of contaminants to groundwater will occur. Erosion control measures will be employed to prevent impacts to surface water bodies.	Contaminants would be removed from surface and subsurface soil. Therefore, no migration of contaminants to groundwater will occur. Erosion control measures will be employed to prevent impacts to surface water bodies.
Human Aspects	No human impact.	There will be minimal increase in traffic due to excavation activities.	There will be minimal increase in traffic due to excavation activities.	There will be minimal increase in traffic due to excavation activities.

Appendix I

Compliance With NEPA Requirements
Building 4343

Environmental Consideration (i.e., Attributes)	**Alternative One: No** Further Action	**Alternative Two:** Excavation with Waste in Place, Off-site Disposal, Removal of Sumps, Demolition of Building 4343, and Land Use Controls	**Alternative Three:** Excavation for Clean Close Out, Off-site Disposal, and Removal of Sumps, Demolition of Building 4343	**Alternative Four**: Stabilization, Removal of Sumps, Demolition of Building 4343, and Land Use Controls
Land – Soil erosion, land use	No effect.	Erosion control measures must be implemented during excavation activities. No impacts on current land use.	Erosion control measures must be implemented during excavation activities. No impacts on current land use.	Erosion control measures must be implemented during excavation activities. No impacts on current land use.
Waste disposal – solid waste, hazardous waste	No effect. No waste generated.	Will require disposal of decontamination water. In addition, soil, sump, and building debris will be disposed at appropriate (RCRA Subtitle C or D) landfill facility.	Will require disposal of decontamination water. In addition, soil, sump, and building debris will be disposed at appropriate (RCRA Subtitle C or D) landfill facility.	Will require disposal of decontamination water. In addition, sump and building debris will be disposed at appropriate (RCRA Subtitle C or D) landfill facility.
Resources	No effect. No increased use of resources.	No effect. No increased use of resources.	No effect. No increased use of resources.	No effect. No increased use of resources.
Air	Essentially no effect, cadmium is not likely to be carried on soil particles through air or volatilized into atmosphere.	Increase in dust during excavation activities. Dust suppression measures will be employed to keep dust generation to a minimum.	Increase in dust during excavation activities. Dust suppression measures will be employed to keep dust generation to a minimum.	Increase in dust during excavation activities. Dust suppression measures will be employed to keep dust generation to a minimum.

RFAAP = Radford Army Ammunition Plant
RCRA = Resource Conservation and Recovery Act
dB = Decibels

MEMORANDUM

TO: Jeff Parks

FROM: Eric Malarek

SUBJECT: Radford Army Ammunition Plant Data Validation – Explosives and PETN/Nitroglycerine DataChem, Inc., SDG RD020

DATE: September 5, 2002

The purpose of this memorandum is to present the data validation report for the samples collected at Radford Army Ammunition Plant on July 8-9, 2002. Samples were analyzed for explosives using USEPA SW-846 8330 and PETN/nitroglycerine using USEPA SW-846 8332. A total of ten soil samples were validated. The sample ID is:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
31SB05A	02U01089	B43SB34A	02U01097
31SB05B	02U01090	B43SB34B	02U01098
31SB05C	02U01091	39SB05A	02U01099
B43SB35A	02U01092	39SB06A	02U01100
B43SB35B	02U01093	39SS07	02U01101

Data were reviewed by Eric Malarek and validated using a combination of method-specific criteria, laboratory SOP, and the *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September, 1994). Parameters evaluated are presented in Table 1. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1. Laboratory Performance Criteria

Qualified		Parameter
Yes	No	
	X	Holding Times
	X	Blank Analysis
	X	Initial Calibration
	X	Continuing Calibration
	X	System Monitoring Compounds
X		Laboratory Control Sample
	X	Matrix Spike/Spike Duplicate
	X	Quantitation Verification

The quality of data collected in support of this sampling activity is considered acceptable with noted qualifications.

Eric Malarek, Chemist

9/5/02

Date

RADFORD ARMY AMMUNITION PLANT VALIDATION REPORT
EXPLOSIVES, PETN, and NITROGLYCERINE REVIEW
SDG RD020

I-Holding Times

The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of sample extraction and analysis. Holding time criteria: For soil samples, cooled @4°C ±2°C, the maximum holding time is 14 days from sample collection to extraction and 40 days from extraction to analysis.

- The samples were collected on 07/8-9/02, extracted on 07/13/02 for 8330, extracted on 07/11/02 for 8332, and analyzed on 07/20/02. All criteria were met and no qualifiers were applied.

II-Blank Analysis

The purpose of laboratory or field blank analyses is to determine the existence and magnitude of contamination problems resulting from laboratory or field activities. One method blank per analytical batch must be run on each instrument used to analyze samples. No contaminants should be present in the blanks. Action levels are based upon 100% solids and adjusted for each sample as appropriate. Table 2 summarizes the blank contamination analysis. The soil rinse blanks included samples 061102R, 061902R1, 071002R2, and 072502RB. The maximum concentration from these rinse blanks was used for this assessment.

Table 2. Blank Contamination Analysis Summary

Analysis Date	QC Blank ID	Compound	Max Conc. µg/g	Action Level µg/g	B qualified samples
07/20/02	BL-197737-1	All target compounds < MRL	NA	NA	None
07/20/02	BL-197738-1	All target compounds < MRL	NA	NA	None
Various	RBs	1,3,5-Trinitrobenzene	0.00194	0.0097	None
Various	RBs	2-Nitrotoluene	0.00154	0.0077	None
Various	RBs	4-Nitrotoluene	0.00130	0.0065	None
Various	RBs	PETN	0.0173	0.0865	None
Various	RBs	Nitroglycerine	0.0118	0.0590	None

III-Initial Calibration

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable qualitative and quantitative data for the target compounds. The initial 5 point calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run. The correlation coefficient (r^2) must be ≥ 0.990 and/or the percent relative standard deviation (%RSD) must be ≤ 15%.

- For the initial calibration performed on 10/24/02 on instrument LC-08, all criteria were met for target compounds. All compounds were determined using linear regression with correlation coefficients ≥ 0.990. No qualifiers were applied.

- For the PETN/NG initial calibration performed on 05/06/02 on instrument LC-03, all criteria were met for target compounds. All compounds were determined using linear regression with correlation coefficients ≥ 0.990. No qualifiers were applied.

IV-Continuing Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable qualitative and quantitative data for the target compounds. Continuing calibration standards are analyzed after every 10 injections, and at the end of the analysis sequence. The percent difference (%D) from initial calibration should be no greater than ± 15%.

- For continuing calibration performed on 07/19/02 @20:26 on instrument LC-08, all criteria were met for target compounds. No qualifiers were applied.
- For continuing calibration performed on 07/20/02 @01:20 on instrument LC-08, all criteria were met for target compounds. No qualifiers were applied.
- For continuing calibration performed on 07/20/02 @06:48 on instrument LC-08, all criteria were met for target compounds. No qualifiers were applied.
- For continuing calibration performed on 07/20/02 @10:41 on instrument LC-08, all criteria were met for target compounds. No qualifiers were applied.
- For continuing calibration performed on 07/23/02 @17:59 on instrument LC-08, all criteria were met for target compounds. No qualifiers were applied.
- For PETN/NG continuing calibration performed on 07/19/02 @20:39 on instrument LC-03, all criteria were met for target compounds. No qualifiers were applied.
- For PETN/NG continuing calibration performed on 07/20/02 @00:08 on instrument LC-03, all criteria were met for target compounds. No qualifiers were applied.
- For PETN/NG continuing calibration performed on 07/20/02 @03:17 on instrument LC-03, all criteria were met for target compounds. No qualifiers were applied.
- For PETN/NG continuing calibration performed on 07/20/02 @06:09 on instrument LC-03, all criteria were met for target compounds. No qualifiers were applied.
- For PETN/NG continuing calibration performed on 07/20/02 @09:01 on instrument LC-03, all criteria were met for target compounds. No qualifiers were applied.

V-System Monitoring Compound (Surrogates)
Laboratory performance on individual samples is established by means of spiking activities. The percent recovery (%R) for all samples and blanks must be within the laboratory control limits.

Criteria: 8330: 3,4-dinitrotoluene (80.5-115%) 8332: 1-nitronaphthalene (65.0-125%)

- All criteria were met. No qualifiers were applied.

VI-Laboratory Control Sample
Laboratory control samples (LCS) are used to monitor long-term accuracy of the analytical method. The analysis is performed at a frequency of 1 per analytical batch. The percent recoveries (%Rs) must be within the laboratory control limits (60-120%).

- Sample QC-197737-1 was used as LCS for 8330 compounds. Compound 4-amino-2,6-dinitrotoluene (127%) was above criteria. All detects were qualified estimated bias high "K" and non-detects no qualifier.

- Sample QC-197738-1 was used as LCS for 8332 compounds. All criteria were met. No qualifiers were applied.

VII-Matrix Spike/Matrix Spike Duplicate
Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. The percent recoveries (%Rs) and the relative percent difference (RPD) must be within the specified control limits.

- Sample 31SB05A (02U01089) was used for the MS/MSD analysis. All criteria were met. No qualifiers were applied.

VIII-Quantitation Verification
The accuracy of analytical results was verified through the calculation of several parameters. The calculation was based on a linear curve. The absolute percent difference (%D) between the calculated and the reported value must be within 10% difference. The explosives for SW-846 method 8330 were air-dried prior to analysis because RDX and HMX are water soluble and moisture in the soil could affect the results. All values <MRL and >MDL were qualified as estimated "J".

Sample: 39SB06A (02U00798), 2,4-dinitrotoluene

$y = mx + b$

where: y is the response
m is the slope
x is the amount or concentration of analyte in extract (µg/mL)
b is a constant

$Y = 4.917$ $m = 122.35820$ $b = -0.785833$

x µg/mL = (4.917+ 0.785833) / (122.35820) = 0.0466 µg/mL

Conc. µg/g = [(Ce*Vf*Df)/(Ws)]

Where: Ce is the concentration of analyte in extract (µg/mL)
Vf is the volume of the concentrated extract (mL)
Df is the dilution factor
Ws is the weight of sample (g)

Conc. µg/g = (0. 0466 µg/mL* 10 mL*1) / (2 g) = 0.233 µg/g

Reported value = 0.233 µg/g
%D = 0.0%
Values were within 10% difference.

Sample: 31SB05 (02U01089), nitroglycerin

$y = mx + b$

where: y is the response
m is the slope
x is the amount or concentration of analyte in extract (µg/mL)
b is a constant

Y = 9.503 m = 37.80651 b = 2.39471

x µg/mL = (9.503 - 2.39471) / (37.80651) = 0.188 µg/mL

Conc. µg/g = [(Ce*Vf*Df)/(Ws)*(D)]

Where: Ce is the concentration of analyte in extract (µg/mL)
Vf is the volume of the concentrated extract (mL)
Df is the dilution factor
Ws is the weight of sample (g)
D is the percent dry weight (100 - % moisture in sample)/100

Conc. µg/g = (0. 188 µg/mL* 2 mL*1) / (1 g * 0.901) = 0.417 µg/g

Reported value = 0.417 µg/g
%D = 0.0%
Values were within 10% difference.

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690GY

Date Printed.....: 24-JUL-02 15:19

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 8330
Aliquot Weight/Volume: 2 gm
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35A
DCL Sample Name...: 02U01092
DCL Report Group..: 02U-0088-38

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:10
Reporting Units...: ug/g
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 96.2

DCL Analysis Group: G026R009
Analysis Method...: 8330
Instrument Type...: HPLC
Instrument ID.....: LC8
Column Type.....: ULTRACARB ODS
☒Primary
☐Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
1,3,5-Trinitrobenzene	20-JUL-02 11:47	0.0246	ND		U	1	0.10
1,3-Dinitrobenzene	20-JUL-02 11:47	0.0216	ND		U	1	0.10
2,4,6-Trinitrotoluene	20-JUL-02 11:47	0.0187	ND		U	1	0.20
2,4-Dinitrotoluene	20-JUL-02 11:47	0.0163	ND		U	1	0.20
2,6-Dinitrotoluene	20-JUL-02 11:47	0.0246	ND		U	1	0.20
2-Amino-4,6-Dinitrotoluene	20-JUL-02 11:47	0.0372	ND		U	1	0.20
2-Nitrotoluene	20-JUL-02 11:47	0.239	ND		U	1	0.40
3-Nitrotoluene	20-JUL-02 11:47	0.138	ND		U	1	0.40
4-Amino-2,6-Dinitrotoluene	20-JUL-02 11:47	0.0444	ND		U	1	0.20
4-Nitrotoluene	20-JUL-02 11:47	0.173	ND		U	1	0.40
HMX	20-JUL-02 11:47	0.0602	ND		U	1	0.20
Nitrobenzene	20-JUL-02 11:47	0.0583	ND		U	1	0.20
RDX	20-JUL-02 11:47	0.0350	ND		U	1	0.20
Tetryl	20-JUL-02 11:47	0.0780	ND		U	1	0.20

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
3,4-Dinitrotoluene	4.75	5.00	95.0

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FORM A (TYPE I)
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SAMPLE ANALYSIS DATA SHEET

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S02690GZ

Date Printed.....: 24-JUL-02 15:19

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 8330
Aliquot Weight/Volume: 2 gm
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35B
DCL Sample Name...: 02U01093
DCL Report Group..: 02U-0088-38

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:15
Reporting Units...: ug/g
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 79.7

DCL Analysis Group: G026R009
Analysis Method...: 8330
Instrument Type...: HPLC
Instrument ID.....: LC8
Column Type.....: ULTRACARB ODS
☒Primary
☐Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
1,3,5-Trinitrobenzene	20-JUL-02 12:21	0.0246	ND		U	1	0.10
1,3-Dinitrobenzene	20-JUL-02 12:21	0.0216	ND		U	1	0.10
2,4,6-Trinitrotoluene	20-JUL-02 12:21	0.0187	ND		U	1	0.20
2,4-Dinitrotoluene	20-JUL-02 12:21	0.0163	ND		U	1	0.20
2,6-Dinitrotoluene	20-JUL-02 12:21	0.0246	ND		U	1	0.20
2-Amino-4,6-Dinitrotoluene	20-JUL-02 12:21	0.0372	ND		U	1	0.20
2-Nitrotoluene	20-JUL-02 12:21	0.239	ND		U	1	0.40
3-Nitrotoluene	20-JUL-02 12:21	0.138	ND		U	1	0.40
4-Amino-2,6-Dinitrotoluene	20-JUL-02 12:21	0.0444	ND		U	1	0.20
4-Nitrotoluene	20-JUL-02 12:21	0.173	ND		U	1	0.40
HMX	20-JUL-02 12:21	0.0602	ND		U	1	0.20
Nitrobenzene	20-JUL-02 12:21	0.0583	ND		U	1	0.20
RDX	20-JUL-02 12:21	0.0350	ND		U	1	0.20
Tetryl	20-JUL-02 12:21	0.0780	ND		U	1	0.20

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
3,4-Dinitrotoluene	4.72	5.00	94.3

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07240215190227

S02690H0

SAMPLE ANALYSIS DATA SHEET

Date Printed.....: 24-JUL-02 15:19

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 8330
Aliquot Weight/Volume: 2 gm
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34A
DCL Sample Name...: 02U01097
DCL Report Group..: 02U-0088-38

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:55
Reporting Units...: ug/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 91.4

DCL Analysis Group: G026R009
Analysis Method...: 8330
Instrument Type...: HPLC
Instrument ID.....: LC8
Column Type.....: ULTRACARB ODS
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
1,3,5-Trinitrobenzene	20-JUL-02 12:54	0.0246	ND		U	1	0.10
1,3-Dinitrobenzene	20-JUL-02 12:54	0.0216	ND		U	1	0.10
2,4,6-Trinitrotoluene	20-JUL-02 12:54	0.0187	ND		U	1	0.20
2,4-Dinitrotoluene	20-JUL-02 12:54	0.0163	ND		U	1	0.20
2,6-Dinitrotoluene	20-JUL-02 12:54	0.0246	ND		U	1	0.20
2-Amino-4,6-Dinitrotoluene	20-JUL-02 12:54	0.0372	ND		U	1	0.20
2-Nitrotoluene	20-JUL-02 12:54	0.239	ND		U	1	0.20
3-Nitrotoluene	20-JUL-02 12:54	0.138	ND		U	1	0.40
4-Amino-2,6-Dinitrotoluene	20-JUL-02 12:54	0.0444	ND		U	1	0.40
4-Nitrotoluene	20-JUL-02 12:54	0.173	ND		U	1	0.20
HMX	20-JUL-02 12:54	0.0602	ND		U	1	0.40
Nitrobenzene	20-JUL-02 12:54	0.0583	ND		U	1	0.20
RDX	20-JUL-02 12:54	0.0350	ND		U	1	0.20
Tetryl	20-JUL-02 12:54	0.0780	ND		U	1	0.20

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
3,4-Dinitrotoluene	4.71	5.00	94.1

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SAMPLE ANALYSIS DATA SHEET

Date Printed.....: 24-JUL-02 15:19

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 8330
Aliquot Weight/Volume: 2 gm
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34B
DCL Sample Name...: 02U01098
DCL Report Group..: 02U-0088-38

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 16:00
Reporting Units...: ug/g
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 76.7

DCL Analysis Group: G026R009
Analysis Method...: 8330
Instrument Type...: HPLC
Instrument ID.....: LC8
Column Type.....: ULTRACARB ODS
☒Primary
☐Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
1,3,5-Trinitrobenzene	20-JUL-02 13:28	0.0246	ND		U	1	0.10
1,3-Dinitrobenzene	20-JUL-02 13:28	0.0216	ND		U	1	0.10
2,4,6-Trinitrotoluene	20-JUL-02 13:28	0.0187	ND		U	1	0.20
2,4-Dinitrotoluene	20-JUL-02 13:28	0.0163	ND		U	1	0.20
2,6-Dinitrotoluene	20-JUL-02 13:28	0.0246	ND		U	1	0.20
2-Amino-4,6-Dinitrotoluene	20-JUL-02 13:28	0.0372	ND		U	1	0.20
2-Nitrotoluene	20-JUL-02 13:28	0.239	ND		U	1	0.40
3-Nitrotoluene	20-JUL-02 13:28	0.138	ND		U	1	0.40
4-Amino-2,6-Dinitrotoluene	20-JUL-02 13:28	0.0444	ND		U	1	0.20
4-Nitrotoluene	20-JUL-02 13:28	0.173	ND		U	1	0.40
HMX	20-JUL-02 13:28	0.0602	ND		U	1	0.20
Nitrobenzene	20-JUL-02 13:28	0.0583	ND		U	1	0.20
RDX	20-JUL-02 13:28	0.0350	ND		U	1	0.20
Tetryl	20-JUL-02 13:28	0.0780	ND		U	1	0.20

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
3,4-Dinitrotoluene	4.84	5.00	96.7

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SAMPLE ANALYSIS DATA SHEET

S02690H8

Date Printed.....: 24-JUL-02 16:41

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 11-JUL-02 00:00
Preparation Method...: 8332
Aliquot Weight/Volume: 1 gm
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35A
DCL Sample Name...: 02U01092
DCL Report Group..: 02U-0088-39

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:10
Reporting Units...: ug/g
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 96.2

DCL Analysis Group: G026R011
Analysis Method...: EPA 8332
Instrument Type...: HPLC
Instrument ID.....: lc3
Column Type.....: ULTRACARB ODS
☒Primary
☐Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
PETN	20-JUL-02 06:30	0.0932	ND		U	1	0.312
Nitroglycerine	20-JUL-02 06:30	0.104	ND		U	1	0.312

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
1-Nitronaphthalene	9.94	10.0	99.4

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SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690H9

Date Printed.....: 24-JUL-02 16:41

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 11-JUL-02 00:00
Preparation Method...: 8332
Aliquot Weight/Volume: 1 gm
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35B
DCL Sample Name...: 02U01093
DCL Report Group..: 02U-0088-39

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:15
Reporting Units...: ug/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 79.7

DCL Analysis Group: G026R011
Analysis Method...: EPA 8332
Instrument Type...: HPLC
Instrument ID.....: lc3
Column Type.....: ULTRACARB ODS
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
PETN	20-JUL-02 06:52	0.113	ND		U	1	0.376
Nitroglycerine	20-JUL-02 06:52	0.125	ND		U	1	0.376

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
1-Nitronaphthalene	9.52	10.0	95.2

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690HB

Date Printed.....: 24-JUL-02 16:41

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 11-JUL-02 00:00
Preparation Method...: 8332
Aliquot Weight/Volume: 1 gm
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34A
DCL Sample Name...: 02U01097
DCL Report Group..: 02U-0088-39

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:55
Reporting Units...: ug/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 91.4

DCL Analysis Group: G026R011
Analysis Method...: EPA 8332
Instrument Type...: HPLC
Instrument ID.....: lc3
Column Type.....: ULTRACARB ODS
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
PETN	20-JUL-02 07:13	0.0981	ND		U	1	0.328
Nitroglycerine	20-JUL-02 07:13	0.109	ND		U	1	0.328

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
1-Nitronaphthalene	9.81	10.0	98.1

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FORM A (TYPE I)
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SAMPLE ANALYSIS DATA SHEET

S02690HC

Date Printed.....: 24-JUL-02 16:41

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 11-JUL-02 00:00
Preparation Method...: 8332
Aliquot Weight/Volume: 1 gm
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34B
DCL Sample Name...: 02U01098
DCL Report Group..: 02U-0088-39

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 16:00
Reporting Units...: ug/g
Report Basis.....: ☐As Received ☒Dried
Percent Solids.....: 76.7

DCL Analysis Group: G026R011
Analysis Method...: EPA 8332
Instrument Type...: HPLC
Instrument ID.....: lc3
Column Type.....: ULTRACARB ODS
☒Primary
☐Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
PETN	20-JUL-02 07:35	0.117	ND		U	1	0.391
Nitroglycerine	20-JUL-02 07:35	0.130	ND		U	1	0.391

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
1-Nitronaphthalene	9.74	10.0	97.4

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MEMORANDUM

TO: Jeff Parks

FROM: Eric Malarek

SUBJECT: Radford Army Ammunition Plant Data Validation – Chlorinated Herbicides
DataChem, Inc., SDG RD020

DATE: September 9, 2002

The purpose of this memorandum is to present the data validation report for the samples collected at the Radford Army Ammunition Plant on July 8-9, 2002. Samples were analyzed for chlorinated herbicides using USEPA SW846 Method 8151A. A total of nine soil samples were validated. The sample IDs are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
31SB05A	02U01089	B43SB34A	02U01097
31SB05B	02U01090	39SB05A	02U01099
31SB05C	02U01091	39SB06A	02U01100
B43SB35A	02U01092	39SS07	02U01101
B43SB35B	02U01093		

Data were reviewed by Eric Malarek and validated using a combination of method-specific criteria, laboratory SOP, and the *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September, 1994). Parameters evaluated are presented in Table 1. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1. Laboratory Performance Criteria

Qualified		Parameter
Yes	No	
	X	Holding Times
	X	Initial Calibration
	X	Continuing Calibration
	X	Blank Analysis
	X	System Monitoring Compounds
	X	Laboratory Control Sample
X		Matrix Spike/Spike Duplicate
	X	Quantitation Verification

The quality of data collected in support of this sampling activity is considered acceptable with noted qualifications.

Eric Malarek, Chemist

9/9/02
Date

RADFORD ARMY AMMUNITION PLANT VALIDATION REPORT
CHLORINATED HERBICIDES REVIEW
SDG RD020

I-Holding Times

The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of sample extraction and analysis. Holding time criteria: For chlorinated herbicides in cooled @4°C±2°C soil samples, the maximum holding time is 14 days from sample collection to extraction and 40 days from extraction to analysis.

- The samples were collected 07/8-9/02, extracted on 07/13/02, and analyzed on 07/19/02 and 07/22/02. All criteria were met. No qualifiers were applied.

II-Initial Calibration

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for semivolatile target compounds. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve. Percent relative standard deviation (%RSD) for a 5-point standard calibration should be ≤20% for each target compound.

- For initial calibration performed on 07/15-16/02 on instrument EC06, all criteria were met. All compounds were quantified using second order regression. No qualifiers were applied.

III-Continuing Calibration

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for semivolatile target compounds. Continuing calibration establishes the 12-hour relative response factors on which the quantitations are based and checks satisfactory performance of the instrument on a day-to-day basis. Percent difference (%D) between the initial calibration CF and the continuing calibration CF must be ≤15%.

- For continuing calibration performed on 07/18/02 @04:04 on instrument EC06, all criteria were met for the target compound. No qualifiers were applied.

- For continuing calibration performed on 07/18/02 @04:47 on instrument EC06, all criteria were met for the target compound. No qualifiers were applied.

- For continuing calibration performed on 07/18/02 @15:32 on instrument EC06, 2,4-D (15.2%), 2,4,5-T (21.8%), and 2,4-DB (26.8%) were outside criteria on the secondary column. No qualifiers were applied based upon these outliers.

- For continuing calibration performed on 07/18/02 @16:15 on instrument EC06, all criteria were met for the target compound. No qualifiers were applied.

- For continuing calibration performed on 07/19/02 @21:32 on instrument EC06, 2,4-D (20.4%), 2,4,5-T (27.8%), and 2,4-DB (32.0%) were outside criteria on the secondary column. Compounds 2,4,5-T (15.2%), and 2,4-DB (21.2%) were outside criteria on the primary column. Since all samples were non-detect, no qualifiers were applied based upon these outliers.

- For continuing calibration performed on 07/19/02 @22:15 on instrument EC06, all criteria were met for the target compound. No qualifiers were applied.

- For continuing calibration performed on 07/22/02 @14:28 on instrument EC06, 2,4-D (18.8%), 2,4,5-T (25.2%), and 2,4-DB (32.0%) were outside criteria on the secondary column. Compounds 2,4,5-T (18.4%), and 2,4-DB (26.4%) were outside criteria on the primary column. Since all samples were non-detect, no qualifiers were applied based upon these outliers.

- For continuing calibration performed on 07/22/02 @15:11 on instrument EC06, all criteria were met for the target compound. No qualifiers were applied.

- For continuing calibration performed on 07/22/02 @18:04 on instrument EC06, 2,4-D (20.4%), 2,4,5-T (25.6%), and 2,4-DB (32.0%) were outside criteria on the secondary column. Compound 2,4-DB (33.2%) was outside criteria on the primary column. Since all samples were non-detect, no qualifiers were applied based upon these outliers.

- For continuing calibration performed on 07/22/02 @18:47 on instrument EC06, all criteria were met for the target compound. No qualifiers were applied.

IV-Blank Analysis

The purpose of blank analyses is to determine the presence and magnitude of contamination problems resulting from field or laboratory activities. No contaminants should be detected in any of the associated blanks. Positive sample results are qualified "B" if the concentration of the analyte is ≤ five times (5X) the absolute maximum blank concentration. Action levels are based upon 100% solids and adjusted for each sample as appropriate. Table 2 summarizes the blank contamination analysis. The soil rinse blanks included samples 061102R, 061902R1, 071002R2, and 072502RB. The maximum concentration from these rinse blanks was used for this assessment.

Table 2. Blank Contamination Analysis Summary

Analysis Date	QC Blank ID	Compound	Max Conc. µg/kg	Action Level µg/kg	B qualified samples
07/18/02	BL-197742-1	All target compounds non-detect	NA	NA	None
Various	RBs	2,4-DB	30.1	151	None
Various	RBs	MCPP	70.9	2340	None

V-System Monitoring Compounds (Surrogates)

Laboratory performance on individual samples is established by means of spiking activities. All samples are spiked with surrogate compounds prior to sample preparation. Spike recoveries must be within the specified control limits.

Control Limit: DCPAA (22.4-226%).

- Sample 31SB05A (15.1%) was outside criteria due to sample dilution. No qualifiers were applied based upon this outlier.

VI-Laboratory Control Samples

Data for laboratory control samples (LCS) are generated to determine long-term precision and accuracy of the analytical method. Percent recoveries must be within the specified control limits.

- Sample QC-197742-1 was used as the LCS. All criteria were met. No qualifiers were applied.

VII-Matrix Spike/Matrix Spike Duplicate

Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. The percent recoveries (%Rs) and the relative percent difference (RPD) must be within the specified control limits.

- Sample 31SB05B (02U01090) was used for the MS/MSD analysis. Compounds 2,4-D (RPD=64%), 2,4-DB (19.9, 34.3%; RPD=53.0%), dicamba (22.2, 17.8%), and dinoseb (2.4, 8.9%; RPD=120%) were outside criteria. Since all samples were non-detect, 2,4-D, 2,4-DB, dicamba, and dinoseb were qualified "UL" based upon these outliers.

VIII-Quantitation Verification

The accuracy of analytical results is verified through the calculation of several parameters. Percent difference (%D) between the calculated value and the reported value must be within 10%. All positive values must have less than or equal to 40% %D between the primary and secondary columns. All samples were non-detect.

Sample: 31SB05BMS (02U01090MS), 2,4-DB

Conc. µg/kg = (Ce * Ve * DF) / (Ws * D)

where: Conc. = Sample concentration in µg/kg
Ce = Analyte concentration in extract (µg/mL)
Ve = Final Volume of extract (mL)
DF = Dilution factor
W(s) = Weight of sample in kilograms.
D = Percent dry weight (100 - % moisture in sample)/100

Conc. µg/kg = (0.049748 * 5 * 10) / (0.030 * 1.0) = 82.9 µg/kg (Wet Weight)

Reported value = 82.9 µg/kg (Wet Weight)
%D = 0.0%
Values were within 10% difference.

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690JB

Date Printed.....: 23-JUL-02 12:29

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 8151A
Aliquot Weight/Volume: 30 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35A
DCL Sample Name...: 02U01092
DCL Report Group..: 02U-0088-43

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:10
Reporting Units...: ug/Kg
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 96.2

DCL Analysis Group: G026Q00S
Analysis Method...: 8151A
Instrument Type...: GC/ECD
Instrument ID.....: EC-6
Column Type.....: DB-608
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
2,4-D	19-JUL-02 15:48	93.2	ND	VL		10	208.
2,4-DB	19-JUL-02 15:48	147.	ND	VL		10	1040
2,4,5-T	19-JUL-02 15:48	28.9	ND			10	104.
2,4,5-TP	19-JUL-02 15:48	19.8	ND			10	104.
Dalapon	19-JUL-02 15:48	148.	ND			10	1040
Dicamba	19-JUL-02 15:48	21.7	ND	VL		10	208.
Dichlorprop	19-JUL-02 15:48	101.	ND			10	208.
Dinoseb	19-JUL-02 15:48	66.4	ND	VL		10	208.
MCPA	19-JUL-02 15:48	61100	ND			10	104000
MCPP	19-JUL-02 15:48	15500	ND			10	104000

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
2,4-Dichlorophenylacetic acid	310.	333.	93.1

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690JC

Date Printed.....: 23-JUL-02 12:29

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 8151A
Aliquot Weight/Volume: 30 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35B
DCL Sample Name...: 02U01093
DCL Report Group..: 02U-0088-43

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:15
Reporting Units...: ug/Kg
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 79.7

DCL Analysis Group: G026Q00S
Analysis Method...: 8151A
Instrument Type...: GC/ECD
Instrument ID.....: EC-6
Column Type.....: DB-608
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
2,4-D	19-JUL-02 16:31	113.	ND	VL		10	251.
2,4-DB	19-JUL-02 16:31	177.	ND	VL		10	1250
2,4,5-T	19-JUL-02 16:31	34.9	ND			10	125.
2,4,5-TP	19-JUL-02 16:31	23.8	ND			10	125.
Dalapon	19-JUL-02 16:31	178.	ND			10	1250
Dicamba	19-JUL-02 16:31	26.2	ND	VL		10	251.
Dichlorprop	19-JUL-02 16:31	121.	ND			10	251.
Dinoseb	19-JUL-02 16:31	80.2	ND	VL		10	251.
MCPA	19-JUL-02 16:31	73800	ND			10	125000
MCPP	19-JUL-02 16:31	18700	ND			10	125000

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
2,4-Dichlorophenylacetic acid	307.	333.	92.2

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690JD

Date Printed.....: 23-JUL-02 12:29

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 8151A
Aliquot Weight/Volume: 30 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34A
DCL Sample Name...: 02U01097
DCL Report Group..: 02U-0088-43

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:55
Reporting Units...: ug/Kg
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 91.4

DCL Analysis Group: G026Q00S
Analysis Method...: 8151A
Instrument Type...: GC/ECD
Instrument ID.....: EC-6
Column Type.....: DB-608
☒Primary
☐Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
2,4-D	19-JUL-02 17:14	98.1	ND	VL		10	219.
2,4-DB	19-JUL-02 17:14	154.	ND	VL		10	1090
2,4,5-T	19-JUL-02 17:14	30.4	ND			10	109.
2,4,5-TP	19-JUL-02 17:14	20.8	ND			10	109.
Dalapon	19-JUL-02 17:14	155.	ND			10	1090
Dicamba	19-JUL-02 17:14	22.9	ND	VL		10	219.
Dichlorprop	19-JUL-02 17:14	106.	ND			10	219.
Dinoseb	19-JUL-02 17:14	69.9	ND	VL		10	219.
MCPA	19-JUL-02 17:14	64300	ND			10	109000
MCPP	19-JUL-02 17:14	16300	ND			10	109000

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
2,4-Dichlorophenylacetic acid	288.	333.	86.5

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MEMORANDUM

TO: Jeff Parks

FROM: Eric Malarek

SUBJECT: Radford Army Ammunition Plant Data Validation
Polynuclear Aromatic Hydrocarbons
DataChem, Inc., SDG RD020

DATE: September 10, 2002

The purpose of this memorandum is to present the data validation report for the samples collected Radford Army Ammunition Plant on July 8-9, 2002. Samples were analyzed for polynuclear aromatic hydrocarbons (PAHs) using USEPA SW846 Method 3550A/8270C Selective Ion Monitoring (SIM). A total of four soil samples were validated. The sample IDs are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
B43SB35A	02U01092	B43SB34A	02U01097
B43SB35B	02U01093	B43SB34B	02U01098

Data were reviewed by Eric Malarek and validated using a combination of method-specific criteria, laboratory SOP, and the *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September, 1994). Parameters evaluated are presented in Table 1. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1. Laboratory Performance Criteria

Qualified		Parameter
Yes	No	
	X	Holding Times
	X	Instrument Performance Check
X		Initial Calibration
X		Continuing Calibration
X		Blank Analysis
	X	Surrogate Spikes
	X	Internal Standards
	X	Laboratory Control Standard
	X	Matrix Spike/Spike Duplicate
X		Quantitation Verification

The quality of data collected in support of this sampling activity is considered acceptable with the noted qualifications.

Eric Malarek, Chemist

9/10/02
Date

RADFORD ARMY AMMUNITION PLANT VALIDATION REPORT
POLYNUCLEAR AROMATIC HYDROCARBONS REVIEW
SDG RD020

I-Holding Times
The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of sample extraction and analysis. Holding time criteria: For PAH compounds in cooled (@4°C ± 2°C) soil samples, the maximum holding time is 14 days from sample collection to preparative extraction and 40 days from preparative extraction to determinative analysis.

- The samples were collected on 07/08-09/02, extracted on 07/13/02, and analyzed on 07/15/02. All criteria were met and no qualifiers were applied.

II-Instrument Performance Check
GC/MS instrument performance checks are performed to ensure mass resolution, identification and, to some degree, sensitivity. The analysis of the instrument performance check solution must be performed at the beginning of each 12-hour period during which samples are analyzed.

- The instrument performance check, decafluorotriphenylphosphine (DFTPP), met the ion abundance criteria. No qualification was applied.

III-Initial Calibration.
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for specified compounds. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve. The minimum relative response factor (RRF) criteria must be ≥ 0.05. Initial calibration percent relative standard deviation (%RSD) must be ≤ 15% on the average for all compounds (< 30% for CCCs).

- For initial calibration performed on 03/08/02 on instrument 5972-R, dibenz(a,h)anthracene (15.5%) was outside criteria. All RRFs were ≥ 0.05. All detects were qualified estimated "J" and non-detects no qualifier.

IV-Continuing Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used was capable of producing acceptable qualitative and quantitative data for semivolatile target compounds. Continuing calibration standards containing both target and surrogates compounds are analyzed at the beginning of each 12-hour analysis period following the analysis of the instrument performance check and prior to the analysis of blanks and samples. The minimum relative response factors (RRF) for semivolatile target compounds and surrogates must be ≥ 0.05. The percent difference (%D) between the initial calibration RRF and the continuing calibration RRF must be within ± 20% for all target compounds. Grossly exceeding is defined where %D>40%.

- For continuing calibration performed on 07/15/02 @15:36 on instrument 5972-R, pyrene (37.9%) was outside criteria. All detects were qualified estimated "J" and non-detects no qualifier.

V-Blank Analysis

The purpose of laboratory (or field) blank analyses is to determine the existence and magnitude of contamination problems resulting from field and laboratory activities. No contamination should be found in any of the blanks > MDL. Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤ 5 times (5X) the maximum amount for PAH compounds detected. Action levels are based upon 100% solids and adjusted for each sample as appropriate. Table 2 summarizes the blank contamination analysis. The soil rinse blanks included samples 061102R, 061902R1, 071002R2, and 072502RB. The maximum concentration from these rinse blanks was used for this assessment.

Table 2. Blank Contamination Analysis Summary

Analysis Date	QC Blank ID	Compound	Max Conc. µg/kg	Action Level µg/kg	B qualified samples
07/15/02	BL-196558-1	naphthalene	1.8	9.00	B43SB35B, B43SB34A, B43SB34B
07/15/02	BL-196558-1	2-methylnaphthalene	0.97	4.85	B43SB34A
Various	RBs	naphthalene	1.19	5.95	B43SB35B, B43SB34A, B43SB34B
Various	RBs	2-methylnaphthalene	0.66	3.30	B43SB34A
Various	RBs	acenaphthene	2.74	13.7	B43SB35A

VI-Surrogate Spikes

Laboratory performance on individual samples is evaluated through the review of surrogate spike samples. Surrogate spikes are added to all samples and blanks to measure their recovery in sample and blank matrices. The percent recoveries (%Rs) must be within the specified control limits.

Criteria: 2-Fluorobiphenyl (35.7-114%)
Terphenyl – d14 (43.8-136%)

- All criteria were met. No qualifiers were applied.

VII-Internal Standards

Internal standards performance criteria ensure that GC/MS sensitivity and response are stable during every analytical run. Internal standard area counts for samples and blanks must not vary by more than a factor of two (- 50% to + 100%) from the associated calibration standard. The retention time of the internal standards in samples and blanks must not vary by more than ± 30 seconds from the retention time of the associated calibration standard.

- All criteria were met. No qualifiers were applied.

VIII-Laboratory Control Samples

Laboratory control samples (LCS) are used to monitor laboratory accuracy by calculating the percent recoveries of the spiked compounds. All LCS percent recoveries must be within the specified control limits.

- Sample QC-197744-1 was used as LCS for PAHs. All criteria were met. No qualifiers were applied. All samples apply to this LCS.

IX-Matrix Spike/Matrix Spike Duplicate

Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. The percent recoveries (%Rs) and the relative percent difference (RPD) must be within the specified control limits.

- Sample B43SB35B (02U01093) was used for the MS/MSD analysis. All criteria were met. No qualifiers were applied. All samples apply to this MS/MSD.

X-Quantitation Verification
The accuracy of analytical results was verified through the calculation of several parameters. Percent difference (%D) between the calculated and reported values must be ≤10%. Any sample value > MDL and < MRL is qualified as estimated, "J".

Sample: B43SB35A (02U01092), pyrene

Conc. µg/kg = (Ax * Is * Vt * DF) / (Ais * RRF * Vi * Ws * D)

where: Conc. = Sample concentration in µg/kg
Ax = Area of characteristic ion for compound being measured.
Is = Amount of internal standard injected (ng).
Vt = Volume of total extract, taking into account dilutions (i.e., a 1-to-10 dilution of a 1-mL extract will mean V(t) = 10,000 uL.
Ais = Area of characteristic ion for the internal standard.
RRF = Average relative response factor for compound being measured (from ICAL)
Vi = Volume of extract injected (uL).
W(s) = Weight of sample extracted or diluted in grams.
D = Percent dry weight (100 - % moisture in sample)/100
DF = Dilution factor

Conc. µg/kg = (34668 * 1 * 1000 * 1) / (33578 * 1.801 * 1 * 30 * 0.962) = 20 µg/kg
Reported Value = 20 µg/kg
% Difference = 0.0%
Values were within 10% difference

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

Form RLIMS63A-V1.3
07170210273132
Page 4

S02690JN

Date Printed.....: 17-JUL-02 10:27

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: G026H00B
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 3550
Aliquot Weight/Volume: 30 grams
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35A
DCL Sample Name...: 02U01092
DCL Report Group..: 02U-0088-45

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:10
Reporting Units...: ug/kg
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 96.2

DCL Analysis Group: G026H00B
Analysis Method...: GC/MS SIM
Instrument Type...: GC/MS SV
Instrument ID.....: 5972-R
Column Type.....: DB5 30m x .32mm
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Naphthalene	15-JUL-02 17:19	0.68	11.		B	1	1.8
2-Methylnaphthalene	15-JUL-02 17:19	0.60	11.		B	1	1.8
Acenaphthylene	15-JUL-02 17:19	0.23	6.9			1	1.8
Acenaphthene	15-JUL-02 17:19	0.98	5.5	B		1	1.8
Fluorene	15-JUL-02 17:19	0.47	4.7			1	1.8
Phenanthrene	15-JUL-02 17:19	0.27	12.			1	1.8
Anthracene	15-JUL-02 17:19	0.19	3.4			1	1.8
Fluoranthene	15-JUL-02 17:19	0.30	15.			1	1.8
Pyrene	15-JUL-02 17:19	0.40	20.	J		1	1.8
Benzo(a)anthracene	15-JUL-02 17:19	0.23	8.7			1	1.8
Chrysene	15-JUL-02 17:19	0.28	16.			1	1.8
Benzo(b)fluoranthene	15-JUL-02 17:19	0.34	27.			1	1.8
Benzo(k)fluoranthene	15-JUL-02 17:19	0.31	8.1			1	1.8
Benzo(a)pyrene	15-JUL-02 17:19	0.20	7.4			1	1.8
Indeno(1,2,3cd)pyrene	15-JUL-02 17:19	0.57	8.4			1	1.8
Dibenz(a,h)Anthracene	15-JUL-02 17:19	0.60	1.9	J		1	1.8
Benzo(g,h,i)perylene	15-JUL-02 17:19	0.62	6.5			1	1.8

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
2-Fluorobiphenyl	64.1	66.7	96.2
Terphenyl-d14	58.0	66.7	87.0

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690JP

Date Printed.....: 17-JUL-02 10:27

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: G026H00B
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 3550
Aliquot Weight/Volume: 30 grams
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35B
DCL Sample Name...: 02U01093
DCL Report Group..: 02U-0088-45

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:15
Reporting Units...: ug/kg
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 79.7

DCL Analysis Group: G026H00B
Analysis Method...: GC/MS SIM
Instrument Type...: GC/MS SV
Instrument ID.....: 5972-R
Column Type.....: DB5 30m x .32mm
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Naphthalene	15-JUL-02 17:53	0.82	1.7	B	JB	1	2.1
2-Methylnaphthalene	15-JUL-02 17:53	0.72	ND			1	2.1
Acenaphthylene	15-JUL-02 17:53	0.28	ND			1	2.1
Acenaphthene	15-JUL-02 17:53	1.2	ND			1	2.1
Fluorene	15-JUL-02 17:53	0.57	ND			1	2.1
Phenanthrene	15-JUL-02 17:53	0.33	ND			1	2.1
Anthracene	15-JUL-02 17:53	0.23	ND			1	2.1
Fluoranthene	15-JUL-02 17:53	0.37	ND			1	2.1
Pyrene	15-JUL-02 17:53	0.48	ND			1	2.1
Benzo(a)anthracene	15-JUL-02 17:53	0.28	ND			1	2.1
Chrysene	15-JUL-02 17:53	0.34	ND			1	2.1
Benzo(b)fluoranthene	15-JUL-02 17:53	0.41	ND			1	2.1
Benzo(k)fluoranthene	15-JUL-02 17:53	0.37	ND			1	2.1
Benzo(a)pyrene	15-JUL-02 17:53	0.24	ND			1	2.1
Indeno(1,2,3cd)pyrene	15-JUL-02 17:53	0.68	ND			1	2.1
Dibenz(a,h)Anthracene	15-JUL-02 17:53	0.73	ND			1	2.1
Benzo(g,h,i)perylene	15-JUL-02 17:53	0.75	ND			1	2.1

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
2-Fluorobiphenyl	43.8	66.7	65.7
Terphenyl-d14	47.0	66.7	70.5

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690JQ

Date Printed.....: 17-JUL-02 10:27

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: G026H00B
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 3550
Aliquot Weight/Volume: 30 grams
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34A
DCL Sample Name...: 02U01097
DCL Report Group..: 02U-0088-45

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:55
Reporting Units...: ug/kg
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 91.4

DCL Analysis Group: G026H00B
Analysis Method...: GC/MS SIM
Instrument Type...: GC/MS SV
Instrument ID.....: 5972-R
Column Type.....: DB5 30m x .32mm
☒Primary
☐Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Naphthalene	15-JUL-02 19:33	0.72	2.7	B	B	1	1.9
2-Methylnaphthalene	15-JUL-02 19:33	0.63	1.7	B	JB	1	1.9
Acenaphthylene	15-JUL-02 19:33	0.25	0.77	J	J	1	1.9
Acenaphthene	15-JUL-02 19:33	1.0	ND			1	1.9
Fluorene	15-JUL-02 19:33	0.49	ND			1	1.9
Phenanthrene	15-JUL-02 19:33	0.28	7.1			1	1.9
Anthracene	15-JUL-02 19:33	0.20	ND			1	1.9
Fluoranthene	15-JUL-02 19:33	0.32	9.3			1	1.9
Pyrene	15-JUL-02 19:33	0.42	13.	J		1	1.9
Benzo(a)anthracene	15-JUL-02 19:33	0.25	3.1			1	1.9
Chrysene	15-JUL-02 19:33	0.30	7.3			1	1.9
Benzo(b)fluoranthene	15-JUL-02 19:33	0.35	7.6			1	1.9
Benzo(k)fluoranthene	15-JUL-02 19:33	0.32	2.0			1	1.9
Benzo(a)pyrene	15-JUL-02 19:33	0.21	3.1			1	1.9
Indeno(1,2,3cd)pyrene	15-JUL-02 19:33	0.60	3.3			1	1.9
Dibenz(a,h)Anthracene	15-JUL-02 19:33	0.63	0.80	J	J	1	1.9
Benzo(g,h,i)perylene	15-JUL-02 19:33	0.65	3.3			1	1.9

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
2-Fluorobiphenyl	48.6	66.7	72.9
Terphenyl-d14	48.9	66.7	73.4

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

Form RLIMS63A-V1.3
07170210273132
Page 7

S02690JR

Date Printed.....: 17-JUL-02 10:27

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: G026H00B
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 3550
Aliquot Weight/Volume: 30 grams
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34B
DCL Sample Name...: 02U01098
DCL Report Group..: 02U-0088-45

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 16:00
Reporting Units...: ug/kg
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 76.7

DCL Analysis Group: G026H00B
Analysis Method...: GC/MS SIM
Instrument Type...: GC/MS SV
Instrument ID.....: 5972-R
Column Type.....: DB5 30m x .32mm
☒Primary
☐Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Naphthalene	15-JUL-02 20:06	0.86	2.0	B	JB	1	2.2
2-Methylnaphthalene	15-JUL-02 20:06	0.75	ND			1	2.2
Acenaphthylene	15-JUL-02 20:06	0.29	ND			1	2.2
Acenaphthene	15-JUL-02 20:06	1.2	ND			1	2.2
Fluorene	15-JUL-02 20:06	0.59	ND			1	2.2
Phenanthrene	15-JUL-02 20:06	0.34	1.3	J	J	1	2.2
Anthracene	15-JUL-02 20:06	0.24	ND			1	2.2
Fluoranthene	15-JUL-02 20:06	0.38	1.6	J	J	1	2.2
Pyrene	15-JUL-02 20:06	0.50	3.3	J		1	2.2
Benzo(a)anthracene	15-JUL-02 20:06	0.29	0.96	J	J	1	2.2
Chrysene	15-JUL-02 20:06	0.35	1.4	J	J	1	2.2
Benzo(b)fluoranthene	15-JUL-02 20:06	0.42	1.3	J	J	1	2.2
Benzo(k)fluoranthene	15-JUL-02 20:06	0.39	ND			1	2.2
Benzo(a)pyrene	15-JUL-02 20:06	0.25	0.96	J	J	1	2.2
Indeno(1,2,3cd)pyrene	15-JUL-02 20:06	0.71	ND			1	2.2
Dibenz(a,h)Anthracene	15-JUL-02 20:06	0.75	ND			1	2.2
Benzo(g,h,i)perylene	15-JUL-02 20:06	0.78	ND			1	2.2

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
2-Fluorobiphenyl	60.6	66.7	90.9
Terphenyl-d14	58.2	66.7	87.3

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MEMORANDUM

TO: Jeff Parks

FROM: Eric Malarek

SUBJECT: Radford Army Ammunition Plant Data Validation – Pesticides and PCBs
DataChem, Inc., SDG RD020

DATE: September 9, 2002

The purpose of this memorandum is to present the data validation report for the samples collected at the Radford Army Ammunition Plant on July 8-9, 2002. Samples were analyzed for pesticides and PCBs using USEPA Method 3550B/8081A and 3550/8082, respectively. Samples 31SB05A, 31SB05B, 31SB05C, B43SB35A, B43SB35B, B43SB34A, 39SB05A, 39SB06A, and 39SS07 were analyzed for pesticides and PCBs. All other samples were analyzed for only for PCBs. A total of twelve soil samples were validated. The sample IDs are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
31SB05A	02U01089	B43SS03	02U01096
31SB05B	02U01090	B43SB34A	02U01097
31SB05C	02U01091	B43SB34B	02U01098
B43SB35A	02U01092	39SB05A	02U01099
B43SB35B	02U01093	39SB06A	02U01100
B43SS02	02U01095	39SS07	02U01101

Data were reviewed by Eric Malarek and validated using a combination of method-specific criteria, laboratory SOP, and the *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September, 1994). Parameters evaluated are presented in Table 1. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1. Laboratory Performance Criteria

Qualified		Parameter
Yes	No	
	X	Holding Times
	X	Instrument Performance Check
	X	Initial Calibration
	X	Continuing Calibration
X		Blank Analysis
	X	System Monitoring Compounds
	X	Laboratory Control Samples
X		Matrix Spike/Spike Duplicate
X		Quantitation Verification

The quality of data collected in support of this sampling activity is considered acceptable with noted qualifications.

Eric Malarek, Chemist

9/9/02
Date

RADFORD ARMY AMMUNITION PLANT VALIDATION REPORT
PESTICIDE/PCB REVIEW
SDG RD020

I-Holding Times
The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of sample extraction and analysis. Holding time criteria: For soil samples, cooled @4°C ±2°C, the maximum holding time is 14 days from sample collection to preparative extraction and 40 days from preparative extraction to determinative analysis.

- The samples were collected 07/8-9/02, extracted for the pesticides on 07/13/02, extracted for PCBs on 07/14/02, analyzed for pesticides on 07/21/02, and analyzed for PCBs on 07/16/02. All criteria were met. No qualifiers were applied.

II-Instrument Performance Check (Degradation Standard)
Performance checks on the gas chromatograph with electron capture detector (GC/ECD) system are performed to ensure adequate resolution and instrument sensitivity. The performance evaluation mixture (PEM) must be analyzed at the beginning of the analytical sequence. The breakdown of Endrin and 4,4'-DDT must be ≤ 15% on both columns.

- For analysis performed on 07/20/02, endrin and 4,4'-DDT percent breakdowns were 8.89% and 7.46% on the DB-608 column and 1.39% and 5.63% on the DB-1701 column, respectively. All criteria were met. No qualifiers were applied.

- For analysis performed on 07/21/02, endrin and 4,4'-DDT percent breakdowns were 10.1% and 7.66% on the DB-608 column and 1.37% and 4.97% on the DB-1701 column, respectively. All criteria were met. No qualifiers were applied.

- For analysis performed on 07/22/02, endrin and 4,4'-DDT percent breakdowns were 10.9% and 7.04% on the DB-608 column and 1.26% and 4.77% on the DB-1701 column, respectively. All criteria were met. No qualifiers were applied.

III-Initial Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable qualitative and quantitative data for the target compounds. The initial 5 point calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run. The percent relative standard deviation (%RSD) for all single peak target analytes, and aroclors 1016, 1242, 1254, and 1260 must be < 20% or the mean %RSD for all analytes in the standard must be ≤ 20%. If linear regression is used, the correlation coefficient must be ≥0.990.

- For the pesticide initial calibration performed on 07/20/02 on instrument EC09, all criteria were met. All compounds were quantified using second order regression. No qualifiers were applied.

- For the PCB initial calibration performed on 07/04-05/02 on instrument EC11, all criteria were met. No qualifiers were applied.

IV-Continuing Calibration

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable qualitative and quantitative data for pesticide/PCB target compounds. Continuing calibration standards containing both target compounds and surrogates are analyzed at the beginning of each 12-hour analytical shift and after every 20 samples. The percent difference (%D) or the mean %RSD for all analytes in the standard from the initial calibration should be no greater than ± 15%.

- For pesticide continuing calibration mix A performed on 07/20/02 @20:07 on instrument EC09, all criteria were met. No qualifiers were applied.
- For pesticide continuing calibration mix B performed on 07/21/02 @02:16 on instrument EC09, all criteria were met. No qualifiers were applied.
- For pesticide continuing calibration mix A performed on 07/21/02 @16:50 on instrument EC09, all criteria were met. No qualifiers were applied.
- For pesticide continuing calibration mix B performed on 07/21/02 @17:36 on instrument EC09, all criteria were met. No qualifiers were applied.
- For pesticide continuing calibration mix A performed on 07/22/02 @04:21 on instrument EC09, all criteria were met. No qualifiers were applied.
- For pesticide continuing calibration mix B performed on 07/22/02 @05:07 on instrument EC09, all criteria were met. No qualifiers were applied.
- For PCB continuing calibration performed on 07/16/02 @04:27 on instrument EC11, all criteria were met. No qualifiers were applied.
- For PCB continuing calibration performed on 07/16/02 @13:44 on instrument EC11, all criteria were met. No qualifiers were applied.
- For PCB continuing calibration performed on 07/16/02 @20:43 on instrument EC11, all criteria were met. No qualifiers were applied.

V-Blank Analysis

The purpose of laboratory or field blank analyses is to determine the existence and magnitude of contamination problems resulting from laboratory or field activities. One method blank per analytical batch must be run on each instrument used to analyze samples. No contaminants should be present in the blanks > MDL or MRL. Action levels are based upon 100% solids and adjusted for each sample as appropriate. Table 2 summarizes the blank contamination analysis. The soil rinse blanks included samples 061102R, 061902R1, 071002R2, and 072502RB. The maximum concentration from these rinse blanks was used for this assessment.

Table 2. Blank Contamination Analysis Summary

Parameter	Analysis Date	QC Blank ID	Compound	Max Conc. µg/kg	Action Level µg/kg	B qualified samples
Pesticides	07/21/02	BL-197741-1	All target compounds <MRL	NA	NA	None
Pesticides	Various	RBs	4,4'-DDE	0.39	1.95	None
Pesticides	Various	RBs	4,4'-DDT	0.26	1.30	39SB05A
Pesticides	Various	RBs	Lindane	0.29	1.45	None
PCBs	07/16/02	BL-197740-1	All target compounds <MRL	NA	NA	None
PCBs	Various	RBs	All target compounds <MRL	NA	NA	None

VI-System Monitoring Compound (Surrogates)
Laboratory performance on individual samples is established by means of spiking activities. The percent recovery (%R) for all samples and blanks must be within the specified laboratory control limits.

Criteria:	Decachlorobiphenyl :	PCBs: 47.1-141%	Pesticides: 40.0-160%
	Tetrachloro-m-xylene:		Pesticides: 38.0-156%

- All criteria were met. No qualifiers were applied.

VII-Laboratory Control Samples
Laboratory control samples (LCS) are used to monitor long-term precision and accuracy of the analytical method. The analysis is performed at a frequency of 1 per analytical batch. The percent recoveries (%Rs) must be within the specified control limits.

- Sample QC-197741-1 was used for the pesticides LCS. All criteria were met. No qualifiers were applied. All samples were analyzed using this LCS.

- Sample QC-197740-1 was used for the PCB LCS. All criteria were met. No qualifiers were applied. All samples were analyzed using this LCS.

VIII-Matrix Spike/Matrix Spike Duplicate
Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. The percent recoveries (%Rs) and the relative percent difference (RPD) must be within the specified control limits.

- Sample 31SB05A (02U01089) was used for the MS/MSD analysis for Pesticides. Endrin aldehyde (9.6%; RPD=200%) was outside criteria. Endrin aldehyde was qualified bias "J" for detects and "UJ" for non-detects for low recoveries and high RPDs. The LCS was within criteria. All samples were analyzed using this MS/MSD.

- Sample 31SB05A (02U01089) was used for the MS/MSD analysis for PCBs. All criteria were met. No qualifiers were applied. All samples were analyzed using this MS/MSD.

IX-Quantitation Verification
The accuracy of analytical results was verified through the calculation of several parameters. The difference between the calculated value and the reported value must be within 10% difference. All values <MRL and >MDL were qualified as estimated "J". All positive values must have less than or equal to 40% %D between the primary and secondary columns. All criteria were met.

Sample: 31SB05A (02U01089), 4,4'-DDD

Conc. µg/kg = (Ce * Ve * DF) / (Ws * D)

where:	Conc.	= Sample concentration in µg/kg
	Ce	= Analyte concentration in extract (µg/mL)
	Ve	= Final Volume of extract (mL)
	DF	= Dilution factor
	W(s)	= Weight of sample in kilograms.
	D	= Percent dry weight (100 - % moisture in sample)/100

Conc. µg/kg = (0.001886 * 10 * 1) / (0.030 * 0.901) = 0.698 µg/kg

Reported value = 0.698 µg/kg
%D = 0.0%
Values were within 10% difference.

Sample: 31SB05AMS (02U01089MS), Aroclor 1016

Conc. µg/g = (Ce * Ve * DF) / (Ws * D)

where: Conc. = Sample concentration in µg/g
Ce = Analyte concentration in extract (µg/mL)
Ve = Final Volume of extract (mL)
DF = Dilution factor
W(s) = Weight of sample in grams.
D = Percent dry weight (100 - % moisture in sample)/100

Conc1 µg/kg = (0.458192 * 10 * 1) / (3.0 * 1.0) = 1.53 µg/g (Wet Weight)
Conc2 µg/kg = (0.405710 * 10 * 1) / (3.0 * 1.0) = 1.35 µg/g (Wet Weight)
Conc3 µg/kg = (0.423695 * 10 * 1) / (3.0 * 1.0) = 1.41 µg/g (Wet Weight)
Conc4 µg/kg = (0.434869 * 10 * 1) / (3.0 * 1.0) = 1.45 µg/g (Wet Weight)
Conc5 µg/kg = (0.464223 * 10 * 1) / (3.0 * 1.0) = 1.55 µg/g (Wet Weight)

Average concentration = 1.46 µg/g (Wet Weight)
Reported Value = 1.43 µg/g (Wet Weight)
% Difference = 2.0%
Values were within 10% difference.

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

Form RLIMS63A-V1.3
07230213051927

SAMPLE ANALYSIS DATA SHEET

S02690J1

Date Printed.....: 23-JUL-02 13:05

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: G026L02D
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 3550B
Aliquot Weight/Volume: 30 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35A
DCL Sample Name...: 02U01092
DCL Report Group..: 02U-0088-42

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:10
Reporting Units...: ug/kg
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 96.2

DCL Analysis Group: G026L02D
Analysis Method...: 8081A
Instrument Type...: GC/ECD
Instrument ID.....: EC09
Column Type.....: DB-608
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
4,4'-DDD	21-JUL-02 13:00	0.147	0.479	J	J	1	0.693
4,4'-DDE	21-JUL-02 13:00	0.146	ND			1	0.693
4,4'-DDT	21-JUL-02 13:00	0.245	21.8			1	0.693
Aldrin	21-JUL-02 13:00	0.516	ND			1	0.693
Dieldrin	21-JUL-02 13:00	0.426	ND			1	0.693
Endosulfan I	21-JUL-02 13:00	0.108	ND			1	0.693
Endosulfan II	21-JUL-02 13:00	0.247	2.46			1	0.693
Endosulfan Sulfate	21-JUL-02 13:00	0.218	ND			1	0.693
Endrin	21-JUL-02 13:00	0.166	ND			1	0.693
Endrin Ketone	21-JUL-02 13:00	0.559	ND			1	0.693
Endrin aldehyde	21-JUL-02 13:00	0.350	2.89	J		1	0.693
Heptachlor	21-JUL-02 13:00	0.640	ND			1	0.693
Heptachlor Epoxide	21-JUL-02 13:00	0.420	ND			1	0.693
Lindane	21-JUL-02 13:00	0.343	ND			1	0.693
Methoxychlor	21-JUL-02 13:00	0.529	ND			1	0.693
Toxaphene	21-JUL-02 13:00	8.96	ND			1	34.6
alpha-BHC	21-JUL-02 13:00	0.113	ND			1	0.693
alpha-Chlordane	21-JUL-02 13:00	0.128	ND			1	0.693
beta-BHC	21-JUL-02 13:00	0.141	ND			1	0.693
delta-BHC	21-JUL-02 13:00	0.121	ND			1	0.693
gamma-Chlordane	21-JUL-02 13:00	0.161	ND			1	0.693

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
Decachlorobiphenyl	19.2	16.7	115.
Tetrachloro-m-xylene	17.1	16.7	102.

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690HN

Date Printed.....: 23-JUL-02 13:35

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 14-JUL-02 00:00
Preparation Method...: 3550
Aliquot Weight/Volume: 3 g.
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35A
DCL Sample Name...: 02U01092
DCL Report Group..: 02U-0088-41

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:10
Reporting Units...: ug/g
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 96.2

DCL Analysis Group: G026Q019
Analysis Method...: 8082
Instrument Type...: GC/ECD
Instrument ID.....: EC11
Column Type.....: DB-608
☒Primary
☐Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
PCB-1016	16-JUL-02 11:25	0.0106	ND			1	0.0346
PCB-1221	16-JUL-02 11:25	0.0657	ND			1	0.0693
PCB-1232	16-JUL-02 11:25	0.0192	ND			1	0.0346
PCB-1242	16-JUL-02 11:25	0.0148	ND			1	0.0346
PCB-1248	16-JUL-02 11:25	0.0164	ND			1	0.0346
PCB-1254	16-JUL-02 11:25	0.0102	0.344			1	0.0346
PCB-1260	16-JUL-02 11:25	0.00541	ND			1	0.0346

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
DCB	0.167	0.167	100.

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690J2

Date Printed.....: 23-JUL-02 13:05

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: G026L02D
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 3550B
Aliquot Weight/Volume: 30 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35B
DCL Sample Name...: 02U01093
DCL Report Group..: 02U-0088-42

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:15
Reporting Units...: ug/kg
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 79.7

DCL Analysis Group: G026L02D
Analysis Method...: 8081A
Instrument Type...: GC/ECD
Instrument ID.....: EC09
Column Type.....: DB-608
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
4,4'-DDD	21-JUL-02 13:46	0.177	0.222	J	J	1	0.837
4,4'-DDE	21-JUL-02 13:46	0.176	ND			1	0.837
4,4'-DDT	21-JUL-02 13:46	0.296	ND			1	0.837
Aldrin	21-JUL-02 13:46	0.622	ND			1	0.837
Dieldrin	21-JUL-02 13:46	0.514	ND			1	0.837
Endosulfan I	21-JUL-02 13:46	0.130	ND			1	0.837
Endosulfan II	21-JUL-02 13:46	0.299	ND			1	0.837
Endosulfan Sulfate	21-JUL-02 13:46	0.263	ND			1	0.837
Endrin	21-JUL-02 13:46	0.201	ND			1	0.837
Endrin Ketone	21-JUL-02 13:46	0.675	ND			1	0.837
Endrin aldehyde	21-JUL-02 13:46	0.423	ND	UJ		1	0.837
Heptachlor	21-JUL-02 13:46	0.773	ND			1	0.837
Heptachlor Epoxide	21-JUL-02 13:46	0.507	ND			1	0.837
Lindane	21-JUL-02 13:46	0.414	ND			1	0.837
Methoxychlor	21-JUL-02 13:46	0.639	ND			1	0.837
Toxaphene	21-JUL-02 13:46	10.8	ND			1	41.8
alpha-BHC	21-JUL-02 13:46	0.137	ND			1	0.837
alpha-Chlordane	21-JUL-02 13:46	0.154	ND			1	0.837
beta-BHC	21-JUL-02 13:46	0.171	ND			1	0.837
delta-BHC	21-JUL-02 13:46	0.146	ND			1	0.837
gamma-Chlordane	21-JUL-02 13:46	0.194	ND			1	0.837

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
Decachlorobiphenyl	18.8	16.7	113.
Tetrachloro-m-xylene	16.6	16.7	99.3

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690HP

Date Printed.....: 23-JUL-02 13:35

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 14-JUL-02 00:00
Preparation Method...: 3550
Aliquot Weight/Volume: 3 g.
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35B
DCL Sample Name...: 02U01093
DCL Report Group..: 02U-0088-41

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:15
Reporting Units...: ug/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 79.7

DCL Analysis Group: G026Q019
Analysis Method...: 8082
Instrument Type...: GC/ECD
Instrument ID.....: EC11
Column Type.....: DB-608
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
PCB-1016	16-JUL-02 12:11	0.0128	ND			1	0.0418
PCB-1221	16-JUL-02 12:11	0.0793	ND			1	0.0837
PCB-1232	16-JUL-02 12:11	0.0232	ND			1	0.0418
PCB-1242	16-JUL-02 12:11	0.0178	ND			1	0.0418
PCB-1248	16-JUL-02 12:11	0.0198	ND			1	0.0418
PCB-1254	16-JUL-02 12:11	0.0123	ND			1	0.0418
PCB-1260	16-JUL-02 12:11	0.00652	ND			1	0.0418

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
DCB	0.161	0.167	96.4

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690HQ

Date Printed.....: 23-JUL-02 13:35

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 14-JUL-02 00:00
Preparation Method...: 3550
Aliquot Weight/Volume: 3 g.
Net Weight/Volume....: Not Required

Client Sample Name: B43SS02|B43SS02
DCL Sample Name...: 02U01095
DCL Report Group..: 02U-0088-41

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:45
Reporting Units...: ug/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 85.6

DCL Analysis Group: G026Q019
Analysis Method...: 8082
Instrument Type...: GC/ECD
Instrument ID.....: EC11
Column Type.....: DB-608
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
PCB-1016	16-JUL-02 14:31	0.0119	ND			1	0.0389
PCB-1221	16-JUL-02 14:31	0.0738	ND			1	0.0779
PCB-1232	16-JUL-02 14:31	0.0216	ND			1	0.0389
PCB-1242	16-JUL-02 14:31	0.0166	ND			1	0.0389
PCB-1248	16-JUL-02 14:31	0.0185	ND			1	0.0389
PCB-1254	16-JUL-02 14:31	0.0115	0.0404			1	0.0389
PCB-1260	16-JUL-02 14:31	0.00607	ND			1	0.0389

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
DCB	0.167	0.167	100.

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690HR

Date Printed.....: 23-JUL-02 13:35

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 14-JUL-02 00:00
Preparation Method...: 3550
Aliquot Weight/Volume: 3 g.
Net Weight/Volume....: Not Required

Client Sample Name: B43SS03|B43SS03
DCL Sample Name...: 02U01096
DCL Report Group..: 02U-0088-41

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:50
Reporting Units...: ug/g
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 88.6

DCL Analysis Group: G026Q019
Analysis Method...: 8082
Instrument Type...: GC/ECD
Instrument ID.....: EC11
Column Type.....: DB-608
☒Primary
☐Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
PCB-1016	16-JUL-02 15:17	0.0115	ND			1	0.0376
PCB-1221	16-JUL-02 15:17	0.0713	ND			1	0.0753
PCB-1232	16-JUL-02 15:17	0.0209	ND			1	0.0376
PCB-1242	16-JUL-02 15:17	0.0160	ND			1	0.0376
PCB-1248	16-JUL-02 15:17	0.0178	ND			1	0.0376
PCB-1254	16-JUL-02 15:17	0.0111	0.0212	J	J	1	0.0376
PCB-1260	16-JUL-02 15:17	0.00587	ND			1	0.0376

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
DCB	0.190	0.167	114.

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690J3

Date Printed.....: 23-JUL-02 13:05

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: G026L02D
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 3550B
Aliquot Weight/Volume: 30 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34A
DCL Sample Name...: 02U01097
DCL Report Group..: 02U-0088-42

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:55
Reporting Units...: ug/kg
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 91.4

DCL Analysis Group: G026L02D
Analysis Method...: 8081A
Instrument Type...: GC/ECD
Instrument ID.....: EC09
Column Type.....: DB-608
☒Primary
☐Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
4,4'-DDD	21-JUL-02 14:31	0.154	0.570	J	J	1	0.730
4,4'-DDE	21-JUL-02 14:31	0.153	ND			1	0.730
4,4'-DDT	21-JUL-02 14:31	0.258	15.3			1	0.730
Aldrin	21-JUL-02 14:31	0.543	ND			1	0.730
Dieldrin	21-JUL-02 14:31	0.449	ND			1	0.730
Endosulfan I	21-JUL-02 14:31	0.114	ND			1	0.730
Endosulfan II	21-JUL-02 14:31	0.260	2.26			1	0.730
Endosulfan Sulfate	21-JUL-02 14:31	0.230	ND			1	0.730
Endrin	21-JUL-02 14:31	0.175	0.498	J	J	1	0.730
Endrin Ketone	21-JUL-02 14:31	0.589	ND			1	0.730
Endrin aldehyde	21-JUL-02 14:31	0.369	ND	UJ		1	0.730
Heptachlor	21-JUL-02 14:31	0.674	ND			1	0.730
Heptachlor Epoxide	21-JUL-02 14:31	0.442	ND			1	0.730
Lindane	21-JUL-02 14:31	0.361	ND			1	0.730
Methoxychlor	21-JUL-02 14:31	0.557	1.97			1	0.730
Toxaphene	21-JUL-02 14:31	9.43	ND			1	36.4
alpha-BHC	21-JUL-02 14:31	0.119	ND			1	0.730
alpha-Chlordane	21-JUL-02 14:31	0.135	ND			1	0.730
beta-BHC	21-JUL-02 14:31	0.149	ND			1	0.730
delta-BHC	21-JUL-02 14:31	0.127	ND			1	0.730
gamma-Chlordane	21-JUL-02 14:31	0.170	ND			1	0.730

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
Decachlorobiphenyl	18.3	16.7	110.
Tetrachloro-m-xylene	16.5	16.7	98.7

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690HS

Date Printed.....: 23-JUL-02 13:35

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 14-JUL-02 00:00
Preparation Method...: 3550
Aliquot Weight/Volume: 3 g.
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34A
DCL Sample Name...: 02U01097
DCL Report Group..: 02U-0088-41

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:55
Reporting Units...: ug/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 91.4

DCL Analysis Group: G026Q019
Analysis Method...: 8082
Instrument Type...: GC/ECD
Instrument ID.....: EC11
Column Type.....: DB-608
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
PCB-1016	16-JUL-02 16:04	0.0112	ND			1	0.0364
PCB-1221	16-JUL-02 16:04	0.0691	ND			1	0.0730
PCB-1232	16-JUL-02 16:04	0.0202	ND			1	0.0364
PCB-1242	16-JUL-02 16:04	0.0155	ND			1	0.0364
PCB-1248	16-JUL-02 16:04	0.0173	ND			1	0.0364
PCB-1254	16-JUL-02 16:04	0.0108	0.0416			1	0.0364
PCB-1260	16-JUL-02 16:04	0.00569	ND			1	0.0364

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
DCB	0.179	0.167	107.

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

Form RLIMS63A-V1.3
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S02690HT

SAMPLE ANALYSIS DATA SHEET

Date Printed.....: 23-JUL-02 13:35

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 14-JUL-02 00:00
Preparation Method...: 3550
Aliquot Weight/Volume: 3 g.
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34B
DCL Sample Name...: 02U01098
DCL Report Group..: 02U-0088-41

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 16:00
Reporting Units...: ug/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 76.7

DCL Analysis Group: G026Q019
Analysis Method...: 8082
Instrument Type...: GC/ECD
Instrument ID.....: EC11
Column Type.....: DB-608
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
PCB-1016	16-JUL-02 16:50	0.0133	ND			1	0.0434
PCB-1221	16-JUL-02 16:50	0.0824	ND			1	0.0870
PCB-1232	16-JUL-02 16:50	0.0241	ND			1	0.0434
PCB-1242	16-JUL-02 16:50	0.0185	ND			1	0.0434
PCB-1248	16-JUL-02 16:50	0.0206	ND			1	0.0434
PCB-1254	16-JUL-02 16:50	0.0128	ND			1	0.0434
PCB-1260	16-JUL-02 16:50	0.00678	ND			1	0.0434

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
DCB	0.185	0.167	111.

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MEMORANDUM

TO: Jeff Parks

FROM: Eric Malarek

SUBJECT: Radford Army Ammunition Plant Data Validation – pH
DataChem, Inc., SDG RD020

DATE: September 10, 2002

The purpose of this memorandum is to present the data validation report for the samples collected at the Radford Army Ammunition Plant on July 8-9, 2002. Samples were analyzed for pH using SW-846 9045C. A total of five soil samples were validated. The sample IDs are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
31SB05A	02U01089	B43SB34A	02U01097
31SB05B	02U01090	39SB05A	02U01099
31SB05C	02U01091		

Data were reviewed by Eric Malarek and validated using a combination of method-specific criteria, laboratory SOP, and the *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993). Parameters evaluated are presented in Table 1. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1. Laboratory Performance Criteria

Qualified		Parameter
Yes	No	
X		Holding Times
	X	Initial and Continuing Calibration
	X	Laboratory Control Samples
	X	Sample Duplicate
	X	Calculation Verification

The quality of data collected in support of this sampling activity is considered acceptable with noted qualifications.

Eric Malarek, Chemist

9/10/02
Date

RADFORD ARMY AMMUNITION PLANT VALIDATION REPORT
pH REVIEW
SDG RD020

I-Holding Times and Preservation
Holding time criteria: Preserved, Cool 4°C±2°C, ASAP within 24 hours for pH. The dates and times were compared between the sample collection and laboratory analysis.

- Samples were collected 07/08-09/02 and analyzed for pH on 07/15/02. pH should be analyzed ASAP within 24 hours. All samples were estimated as "J".

II-Initial and Continuing Calibration
Bench and run summary sheets were reviewed to determine whether calibration was performed at the beginning of sample analysis using the following criteria. Percent recoveries for initial and continuing calibration must be ±0.05 units for pH.

pH: 1 - blank
3 – buffer standards

- pH analysis was run on 07/15/02. All criteria were met. No qualifiers were applied.

III-Laboratory Control Samples
The laboratory control sample (LCS) serves as a monitor of the overall performance of each step during the analysis, including the sample preparation. All LCS results must fall within the control limits.

- Sample QC-197715-1 was used as pH LCS. All criteria were met. No qualifier was applied.

IV-Duplicate Sample Analysis
Duplicate sample determinations are used to demonstrate acceptable method precision by the laboratory at the time of analysis. Duplicate analysis are also performed to generate data in order to determine the long-term precision of the analytical method on various matrices. RPDs must be within established control limits.

- Sample 31SE11 (02U01117) was used as sample duplicate. All criteria were met. No qualifiers were applied.

V-Calculation Verification
The accuracy of analytical results is verified through the calculation of several parameters. The percent difference (%D) between the calculated and the reported values should be within 10%. The following calculations were performed for verification:

pH Sample: 31SB05A (02U01089)

pH (units) = Reading

pH (units) = 7.37

Reported Value = 7.37 units

% Difference = 0.0%

Form L Cay

DATA CHEM LABORATORIES
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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690K7

Date Printed.....: 19-JUL-02 14:52

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

Client Sample Name: B43SB34|B43SB34A
DCL Sample Name...: 02U01097
DCL Report Group..: 02U-0088-48

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:55
Reporting Units...: pH units
Report Basis.....: [X] As Received [ ] Dried

DCL Preparation Group: Not Applicable
Date Prepared.....: 15-JUL-02 00:00
Preparation Method...: Not Applicable
Aliquot Weight/Volume: 20 g
Net Weight/Volume,...: Not Required

DCL Analysis Group: G026G03J
Analysis Method...: 9045C
Instrument Type...: PP
Instrument ID.....: Orion 720A+
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
pH	15-JUL-02 00:00	+/- 0.1	5.03	J		1	+/- 0.1

Sample Comments

Soil pH measured in water at 24.3°C.

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MEMORANDUM

TO: Jeff Parks

FROM: Eric Malarek

SUBJECT: Radford Army Ammunition Plant Data Validation
Semivolatile Organic Compounds
DataChem, Inc., SDG RD020

DATE: September 9, 2002

The purpose of this memorandum is to present the data validation report for the samples collected at Radford Army Ammunition Plant on July 8-9, 2002. Samples were analyzed for semivolatile organic compounds (SVOCs) using USEPA SW846 Method 3550A/8270C. A total of four soil samples were validated. The sample IDs were:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
B43SB35A	02U01092	B43SB34A	02U01097
B43SB35B	02U01093	B43SB34B	02U01098

Data were reviewed by Eric Malarek and validated using a combination of method-specific criteria, laboratory SOP, and the *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September, 1994). Parameters evaluated are presented in Table 1. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1. Laboratory Performance Criteria

Qualified		Parameter
Yes	No	
	X	Holding Times
	X	Instrument Performance Check
X		Initial Calibration
X		Continuing Calibration
X		Blank Analysis
	X	Surrogate Spikes
	X	Internal Standards
	X	Laboratory Control Standard
	X	Matrix Spike/Spike Duplicate
X		Quantitation Verification

The quality of data collected in support of this sampling activity is considered acceptable with the noted qualifications.

Eric Malarek, Chemist

9/9/02
Date

RADFORD ARMY AMMUNITION PLANT VALIDATION REPORT
SEMIVOLATILE ORGANIC COMPOUNDS REVIEW
SDG RD020

I-Holding Times

The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of sample extraction and analysis. Holding time criteria: For SVOC compounds in cooled (@4°C ± 2°C) soil samples, the maximum holding time is 14 days from sample collection to preparative extraction and 40 days from preparative extraction to determinative analysis.

- The samples were collected on 07/08/02, extracted on 07/13/02, and analyzed on 07/16/02. All criteria were met and no qualifiers were applied.

II-Instrument Performance Check

GC/MS instrument performance checks are performed to ensure mass resolution, identification and, to some degree, sensitivity. The analysis of the instrument performance check solution must be performed at the beginning of each 12-hour period during which samples are analyzed.

- The instrument performance check, decafluorotriphenylphosphine (DFTPP), met the ion abundance criteria. No qualification was applied.

III-Initial Calibration

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for specified compounds. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve. The minimum relative response factor (RRF) criteria must be ≥ 0.05. Initial calibration percent relative standard deviation (%RSD) must be ≤ 15% on the average for all compounds (< 30% for CCCs). Grossly exceeding is defined where %D>30%.

- For initial calibration performed on 07/15/02 on instrument 5972-Q, target compounds benzoic acid (39.9%), 3-nitroaniline (26.6%), 4-nitroaniline (38.6%), carbazole (20.2%), dibenzofuran (18.1%), fluorene (18.4%), bis(2-ethylhexyl)phthalate (16.6%) were outside of criteria. All RRFs were ≥ 0.05. For benzoic acid, 3-nitroaniline, 4-nitroaniline, carbazole, dibenzofuran, fluorene, and bis(2-ethylhexyl)phthalate, all detects were qualified "J" and non-detects no qualifier based upon these outliers. All samples were analyzed using this initial calibration

IV-Continuing Calibration

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used was capable of producing acceptable qualitative and quantitative data for semivolatile target compounds. Continuing calibration standards containing both target and surrogates compounds are analyzed at the beginning of each 12-hour analysis period following the analysis of the instrument performance check and prior to the analysis of blanks and samples. The minimum relative response factors (RRF) for semivolatile target compounds and surrogates must be ≥ 0.05. The percent difference (%D) between the initial calibration RRF and the continuing calibration RRF must be within ± 20% for all target compounds. Grossly exceeding is defined where %D>40%.

- For continuing calibration performed on 07/16/02 @10:12 on instrument 5972-Q, carbazole (22.0%) was outside criteria. All RRFs were ≥ 0.05. Detects were qualified "J" and non-detects no qualifiers were applied based upon these outliers. All samples were analyzed using this continuing calibration.

V-Blank Analysis.
The purpose of laboratory (or field) blank analyses is to determine the existence and magnitude of contamination problems resulting from field and laboratory activities. No contamination should be found in any of the blanks > MDL. Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤ 5 times (10 times for phthalate esters) the maximum amount for SVOC compounds detected. Action levels are based upon 100% solids and adjusted for each sample as appropriate. Table 2 summarizes the blank contamination analysis. The soil rinse blanks included samples 061102R, 061902R1, 071002R2, and 072502RB. The maximum concentration from these rinse blanks was used for this assessment.

Table 2. Blank Contamination Analysis Summary

Analysis Date	QC Blank ID	Compound	Max Conc. µg/kg	Action Level µg/kg	B qualified samples
07/16/02	BL-197743-1	Bis(2-ethylhexyl)phthalate	42	420	All Samples
07/16/02	BL-197743-1	Di-n-octylphthalate	20	200	B43SB35B, B43SB34A, B43SB34B
Various	RBs	Phenol	211	1060	None
Various	RBs	Benzyl alcohol	95.7	479	None
Various	RBs	2-methylphenol	8.58	42.9	None
Various	RBs	4-methylphenol	11.2	56.0	None
Various	RBs	Benzoic acid	363	1820	None
Various	RBs	Diethylphthalate	330	3300	None
Various	RBs	Di-n-butylphthalate	2079	20800	None
Various	RBs	Butylbenzylphthalate	20.1	201	None
Various	RBs	Bis(2-ethylhexyl)phthalate	165	1650	All Samples

VI-Surrogate Spikes
Laboratory performance on individual samples is evaluated through the review of surrogate spike samples. Surrogate spikes are added to all samples and blanks to measure their recovery in sample and blank matrices. The percent recoveries (%Rs) must be within the specified control limits.

Criteria:
2,4,6-Tribromophenol (28.6-120%)
2-Fluorobiphenyl (32.8-125%)
2-Fluorophenol (18.6-109%)
Nitrobenzene-d5 (21.7-122%)
Phenol – d5 (16.0-117%)
Terphenyl – d14 (22.8-143%)

- All criteria were met. No qualifiers were applied.

VII-Internal Standards
Internal standards performance criteria ensure that GC/MS sensitivity and response are stable during every analytical run. Internal standard area counts for samples and blanks must not vary by more than a factor of two (- 50% to + 100%) from the associated calibration standard. The retention time of the internal standards in samples and blanks must not vary by more than ± 30 seconds from the retention time of the associated calibration standard.

- All criteria were met. No qualifiers were applied.

VIII-Laboratory Control Samples
Laboratory control samples (LCS) are used to monitor laboratory accuracy by calculating the percent recoveries of the spiked compounds. All LCS percent recoveries must be within the specified control limits.

- Sample QC-197743-1 was used as LCS for SVOCs. All criteria were met. No qualifiers were applied. All samples apply to this LCS.

IX-Matrix Spike/Matrix Spike Duplicate
Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. The percent recoveries (%Rs) and the relative percent difference (RPD) must be within the specified control limits.

- Sample B43SB35A (02U01092) was used for the MS/MSD analysis. All criteria were met. No qualifiers were applied.

X-Quantitation Verification
The accuracy of analytical results was verified through the calculation of several parameters. Percent difference (%D) between the calculated and reported values must be ≤10%. Any sample value > MDL and < MRL is qualified as estimated, "J".

Sample: B43SB35A (02U01092), phenanthrene

Conc. µg/kg = (Ax * Is * Vt * DF) / (Ais * RRF * Vi * Ws * D)

where:
- Conc. = Sample concentration in µg/kg
- Ax = Area of characteristic ion for compound being measured.
- Is = Amount of internal standard injected (ng).
- Vt = Volume of total extract, taking into account dilutions (i.e., a 1-to-10 dilution of a 1-mL extract will mean V(t) = 10,000 uL.
- Ais = Area of characteristic ion for the internal standard.
- RRF = Average relative response factor for compound being measured (from ICAL)
- Vi = Volume of extract injected (uL).
- W(s) = Weight of sample extracted or diluted in grams.
- D = Percent dry weight (100 - % moisture in sample)/100
- DF = Dilution factor

Conc. µg/kg = (9068 * 40 * 1000 * 1) / (1445327 * 1.128 * 1 * 30 * 0.962) = 7.7 µg/kg
Reported Value = 7.7 µg/kg
% Difference = 0.0%
Values were within 10% difference

DATA CHEM LABORATORIES
A Sorenson Company

SAMPLE ANALYSIS DATA SHEET

S02690JJ

Date Printed.....: 17-JUL-02 10:16

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: G026H038
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 3550A
Aliquot Weight/Volume: 30 grams
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35A
DCL Sample Name...: 02U01092
DCL Report Group..: 02U-0088-44

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:10
Reporting Units...: ug/kg
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 96.2

DCL Analysis Group: G026H038
Analysis Method...: 8270C
Instrument Type...: GC/MS SV
Instrument ID.....: 5972-Q
Column Type.....: DB5 30m x .32mm
☒Primary
☐Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Pyridine	16-JUL-02 11:48	48.	ND			1	170
Phenol	16-JUL-02 11:48	9.1	ND			1	170
Bis(2-chloroethyl)ether	16-JUL-02 11:48	3.9	ND			1	170
2-Chlorophenol	16-JUL-02 11:48	4.2	ND			1	170
1,3-Dichlorobenzene	16-JUL-02 11:48	5.4	ND			1	170
1,4-Dichlorobenzene	16-JUL-02 11:48	6.0	ND			1	170
Benzyl Alcohol	16-JUL-02 11:48	20.	ND			1	170
1,2-Dichlorobenzene	16-JUL-02 11:48	5.0	ND			1	170
2-Methylphenol	16-JUL-02 11:48	7.1	ND			1	170
Bis(2-chloroisopropyl)ether	16-JUL-02 11:48	3.9	ND			1	170
4-Methylphenol	16-JUL-02 11:48	6.2	ND			1	170
N-Nitrosodi-n-propyl amine	16-JUL-02 11:48	23.	ND			1	170
Hexachloroethane	16-JUL-02 11:48	4.7	ND			1	170
Nitrobenzene	16-JUL-02 11:48	8.6	ND			1	170
Isophorone	16-JUL-02 11:48	4.4	ND			1	170
2-Nitrophenol	16-JUL-02 11:48	5.8	ND			1	170
2,4-Dimethylphenol	16-JUL-02 11:48	33.	ND			1	170
Benzoic acid	16-JUL-02 11:48	120	ND			1	870
bis(2-Chloroethoxy)methane	16-JUL-02 11:48	5.4	ND			1	170
2,4-Dichlorophenol	16-JUL-02 11:48	4.1	ND			1	170
1,2,4-Trichlorobenzene	16-JUL-02 11:48	7.2	ND			1	170
Naphthalene	16-JUL-02 11:48	6.4	ND			1	170
4-Chloroaniline	16-JUL-02 11:48	22.	ND			1	170
Hexachlorobutadiene	16-JUL-02 11:48	5.9	ND			1	170
4-Chloro-3-methylphenol	16-JUL-02 11:48	8.3	ND			1	170
2-Methylnaphthalene	16-JUL-02 11:48	6.7	ND			1	170
Hexachlorocyclopentadiene	16-JUL-02 11:48	25.	ND			1	170
2,4,6-Trichlorophenol	16-JUL-02 11:48	5.0	ND			1	170
2,4,5-Trichlorophenol	16-JUL-02 11:48	6.4	ND			1	170
2-Chloronaphthalene	16-JUL-02 11:48	4.5	ND			1	170
2-Nitroaniline	16-JUL-02 11:48	6.0	ND			1	170
Dimethylphthalate	16-JUL-02 11:48	4.6	ND			1	170
2,6-Dinitrotoluene	16-JUL-02 11:48	4.4	ND			1	170
Acenaphthylene	16-JUL-02 11:48	4.7	ND			1	170
3-Nitroaniline	16-JUL-02 11:48	10.	ND			1	170
Acenaphthene	16-JUL-02 11:48	4.9	ND			1	170
2,4-Dinitrophenol	16-JUL-02 11:48	140	ND			1	870
4-Nitrophenol	16-JUL-02 11:48	170	ND			1	870
Dibenzofuran	16-JUL-02 11:48	5.0	ND			1	170
2,4-Dinitrotoluene	16-JUL-02 11:48	5.9	ND			1	170
Diethylphthalate	16-JUL-02 11:48	5.1	ND			1	170

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DATA CHEM LABORATORIES
A Sorenson Company

FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690JJ

Date Printed.....: 17-JUL-02 10:16
Client Name.....: SHAW E&I, Inc.--Radford Army

DCL Sample Name...: 02U01092
DCL Report Group..: 02U-0088-44

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
4-Chlorophenyl Phenyl Ether	16-JUL-02 11:48	5.5	ND			1	170
Fluorene	16-JUL-02 11:48	5.7	ND			1	170
4-Nitroaniline	16-JUL-02 11:48	6.1	ND			1	170
4,6-Dinitro-2-Methylphenol	16-JUL-02 11:48	110	ND			1	870
N-nitrosodiphenylamine	16-JUL-02 11:48	8.3	ND			1	170
4-Bromophenyl Phenyl Ether	16-JUL-02 11:48	4.5	ND			1	170
Hexachlorobenzene	16-JUL-02 11:48	6.5	ND			1	170
Pentachlorophenol	16-JUL-02 11:48	150	ND			1	870
Phenanthrene	16-JUL-02 11:48	5.5	7.7	J	J	1	170
Anthracene	16-JUL-02 11:48	5.1	ND			1	170
Carbazole	16-JUL-02 11:48	7.6	ND			1	170
Di-n-butylphthalate	16-JUL-02 11:48	51.	ND			1	170
Fluoranthene	16-JUL-02 11:48	5.7	8.8	J	J	1	170
Pyrene	16-JUL-02 11:48	5.4	8.2	J	J	1	170
Butylbenzylphthalate	16-JUL-02 11:48	6.9	ND			1	170
3,3'-Dichlorobenzidine	16-JUL-02 11:48	15.	ND			1	170
Benzo(a)anthracene	16-JUL-02 11:48	5.0	8.0	J	J	1	170
Chrysene	16-JUL-02 11:48	4.0	8.6	J	J	1	170
Bis(2-ethylhexyl)phthalate	16-JUL-02 11:48	12.	53.	B	JB	1	170
Di-n-octylphthalate	16-JUL-02 11:48	7.8	ND			1	170
Benzo(b)fluoranthene	16-JUL-02 11:48	3.7	10.	J	J	1	170
Benzo(k)fluoranthene	16-JUL-02 11:48	5.0	ND			1	170
Benzo(a)pyrene	16-JUL-02 11:48	4.3	ND			1	170
Indeno(1,2,3-c,d)pyrene	16-JUL-02 11:48	6.7	12.	J	J	1	170
Dibenz(a,h)Anthracene	16-JUL-02 11:48	5.1	ND			1	170
Benzo(g,h,i)perylene	16-JUL-02 11:48	4.9	11.	J	J	1	170

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
2,4,6-Tribromophenol	1480	1670	88.6
2-Fluorobiphenyl	1380	1670	82.6
2-Fluorophenol	1330	1670	79.8
Nitrobenzene-d5	1390	1670	83.2
Phenol-d5	1690	1670	102.
Terphenyl-d14	1520	1670	91.1

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DATA CHEM LABORATORIES
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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690JK

Date Printed.....: 17-JUL-02 10:16

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: G026H038
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 3550A
Aliquot Weight/Volume: 30 grams
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35B
DCL Sample Name...: 02U01093
DCL Report Group..: 02U-0088-44

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:15
Reporting Units...: ug/kg
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 79.7

DCL Analysis Group: G026H038
Analysis Method...: 8270C
Instrument Type...: GC/MS SV
Instrument ID.....: 5972-Q
Column Type.....: DB5 30m x .32mm
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Pyridine	16-JUL-02 13:24	58.	ND			1	210
Phenol	16-JUL-02 13:24	11.	ND			1	210
Bis(2-chloroethyl)ether	16-JUL-02 13:24	4.8	ND			1	210
2-Chlorophenol	16-JUL-02 13:24	5.0	ND			1	210
1,3-Dichlorobenzene	16-JUL-02 13:24	6.6	ND			1	210
1,4-Dichlorobenzene	16-JUL-02 13:24	7.2	ND			1	210
Benzyl Alcohol	16-JUL-02 13:24	25.	ND			1	210
1,2-Dichlorobenzene	16-JUL-02 13:24	6.0	ND			1	210
2-Methylphenol	16-JUL-02 13:24	8.5	ND			1	210
Bis(2-chloroisopropyl)ether	16-JUL-02 13:24	4.7	ND			1	210
4-Methylphenol	16-JUL-02 13:24	7.5	ND			1	210
N-Nitrosodi-n-propyl amine	16-JUL-02 13:24	27.	ND			1	210
Hexachloroethane	16-JUL-02 13:24	5.6	ND			1	210
Nitrobenzene	16-JUL-02 13:24	10.	ND			1	210
Isophorone	16-JUL-02 13:24	5.3	ND			1	210
2-Nitrophenol	16-JUL-02 13:24	7.0	ND			1	210
2,4-Dimethylphenol	16-JUL-02 13:24	40.	ND			1	210
Benzoic acid	16-JUL-02 13:24	140	ND			1	1000
bis(2-Chloroethoxy)methane	16-JUL-02 13:24	6.5	ND			1	210
2,4-Dichlorophenol	16-JUL-02 13:24	5.0	ND			1	210
1,2,4-Trichlorobenzene	16-JUL-02 13:24	8.7	ND			1	210
Naphthalene	16-JUL-02 13:24	7.7	ND			1	210
4-Chloroaniline	16-JUL-02 13:24	26.	ND			1	210
Hexachlorobutadiene	16-JUL-02 13:24	7.1	ND			1	210
4-Chloro-3-methylphenol	16-JUL-02 13:24	10.	ND			1	210
2-Methylnaphthalene	16-JUL-02 13:24	8.1	ND			1	210
Hexachlorocyclopentadiene	16-JUL-02 13:24	31.	ND			1	210
2,4,6-Trichlorophenol	16-JUL-02 13:24	6.0	ND			1	210
2,4,5-Trichlorophenol	16-JUL-02 13:24	7.7	ND			1	210
2-Chloronaphthalene	16-JUL-02 13:24	5.4	ND			1	210
2-Nitroaniline	16-JUL-02 13:24	7.3	ND			1	210
Dimethylphthalate	16-JUL-02 13:24	5.6	ND			1	210
2,6-Dinitrotoluene	16-JUL-02 13:24	5.3	ND			1	210
Acenaphthylene	16-JUL-02 13:24	5.7	ND			1	210
3-Nitroaniline	16-JUL-02 13:24	12.	ND			1	210
Acenaphthene	16-JUL-02 13:24	5.9	ND			1	210
2,4-Dinitrophenol	16-JUL-02 13:24	160	ND			1	1000
4-Nitrophenol	16-JUL-02 13:24	210	ND			1	1000
Dibenzofuran	16-JUL-02 13:24	6.0	ND			1	210
2,4-Dinitrotoluene	16-JUL-02 13:24	7.1	ND			1	210
Diethylphthalate	16-JUL-02 13:24	6.1	ND			1	210

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

Form RLIMS63A-V1.3
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Page 8



Date Printed.....: 17-JUL-02 10:16
Client Name.....: SHAW E&I, Inc.--Radford Army

DCL Sample Name...: 02U01093
DCL Report Group..: 02U-0088-44

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
4-Chlorophenyl Phenyl Ether	16-JUL-02 13:24	6.6	ND			1	210
Fluorene	16-JUL-02 13:24	6.9	ND			1	210
4-Nitroaniline	16-JUL-02 13:24	7.4	ND			1	210
4,6-Dinitro-2-Methylphenol	16-JUL-02 13:24	140	ND			1	1000
N-nitrosodiphenylamine	16-JUL-02 13:24	10.	ND			1	210
4-Bromophenyl Phenyl Ether	16-JUL-02 13:24	5.4	ND			1	210
Hexachlorobenzene	16-JUL-02 13:24	7.9	ND			1	210
Pentachlorophenol	16-JUL-02 13:24	180	ND			1	1000
Phenanthrene	16-JUL-02 13:24	6.6	ND			1	210
Anthracene	16-JUL-02 13:24	6.2	ND			1	210
Carbazole	16-JUL-02 13:24	9.2	ND			1	210
Di-n-butylphthalate	16-JUL-02 13:24	61.	ND			1	210
Fluoranthene	16-JUL-02 13:24	6.9	ND			1	210
Pyrene	16-JUL-02 13:24	6.5	ND			1	210
Butylbenzylphthalate	16-JUL-02 13:24	8.3	ND			1	210
3,3'-Dichlorobenzidine	16-JUL-02 13:24	19.	ND			1	210
Benzo(a)anthracene	16-JUL-02 13:24	6.1	ND			1	210
Chrysene	16-JUL-02 13:24	4.9	ND			1	210
Bis(2-ethylhexyl)phthalate	16-JUL-02 13:24	14.	86.	B	JB	1	210
Di-n-octylphthalate	16-JUL-02 13:24	9.4	23.	B	JB	1	210
Benzo(b)fluoranthene	16-JUL-02 13:24	4.5	ND			1	210
Benzo(k)fluoranthene	16-JUL-02 13:24	6.0	ND			1	210
Benzo(a)pyrene	16-JUL-02 13:24	5.2	ND			1	210
Indeno(1,2,3-c,d)pyrene	16-JUL-02 13:24	8.1	ND			1	210
Dibenz(a,h)Anthracene	16-JUL-02 13:24	6.1	ND			1	210
Benzo(g,h,i)perylene	16-JUL-02 13:24	5.9	ND			1	210

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
2,4,6-Tribromophenol	1560	1670	93.4
2-Fluorobiphenyl	1460	1670	87.7
2-Fluorophenol	1350	1670	81.0
Nitrobenzene-d5	1390	1670	83.3
Phenol-d5	1630	1670	97.6
Terphenyl-d14	1480	1670	89.0

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET



Date Printed.....: 17-JUL-02 10:16

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: G026H038
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 3550A
Aliquot Weight/Volume: 30 grams
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34A
DCL Sample Name...: 02U01097
DCL Report Group..: 02U-0088-44

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:55
Reporting Units...: ug/kg
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 91.4

DCL Analysis Group: G026H038
Analysis Method...: 8270C
Instrument Type...: GC/MS SV
Instrument ID.....: 5972-Q
Column Type.....: DB5 30m x .32mm
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Pyridine	16-JUL-02 13:55	51.	ND			1	180
Phenol	16-JUL-02 13:55	9.6	ND			1	180
Bis(2-chloroethyl)ether	16-JUL-02 13:55	4.1	ND			1	180
2-Chlorophenol	16-JUL-02 13:55	4.4	ND			1	180
1,3-Dichlorobenzene	16-JUL-02 13:55	5.7	ND			1	180
1,4-Dichlorobenzene	16-JUL-02 13:55	6.3	ND			1	180
Benzyl Alcohol	16-JUL-02 13:55	22.	ND			1	180
1,2-Dichlorobenzene	16-JUL-02 13:55	5.2	ND			1	180
2-Methylphenol	16-JUL-02 13:55	7.5	ND			1	180
Bis(2-chloroisopropyl)ether	16-JUL-02 13:55	4.1	ND			1	180
4-Methylphenol	16-JUL-02 13:55	6.5	ND			1	180
N-Nitrosodi-n-propyl amine	16-JUL-02 13:55	24.	ND			1	180
Hexachloroethane	16-JUL-02 13:55	4.9	ND			1	180
Nitrobenzene	16-JUL-02 13:55	9.1	ND			1	180
Isophorone	16-JUL-02 13:55	4.6	ND			1	180
2-Nitrophenol	16-JUL-02 13:55	6.1	ND			1	180
2,4-Dimethylphenol	16-JUL-02 13:55	35.	ND			1	180
Benzoic acid	16-JUL-02 13:55	130	ND			1	910
bis(2-Chloroethoxy)methane	16-JUL-02 13:55	5.6	ND			1	180
2,4-Dichlorophenol	16-JUL-02 13:55	4.3	ND			1	180
1,2,4-Trichlorobenzene	16-JUL-02 13:55	7.6	ND			1	180
Naphthalene	16-JUL-02 13:55	6.7	ND			1	180
4-Chloroaniline	16-JUL-02 13:55	23.	ND			1	180
Hexachlorobutadiene	16-JUL-02 13:55	6.2	ND			1	180
4-Chloro-3-methylphenol	16-JUL-02 13:55	8.0	ND			1	180
2-Methylnaphthalene	16-JUL-02 13:55	7.0	ND			1	180
Hexachlorocyclopentadiene	16-JUL-02 13:55	27.	ND			1	180
2,4,6-Trichlorophenol	16-JUL-02 13:55	5.3	ND			1	180
2,4,5-Trichlorophenol	16-JUL-02 13:55	6.7	ND			1	180
2-Chloronaphthalene	16-JUL-02 13:55	4.7	ND			1	180
2-Nitroaniline	16-JUL-02 13:55	6.3	ND			1	180
Dimethylphthalate	16-JUL-02 13:55	4.8	ND			1	180
2,6-Dinitrotoluene	16-JUL-02 13:55	4.6	ND			1	180
Acenaphthylene	16-JUL-02 13:55	5.0	ND			1	180
3-Nitroaniline	16-JUL-02 13:55	11.	ND			1	180
Acenaphthene	16-JUL-02 13:55	5.1	ND			1	180
2,4-Dinitrophenol	16-JUL-02 13:55	140	ND			1	910
4-Nitrophenol	16-JUL-02 13:55	180	ND			1	910
Dibenzofuran	16-JUL-02 13:55	5.3	ND			1	180
2,4-Dinitrotoluene	16-JUL-02 13:55	6.2	ND			1	180
Diethylphthalate	16-JUL-02 13:55	5.3	ND			1	180

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET



Date Printed.....: 17-JUL-02 10:16
Client Name.....: SHAW E&I, Inc.--Radford Army

DCL Sample Name...: 02U01097
DCL Report Group..: 02U-0088-44

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
4-Chlorophenyl Phenyl Ether	16-JUL-02 13:55	5.8	ND			1	180
Fluorene	16-JUL-02 13:55	6.0	ND			1	180
4-Nitroaniline	16-JUL-02 13:55	6.4	ND			1	180
4,6-Dinitro-2-Methylphenol	16-JUL-02 13:55	120	ND			1	910
N-nitrosodiphenylamine	16-JUL-02 13:55	8.7	ND			1	180
4-Bromophenyl Phenyl Ether	16-JUL-02 13:55	4.7	ND			1	180
Hexachlorobenzene	16-JUL-02 13:55	6.8	ND			1	180
Pentachlorophenol	16-JUL-02 13:55	160	ND			1	910
Phenanthrene	16-JUL-02 13:55	5.7	14.	J	J	1	180
Anthracene	16-JUL-02 13:55	5.4	ND			1	180
Carbazole	16-JUL-02 13:55	8.0	ND			1	180
Di-n-butylphthalate	16-JUL-02 13:55	53.	ND			1	180
Fluoranthene	16-JUL-02 13:55	6.0	16.	J	J	1	180
Pyrene	16-JUL-02 13:55	5.6	15.	J	J	1	180
Butylbenzylphthalate	16-JUL-02 13:55	7.2	ND			1	180
3,3'-Dichlorobenzidine	16-JUL-02 13:55	16.	ND			1	180
Benzo(a)anthracene	16-JUL-02 13:55	5.3	ND			1	180
Chrysene	16-JUL-02 13:55	4.3	15.	J	J	1	180
Bis(2-ethylhexyl)phthalate	16-JUL-02 13:55	12.	55.	B	JB	1	180
Di-n-octylphthalate	16-JUL-02 13:55	8.2	51.	B	JB	1	180
Benzo(b)fluoranthene	16-JUL-02 13:55	3.9	12.	J	J	1	180
Benzo(k)fluoranthene	16-JUL-02 13:55	5.2	ND			1	180
Benzo(a)pyrene	16-JUL-02 13:55	4.6	ND			1	180
Indeno(1,2,3-c,d)pyrene	16-JUL-02 13:55	7.1	ND			1	180
Dibenz(a,h)Anthracene	16-JUL-02 13:55	5.3	ND			1	180
Benzo(g,h,i)perylene	16-JUL-02 13:55	5.2	ND			1	180

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
2,4,6-Tribromophenol	1640	1670	98.1
2-Fluorobiphenyl	1400	1670	83.9
2-Fluorophenol	1270	1670	76.3
Nitrobenzene-d5	1330	1670	79.7
Phenol-d5	1590	1670	95.3
Terphenyl-d14	1490	1670	89.5

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

Form RLIMS63A-V1.3
07170210163492
Page 11

S02690JM

Date Printed.....: 17-JUL-02 10:16

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: G026H038
Date Prepared.....: 13-JUL-02 00:00
Preparation Method...: 3550A
Aliquot Weight/Volume: 30 grams
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34B
DCL Sample Name...: 02U01098
DCL Report Group..: 02U-0088-44

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 16:00
Reporting Units...: ug/kg
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 76.7

DCL Analysis Group: G026H038
Analysis Method...: 8270C
Instrument Type...: GC/MS SV
Instrument ID.....: 5972-Q
Column Type.....: DB5 30m x .32mm
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Pyridine	16-JUL-02 14:27	60.	ND			1	220
Phenol	16-JUL-02 14:27	11.	ND			1	220
Bis(2-chloroethyl)ether	16-JUL-02 14:27	4.9	ND			1	220
2-Chlorophenol	16-JUL-02 14:27	5.2	ND			1	220
1,3-Dichlorobenzene	16-JUL-02 14:27	6.8	ND			1	220
1,4-Dichlorobenzene	16-JUL-02 14:27	7.5	ND			1	220
Benzyl Alcohol	16-JUL-02 14:27	26.	ND			1	220
1,2-Dichlorobenzene	16-JUL-02 14:27	6.2	ND			1	220
2-Methylphenol	16-JUL-02 14:27	8.9	ND			1	220
Bis(2-chloroisopropyl)ether	16-JUL-02 14:27	4.9	ND			1	220
4-Methylphenol	16-JUL-02 14:27	7.7	ND			1	220
N-Nitrosodi-n-propyl amine	16-JUL-02 14:27	28.	ND			1	220
Hexachloroethane	16-JUL-02 14:27	5.8	ND			1	220
Nitrobenzene	16-JUL-02 14:27	11.	ND			1	220
Isophorone	16-JUL-02 14:27	5.5	ND			1	220
2-Nitrophenol	16-JUL-02 14:27	7.2	ND			1	220
2,4-Dimethylphenol	16-JUL-02 14:27	41.	ND			1	220
Benzoic acid	16-JUL-02 14:27	150	ND			1	1100
bis(2-Chloroethoxy)methane	16-JUL-02 14:27	6.7	ND			1	220
2,4-Dichlorophenol	16-JUL-02 14:27	5.2	ND			1	220
1,2,4-Trichlorobenzene	16-JUL-02 14:27	9.0	ND			1	220
Naphthalene	16-JUL-02 14:27	8.0	ND			1	220
4-Chloroaniline	16-JUL-02 14:27	27.	ND			1	220
Hexachlorobutadiene	16-JUL-02 14:27	7.3	ND			1	220
4-Chloro-3-methylphenol	16-JUL-02 14:27	10.	ND			1	220
2-Methylnaphthalene	16-JUL-02 14:27	8.4	ND			1	220
Hexachlorocyclopentadiene	16-JUL-02 14:27	32.	ND			1	220
2,4,6-Trichlorophenol	16-JUL-02 14:27	6.3	ND			1	220
2,4,5-Trichlorophenol	16-JUL-02 14:27	8.0	ND			1	220
2-Chloronaphthalene	16-JUL-02 14:27	5.6	ND			1	220
2-Nitroaniline	16-JUL-02 14:27	7.5	ND			1	220
Dimethylphthalate	16-JUL-02 14:27	5.8	ND			1	220
2,6-Dinitrotoluene	16-JUL-02 14:27	5.5	ND			1	220
Acenaphthylene	16-JUL-02 14:27	5.9	ND			1	220
3-Nitroaniline	16-JUL-02 14:27	13.	ND			1	220
Acenaphthene	16-JUL-02 14:27	6.1	ND			1	220
2,4-Dinitrophenol	16-JUL-02 14:27	170	ND			1	1100
4-Nitrophenol	16-JUL-02 14:27	220	ND			1	1100
Dibenzofuran	16-JUL-02 14:27	6.3	ND			1	220
2,4-Dinitrotoluene	16-JUL-02 14:27	7.4	ND			1	220
Diethylphthalate	16-JUL-02 14:27	6.4	ND			1	220

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DATA CHEM LABORATORIES
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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690JM

Date Printed.....: 17-JUL-02 10:16
Client Name.....: SHAW E&I, Inc.--Radford Army

DCL Sample Name...: 02U01098
DCL Report Group..: 02U-0088-44

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
4-Chlorophenyl Phenyl Ether	16-JUL-02 14:27	6.9	ND			1	220
Fluorene	16-JUL-02 14:27	7.2	ND			1	220
4-Nitroaniline	16-JUL-02 14:27	7.6	ND			1	220
4,6-Dinitro-2-Methylphenol	16-JUL-02 14:27	140	ND			1	1100
N-nitrosodiphenylamine	16-JUL-02 14:27	10.	ND			1	220
4-Bromophenyl Phenyl Ether	16-JUL-02 14:27	5.6	ND			1	220
Hexachlorobenzene	16-JUL-02 14:27	8.2	ND			1	220
Pentachlorophenol	16-JUL-02 14:27	190	ND			1	1100
Phenanthrene	16-JUL-02 14:27	6.8	ND			1	220
Anthracene	16-JUL-02 14:27	6.4	ND			1	220
Carbazole	16-JUL-02 14:27	9.5	ND			1	220
Di-n-butylphthalate	16-JUL-02 14:27	63.	ND			1	220
Fluoranthene	16-JUL-02 14:27	7.2	ND			1	220
Pyrene	16-JUL-02 14:27	6.7	ND			1	220
Butylbenzylphthalate	16-JUL-02 14:27	8.6	ND			1	220
3,3'-Dichlorobenzidine	16-JUL-02 14:27	19.	ND			1	220
Benzo(a)anthracene	16-JUL-02 14:27	6.3	ND			1	220
Chrysene	16-JUL-02 14:27	5.1	ND			1	220
Bis(2-ethylhexyl)phthalate	16-JUL-02 14:27	15.	66.	B	JB	1	220
Di-n-octylphthalate	16-JUL-02 14:27	9.8	11.	B	JB	1	220
Benzo(b)fluoranthene	16-JUL-02 14:27	4.7	ND			1	220
Benzo(k)fluoranthene	16-JUL-02 14:27	6.2	ND			1	220
Benzo(a)pyrene	16-JUL-02 14:27	5.4	ND			1	220
Indeno(1,2,3-c,d)pyrene	16-JUL-02 14:27	8.4	ND			1	220
Dibenz(a,h)Anthracene	16-JUL-02 14:27	6.4	ND			1	220
Benzo(g,h,i)perylene	16-JUL-02 14:27	6.2	ND			1	220

Surrogate Recoveries

Analyte	Result	Spiked Amount	Percent Recovery
2,4,6-Tribromophenol	1660	1670	99.8
2-Fluorobiphenyl	1340	1670	80.6
2-Fluorophenol	1400	1670	84.0
Nitrobenzene-d5	1370	1670	82.1
Phenol-d5	1690	1670	101.
Terphenyl-d14	1460	1670	87.3

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MEMORANDUM

TO: Jeff Parks

FROM: Eric Malarek

SUBJECT: Radford Army Ammunition Plant Data Validation – TAL Metals
DataChem, Inc., SDG RD020

DATE: September 5, 2002

The purpose of this memorandum is to present the data validation report for the samples collected at Radford Army Ammunition Plant on July 08-09, 2002. Samples were analyzed for target analyte list (TAL) metals using SW-846 3051/6010B for ICP metals, SW-846 ILMO5.0/6020 for ICP-MS metals, and SW-846 7471A for mercury. A total of sixteen soil samples were validated. The sample IDs are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
31SB05A	02U01089	39SB05A	02U01099
31SB05B	02U01090	39SB06A	02U01100
31SB05C	02U01091	39SS07	02U01101
B43SB35B	02U01093	39SS08	02U01102
B43SS01	02U01094	39SS09	02U01103
B43SS02	02U01095	39SS10	02U01104
B43SS03	02U01096	39SS11	02U01105
B43SB34B	02U01098	39SS12	02U01106

Data were reviewed by Eric Malarek and validated using a combination of method-specific criteria, laboratory SOP, and the *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993). Parameters evaluated under data validation procedure Level IM3 are presented in Table 1. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1. Laboratory Performance Criteria

Qualified		Parameter
Yes	No	
	X	Holding Times
X		Initial and Continuing Calibration
X		Blank Analysis
	X	ICP Interference Check Sample (ICS)
X		Laboratory Control Sample and Laboratory Control Sample Duplicate
X		Sample Duplicate
X		Matrix Spike and Spike Duplicate
X		ICP Serial Dilution
X		Quantitation Verification

The quality of data collected in support of this sampling activity is considered acceptable with noted qualifications.

Eric Malarek, Chemist

9/5/02
Date

RADFORD ARMY AMMUNITION PLANT VALIDATION REPORT
TAL METALS REVIEW
SDG RD020

I-Holding Times

The primary objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of sample analysis. Holding time criteria: For soil samples cooled @4 °C ± 2 °C, the maximum holding time is 180 days for ICP-MS metals and 28 days for mercury.

- The samples were collected on 07/08-09/02. ICP metals were prepared 07/17/02, ICP-MS metals were prepared 07/28/02, and mercury samples were prepared 07/22/02. ICP metals were analyzed 07/19/02, ICP-MS metals were analyzed 08/13/02, and mercury samples were analyzed 07/24/02. All criteria were met and no qualifiers were applied.

II-Initial and Continuing Calibration

Requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable quantitative data. Initial calibration demonstrates that the instrument is capable of acceptable performance at the beginning of the analysis run, and continuing calibration verification documents that the initial calibration is still valid.

ICP and ICP-MS:	1- blank	Hg:	1 – blank
	3 – standards ($r \geq 0.995$)		5 – standards ($r \geq 0.995$)
	ICV/CCV Std. – 90-110%		ICV/CCV Std. – 90-110%
	MRL Std. – 50-150%		MRL Std. – 50-150%

- ICP metals were analyzed 07/19/02 and ICP-MS metals were analyzed 08/13/02. Total mercury was analyzed on 07/24/02 with a correlation coefficient of 0.9999. Table 2 summarizes the MRL standard analysis. Samples with concentrations detected less than two times the MRL with out of criteria MRL recovery were qualified.

Table 2 MRL Analysis Summary

Analysis Date	Analysis	MRL (µg/L)	MRL %Recovery	Qualified samples @ <2xMRL	Validation Qualifiers
07/19/02	ICP	NA	All within criteria	None	NA
08/13/02	ICP-MS	NA	All within criteria	None	NA
07/24/02	Hg	NA	All within criteria	None	NA

III-Blanks

Blanks (preparation and calibration blanks) are assessed to determine the existence and magnitude of contamination problems. No contaminants should be detected in any of the associated blanks. Samples are qualified "B" when they are less than 5X the absolute value of the maximum blank concentration. Action levels are based upon 100% solids and adjusted for each sample as appropriate. Table 2 summarizes the blank contamination analysis. The soil rinse blanks included samples 061102R, 061902R1, 071002R2, and 072502RB. The maximum concentration from these rinse blanks was used for this assessment.

Table 2. Blank Contamination Analysis Summary

Analysis Date	Analysis	QC Blank ID	Target Compound	Max Conc. mg/kg	Action Level mg/kg	B qualified samples
07/19/02	ICP	ICB/CCBs	Ag	0.701	3.51	All Samples, except B43SB34B
07/19/02	ICP	ICB/CCBs	Mg	3.768	18.8	None
07/19/02	ICP	BL-197730-1	Ag	0.061	0.31	None
07/19/02	ICP	BL-197730-1	V	0.090	0.45	None
08/13/02	ICP-MS	ICB/CCBs	Pb	0.0391	0.20	None
08/13/02	ICP-MS	BL-197731-1	Pb	0.259	1.30	None
08/13/02	ICP-MS	BL-197731-1	Se	0.365	1.83	31SB05A
Various	ICP-MS	RBs	Sb	0.070	0.35	31SB05A, 31SB05C, B43SS01, B43SS02, B43SS03, 39SB05A, 39SB06A, 39SS07, 39SS08
Various	ICP-MS	RBs	Be	0.10	0.50	None
Various	ICP-MS	RBs	Cd	0.013	0.065	None
Various	ICP-MS	RBs	Pb	0.494	2.47	None
Various	ICP	RBs	Ca	4.97	24.9	None
Various	ICP	RBs	Cr	0.597	2.99	None
Various	ICP	RBs	Fe	4.56	22.8	None
Various	ICP	RBs	Mn	0.121	0.61	None
Various	ICP	RBs	Na	5.10	25.5	B43SB35B, B43SS02, B43SS03, 39SB05A, 39SB06A, 39SS10
Various	Hg	RBs	All <MRL	NA	NA	None
07/24/02	Hg	ICB/CCBs	All <MRL	NA	NA	None
07/24/02	Hg	BI-197732-1	All <MRL	NA	NA	None

IV-ICP and ICP-MS Interference Check Sample (ICS)
The ICP Interference Check Sample (ICS) verifies interelement and background correction factors. ICP Interference Check is performed at the beginning and end of each sample analysis run. Control limits are 80-120%.

- All criteria were met. No qualifiers were applied.

V-Laboratory Control Samples (LCS) and Laboratory Control Sample Duplicate
The laboratory control sample (LCS) serves as a monitor of the overall performance of each step during the analysis, including the sample preparation. All soil LCS and LCSD results must fall within the concentration control limits and %RPD limits.

- Sample QC-197730-1 was used as LCS/LCSD for ICP metals. All criteria were met. No qualifiers were applied.

- Sample QD-197731-1 was used as LCS/LCSD for ICP-MS metals. All criteria were met. No qualifiers were applied.

- Sample QC-197732-1 was used as LCS/LCSD for mercury. All criteria were met. No qualifiers were applied.

VI-Duplicate Sample Analysis
Duplicate sample determinations are used to demonstrate acceptable method precision by the laboratory at the time of analysis. Duplicate analysis are also performed to generate data in order to determine the long-term precision of the analytical method on various matrices. RPDs must be within established control limits (RPD≤20%).

- Sample 31SB05A (02U01089) was used as sample duplicate for ICP metals analysis. All criteria were met. No qualifiers were applied.

- Sample 31SB05A (02U01089) was used as sample duplicate for ICP-MS metals analysis. Cadmium (23%), lead (50%), selenium (200%), and thallium (39%) were outside criteria. Selenium was outside due to low sample concentrations, therefore no qualifiers were applied based upon this outlier. Cadmium, lead, and thallium were qualified "J" for detects.

- Sample 31SB05AMS (02U01089MS) was used as sample duplicate for mercury analysis. All criteria were met. No qualifiers were applied.

VI-Matrix Spike and Spike Duplicate

MS/MSD are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. Specific criteria include the analyses of matrix spike and matrix spike duplicate samples at a frequency of one MS and MSD per 20 samples of similar matrix. MS and MSD recoveries and relative percent differences between MS and MSD recoveries should be within the specified limits. (75-125%; RPD≤20%)

- For the MS/MSD analyses, sample 31SB05A (02U01089) was used for ICP metals. Aluminum (292, -60.3%), iron (579, 366%), and zinc (64.3%) were outside of control limits. All of the %RPDs were within control limits. The sample concentration was >4 times the spike added for aluminum and iron, therefore no qualifiers were applied based upon this outlier. For zinc, all detects were qualified "L" and non-detects "UL" based upon the low recovery.

- For the MS/MSD analyses, sample 31SB05A (02U01089) was used for ICP-MS metals. Antimony (53.4, 58.7%) was outside of control limits. For antimony, all detects were qualified "L" and non-detects "UL" based upon the low recoveries.

- For the MS/MSD analyses, sample 31SB05A (02U01089) was used for mercury. Mercury (69.7%) was outside of control limits. For mercury, all detects were qualified "L" and non-detects "UL" based upon the low recoveries.

VIII-ICP and ICP-MS Serial Dilution

An ICP-MS serial dilution is performed to determine whether significant physical or chemical interferences exist due to sample matrix at high concentrations. An analysis of a 5-fold dilution should agree within 10% difference of the original result when the concentration in sample is a factor of 50 above MDL.

- The serial dilution for the ICP was analyzed for sample 31SB05A (02U01089). Iron (12.4%), manganese (11.4%), and zinc (18.0%) were outside of criteria limits. Iron, manganese, and zinc were qualified "J" for detects and no qualifier for non-detects based upon these outliers.

- The serial dilution for the ICP-MS was analyzed for sample 31SB05A (02U01089). Antimony (100%), arsenic (100%), cadmium (100%), selenium (100%), and thallium (100%) were outside of criteria limits. Sample concentrations were <50 times MDL for antimony, arsenic, cadmium, selenium, and thallium, therefore no qualifiers were applied based upon these outliers.

- The serial dilution for the ICP-MS was analyzed for sample 31SE11 (02U01117). Antimony (100%), arsenic (100%), cadmium (100%), and thallium (100%) were outside of criteria limits. Sample concentrations were <50 times MDL for antimony, arsenic, cadmium, and thallium, therefore no qualifiers were applied based upon these outliers.

IX-Quantitation Verification

The accuracy of analytical results is verified through the calculation of several parameters. The percent difference (%D) between the calculated and the reported values should be within 10%. All results less than the method reporting limit (MRL) and greater than the method detection limit (MDL) are reported as estimated "J". The following calculations were performed for verification:

ICP Sample: 31SB05A (02U01089), Aluminum

Conc. (mg/kg) = {(conc. ug/L) *(Final Volume L) * (DF)} / {(Weight Sample g) * (Fraction Solids)}

Conc. (mg/kg) = 6498.48 / (0.901) = 7210 mg/kg (Direct Reading from Software)

Reported concentration = 7210 mg/kg
%D = 0.0%
Values were within 10% difference.

ICP-MS Sample: 31SB05A (02U01089), Arsenic

Conc. (mg/kg) = {(conc. ug/L) *(Final Volume L) * (DF)} / {(Weight Sample g) * (Fraction Solids)}

Conc. (mg/kg) = {(10.636 ug/L)*(0.100 L)*(5)} / {(1.0011 g)*(0.901)} = 5.90 mg/kg

Reported concentration = 5.90 mg/kg
%D = 0.0%
Values were within 10% difference.

CVAA Sample: 31SB05A (02U01089), Mercury

Conc. (mg/kg) = {(conc. ug/L) *(Final Volume L) * (DF)} / {(Weight Sample g) * (Fraction Solids)}

Conc. (mg/kg) = {(0.5440 ug/L)*(0.100 L)*(1)} / {(0.5 g)*(0. 901)} = 0.121 mg/kg

Reported concentration = 0.121 mg/kg
%D = 0.0%
Values were within 10% difference.

Form I Corr

DATA CHEM LABORATORIES
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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET



Date Printed.....: 08-AUG-02 14:30

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 17-JUL-02 00:00
Preparation Method...: 3051
Aliquot Weight/Volume: 0.5 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35B
DCL Sample Name...: 02U01093
DCL Report Group..: 02U-0088-33

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:15
Reporting Units...: µg/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 79.7

DCL Analysis Group: G026P011
Analysis Method...: 6010B
Instrument Type...: ICP
Instrument ID.....: ICP-E
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Aluminum	19-JUL-02 13:44	6.9	38000			1	25.1
Barium	19-JUL-02 13:44	0.42	45.8			1	2.51
Beryllium	19-JUL-02 00:00	0.0433	0.57	J	B	1	0.627
Calcium	19-JUL-02 13:44	3.5	909.			1	12.5
Chromium	19-JUL-02 13:44	0.47	95.4			1	1.25
Cobalt	19-JUL-02 13:44	1.0	7.11			1	6.27
Copper	19-JUL-02 13:44	0.77	24.9			1	2.51
Iron	19-JUL-02 13:44	4.2	37800	J		1	6.27
Magnesium	19-JUL-02 13:44	3.0	1070			1	12.5
Manganese	19-JUL-02 13:44	0.070	159.	J		1	1.25
Nickel	19-JUL-02 13:44	1.2	13.7			1	5.02
Potassium	19-JUL-02 13:44	42.	1090			1	376.
Silver	19-JUL-02 13:44	0.62	0.80	B	B	1	1.25
Sodium	19-JUL-02 13:44	4.7	12.	B	B	1	25.1
Vanadium	19-JUL-02 13:44	0.73	75.4			1	6.27
Zinc	19-JUL-02 13:44	0.45	36.8	J		1	2.51

Form E Corr

DATA CHEM LABORATORIES
A Sorenson Company

FORM A (TYPE I)
SINGLE METHOD ANALYSES

Form RLIMS63A-V1.3
08080214302138

SAMPLE ANALYSIS DATA SHEET

S02690BN

Date Printed.....: 08-AUG-02 14:30

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 17-JUL-02 00:00
Preparation Method...: 3051
Aliquot Weight/Volume: 0.5 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SS01|B43SS01
DCL Sample Name...: 02U01094
DCL Report Group..: 02U-0088-33

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:25
Reporting Units...: µg/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 87.5

DCL Analysis Group: G026P011
Analysis Method...: 6010B
Instrument Type...: ICP
Instrument ID.....: ICP-E
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Aluminum	19-JUL-02 13:46	6.3	15200			1	22.9
Barium	19-JUL-02 13:46	0.38	62.1			1	2.29
Beryllium	19-JUL-02 00:00	0.0394	0.46	J	B	1	0.571
Calcium	19-JUL-02 13:46	3.2	31500			1	11.4
Chromium	19-JUL-02 13:46	0.43	41.0			1	1.14
Cobalt	19-JUL-02 13:46	0.93	5.98			1	5.71
Copper	19-JUL-02 13:46	0.71	20.0			1	2.29
Iron	19-JUL-02 13:46	3.8	16800	J		1	5.71
Magnesium	19-JUL-02 13:46	2.7	19400			1	11.4
Manganese	19-JUL-02 13:46	0.064	269.	J		1	1.14
Nickel	19-JUL-02 13:46	1.0	8.82			1	4.57
Potassium	19-JUL-02 13:46	38.	966.			1	343.
Silver	19-JUL-02 13:46	0.56	0.69	B	B	1	1.14
Sodium	19-JUL-02 13:46	4.3	39.1			1	22.9
Vanadium	19-JUL-02 13:46	0.66	35.0			1	5.71
Zinc	19-JUL-02 13:46	0.41	53.0	J		1	2.29

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690BP

Date Printed.....: 08-AUG-02 14:30

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 17-JUL-02 00:00
Preparation Method...: 3051
Aliquot Weight/Volume: 0.5 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SS02|B43SS02
DCL Sample Name...: 02U01095
DCL Report Group..: 02U-0088-33

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:45
Reporting Units...: µg/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 85.6

DCL Analysis Group: G026P011
Analysis Method...: 6010B
Instrument Type...: ICP
Instrument ID.....: ICP-E
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Aluminum	19-JUL-02 13:48	6.5	7660			1	23.4
Barium	19-JUL-02 13:48	0.39	41.1			1	2.34
Beryllium	19-JUL-02 00:00	0.0403	0.57	J	B	1	0.584
Calcium	19-JUL-02 13:48	3.3	9190			1	11.7
Chromium	19-JUL-02 13:48	0.44	27.2			1	1.17
Cobalt	19-JUL-02 13:48	0.95	10.3			1	5.84
Copper	19-JUL-02 13:48	0.72	19.6			1	2.34
Iron	19-JUL-02 13:48	3.9	13800	J		1	5.84
Magnesium	19-JUL-02 13:48	2.8	7300			1	11.7
Manganese	19-JUL-02 13:48	0.065	290.	J		1	1.17
Nickel	19-JUL-02 13:48	1.1	16.1			1	4.67
Potassium	19-JUL-02 13:48	39.	1070			1	350.
Silver	19-JUL-02 13:48	0.58	0.66	B	B	1	1.17
Sodium	19-JUL-02 13:48	4.4	13.	B	B	1	23.4
Vanadium	19-JUL-02 13:48	0.68	15.8			1	5.84
Zinc	19-JUL-02 13:48	0.42	30.6	J		1	2.34

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DATA CHEM LABORATORIES
A Sorenson Company

FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690BQ

Date Printed.....: 08-AUG-02 14:30

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 17-JUL-02 00:00
Preparation Method...: 3051
Aliquot Weight/Volume: 0.5 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SS03|B43SS03
DCL Sample Name...: 02U01096
DCL Report Group..: 02U-0088-33

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:50
Reporting Units...: µg/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 88.6

DCL Analysis Group: G026P011
Analysis Method...: 6010B
Instrument Type...: ICP
Instrument ID.....: ICP-E
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Aluminum	19-JUL-02 13:50	6.2	11700			1	22.6
Barium	19-JUL-02 13:50	0.38	60.0			1	2.26
Beryllium	19-JUL-02 00:00	0.0389	0.46	J	B	1	0.564
Calcium	19-JUL-02 13:50	3.2	1940			1	11.3
Chromium	19-JUL-02 13:50	0.42	19.9			1	1.13
Cobalt	19-JUL-02 13:50	0.91	10.6			1	5.64
Copper	19-JUL-02 13:50	0.70	10.0			1	2.26
Iron	19-JUL-02 13:50	3.8	15200	J		1	5.64
Magnesium	19-JUL-02 13:50	2.7	2400			1	11.3
Manganese	19-JUL-02 13:50	0.063	561.	J		1	1.13
Nickel	19-JUL-02 13:50	1.0	11.7			1	4.51
Potassium	19-JUL-02 13:50	38.	1100			1	339.
Silver	19-JUL-02 13:50	0.56	0.73	B	B	1	1.13
Sodium	19-JUL-02 13:50	4.2	8.5	B	B	1	22.6
Vanadium	19-JUL-02 13:50	0.65	25.4			1	5.64
Zinc	19-JUL-02 13:50	0.40	31.5	J		1	2.26

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690BR

Date Printed.....: 08-AUG-02 14:30

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 17-JUL-02 00:00
Preparation Method...: 3051
Aliquot Weight/Volume: 0.5 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34B
DCL Sample Name...: 02U01098
DCL Report Group..: 02U-0088-33

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 16:00
Reporting Units...: µg/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 76.7

DCL Analysis Group: G026P011
Analysis Method...: 6010B
Instrument Type...: ICP
Instrument ID.....: ICP-E
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Aluminum	19-JUL-02 13:52	7.2	30100			1	26.1
Barium	19-JUL-02 13:52	0.44	78.3			1	2.61
Beryllium	19-JUL-02 00:00	0.0450	0.34	J	B	1	0.652
Calcium	19-JUL-02 13:52	3.6	794.			1	13.0
Chromium	19-JUL-02 13:52	0.49	40.5			1	1.30
Cobalt	19-JUL-02 13:52	1.1	2.5	J	B	1	6.52
Copper	19-JUL-02 13:52	0.80	16.2			1	2.61
Iron	19-JUL-02 13:52	4.4	17200	J		1	6.52
Magnesium	19-JUL-02 13:52	3.1	1060			1	13.0
Manganese	19-JUL-02 13:52	0.073	29.8	J		1	1.30
Nickel	19-JUL-02 13:52	1.2	7.91			1	5.22
Potassium	19-JUL-02 13:52	44.	756.			1	391.
Silver	19-JUL-02 13:52	0.64	ND		U	1	1.30
Sodium	19-JUL-02 13:52	4.9	31.1	B		1	26.1
Vanadium	19-JUL-02 13:52	0.75	42.5			1	6.52
Zinc	19-JUL-02 13:52	0.47	35.9	J		1	2.61

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690C7

Date Printed.....: 14-AUG-02 15:35

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 28-JUL-02 09:00
Preparation Method...: ILM05.0 Draft
Aliquot Weight/Volume: 1.0 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35B
DCL Sample Name...: 02U01093
DCL Report Group..: 02U-0088-34

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:15
Reporting Units...: ug/g
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 79.7

DCL Analysis Group: G027F01X
Analysis Method...: 6020
Instrument Type...: ICP/MS
Instrument ID.....: ICP-MS1
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Antimony	13-AUG-02 17:50	0.21	ND	VL	U	1.00	0.627
Arsenic	13-AUG-02 17:50	0.44	0.841			1.00	0.627
Cadmium	13-AUG-02 17:50	0.060	37.7	J		1.00	0.125
Lead	13-AUG-02 17:50	0.038	19.3	J		1.00	0.376
Selenium	13-AUG-02 17:50	0.41	ND		U	1.00	1.25
Thallium	13-AUG-02 17:50	0.038	0.14	J	B	1.00	0.376

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690C8

Date Printed.....: 14-AUG-02 15:35

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 28-JUL-02 09:00
Preparation Method...: ILM05.0 Draft
Aliquot Weight/Volume: 1.0 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SS01|B43SS01
DCL Sample Name...: 02U01094
DCL Report Group..: 02U-0088-34

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:25
Reporting Units...: ug/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 87.5

DCL Analysis Group: G027F01X
Analysis Method...: 6020
Instrument Type...: ICP/MS
Instrument ID.....: ICP-MS1
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Antimony	13-AUG-02 17:55	0.19	0.39	B	B	1.00	0.571
Arsenic	13-AUG-02 17:55	0.40	4.97			1.00	0.571
Cadmium	13-AUG-02 17:55	0.054	107.	J		1.00	0.114
Lead	13-AUG-02 17:55	0.035	58.9	J		1.00	0.343
Selenium	13-AUG-02 17:55	0.37	ND		U	1.00	1.14
Thallium	13-AUG-02 17:55	0.034	0.18	J	B	1.00	0.343

SAMPLE ANALYSIS DATA SHEET



Date Printed.....: 14-AUG-02 15:35

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 28-JUL-02 09:00
Preparation Method...: ILM05.0 Draft
Aliquot Weight/Volume: 1.0 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SS02|B43SS02
DCL Sample Name...: 02U01095
DCL Report Group..: 02U-0088-34

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:45
Reporting Units...: ug/g
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 85.6

DCL Analysis Group: G027F01X
Analysis Method...: 6020
Instrument Type...: ICP/MS
Instrument ID.....: ICP-MS1
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Antimony	13-AUG-02 17:59	0.20	0.20	B	B	1.00	0.584
Arsenic	13-AUG-02 17:59	0.41	2.05			1.00	0.584
Cadmium	13-AUG-02 17:59	0.056	273.	J		1.00	0.117
Lead	13-AUG-02 17:59	0.035	27.1	J		1.00	0.350
Selenium	13-AUG-02 17:59	0.38	ND		U	1.00	1.17
Thallium	13-AUG-02 17:59	0.035	0.090	J	B	1.00	0.350

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690CB

Date Printed.....: 14-AUG-02 15:35

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 28-JUL-02 09:00
Preparation Method...: ILM05.0 Draft
Aliquot Weight/Volume: 1.0 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SS03|B43SS03
DCL Sample Name...: 02U01096
DCL Report Group..: 02U-0088-34

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:50
Reporting Units...: ug/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 88.6

DCL Analysis Group: G027F01X
Analysis Method...: 6020
Instrument Type...: ICP/MS
Instrument ID.....: ICP-MS1
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Antimony	13-AUG-02 18:03	0.19	0.20	B	B	1.00	0.564
Arsenic	13-AUG-02 18:03	0.39	3.04			1.00	0.564
Cadmium	13-AUG-02 18:03	0.054	2.36	J		1.00	0.113
Lead	13-AUG-02 18:03	0.034	29.2	J		1.00	0.339
Selenium	13-AUG-02 18:03	0.37	ND		U	1.00	1.13
Thallium	13-AUG-02 18:03	0.034	0.12	J	B	1.00	0.339

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A Sorenson Company

FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690CC

Date Printed.....: 14-AUG-02 15:35

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 28-JUL-02 09:00
Preparation Method...: ILM05.0 Draft
Aliquot Weight/Volume: 1.0 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34B
DCL Sample Name...: 02U01098
DCL Report Group..: 02U-0088-34

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 16:00
Reporting Units...: ug/g
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 76.7

DCL Analysis Group: G027F01X
Analysis Method...: 6020
Instrument Type...: ICP/MS
Instrument ID.....: ICP-MS1
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Antimony	13-AUG-02 18:08	0.22	ND	VL	U	1.00	0.652
Arsenic	13-AUG-02 18:08	0.46	4.25			1.00	0.652
Cadmium	13-AUG-02 18:08	0.062	18.5	J		1.00	0.130
Lead	13-AUG-02 18:08	0.039	14.7	J		1.00	0.391
Selenium	13-AUG-02 18:08	0.43	ND		U	1.00	1.30
Thallium	13-AUG-02 18:08	0.039	0.16	J	B	1.00	0.391

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

Form RLIMS63A-V1.3
07240213391610

S02690CW

SAMPLE ANALYSIS DATA SHEET

Date Printed.....: 24-JUL-02 13:39

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 22-JUL-02 00:00
Preparation Method...: 7471A
Aliquot Weight/Volume: 0.50 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35B
DCL Sample Name...: 02U01093
DCL Report Group..: 02U-0088-35

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:15
Reporting Units...: ug/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 79.7

DCL Analysis Group: G026R00J
Analysis Method...: 7471A
Instrument Type...: CVAA
Instrument ID.....: AAS-CVG
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Mercury	24-JUL-02 10:54	0.025	0.026	L	B	1	0.0627

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690CX

Date Printed.....: 24-JUL-02 13:39

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 22-JUL-02 00:00
Preparation Method...: 7471A
Aliquot Weight/Volume: 0.50 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SS01|B43SS01
DCL Sample Name...: 02U01094
DCL Report Group..: 02U-0088-35

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:25
Reporting Units...: ug/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 87.5

DCL Analysis Group: G026R00J
Analysis Method...: 7471A
Instrument Type...: CVAA
Instrument ID.....: AAS-CVG
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Mercury	24-JUL-02 10:55	0.023	0.0871	L		1	0.0571

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690CY

Date Printed.....: 24-JUL-02 13:39

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 22-JUL-02 00:00
Preparation Method...: 7471A
Aliquot Weight/Volume: 0.50 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SS02|B43SS02
DCL Sample Name...: 02U01095
DCL Report Group..: 02U-0088-35

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:45
Reporting Units...: ug/g
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 85.6

DCL Analysis Group: G026R00J
Analysis Method...: 7471A
Instrument Type...: CVAA
Instrument ID.....: AAS-CVG
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Mercury	24-JUL-02 11:00	0.023	0.025	L	B	1	0.0584

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DATA CHEM LABORATORIES
A Sorenson Company

FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690CZ

Date Printed.....: 24-JUL-02 13:39

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 22-JUL-02 00:00
Preparation Method...: 7471A
Aliquot Weight/Volume: 0.50 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SS03|B43SS03
DCL Sample Name...: 02U01096
DCL Report Group..: 02U-0088-35

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:50
Reporting Units...: ug/g
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 88.6

DCL Analysis Group: G026R00J
Analysis Method...: 7471A
Instrument Type...: CVAA
Instrument ID.....: AAS-CVG
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Mercury	24-JUL-02 11:01	0.022	0.0584	L		1	0.0564

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DATA CHEM LABORATORIES
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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690D0

Date Printed.....: 24-JUL-02 13:39

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 22-JUL-02 00:00
Preparation Method...: 7471A
Aliquot Weight/Volume: 0.50 g
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34B
DCL Sample Name...: 02U01098
DCL Report Group..: 02U-0088-35

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 16:00
Reporting Units...: ug/g
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 76.7

DCL Analysis Group: G026R00J
Analysis Method...: 7471A
Instrument Type...: CVAA
Instrument ID.....: AAS-CVG
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Mercury	24-JUL-02 11:03	0.026	0.114	L		1	0.0652

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MEMORANDUM

TO: Jeff Parks

FROM: Eric Malarek

SUBJECT: Radford Army Ammunition Plant Data Validation – TOC
DataChem, Inc., SDG RD020

DATE: September 10, 2002

The purpose of this memorandum is to present the data validation report for the samples collected at the Radford Army Ammunition Plant on July 8-9, 2002. Samples were analyzed for total organic carbon (TOC) using the Lloyd Kahn Method. A total of five soil samples were validated. The sample IDs are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
31SB05A	02U01089	B43SB34A	02U01097
31SB05B	02U01090	39SB05A	02U01099
31SB05C	02U01091		

Data were reviewed by Eric Malarek and validated using a combination of method-specific criteria, laboratory SOP, and the *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993). Parameters evaluated are presented in Table 1. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1. Laboratory Performance Criteria

Qualified		Parameter
Yes	No	
	X	Holding Times
	X	Initial and Continuing Calibration
	X	Blank Analysis
	X	Laboratory Control Samples
	X	Matrix Spike/Spike Duplicate
	X	Calculation Verification

The quality of data collected in support of this sampling activity is considered acceptable.

Eric Malarek, Chemist

9/12/02
Date

RADFORD ARMY AMMUNITION PLANT VALIDATION REPORT
TOC REVIEW
SDG RD020

I-Holding Times and Preservation
Holding time criteria: Preserved, Cool 4°C±2°C, 28 day for TOC. The dates and times were compared between the sample collection and laboratory analysis.

- Sample was collected 07/08-09/02 and analyzed for TOC on 07/17/02. All criteria were met. No qualifiers were applied.

II-Initial and Continuing Calibration
Bench and run summary sheets were reviewed to determine whether calibration was performed at the beginning of sample analysis using the following criteria. Percent recoveries for initial (85-115%) and continuing calibration (90-110%) must be within limits.

TOC: 1 - blank
5 - standards ($r \geq 0.995$)
ICV (85-115%)
CCV (90-110%)

- TOC analysis was run on 07/17/02. All criteria were met. No qualifiers were applied.

III-Blank Analysis
Blanks are assessed to determine the existence and magnitude of contamination problems. The following analytes were detected in associated blanks. Any sample with detected concentrations of less than the five times the maximum (5x Max) concentration detected with the QC blanks were qualified "B." Table 2 summarizes the blank contamination analysis. There was no rinse blank collected for TOC.

Table 2. Blank Contamination Analysis Summary

Analysis Date	Analysis	QC Blank ID	Target Compound	Max Conc. ug/g	Action Level ug/g	B qualified samples
07/17/02	TOC	BL-197714-1	TOC	200	1000	None

IV-Laboratory Control Samples
The laboratory Control Sample (LCS) serves as a monitor of the overall performance of each step during the analysis, including the sample preparation. All LCS results must fall within the control limits (80-120%).

- Sample QC-197714-1 was used as TOC LCS. All criteria were met. No qualifier was applied.

V-Matrix Spike/Matrix Spike Duplicate
Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. The percent recoveries (%Rs) and the relative percent difference (RPD) must be within the specified control limits (75-125%; $\%RPD \leq 20\%$).

- Sample 31SE9B (02U01079) from SDG RD019 was used for the MS/MSD analysis. All criteria were met. No qualifier was applied.

VI-Calculation Verification

The accuracy of analytical results is verified through the calculation of several parameters. The percent difference (%D) between the calculated and the reported values should be within 10%. All samples were analyzed in duplicate. The following calculations were performed for verification:

TOC Sample: 31SB05A (02U01089), TOC

Conc. (ug/g) = Conc (ug/g) / D (using manufacturer software)

Where: D = Percent dry weight (100 - % moisture in sample)/100

Conc. (ug/g) = 47985 / 0.901 = 53300 ug/g

Reported Value = 53300 ug/g

% Difference = 0.0%

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DATA CHEM LABORATORIES
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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690K2

Date Printed.....: 19-JUL-02 12:02

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: 17-JUL-02 00:00
Preparation Method...: Not Applicable
Aliquot Weight/Volume: See Data
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34A
DCL Sample Name...: 02U01097
DCL Report Group..: 02U-0088-47

Matrix.....: SOIL
Date Sampled.....: 08-JUL-02 15:55
Reporting Units...: ug/g
Report Basis.....: ☐As Received ☒Dried
Percent Solids....: 91.4

DCL Analysis Group: G026L00T
Analysis Method...: Lloyd Kahn
Instrument Type...: TOC
Instrument ID.....: LECO CHN-1000
Column Type.....: Not Applicable

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Total Organic Carbon	17-JUL-02 00:00	185.	3950				1090

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MEMORANDUM

TO: Jeff Parks

FROM: Eric Malarek

SUBJECT: Radford Army Ammunition Plant Data Validation - Volatiles
DataChem, Inc., SDG RD020

DATE: September 5, 2002

The purpose of this memorandum is to present the data validation report for the samples collected at Radford Army Ammunition Plant on July 8-9, 2002. The samples were analyzed for volatile organic compounds (VOCs) using USEPA SW846 Method 5035/8260B. A total of ten soil samples were validated. The sample IDs are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
31SB05A	02U01089	B43SB34A	02U01097
31SB05B	02U01090	B43SB34B	02U01098
31SB05C	02U01091	39SB05A	02U01099
B43SB35A	02U01092	39SB06A	02U01100
B43SB35B	02U01093	39SS07	02U01101

Data were reviewed by Eric Malarek and validated using a combination of method-specific criteria, laboratory SOP, and the *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994). Parameters evaluated under data validation procedure Level M3 are presented in Table 1. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1. Laboratory Performance Criteria

Qualified		Parameter
Yes	No	
	X	Holding Times
	X	Instrument Performance Results
	X	Initial Calibration
X		Continuing Calibration
X		Blank Analysis
X		Laboratory Control Sample
X		Matrix Spike/ Spike Duplicate Sample
	X	System Monitoring Compounds
	X	Internal Standards
X		Quantitation Verification

The quality of data collected in support of this sampling activity is considered acceptable with the noted qualifications.

Eric Malarek, Chemist

9/5/02
Date

RADFORD ARMY AMMUNITION PLANT VALIDATION REPORT
VOLATILES REVIEW
SDG RD020

I-Holding Times

The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of analysis. Holding time criteria: For soil samples cooled @ 4°C ± 2°C; the maximum holding time is 14 days from sample collection to analysis.

- The samples were collected on 07/9-10/02. The samples were analyzed for the on 07/12/02. All criteria were met. No qualifiers were applied.

II-Instrument Performance Check

The analysis of the instrument performance check solution must be performed at the beginning of each 12-hour period during which samples are analyzed.

- The instrument performance check, bromofluorobenzene (BFB), met the ion abundance criteria. No qualification was applied.

III-Initial Calibration

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for volatile target compounds. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve. The minimum relative response factor (RRF) must be ≥ 0.05. Percent relative standard deviation (%RSD) must be ≤ 15% for each target compound and must be ≤ 30% for each calibration check compound. Grossly exceeding is defined where %RSD>30%.

- For initial calibration performed on 06/17/02 on instrument 5971-M, all criteria were met. No qualifiers were applied. All samples were analyzed using this initial calibration.

IV-Continuing Calibration

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for volatile target compounds. Continuing calibration establishes the 12-hour relative response factors on which the quantitations are based and checks satisfactory performance of the instrument on a day-to-day basis. The minimum relative response factor (RRF) must be ≥ 0.05. The percent difference (%D) between the initial calibration RRF and the continuing calibration RRF must be within 20% for all target compounds. Grossly exceeding values are considered >40%.

- For continuing calibration performed on 07/12/02 @12:09 on instrument 5971-M, the %Ds/RRFs were outside control limits for acetone (55.2%; grossly exceeding), 2-butanone (27.9%), and 1,2-dichloroethane (20.8%). Acetone was qualified "J" for detects and "UJ" for non-detects. Compounds 2-butanone and 1,2-dichloroethane were qualified "J" for detects and no qualifier for non-detects. All samples were analyzed using this continuing calibration.

V-Blank Analysis

The purpose of blank analyses is to determine the presence and magnitude of contamination problems resulting from field and laboratory activities. A method blank analysis must be performed after the calibration standards and once every 12-hour time period beginning with the injection of BFB. No contaminants should be detected in any of the associated blanks > the MDL. Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤ 10 times (10x) the maximum amount in any blank for the common laboratory contaminants methylene chloride, acetone and 2-butanone, or 5 times (5X) the maximum amount for other volatile target compounds. Action levels are based upon 100% solids and adjusted for each sample as appropriate. Table 2 summarizes the blank contamination analysis. The soil rinse blanks included samples 061102R, 061902R1, 071002R2, and 072502RB. The maximum concentration from these rinse blanks was used for this assessment.

Table 2 Blank Contamination Analysis Summary

Analysis Date	QC Blank ID	Compound	Max Conc. µg/kg	Action Level µg/kg	B qualified samples
07/12/02	BL-197736-1	All <MRL	NA	NA	None
Various	RBs	Acetone	17	170	31SB05C, 39SS07
Various	RBs	Carbon Disulfide	0.71	3.6	None
Various	RBs	Methylene Chloride	16	80.0	None
Various	RBs	Chloroform	1.9	9.5	None
Various	RBs	Carbon Tetrachloride	0.15	0.8	None
Various	RBs	Bromodichloromethane	0.21	1.1	None
Various	RBs	4-methyl-2-pentanone	2.4	12.0	None
Various	RBs	Toluene	0.36	1.8	None
Various	RBs	m&p-Xylene	0.20	1.0	None

VI-Laboratory Control Sample

Form III and chromatograms.

Data for laboratory control samples (LCS) are evaluated to determine long-term accuracy of the analytical method on various matrices. Percent recoveries (%Rs) should be within the specified control limits.

- Sample QC-197736-1 was used as the LCS. Compounds 2-butanone (186%), acetone (253%), cis-1,3-dichloropropene (153%), and trans-1,3-dichloropropene (171%) were outside criteria. Compounds 2-butanone, acetone, cis-1,3-dichloropropene, and trans-1,3-dichloropropene were qualified "K" for detects and no qualifier for non-detects for high %Rs.

VII-Matrix Spike/Matrix Spike Duplicate

Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. The percent recoveries (%Rs) and the relative percent difference (RPD) must be within the specified control limits.

- Sample 31SE11B (02U01117) was used as a MS/MSD. Compounds 1,2-dibromo-3-chloropropane (45.6, 42.7%), 1,2-dibromoethane (42.2, 37.3%), bromoform (46.2, 43.3%), chlorobenzene (57.9, 47.3%), dibromochloromethane (60.4, 55.1%), styrene (38.5, 24.2%), trichloroethene (48.6, 58.0%), cis-1,3-dichloropropene (57.4, 48.7%), and trans-1,3-dichloropropene (48.5, 40.4%) were outside criteria. For 1,2-dibromo-3-chloropropane, 1,2-dibromoethane, bromoform, chlorobenzene, dibromochloromethane, styrene, trichloroethene, cis-1,3-dichloropropene, and trans-1,3-dichloropropene, all detects were qualified bias low "L" and non-detects "UL".

VIII-System Monitoring Compounds (Surrogates)
Laboratory performance on individual samples is evaluated through the review of surrogate spike samples. Recoveries for system monitoring compounds in volatile samples and blanks must be within the specified control limits.

Criteria: 1,2-Dichloroethane-d4 (52.0-149%)
4-Bromofluorobenzene (65.0-135%)
Toluene-d8 (65.0-135%)

- All criteria were met. No qualifiers were applied.

IX-Internal Standards (IS)
Internal standards performance criteria ensure that GC/MS sensitivity and response are stable during every analytical run. Specific criteria include: area counts (-50% to +100%) of the associated calibration standard, and retention time (± 30 seconds) from that of the associated calibration standard.

- All criteria were met. No qualifiers were applied.

X-Quantitation Verification
The accuracy of analytical results is verified through the calculation of several parameters. The percent difference (%D) between the calculated and the reported values should be within 10%. Any sample value > MDL and < MRL is qualified as estimated, "J". Any tentatively identified compound (TIC), if found, was qualified as estimated.

Sample: 31SB05C (02U01091), Acetone

Conc. (µg/kg) = {(Ax)*(Is)*(DF)*(Vp)} / {(Ais)*(RRF)*(Ws)*Fs)}
where:
Ax is the compound area
Is is the corresponding internal standard concentration (ng/mL)
DF is the dilution factor
Vp is the volume purged (mL)
Ais is the corresponding internal standard area
RRF is the relative response factor
Ws is the weight of the sample (g)
Fs is the fraction solids for the sample

Conc. µg/kg = (29219 * 50 ng/mL * 1 * 5mL) / (127650 * 0.281 * 5.6g * 0.864) = 42 µg/kg

Reported Conc. = 42 µg/kg
%D = 0.0%
Values were within 10% difference.

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET



Date Printed.....: 08-AUG-02 14:33

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: Not Applicable
Preparation Method...: 5035
Aliquot Weight/Volume: 5.3 grams
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35A
DCL Sample Name...: 02U01092
DCL Report Group..: 02U-0088-37

Matrix.....: SOIL-E
Date Sampled.....: 08-JUL-02 15:10
Reporting Units...: ug/Kg
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 96.2

DCL Analysis Group: G026R00Z
Analysis Method...: 8260B
Instrument Type...: GC/MS VO
Instrument ID.....: 5971-M
Column Type.....: CAP
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Chloromethane	12-JUL-02 16:06	0.81	ND			0.9	4.7
Vinyl Chloride	12-JUL-02 16:06	0.35	ND			0.9	4.7
Bromomethane	12-JUL-02 16:06	0.34	ND			0.9	4.7
Chloroethane	12-JUL-02 16:06	0.54	ND			0.9	4.7
1,1-Dichloroethene	12-JUL-02 16:06	0.31	ND			0.9	4.7
Acetone	12-JUL-02 16:06	2.1	ND	UJ		0.9	4.7
Carbon Disulfide	12-JUL-02 16:06	0.32	ND			0.9	4.7
Methylene Chloride	12-JUL-02 16:06	0.29	ND			0.9	4.7
trans-1,2-Dichloroethene	12-JUL-02 16:06	0.36	ND			0.9	4.7
cis-1,2-Dichloroethene	12-JUL-02 16:06	0.28	ND			0.9	4.7
1,1-Dichloroethane	12-JUL-02 16:06	0.23	ND			0.9	4.7
2-Butanone	12-JUL-02 16:06	1.9	ND			0.9	4.7
Chloroform	12-JUL-02 16:06	0.29	ND			0.9	4.7
1,1,1-Trichloroethane	12-JUL-02 16:06	0.32	ND			0.9	4.7
Carbon Tetrachloride	12-JUL-02 16:06	0.32	ND			0.9	4.7
1,2-Dichloroethane	12-JUL-02 16:06	0.30	ND			0.9	4.7
Benzene	12-JUL-02 16:06	0.26	ND			0.9	4.7
Trichloroethene	12-JUL-02 16:06	0.52	ND	UL		0.9	4.7
1,2-Dichloropropane	12-JUL-02 16:06	0.33	ND			0.9	4.7
Bromodichloromethane	12-JUL-02 16:06	0.27	ND			0.9	4.7
cis-1,3-Dichloropropene	12-JUL-02 16:06	0.23	ND	UL		0.9	4.7
trans-1,3-Dichloropropene	12-JUL-02 16:06	0.21	ND	UL		0.9	4.7
4-Methyl-2-Pentanone	12-JUL-02 16:06	1.7	ND			0.9	4.7
Toluene	12-JUL-02 16:06	0.30	ND			0.9	4.7
1,1,2-Trichloroethane	12-JUL-02 16:06	2.7	ND			0.9	4.7
Tetrachloroethene	12-JUL-02 16:06	0.45	ND			0.9	4.7
2-Hexanone	12-JUL-02 16:06	1.6	ND			0.9	4.7
Dibromochloromethane	12-JUL-02 16:06	0.25	ND	UL		0.9	4.7
Chlorobenzene	12-JUL-02 16:06	0.33	ND	UL		0.9	4.7
1,1,2,2-Tetrachloroethane	12-JUL-02 16:06	0.27	ND			0.9	4.7
Ethylbenzene	12-JUL-02 16:06	0.31	ND			0.9	4.7
m&p-Xylene	12-JUL-02 16:06	0.98	ND			0.9	9.4
o-Xylene	12-JUL-02 16:06	0.98	ND			0.9	4.7
Styrene	12-JUL-02 16:06	0.28	ND	UL		0.9	4.7
Bromoform	12-JUL-02 16:06	0.20	ND	UL		0.9	4.7

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FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET



Date Printed.....: 08-AUG-02 14:33

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: Not Applicable
Preparation Method...: 5035
Aliquot Weight/Volume: 5.0 grams
Net Weight/Volume....: Not Required

Client Sample Name: B43SB35|B43SB35B
DCL Sample Name...: 02U01093
DCL Report Group..: 02U-0088-37

Matrix.....: SOIL-E
Date Sampled.....: 08-JUL-02 15:15
Reporting Units...: ug/Kg
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 79.7

DCL Analysis Group: G026R00Z
Analysis Method...: 8260B
Instrument Type...: GC/MS VO
Instrument ID.....: 5971-M
Column Type.....: CAP
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Chloromethane	12-JUL-02 16:39	1.1	ND			1	6.3
Vinyl Chloride	12-JUL-02 16:39	0.47	ND			1	6.3
Bromomethane	12-JUL-02 16:39	0.46	ND			1	6.3
Chloroethane	12-JUL-02 16:39	0.73	ND			1	6.3
1,1-Dichloroethene	12-JUL-02 16:39	0.41	ND			1	6.3
Acetone	12-JUL-02 16:39	2.8	ND	UJ		1	6.3
Carbon Disulfide	12-JUL-02 16:39	0.43	ND			1	6.3
Methylene Chloride	12-JUL-02 16:39	0.39	ND			1	6.3
trans-1,2-Dichloroethene	12-JUL-02 16:39	0.48	ND			1	6.3
cis-1,2-Dichloroethene	12-JUL-02 16:39	0.38	ND			1	6.3
1,1-Dichloroethane	12-JUL-02 16:39	0.31	ND			1	6.3
2-Butanone	12-JUL-02 16:39	2.5	ND			1	6.3
Chloroform	12-JUL-02 16:39	0.39	ND			1	6.3
1,1,1-Trichloroethane	12-JUL-02 16:39	0.43	ND			1	6.3
Carbon Tetrachloride	12-JUL-02 16:39	0.43	ND			1	6.3
1,2-Dichloroethane	12-JUL-02 16:39	0.41	ND			1	6.3
Benzene	12-JUL-02 16:39	0.35	ND			1	6.3
Trichloroethene	12-JUL-02 16:39	0.70	ND	VL		1	6.3
1,2-Dichloropropane	12-JUL-02 16:39	0.44	ND			1	6.3
Bromodichloromethane	12-JUL-02 16:39	0.36	ND			1	6.3
cis-1,3-Dichloropropene	12-JUL-02 16:39	0.31	ND	VL		1	6.3
trans-1,3-Dichloropropene	12-JUL-02 16:39	0.27	ND	VL		1	6.3
4-Methyl-2-Pentanone	12-JUL-02 16:39	2.2	ND			1	6.3
Toluene	12-JUL-02 16:39	0.41	ND			1	6.3
1,1,2-Trichloroethane	12-JUL-02 16:39	3.6	ND			1	6.3
Tetrachloroethene	12-JUL-02 16:39	0.60	ND			1	6.3
2-Hexanone	12-JUL-02 16:39	2.0	ND	VL		1	6.3
Dibromochloromethane	12-JUL-02 16:39	0.34	ND	VL		1	6.3
Chlorobenzene	12-JUL-02 16:39	0.44	ND			1	6.3
1,1,2,2-Tetrachloroethane	12-JUL-02 16:39	0.36	ND			1	6.3
Ethylbenzene	12-JUL-02 16:39	0.42	ND			1	6.3
m&p-Xylene	12-JUL-02 16:39	1.3	ND			1	13.
o-Xylene	12-JUL-02 16:39	1.3	ND			1	6.3
Styrene	12-JUL-02 16:39	0.38	ND	VL		1	6.3
Bromoform	12-JUL-02 16:39	0.26	ND	VL		1	6.3

DATA CHEM LABORATORIES
A Sorenson Company

FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

S02690GP

Date Printed.....: 08-AUG-02 14:33

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: Not Applicable
Preparation Method...: 5035
Aliquot Weight/Volume: 5.5 grams
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34A
DCL Sample Name...: 02U01097
DCL Report Group..: 02U-0088-37

Matrix.....: SOIL-E
Date Sampled.....: 08-JUL-02 15:55
Reporting Units...: ug/Kg
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 91.4

DCL Analysis Group: G026R00Z
Analysis Method...: 8260B
Instrument Type...: GC/MS VO
Instrument ID.....: 5971-M
Column Type.....: CAP
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Chloromethane	12-JUL-02 17:13	0.85	ND			0.9	4.9
Vinyl Chloride	12-JUL-02 17:13	0.37	ND			0.9	4.9
Bromomethane	12-JUL-02 17:13	0.36	ND			0.9	4.9
Chloroethane	12-JUL-02 17:13	0.57	ND			0.9	4.9
1,1-Dichloroethene	12-JUL-02 17:13	0.33	ND			0.9	4.9
Acetone	12-JUL-02 17:13	2.2	ND	UJ		0.9	4.9
Carbon Disulfide	12-JUL-02 17:13	0.34	ND			0.9	4.9
Methylene Chloride	12-JUL-02 17:13	0.31	ND			0.9	4.9
trans-1,2-Dichloroethene	12-JUL-02 17:13	0.38	ND			0.9	4.9
cis-1,2-Dichloroethene	12-JUL-02 17:13	0.30	ND			0.9	4.9
1,1-Dichloroethane	12-JUL-02 17:13	0.24	ND			0.9	4.9
2-Butanone	12-JUL-02 17:13	2.0	ND			0.9	4.9
Chloroform	12-JUL-02 17:13	0.31	ND			0.9	4.9
1,1,1-Trichloroethane	12-JUL-02 17:13	0.34	ND			0.9	4.9
Carbon Tetrachloride	12-JUL-02 17:13	0.34	ND			0.9	4.9
1,2-Dichloroethane	12-JUL-02 17:13	0.32	ND			0.9	4.9
Benzene	12-JUL-02 17:13	0.27	ND			0.9	4.9
Trichloroethene	12-JUL-02 17:13	0.55	ND	VL		0.9	4.9
1,2-Dichloropropane	12-JUL-02 17:13	0.35	ND			0.9	4.9
Bromodichloromethane	12-JUL-02 17:13	0.28	ND			0.9	4.9
cis-1,3-Dichloropropene	12-JUL-02 17:13	0.24	ND	VL		0.9	4.9
trans-1,3-Dichloropropene	12-JUL-02 17:13	0.22	ND	VL		0.9	4.9
4-Methyl-2-Pentanone	12-JUL-02 17:13	1.8	ND			0.9	4.9
Toluene	12-JUL-02 17:13	0.32	ND			0.9	4.9
1,1,2-Trichloroethane	12-JUL-02 17:13	2.8	ND			0.9	4.9
Tetrachloroethene	12-JUL-02 17:13	0.47	ND			0.9	4.9
2-Hexanone	12-JUL-02 17:13	1.6	ND			0.9	4.9
Dibromochloromethane	12-JUL-02 17:13	0.26	ND	VL		0.9	4.9
Chlorobenzene	12-JUL-02 17:13	0.35	ND	VL		0.9	4.9
1,1,2,2-Tetrachloroethane	12-JUL-02 17:13	0.28	ND			0.9	4.9
Ethylbenzene	12-JUL-02 17:13	0.33	ND			0.9	4.9
m&p-Xylene	12-JUL-02 17:13	1.0	ND			0.9	9.8
o-Xylene	12-JUL-02 17:13	1.0	ND			0.9	4.9
Styrene	12-JUL-02 17:13	0.30	ND	VL		0.9	4.9
Bromoform	12-JUL-02 17:13	0.21	ND	VL		0.9	4.9

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Form I 1/94

DATA CHEM LABORATORIES
A Sorenson Company

FORM A (TYPE I)
SINGLE METHOD ANALYSES

SAMPLE ANALYSIS DATA SHEET

Form RLIMS63A-V1.3
0808021433169
Page 17

S02690GQ

Date Printed.....: 08-AUG-02 14:33

Client Name.....: SHAW E&I, Inc.--Radford Army
Client Ref Number....: PO# 189444
Sampling Site.....: RFAAP
Release Number.....: RD020

Date Received.....: 10-JUL-02 00:00

DCL Preparation Group: Not Applicable
Date Prepared.....: Not Applicable
Preparation Method...: 5035
Aliquot Weight/Volume: 5.9 grams
Net Weight/Volume....: Not Required

Client Sample Name: B43SB34|B43SB34B
DCL Sample Name...: 02U01098
DCL Report Group..: 02U-0088-37

Matrix.....: SOIL-E
Date Sampled.....: 08-JUL-02 16:00
Reporting Units...: ug/Kg
Report Basis.....: ☐ As Received ☒ Dried
Percent Solids....: 76.7

DCL Analysis Group: G026R00Z
Analysis Method...: 8260B
Instrument Type...: GC/MS VO
Instrument ID.....: 5971-M
Column Type.....: CAP
☒ Primary
☐ Confirmation

Analytical Results

Analyte	Date Analyzed	MDL	Result	Comment	Qual.	Dilution	CRDL
Chloromethane	12-JUL-02 17:46	0.90	ND			0.8	5.2
Vinyl Chloride	12-JUL-02 17:46	0.39	ND			0.8	5.2
Bromomethane	12-JUL-02 17:46	0.39	ND			0.8	5.2
Chloroethane	12-JUL-02 17:46	0.61	ND			0.8	5.2
1,1-Dichloroethene	12-JUL-02 17:46	0.34	ND			0.8	5.2
Acetone	12-JUL-02 17:46	2.3	ND	VJ		0.8	5.2
Carbon Disulfide	12-JUL-02 17:46	0.35	ND			0.8	5.2
Methylene Chloride	12-JUL-02 17:46	0.33	ND			0.8	5.2
trans-1,2-Dichloroethene	12-JUL-02 17:46	0.40	ND			0.8	5.2
cis-1,2-Dichloroethene	12-JUL-02 17:46	0.31	ND			0.8	5.2
1,1-Dichloroethane	12-JUL-02 17:46	0.26	ND			0.8	5.2
2-Butanone	12-JUL-02 17:46	2.1	ND			0.8	5.2
Chloroform	12-JUL-02 17:46	0.33	ND			0.8	5.2
1,1,1-Trichloroethane	12-JUL-02 17:46	0.35	ND			0.8	5.2
Carbon Tetrachloride	12-JUL-02 17:46	0.37	ND			0.8	5.2
1,2-Dichloroethane	12-JUL-02 17:46	0.34	ND			0.8	5.2
Benzene	12-JUL-02 17:46	0.29	ND			0.8	5.2
Trichloroethene	12-JUL-02 17:46	0.57	ND	VL		0.8	5.2
1,2-Dichloropropane	12-JUL-02 17:46	0.37	ND			0.8	5.2
Bromodichloromethane	12-JUL-02 17:46	0.30	ND			0.8	5.2
cis-1,3-Dichloropropene	12-JUL-02 17:46	0.26	ND	VL		0.8	5.2
trans-1,3-Dichloropropene	12-JUL-02 17:46	0.22	ND	VL		0.8	5.2
4-Methyl-2-Pentanone	12-JUL-02 17:46	1.8	ND			0.8	5.2
Toluene	12-JUL-02 17:46	0.34	ND			0.8	5.2
1,1,2-Trichloroethane	12-JUL-02 17:46	3.0	ND			0.8	5.2
Tetrachloroethene	12-JUL-02 17:46	0.51	ND			0.8	5.2
2-Hexanone	12-JUL-02 17:46	1.7	ND	VL		0.8	5.2
Dibromochloromethane	12-JUL-02 17:46	0.27	ND	VL		0.8	5.2
Chlorobenzene	12-JUL-02 17:46	0.37	ND			0.8	5.2
1,1,2,2-Tetrachloroethane	12-JUL-02 17:46	0.30	ND			0.8	5.2
Ethylbenzene	12-JUL-02 17:46	0.34	ND			0.8	5.2
m&p-Xylene	12-JUL-02 17:46	1.1	ND			0.8	10.
o-Xylene	12-JUL-02 17:46	1.1	ND			0.8	5.2
Styrene	12-JUL-02 17:46	0.31	ND	VL		0.8	5.2
Bromoform	12-JUL-02 17:46	0.22	ND	VL		0.8	5.2

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