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Delivery Order No. 0008
Environmental Services
Program Support
DACA31-94-D-0064

RADFORD ARMY AMMUNITION PLANT, VIRGINIA

Work Plan Addendum 009: SWMU 31 and Horseshoe Area Groundwater Study

Prepared for:

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

Prepared by:

IT Corporation
2113 Emmorton Park Rd.
Edgewood, MD 21040

Final Document

September 2002

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

Date: November 13, 2002

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
SWMU 31 and the Horseshoe Area Groundwater Study
Work Plan Addendum 9
Document submittal and review

Dear Mr. McKenna and Ms. Jake:

The U.S. Environmental Protection Agency (EPA) has reviewed the Army's September, 2002 *Work Plan Addendum 9* for the investigation of SWMU 31 and the Horseshoe Area Groundwater, located at the Radford Army Ammunition Plant (RFAAP). Based upon our review, *Work Plan Addendum 9* is approved. In accordance with Part II. (E)(5)of RFAAP's Corrective Action Permit, *Work Plan Addendum 9* is now considered final.

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

ATK
ALLIANT TECHSYSTEMS

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

October 9, 2002

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

Subject: Master Work Plan, Final September 2002,
Work Plan Addendum 9, Final September 2002, and
Work Plan Addendum 12, Final September 2002
Radford Army Ammunition Plant
EPA ID# VA1 210020730

Dear Mr. Thomson:

This letter is to provide certification for:

Master Work Plan, Final September 2002,
Work Plan Addendum 9, Final September 2002 and
Work Plan Addendum 12, Final September 2002.

This letter is also to confirm your September 6, 2002 conversation with Messrs. John Tesner, Jerry Redder and Jim McKenna that the draft final version of these documents in your possession are acceptable as final provided revised document covers are sent. Enclosed is one copy of the revised document covers. Additional covers will be provided by separate letter. One copy of the Master Work Plan will be sent under separate cover to the Virginia Department of Environmental Quality per their request.

Briefly, the draft Master Work Plan was submitted on February 8, 2002 and the draft final Work Plan Addenda 9 and 12 were submitted February 15, 2002. EPA commented on these three documents on May 22, 2002. On July 10, 2002 Radford AAP responded to these comments. We submitted a draft final Master Work Plan (June 2002 edition). The issues raised by EPA in their comments on Work Plan Addenda 9 and 12 were addressed in the attachments to our July 10, 2002 letter so revised documents were not submitted. The Virginia Department of Environmental Quality approved Work Plan Addenda 9and 12 on May 29, 2002 and the Master Work Plan on September 22, 2002.

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

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

Enclosure

c: Durwood Willis
Virginia Department of Environmental Quality
P. O. Box 10009

02-815-139
JMcKenna/JJRedder

1

Richmond, VA 23240-0009

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Aberdeen Proving Ground, MD 21010-5403

w/o enclosure
Russell Fish, P.E., EPA Region III

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

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

Coordination: ______________
J. McKenna

02-815-139
JMcKenna/JJRedder

Concerning: ***Master Work Plan, Final September 2002,***
Work Plan Addendum 9, Final September 2002, and
Work Plan Addendum 12, Final September 2002

I certify under penalty of law that these documents 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: For (CEA)
PRINTED NAME: Brian A. Butler
TITLE: LTC, CM, Commanding
Radford AAP

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

ATK
ALLIANT TECHSYSTEMS

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

July 10, 2002

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

Subject: EPA comments dated May 22, 2002 on Master Work Plan, February 2002, Work Plan Addendum 9, February 2002 and Work Plan Addendum 12, February 2002, Radford Army Ammunition Plant
EPA ID# VA1 210020730

Dear Mr. Thomson:

Enclosed is our response to the above subject.

The Master Work Plan has been revised as noted in our response and a certified copy is enclosed. Your additional five copies and the Virginia Department of Environmental Quality copies will be sent under separate cover. As we believe the issues raised by EPA have been addressed in this latest draft, we request the enclosed document be accepted as final..

Regarding Work Plan Addenda 9 and 12 we believe our enclosed response should satisfy the issues raised by EPA without further revisions to either of these documents. Therefore we request that they be approved in their current form.

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

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

Enclosure

c: Durwood Willis
Virginia Department of Environmental Quality
P. O. Box 10009
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E. A. Lohman
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02-815-100
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WPA 9

3

Kenneth G. Barnes
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w/o enclosure
Russell Fish, P.E., EPA Region III

John Tesner
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Coordination: J. McKenna
J. McKenna

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

02-815-100
JMcKenna/JJRedder

ncerning the following document:

Master Work Plan, June 2002, 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: Anthony Miano
TITLE: Vice President Operations
Alliant Ammunition and Powder Company, LLC

Response to EPA Comments on Master Work Plan (MWP) dated February 2002;
Work Plan Addendum (WPA) 009, dated February 2002;
And Work Plan Addendum (WPA) 012, dated February 2002
Comments dated 22 May 2002
From Rob Thomson

GENERAL COMMENTS

Comment 1: The "Preface" to this draft Master Work Plan, Master Quality Assurance Plan and Master Health & Safety Plan (MWP) states that the "MWP provides comprehensive discussions of standard procedures, protocols, and methodologies that are to be followed during execution of field investigations at RCRA sites within the RFAAP." Figure 2-2 of the MWP shows the locations of Solid Waste Management Units (SWMUs) in the Main Manufacturing Area (MMA) and Figure 2-3 shows the "area locations" in the New River Unit (NRU). However, Figure 2-2 provides numerical designation of the SWMUs, and Figure 2-3 provides names of the areas. In addition, Section 3.0 (Environmental Setting) of the MWP provides extensive environmental setting information for certain SWMUs and Hazardous Waste Management Units (HWMUs). However, these SWMUs and HWMUs are only referenced by their designated numbers, except for the Horseshoe Area (HSA). Since the site-specific Work Plan Addenda (WPA) will be referencing this MWP for the installation description and environmental setting, it is important to identify each SWMU, HWMU and Area of Concern (AOC) by its designated name and number combination, and to provide a map that clearly delineates such information. This will aid the reviewer in understanding and cross-referencing the detailed information provided in Section 3.0. Please revise the MWP to address this issue.

Response

The Master Work Plan will be revised to include both the designated name and number combination and maps will be provided that will aid the reviewers with cross-referencing the detailed information in the report.

Comment 2: The MWP contains numerous inconsistencies in its cross reference of the various information provided. As this MWP will be a comprehensive document that will be referenced by the multiple site-specific WPA, all references and cross-references should be accurate and current. Examples of discrepancies and incompleteness include:

a) In Section 5.2.2 of the MWP, the first bullet references Standard Operating Procedure (SOP) 10.3 of Appendix A regarding the qualifications of drilling contractors and personnel responsible for the supervision of the contractor. However, this information is not provided in the referenced SOP.

Response

The SOP referenced in Section 5.2.2 of the MWP should be SOP 20.11, *Drilling Methods and Procedures*, not 10.3, *Boring Logs*. SOP 20.11 specifies the particular drilling procedures. Section 5.2.2 will be augmented to include a statement regarding the qualifications of drilling contractors and the site geologist.

b) The 7th bullet references Section 5.2.7 for information regarding soil sampling methods during drilling. However, this information is not provided in Section 5.2.7.

Response

The 7th bullet should reference Section 5.2.8 not 5.2.7. The MWP will be revised to refer to the correct section.

c) The last bullet references Section 5.2.5 for soil boring abandonment. However, this information is not provided in Section 5.2.5, it is rather provided in Section 5.2.7.

Response

The MWP will be revised to correct the section reference.

d) In Section 5.2.3.1 of the MWP, the first paragraph on page 5-5 references Section 3.6 for site subsurface conditions. Section 3.6 discusses Regional geology. The referenced information is provided in Section 3.7.

Response

The MWP will be revised to correct the section reference.

e) In SOP 20.11, Sections 2.1 and 2.2, the first bullets refer to Sections 2 and 3 for drilling equipment outline. It is not clear where these sections are located, as Sections 2 and 3 of this SOP do not provide the referenced information.

Response

These references to Sections 2 and 3 will be struck from the MWP.

f) In SOP 20.1, Section 3.3.10 references Figure 20.1a for well construction diagram. However, the referenced figure does not exist. Also, Section 5.6 of the Master Quality Assurance Plan references back to this section for the location of a well construction diagram.

Response

The well construction diagram will be included in the revised MWP.

g) In Section 9.5.1 of the Master Quality Assurance Plan, the 5th bullet states that "This assessment will be provided in the form of data validation reports as defined in Section 9.6.2." However, no such definition is provided in Section 9.6.2.

-A

Response

Section 9.5.1 of the MQAP refers to Section 9.6.2 for a definition of the Data Validation Reports but should refer to Section 9.5.2, *Validation and Verification Methods*. The MQAP will be revised to correct the reference.

Please revise the MWP to address these and other discrepancies, and ensure the document can easily be cross-referenced and is complete.

Response

The Master Work Plan will be revised to address inconsistencies and to ensure the document can easily be cross-referenced and is complete.

Comment 3: Decontamination needs to be addressed. Regional guidelines for organic and inorganic sampling decontamination procedures follow:

- wash with non-phosphate detergent,
- tap water rinse,
- 0.1N nitric acid rinse when cross contamination from metals is a concern,
- deionized/distilled water rinse,
- pesticide-grade solvent, methanol rinse when semivolatile and non-volatile organic contamination may be present,
- double rinse with deionized/distilled water, and
- organic-free water rinse (high performance liquid chromatography [HPLC] grade).

The final water rinse is collected for confirmation analyses, to insure there is no carry over of contaminants to other samples. This procedure is recommended for the geo-punch equipment, and any other re-usable equipment.

Response

The MWP will be revised to incorporate the recommended decontamination procedures.

Comment 4: A provision should be included in the subject document(s) for validating 100% of data generated according to procedures consistent with those specified in the documents "Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analysis," April 1993, and "Region III Modifications to National Functional Guidelines for Organic Data Review Multi-media, Multi-concentration"(OLMO1.0-OLMO1.9) September 1994 by an independent third party. That third party should be named prior to sampling. The laboratory deliverable requirements should be modified to include the submission of a complete raw data package, as appropriate, for this review. That data packet and all electronic tapes should be accessible to the EPA upon request.

7

Response

Non-CLP methods are proposed for analytical work for these WPA. These WPA will be using SW 846 methods. For non-CLP methods, 100% of the data is planned to be independently validated in accordance with the USEPA (SW846) method criteria, performed using the USEPA Region III Modifications to the NFG as guidance. The USEPA Region III Modifications to the NFG criteria is specific to USEPA CLP method criteria. The data qualifiers from the USEPA Region III Modification to the NFG will be used. Discussion as to the laboratory deliverables may be found in Section 9.8.3 of the MWP and is adequate (CLP-like) for data validation. Discussion of data validation may be found in MWP Section 9.5. Data will be made available to USEPA upon request and presented in RFI/RI reports.

Comment 5: Whenever a mass spectral analysis is requested using SW-846 methods, such as 8270 and 8260, the laboratory should submit a Tentatively Identified Compound (TIC) list with each analysis. The TIC list can identify unknown and unexpected compounds at all stages of investigation.

Response

In accordance with Section 5.3 of USEPA Region III's Site Screening Process (SSP) developed for Radford (dated 26 October 2001) and approved by EPA Region III on 11 February 2002, TIC's are to be addressed as follows:

5.3 Tentatively Identified Compounds

Chemical analysis to identify and quantify organic compounds is performed with gas chromatography-mass spectrometry (GC-MS) methods. The GC-MS instrument is calibrated for a series of target analytes using chemical standards of known concentration and purity. Quantification of these target analytes is performed against specific internal standards as identified in the respective method. Identification of these target analytes is based on a comparison of the unknown analyte to the chemical standards used during calibration based on the analyte's retention time and mass spectra.

Chromatographic peaks in volatile/semivolatile fractions analyses that are not target analytes, surrogates, or internal standards are potential Tentatively Identified Compounds (TICs). TICs must be qualitatively identified by a National Institute of Standards and Technology (NIST) mass spectral library search and the identification assessed by the data reviewer. For each sample, the laboratory conducts a mass spectral search of the NIST library and report the possible identity for the 10 VOC and/or 20 SVOC largest fraction peaks that are not surrogates, internal standards, or target compounds, but that have an area or height greater than 10 percent of the area or height of the nearest internal standard. TIC results are reported for each sample on the Organic Analyses Data Sheet (Form I - VOC-TIC or SVOC -TIC)

TICs will be reported and included in the COPC identification based upon the degree of match, evidence of similar pattern, analyst professional judgment, availability of toxicity data (e.g., IRIS, HEAST, or NCEA reference doses and/or slope factors), and consultation with EPA Region III (see Section 6.1.1.1). The top 20 TICs will be reported by name and CAS Registry number and may be quantified. Quantification of TICs will be based on input from EPA staff. Positive identification and quantification of TICs will be accomplished by acquiring the appropriate standards and calibrating the GC-MS for the tentatively identified compounds. TICs that lack toxicity data will be discussed in the uncertainty section of the screening risk assessment results.

Where TICs do not provide a quantified value, they do indicate the presence of samples where extensive organic contamination may exist. The top 10 TICs are to be reported for all GC/MS analysis for such analysis.

SPECIFIC COMMENTS

Volume I - Master Work Plan

Comment 6: Figure 2-2 Site Layout and SWMU Location Map: The legend of this map uses an acronym (VI) which is not defined or included in the List of Acronyms. Please either define this acronym in the text where the figure is referenced or include it in the List of Acronyms for Volume I.

Response

The acronym VI (Verification Inspection) in the legend of Figure 2-2 of the MWP will be revised to specify the meaning of the acronym and the acronym will be included within the Acronym list.

Comment 7: Page 6-3, Selection of COPCs, second paragraph: The report recommends using the 95% UCL for screening if the data display the required statistical properties. EPA recommends the use of the maximum detected concentration unless site specific circumstances indicate otherwise. The reason is that stats alone cannot determine if the 95% UCL would give an appropriate screening value. Other important considerations include the characterization of nature and extent and an appropriate exposure unit.

Response

The Army agrees that it is common practice to compare the maximum detected concentration (MDC) for each constituent during the screening process. However, it is stated in the SSP as approved by EPA Region III that the MDC would be used for screening unless the data display the statistical properties required to calculate a valid 95% upper confidence limit (UCL). In those cases, the 95% UCL would be used.

Comment 8: Page 6-3, Soil and Sediment: EPA recommends the use of an alternate screening value for sediment. One would expect much less exposure to sediment compared to soil. The difference is typically about 10 fold less exposure. Therefore, I recommend that the sediment screening value be ten times higher than the soil screening concentration. The result is still screening sediment at approximately a HI = 0.1 and a ICR = 10-6 using a ten fold exposure factor. For example, the screening concentration of aluminum and arsenic in residential soil would be 7800 and 0.43 mg/kg. The screening concentration in sediment for Al and As would be 78000 and 4.3.

Response
The MWP will be revised to incorporate the recommended screening value for sediment. The following paragraph will be added to Section 6.2.2 of the MWP:

In recognition of the special nature of sediment, a ten fold exposure factor will be applied to the screening values for both cancer and non-cancer compounds as identified in the Region III RBC Tables. The result is still screening sediment at approximately a HQ = 0.1 and an increased cancer risk = 1 x 10^{-6} *using this ten fold multiplier. For example, the screening concentration of aluminum and arsenic in residential soil would be 7,800 mg/kg and 0.43 mg/kg, respectively. The screening concentration in sediment for aluminum and arsenic would be 78,000 mg/kg and 4.3 mg/kg, respectively.*

Comment 9: Page 6-3, Soil and Sediment: EPA recommends including an industrial soil lead screening value as a point of reference. US EPA Region III typically uses 1000 mg/kg as the industrial lead screening concentration.

Response
The MWP will be revised to incorporate the recommended screening value for lead. The following bold/italicized text will be added to this paragraph in Section 6.2.2 of the MWP:

If lead concentrations in soil are greater than 400 milligrams per kilogram (mg/kg) (USEPA 1994a), then potential risk associated with lead will be evaluated using the Integrated Exposure Uptake Biokinetic model (USEPA 1994b). As a screening value point of reference, ***USEPA Region III recommends an industrial soil lead screening value of 1,000 mg/kg.*** The model will be run using site-specific input parameters based on Site Screening Process (SSP) findings and consultation with USEPA Region III. If the percentage of children expected to have blood lead levels of 10 micrograms per deciliter (µg/dL) or greater exceeds 5%, then lead will be retained as a COPC to be evaluated in the next steps of the HHRA (Exposure Assessment and Risk Characterization).

Comment 10: Page 6-3, Groundwater and Surface Water: EPA recommends using an exposure factor applied to surface water similar to sediment. One would expect about ten fold less exposure to surface water compared to groundwater. For example, the screening concentration for aluminum and arsenic in groundwater would be 3700 and 0.045 ug/l. The screening concentration in surface water for Al and As would be 37000 and 0.45.

Response

The MWP will be revised to incorporate the recommended screening value for surface water. The following paragraph will be added to Section 6.2.2 of the MWP:

In recognition of the special nature of surface water, a ten fold exposure factor will be applied to the screening values for both cancer and non-cancer compounds as identified in the Region III RBC Tables. The result is still screening surface water at approximately a HQ = 0.1 and an increased cancer risk = 1 x 10^{-6} *using this ten fold multiplier. For example, the screening concentration of aluminum and arsenic in groundwater would be 3,700 μg/L and 0.045 μg/L, respectively. The screening concentration in surface water for aluminum and arsenic would be 37,000 μg/L and 0.45 μg/L, respectively.*

Comment 11: Page 6-5, Exposure Quantification: EPA requires clarification on the calculation of the exposure point concentration (EPC). US EPA Region III interprets the Calculating Concentration Term, 1992 guidance to mean that first the distribution of the data will be determined (normal, lognormal or undetermined). If the data are normally distributed, then use the Student's t statistic to calculate the UCL. If the data are lognormally distributed, then use Land's H-statistic to calculate the UCL. Additionally, US EPA is working on updating this guidance. We have found that the H-statistic is very sensitive to the assumption of lognormality. If the data are not truly lognormal, then the resulting UCL is very high. EPA suggests that if a sample distribution is neither normal nor lognormal, then try a non-parametric approach. The resulting EPC could be much lower.

Response

The Army agrees that the approach that USEPA has described is consistent with what is planned in this WPA. Note the WPA approach is based on the SSP as approved by EPA, Region III. We first test the distribution, then calculate the 95% UCL based on the appropriate distribution. In the case where the distribution is neither normal nor lognormal, the nonparametric distribution will be used. As the reviewer notes, the nonparametric 95% UCLs are often lower. The Army is aware that USEPA have considered updating guidance regarding the use of the H-statistic and using different techniques instead (e.g., bootstrap, jack-knife), but cannot comment as this information is not available for review.

Comment 12: Section 8.7 Laboratories, page 8-8: This section states that "laboratories will meet the requirements established in the EPA document *RCRA Corrective Action Plan."* Please provide the appropriate and complete citation for this document. Irregardless, the laboratory QA/QC must comply with the Region 3 Functional Guidelines, which must be cited in the final document.

1A

It is further stated in this section that "data will be validated in accordance with current EPA guidance." Revise the MWP to add a statement that the appropriate citation for the guidance in effect at the time of the investigations will be provided in the site-specific WPA, including but not limited to the Region III Functional Guidelines.

Response

Section 8.7 will be revised to read as follows:

Laboratories activities will be conducted in accordance with the established guidelines in the USEPA Directive, RCRA Corrective Action Plan (USEPA 1994a). Data will be validated in accordance with current USEPA guidance including Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analysis (USEPA 1993b) and Region III Modifications to National Functional Guidelines for Organic Data Review Multi-media, Multi-concentration (OLM01.0-OLM01.9) September 1994 (USEPA 1994c), or the appropriate guidance in effect at the time of investigation. Preliminary specifications for sampling and analysis will be included in the site-specific WP/QAP/HSP, to be submitted prior to the performance of fieldwork. Specifications will include, as a minimum, proposed SW-846 methods or Standard Methods to be employed, detection limits, practical quantitation limits (PQLs), and the identification of the laboratory. Methods and detections will be, as a minimum, those established by guidance from USEPA Region III or as established by Virginia Department of Environmental Quality (VDEQ) approved plans, if applicable.

Volume II - Master Quality Assurance Plan

Comment 13: Section 3.0 Quality Assurance Objectives, page 3-1: The second paragraph of this section states that "the DQO [data quality objective] process used for developing RFAAP data quality criteria and performance specifications for data operations is consistent with the *Guidance for the Data Quality Objectives Process*, U.S. Environmental Protection Agency (USEPA) QA/G-4, September, 1994." Please note that the most current Guidance is dated August 2000 and revise this citation accordingly. In general, ensure that the latest methods (e.g., sampling and analysis) and guidance documents are cited in the site-specific WPA, including the EPA Region III Functional Guidelines.

Response

Section 3.0 of the MQAP will be revised to specify the most current guidance for the Data Quality Objective Process. The latest methods and guidance documents will be cited, as appropriate, throughout the MWP, MQAP, and MHSP.

Comment 14: Section 2.3.1, More detail is needed in the section detailing data quality objectives. Particular emphasis needs to be placed on the following:

a) State the Problem, historical uses of the site and possible components of concern should be identified. The approach needs to be more consistent in this application; in some areas the treatment is very strong, in others it is weak.

b) The Decision Threshold, which is used to determine the applicability of the proposed analytical methods and their ability to achieve the necessary sensitivity for this sampling event. Maximum containment levels and RBCs are referenced, however these two tables do not incorporate all the compounds identified as possible analytes in this plan. It is recommended that all decision threshold criteria, i.e. including MCLs, RBCs, SSLs, eco screening values, etc., be added to the list of threshold levels to be used. As part of the DQO process the sampling event should have its sampling goals enumerated. This will lead to decision thresholds and resulting actions clearly described in "If...Then" statements. For example: If the concentrations are below the named health risk levels then no further action will be taken. If the concentrations are at or above those levels, then an evaluation of further action will occur, at a minimum, a written report for that evaluation will be submitted. Decision rules need to be stated in this document, or, alternatively the method that will be used to determine the decision rule needs to be established, before sampling begins.

c) The WPA states, "The consequence of decision errors and acceptable probability will be assessed." This document is where that procedure for determining the acceptance probability is to be described.

Response

This comment appears to be directed at WPA 9 and 12. The response is crafted under that assumption. The data quality objectives are specified in Section 2.3 of both WPA 9 and 12. The problem statement, decision inputs, and optimal data design identify the approach to be taken during the site investigation. Previous investigations, conceptual site-model, data gap analysis, and planned field activities and technical approach are further discussed for each SWMU in Section 1.0 of WPA 9 and 12. Decision rules are to be developed based upon the action levels and data found for the parameters of interest.

The analyte list covering this investigation with associated levels of concern (LOCs) may be found in Table 2-6 of the QAPP in WPA 12 and Table 2-7 in WPA 9. Comparison of the data to these LOCs will be discussed in RFI reports after the sampling, analysis, and validation are completed. Analytes without chemical-specific comparison criteria (*i.e.* MCL or RBC values) will be evaluated on an individual basis and will not be removed from the list of constituents of potential concern (COPCs). Several naturally occurring, abundant metals, for example, do not have comparison criteria and are considered essential nutrients (calcium, potassium).

The *Guidance For The Data Quality Objectives Process*, EPA QA/G-4, September 1994 and *USACE Shell for Analytical Chemistry Requirements*, December 1998 provide the basis for the DQO process and are referenced in the QAPP Addenda.

Comment 15: Section 2.4.3 Sample Identification Duplicate samples should be submitted to the laboratory blind. Labeling them in a manner that identifies them as a duplicate reduces their value.

Response

Agreed. Duplicate samples will be submitted to the laboratory blind.

37

COMMONWEALTH *of* VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

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W. Tayloe Murphy, Jr.
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Robert G. Burnley
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May 29, 2002

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

RE: Draft Work Plan Addendum 009 (WPA 9)

Dear Mr. McKenna:

This office has reviewed the referenced draft document and concurs with WPA 9. No revisions to the document are required. Please provide this office a copy of the final document when it is 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

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

May 22, 2002

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
Master Work Plans
Work Plans Addendums 9 & 12
Document submittal and review

Dear Mr. McKenna and Ms. Jake:

The U.S. Environmental Protection Agency (EPA) has reviewed the Army's draft *Master Work Plans, Work Plan Addendum 9, and Work Plan Addendum 12* for the Radford Army Ammunition Plant (RFAAP) and New River Ammunition Storage Depot (NRASD). The reviews were based on guidance provided in "Guidance for Data Quality Objectives (DQO) Process" September 2000 (EPA QA/G-4), "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations" March 2001(EPA QA/R-5), "Guidance for Quality Assurance Project Plans" March 2001 (EPA QA/G-5), and Regional guidance documents, "Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analysis," April 1993, and "Region III Modifications to National Functional Guidelines for Organic Data Review Multi-media, Multi-concentration" (OLMO1.0-OLMO1.9) September 1994. Outlined below, please find EPA's comments based upon that review:

GENERAL COMMENTS

1. The "Preface" to this draft Master Work Plan, Master Quality Assurance Plan and Master Health & Safety Plan (MWP) states that the "MWP provides comprehensive discussions of standard procedures, protocols, and methodologies that are to be followed during execution of field investigations at RCRA sites within the RFAAP." Figure 2-2 of the MWP shows the locations of Solid Waste Management Units (SWMUs) in the Main Manufacturing Area (MMA) and Figure 2-3 shows the "area locations" in the New River Unit (NRU). However, Figure 2-2 provides numerical designation of the SWMUs, and Figure 2-3 provides names of the areas. In addition, Section 3.0 (Environmental Setting) of the MWP provides extensive environmental setting information for certain SWMUs and Hazardous Waste Management Units (HWMUs). However, these SWMUs and HWMUs are only referenced by their designated numbers, except for the Horseshoe Area (HSA). Since the site-specific Work Plan Addenda (WPA) will be referencing this MWP for the installation description and environmental setting, it is important to identify each SWMU, HWMU and Area of Concern (AOC) by its designated name and number combination, and to provide a map that clearly delineates such information. This will aid the reviewer in understanding and cross-referencing the detailed information provided in Section 3.0. Please revise the MWP to address this issue.

2. The MWP contains numerous inconsistencies in its cross reference of the various information provided. As this MWP will be a comprehensive document that will be referenced by the multiple site-specific WPA, all references and cross-references should be accurate and current. Examples of discrepancies and incompleteness include:

   ☐ In Section 5.2.2 of the MWP, the first bullet references Standard Operating Procedure (SOP) 10.3 of Appendix A regarding the qualifications of drilling contractors and personnel responsible for the supervision of the contractor. However, this information is not provided in the referenced SOP.

   The 7th bullet references Section 5.2.7 for information regarding soil sampling methods during drilling.

However, this information is not provided in Section 5.2.7.

The last bullet references Section 5.2.5 for soil boring abandonment. However, this information is not provided in Section 5.2.5, it is rather provided in Section 5.2.7.

☐ In Section 5.2.3.1 of the MWP, the first paragraph on page 5-5 references Section 3.6 for site subsurface conditions. Section 3.6 discusses Regional geology. The referenced information is provided in Section 3.7.

☐ In SOP 20.11, Sections 2.1 and 2.2, the first bullets refer to Sections 2 and 3 for drilling equipment outline. It is not clear where these sections are located, as Sections 2 and 3 of this SOP do not provide the referenced information.

☐ In SOP 20.1, Section 3.3.10 references Figure 20.1a for well construction diagram. However, the referenced figure does not exist. Also, Section 5.6 of the Master Quality Assurance Plan references back to this section for the location of a well construction diagram.

☐ In Section 9.5.1 of the Master Quality Assurance Plan, the 5th bullet states that "This assessment will be provided in the form of data validation reports as defined in Section 9.6.2." However, no such definition is provided in Section 9.6.2.

Please revise the MWP to address these and other discrepancies, and ensure the document can easily be cross-referenced and is complete.

3. Decontamination needs to be addressed. Regional guidelines for organic and inorganic sampling decontamination procedures follow:

- wash with non-phosphate detergent,
- tap water rinse,
- 0.1N nitric acid rinse when cross contamination from metals is a concern,
- deionized/distilled water rinse,
- pesticide-grade solvent, methanol rinse when semivolatile and non-volatile organic contamination may be present,
- double rinse with deionized/distilled water, and
- organic-free water rinse (high performance liquid chromatography [HPLC] grade).

The final water rinse is collected for confirmation analyses, to insure there is no carry over of contaminants to other samples. This procedure is recommended for the geo-punch equipment, and any other re-usable equipment.

4. A provision should be included in the subject document(s) for validating 100% of data generated according to procedures consistent with those specified in the documents "Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analysis," April 1993, and "Region III Modifications to National Functional Guidelines for Organic Data Review Multi-media, Multi-concentration"(OLMO1.0-OLMO1.9) September 1994 by an independent third party. That third party should be named prior to sampling. The laboratory deliverable requirements should be modified to include the submission of a complete raw data package, as appropriate, for this review. That data packet and all electronic tapes should be accessible to the EPA upon request.

5. Whenever a mass spectral analysis is requested using SW-846 methods, such as 8270 and 8260, the laboratory should submit a Tentatively Identified Compound (TIC) list with each analysis. The TIC list can identify unknown and unexpected compounds at all stages of investigation.

SPECIFIC COMMENTS

Volume I - Master Work Plan

6. **Figure 2-2 Site Layout and SWMU Location Map:** The legend of this map uses an acronym (VI) which is not defined or included in the List of Acronyms. Please either define this acronym in the text where the figure is referenced or include it in the List of Acronyms for Volume I.

7. **Page 6-3, Selection of COPCs, second paragraph:** The report recommends using the 95% UCL for screening if the data display the required statistical properties. EPA recommends the use of the maximum detected concentration unless site specific circumstances indicate otherwise. The reason is that stats alone cannot determine if the 95% UCL would give an appropriate screening value. Other important considerations include the characterization of nature and extent and an appropriate exposure unit.

8. **Page 6-3, Soil and Sediment:** EPA recommends the use of an alternate screening value for sediment. One would expect much less exposure to sediment compared to soil. The

difference is typically about 10 fold less exposure. Therefore, I recommend that the sediment screening value be ten times higher than the soil screening concentration. The result is still screening sediment at approximately a HI = 0.1 and a ICR = 10-6 using a ten fold exposure factor. For example, the screening concentration of aluminum and arsenic in residential soil would be 7800 and 0.43 mg/kg. The screening concentration in sediment for Al and As would be 78000 and 4.3.

9. **Page 6-3, Soil and Sediment:** EPA recommends including an industrial soil lead screening value as a point of reference. US EPA Region III typically uses 1000 mg/kg as the industrial lead screening concentration.

10. **Page 6-3, Groundwater and Surface Water:** EPA recommends using an exposure factor applied to surface water similar to sediment. One would expect about ten fold less exposure to surface water compared to groundwater. For example, the screening concentration for aluminum and arsenic in groundwater would be 3700 and 0.045 ug/l. The screening concentration in surface water for Al and As would be 37000 and 0.45.

11. **Page 6-5, Exposure Quantification:** EPA requires clarification on the calculation of the exposure point concentration (EPC). US EPA Region III interprets the Calculating Concentration Term, 1992 guidance to mean that first the distribution of the data will be determined (normal, lognormal or undetermined). If the data are normally distributed, then use the Student's t statistic to calculate the UCL. If the data are lognormally distributed, then use Land's H-statistic to calculate the UCL. Additionally, US EPA is working on updating this guidance. We have found that the H-statistic is very sensitive to the assumption of lognormality. If the data are not truly lognormal, then the resulting UCL is very high. EPA suggests that if a sample distribution is neither normal nor lognormal, then try a non-parametric approach. The resulting EPC could be much lower.

12. **Section 8.7 Laboratories, page 8-8:** This section states that "laboratories will meet the requirements established in the EPA document *RCRA Corrective Action Plan.*" Please provide the appropriate and complete citation for this document. Irregardless, the laboratory QA/QC must comply with the Region 3 Functional Guidelines, which must be cited in the final document.

It is further stated in this section that "data will be validated in accordance with current EPA guidance." Revise the MWP to add a statement that the appropriate citation for the guidance in effect at the time of the investigations will be provided in the site-specific WPA, including but not limited to the Region III Functional Guidelines.

Volume II - Master Quality Assurance Plan

13. **Section 3.0 Quality Assurance Objectives, page 3-1:** The second paragraph of this section states that "the DQO [data quality objective] process used for developing RFAAP data quality criteria and performance specifications for data operations is consistent with the *Guidance for the Data Quality Objectives Process*, U.S. Environmental Protection Agency (USEPA) QA/G-4, September, 1994." Please note that the most current Guidance is dated August 2000 and revise this citation accordingly. In general, ensure that the latest methods (e.g., sampling and analysis) and guidance documents are cited in the site-specific WPA, including the EPA Region III Functional Guidelines.

14. **Section 2.3.1,** More detail is needed in the section detailing data quality objectives. Particular emphasis needs to be placed on the following:

    a) State the Problem, historical uses of the site and possible components of concern should be identified. The approach needs to be more consistent in this application; in some areas the treatment is very strong, in others it is weak.

    b) The Decision Threshold, which is used to determine the applicability of the proposed analytical methods and their ability to achieve the necessary sensitivity for this sampling event. Maximum containment levels and RBCs are referenced, however these two tables do not incorporate all the compounds identified as possible analytes in this plan. It is recommended that all decision threshold criteria, i.e. including MCLs, RBCs, SSLs, eco screening values, etc., be added to the list of threshold levels to be used. As part of the DQO process the sampling event should have its sampling goals enumerated. This will lead to decision thresholds and resulting actions clearly described in "If...Then" statements. For example: If the concentrations are below the named health risk levels then no further action will be taken. If the concentrations are at or above those levels, then an evaluation of further action will occur, at a minimum, a written report for that evaluation will be submitted. Decision rules need to be stated in this document, or, alternatively the method that will be used to determine the decision rule needs to be established, before sampling begins.

c) The WPA states, "The consequence of decision errors and acceptable probability will be assessed." This document is where that procedure for determining the acceptance probability is to be described.

15. **Section 2.4.3 Sample Identification** Duplicate samples should be submitted to the laboratory blind. Labeling them in a manner that identifies them as a duplicate, reduces their value.

This concludes EPA's review of the Army's draft revised *Master Work Plans, Work Plan Addendum 9 and Work Plan Addendum 12 for* the RFAAP and NRASD. The referenced draft *Master Work Plans, Work Plan Addendum 9 and Work Plan Addendum 12* are disapproved by EPA in their current form, and they must be revised to reflect the comments above. However, based upon the content of the above comments, EPA is agreeable with approving the initiation of field sampling activities associated with *Work Plan Addendum 9* and *Work Plan Addendum 12*, provided that comment resolution occurs within the proscribed timeframes outlined in the EPA RCRA Corrective Action permit. Per Part II, Section E.4.e. of the EPA RCRA Corrective Action Permit, the Army is required to revise the above documents and submit a revised copy to EPA for review within 60 days of the receipt of EPA comments. Part II, Section E.4.f. of the Permit allows for an additional 20 days for issuing the revised 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
Mark Leeper, VDEQ

67

ATK
ALLIANT TECHSYSTEMS

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

February 15, 2002

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

Subject: Work Plan Addendum 9 SWMU 31 and Horseshoe Area Groundwater Study,
Draft Final, February 2002
Radford Army Ammunition Plant
EPA ID# VA1 210020730

Dear Mr. Thomson:

Enclosed is a certified copy of "Work Plan Addendum 9 SWMU 31 and Horseshoe Area Groundwater Study, Draft Final, February 2002". Your six additional copies and copies to Virginia Department of Environmental Quality, U.S. Army Operations Support Command, U.S. Army Environmental Center, U.S. Army Center for Health Promotion and Preventive Medicine will be sent under separate cover.

Work Plan Addendum 9 has been revised to address your comments of July 23, 2001. Our response to comments was sent August 14, 2001. On January 29, 2002 the Virginia Department of Environmental Quality reviewed the draft document and concurred with it so no further revision is needed.

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

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

Enclosure

02-815-30
JMcKenna/JJRedder

Concerning the following:

Work Plan Addendum 009:
SWMU 31 and Horseshoe Area Groundwater Study
February 2002
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: H. E. Martin for
PRINTED NAME: Ken Dolph
TITLE: Vice President Operations
Alliant Ammunition and Powder Company, LLC

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

January 29, 2002

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

RE: Draft Work Plan Addendum 009 (WPA 9)

Dear Mr. McKenna:

This office has reviewed the referenced draft document and concurs with WPA 9. No revisions to the document are required. Please provide this office a copy of the final document when it is completed.

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

Sincerely,

Mark Leeper

Mark S. Leeper
Remedial Project Manager

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

WPA 9

Memorandum for Record
draft VDEQ Comments to Work Plan Addendum 9
14 February 2002

Timeline

1. Original comments from VDEQ were received on 31-October-01
2. Original comments with further discussion and new comments attached were received on 10-Jan-02.
3. A teleconference was held on 17-Jan-02 to discuss and resolve issues related to these comments.

COMMENT 1 - 31-OCT-01

I have the disadvantage of not seeing the site, of what is the piping to the lagoons made, it appears they are underground, and if so, have any samples been collected along their path?

Response 31-Oct-01

The piping is believed to be constructed of cast iron. Because these are direct connections between the ponds with no known sumps, the Army believes that constituents along the path of the piping would appear at greater concentrations in the ponds themselves.

Further VDEQ discussion 10-Jan-02

If constituents have been leaking from cracks/seems, contamination of soil and ground water is plausible. Moreover, regardless of the concentrations, no samples have been collected along that path. I propose collecting samples along the piping pathway.

Resolution

After further discussion during the telecon, it was agreed that sampling along the pipeline pathways would not be necessary. It was agreed that any remedy proposed for the settling ponds would include the associated piping. It was also agreed that site maps would label the connection between the former power plant and the settling ponds as "open channel concrete trough".

COMMENT 2 - 31-OCT-01

Section 1.2.1, the nearest residential area is approximately 2 miles away (Fairlawn) from SWMU 31. Is this area on public water, if not, have any of these wells been sampled? Being in a karst environment, contamination in this area should be a concern.

Response 31-Oct-01

Response: Fairlawn is on public water. However to expand on the issue of offpost sampling, the following discussion is provided. The WPA 9 effort is designed to understand better the nature of karst and groundwater flow in the Horseshoe area. Geologic conditions surrounding SWMU 31 indicate a depositional environment suggesting groundwater locally flows to the New River. Additionally, there does not appear to be indications of lineaments in

the area that would lead to off post migration of groundwater. Army policy does not allow for the sampling of off post wells until a pathway is established During the course of this groundwater study should the data confirm a completed groundwater pathway, the Army will immediately consult with the rest of the RFAAP team to assess the appropriate course of action.

Further VDEQ discussion 10-Jan-02

How would you propose finding a pathway, to an area 2 miles away in a karst environment, using conventional well data/slug tests/ pump test information?

Resolution

After further discussion during the telecon, it was agreed that the area -wide groundwater approach was a phased study. The information proposed to be collected in WPA 9 was necessary before further conclusions as to groundwater migration could be reached. The Army also stated that there was no evidence at this time to lead to the conclusion that contaminants were leaving RFAAP via groundwater. It was agreed that no further action needed to be taken on this comment.

COMMENT 3 - 31-OCT-01

Section 1.2.2.3, it appears there is some indecision of whether the wells are upgradient or downgradient. A dye test may clarify this. Is there any proposed time at which a dye test will be performed?

Response 31-Oct-01

No dye tracing is currently proposed for this site. Well information is not definitive, but because these wells are fairly shallow and the river is in close proximity, shallow groundwater flow is believed to follow topography and flow towards the river.

Further VDEQ discussion 10-Jan-02

In the previous paragraph, highlighted in blue, is the reason I feel dye testing would benefit this investigation. At some point during the investigation in the HorseShoe area, dye testing should be completed.

Resolution

During the telecon it was agreed that dye tracing might be necessary in the future but would be premature at this time.

COMMENT 4 - 31-OCT-01

Who signs off on the weir design/construction?

Response 31-Oct-01

Inquiries have indicted that because the work is of such small scale and on a Federal facility that no permits or construction approval is necessary. As a courtesy, a joint permit application will be filed with the VA Marine Resources Division who will forward copies to the Corps of Engineers, the

VDEQ, local wetlands board, and various other State agencies as appropriate.

Further VDEQ discussion 10-Jan-02
OK

COMMENT 5 - 31-OCT-01

Section 1.3.2.2, bedrock monitoring wells are to be positioned in or near large solution features or fractures and / or along photolinaments or faults. Table 1-15 lists the proposed bedrock monitoring well locations.
Five out of nine wells are proposed to be placed near "no known geologic features". Are there geologic features close, but not in the specific area, to the area that can be utilized that will yield the same results? Can we add wells to span a larger area if the features can be located? Bedrock drilling is time consuming and expensive, I just want to make sure we don't cut ourselves short. I think finding a geologic feature would be very beneficial.

Response 31-Oct-01
The discussion in Section 1.3.2.2 concerns existing bedrock wells. No new monitoring wells are planned at this time, however, as the groundwater study progresses the need and usefulness of additional bedrock monitoring wells will be reviewed. The section will be reviewed for clarity and revised accordingly.

Further VDEQ discussion 10-Jan-02
I apologize if I interpreted this incorrectly. It appears that no additional wells will be installed.

COMMENT 6 - 31-OCT-01

Table 1-14, surface water and ground water will be sampled for perchlorate. Will the sludge be sampled for perchlorate as well? If a detection for perchlorate is found, additional sampling may be necessary. My experience has shown vibracoring to be expensive. It may be beneficial to collect a sample while you're out there just in case.

Response 31-Oct-01
At this time, the Army is not aware of an approved method for collecting and analyzing perchlorates in solid (soil, sediment) matrix.

Further VDEQ discussion 10-Jan-0
I spoke to Chris Villarreal of Region VI EPA (214.665.6758) concerning the sampling of Perchlorates. He is the technical lead regarding perchlorate sampling for EPA. He is working with someone that is conducting perchlorate sampling at an Army base. I spoke to this individual and there is a method that works for sampling soil/sediment for perchlorates. The test utilizes EPA Method 314.0 with modification. In a nutshell, the soil sample is added to water and then the water is analyzed. Several labs conduct this test with great success. With this being said, I believe perchlorate sampling can be completed at Radford. One of the labs that were mentioned is GEL out of South Carolina. When we talk about this and

decide on which direction we will go, we can gather more information on the exact procedure of the test.

Resolution

It was agreed during the teleconference that sampling solid matrix for perchlorates would not be necessary. Perchlorate issues have been discovered at other Installations as a result of analysis of groundwater and/or surface water. The Army pointed out that they were doing extensive testing for perchlorates in water.

Additional New Comments 10-Jan-02

I revisited Addendum 009 and have a few more questions. I apologize for the last minute entry.

COMMENT 1 - 10-JAN-02

Is there a permit for Outfall 024? If so, for what constituents are you sampling?

Resolution -Additional New Comment 10-Jan-02

Discussion during the telecon indicated that Outfall 024 had never had a discharge. Outfall 024 information was faxed to VDEQ. It was agreed that no further action on this comment was necessary.

COMMENT 2 - 10-JAN-02

Figure 1-5 SWMU 31 Conceptual Model, indicates leachate possibly infiltrating the ground water, which flows to the New River. In the 1998 RCRA Facility Investigation, completed by ICF Kaiser, several constituents were detected in the lagoons sediment that exceeded residential, industrial RBC's and BTAG criteria. Recommendations in addendum 009 indicate that the collection of deep lagoon sediment, surface water and ground water samples be collected to supplement the current data. It may be advantageous to collect sediment samples, along the stretch of the New River where the lagoons lie, to verify if leachate is a concern.

Resolution -Additional New Comment 10-Jan-02

It was agreed during the telecon that due to the potential for upgradient and upstream contaminant sources, this additional proposed sampling could be done as part of an installation-wide groundwater study evaluating potential sources and pathways. The Current Conditions data is critical to evaluating sampling strategy along the New River. It was agreed that no further action on this comment was necessary.

McKenna, Jim

From: msleeper@deq.state.va.us
ent: Monday, January 28, 2002 12:25 PM
o: McKenna, Jim
Cc: dhwillis@deq.state.va.us
Subject: ...no subject...

Hey Jim,

Sorry I couldn't make the RAB. Someday soon I hope. I would like to kill two birds with this email.

First, in regards to the January 17th 2002 conference call regarding WPA 009, we discussed all the areas in which I had concerns and through the call this office concurs with WPA 009 and no revisions are needed.

Secondly, the Final Facility Wide Background Study Report (Study), dated December 2001, has been reviewed and this office concurs with the Study and no revisions are needed.

Hard copy letters will follow shortly documenting the concurrence for both documents.

anks,

Mark S. Leeper
Federal Facilities Program
Remedial Project Manager
VA Department of Environmental Quality
phone: 804.698.4308 fax: 804.698.4383

McKenna, Jim

om:	McKenna, Jim
nt:	Wednesday, January 23, 2002 7:39 AM
o:	'mark leeper'
Cc:	'john e tesner'; 'Parks, Jeffrey N'; Redder, Jerome; 'rob thomson'
Subject:	FW: ...no subject...

RESPONSE TO COMMENTS.DOC

Mark,

Per our 1:00pm conference call of Thurday, 17 Jan 2002 we thoroughly discussed the attached comments and responses. The outcome was that no revisions are needed to WPA 9. We are working to revise WPA 9 to address EPA Region III comments. A We plan to resubmit WPA 9 in late February 2002.

Jim

-----Original Message-----
From: msleeper@deq.state.va.us [mailto:msleeper@deq.state.va.us]
Sent: Thursday, January 10, 2002 1:11 PM
To: McKenna, Jim
Subject: ...no subject...

y Jim,

Here are my responses to your responses. Please let me know if you have any questions.

Thanks,

Mark S. Leeper
Federal Facilities Program
Remedial Project Manager
VA Department of Environmental Quality
phone: 804.698.4308 fax: 804.698.4383

The following was included as an attachement. Please use UUDECODE to retrieve it. The original file name was 'RESPONSE TO COMMENTS.DOC'.

C 1 DEQ I have the disadvantage of not seeing the site, of what is the piping to the lagoons made, it appears they are underground, and if so, have any samples been collected along their path?

Army **Response: The piping is believed to be constructed of cast iron. Because these are direct connections between the ponds with no known sumps, the Army believes that constituents along the path of the piping would appear at greater concentrations in the ponds themselves.**

DEQ **If constituents have been leaking from cracks/seems, contamination of soil and ground water is plausible. Moreover, regardless of the concentrations, no samples have been collected along that path. I propose collecting samples along the piping pathway.**

2. DEQ Section 1.2.1, the nearest residential area is approximately 2 miles away (Fairlawn) from SWMU 31. Is this area on public water, if not, have any of these wells been sampled? Being in a karst environment, contamination in this area should be a concern.

Army **Response: Fairlawn is on public water. However to expand on the issue of offpost sampling, the following discussion is provided. [The WPA 9 effort is designed to understand better the nature of karst and groundwater flow in the Horseshoe area] Geologic conditions surrounding SWMU 31 indicate a depositional environment suggesting groundwater locally flows to the New River. Additionally, there does not appear to be indications of lineaments in the area that would lead to off post migration of groundwater. Army policy does not allow for the sampling of off post wells until a pathway is established During the course of this groundwater study should the data confirm a completed groundwater pathway, the Army will immediately consult with the rest of the RFAAP team to assess the appropriate course of action.**

C DEQ **How would you propose finding a pathway, to an area 2 miles away in a karst environment, using conventional well data/slug tests/ pump test information?**

3. DEQ Section 1.2.2.3, it appears there is some indecision of whether the wells are upgradient or downgradient. A dye test may clarify this. Is there any proposed time at which a dye test will be performed?

Army **Response: No dye tracing is currently proposed for this site. Well information is not definitive, but because these wells are fairly shallow and the river is in close proximity, shallow groundwater flow is believed to follow topography and flow towards the river.**

DEQ **In the previous paragraph, highlighted in blue, is the reason I feel dye testing would benefit this investigation. At some point during the investigation in the HorseShoe area, dye testing should be completed.**

4 DEQ Who signs off on the weir design/construction?

Army **Response: Inquiries have indicted that because the work is of such small scale and on a Federal facility that no permits or construction approval is necessary. As a courtesy, a joint permit application will be filed with the VA Marine Resources Division who will forward copies to the Corps of Engineers, the VDEQ, local wetlands board, and various other State agencies as appropriate.**

C DEQ OK

65

DEQ 5. Section 1.3.2.2, bedrock monitoring wells are to be positioned in or near large solution features or fractures and / or along photolinaments or faults. Table 1-15 lists the proposed bedrock monitoring well locations.

Five out of nine wells are proposed to be placed near "no known geologic features". Are there geologic features close, but not in the specific area, to the area that can be utilized that will yield the same results? Can we add wells to span a larger area if the features can be located? Bedrock drilling is time consuming and expensive, I just want to make sure we don't cut ourselves short. I think finding a geologic feature would be very beneficial.

Army **Response: The discussion in Section 1.3.2.2 concerns existing bedrock wells. No new monitoring wells are planned at this time, however, as the groundwater study progresses the need and usefulness of additional bedrock monitoring wells will be reviewed. The section will be reviewed for clarity and revised accordingly.**

DEQ **I apologize if I interpreted this incorrectly. It appears that additional wells will be installed.**

DEQ 6. Table 1-14, surface water and ground water will be sampled for perchlorate. Will the sludge be sampled for perchlorate as well? If a detection for perchlorate is found, additional sampling may be necessary. My experience has shown vibracoring to be expensive. It may be beneficial to collect a sample while you're out there just in case.

Army **Response: At this time, the Army is not aware of an approved method for collecting and analyzing perchlorates in solid (soil, sediment) matrix.**

DEQ **I spoke to Chris Villarreal of Region VI EPA (214.665.6758) concerning the sampling of Perchlorates. He is the technical lead regarding perchlorate sampling for EPA. He is working with someone that is conducting perchlorate sampling at an Army base. I spoke to this individual and there is a method that works for sampling soil/sediment for perchlorates. The test utilizes EPA Method 314.0 with modification. In a nutshell, the soil sample is added to water and then the water is analyzed. Several labs conduct this test with great success. With this being said, I believe perchlorate sampling can be completed at Radford. One of the labs that were mentioned is GEL out of South Carolina. When we talk about this and decide on which direction we will go, we can gather more information on the exact procedure of the test.**

DEQ **I revisited Addendum 009 and have a few more questions. I apologize for the last minute entry.**

Is there a permit for Outfall 024? If so, for what constituents are you sampling?

Figure 1-5 SWMU 31 Conceptual Model, indicates leachate possibly infiltrating the ground water, which flows to the New River. In the 1998 RCRA Facility Investigation, completed by ICF Kaiser, several constituents were detected in the lagoons sediment that exceeded residential, industrial RBC's and BTAG criteria. Recommendations in addendum 009 indicate that the collection of deep lagoon sediment, surface water and ground water samples be collected to supplement the current data. It may be advantageous to collect sediment samples, along the stretch of the New River where the lagoons lie, to verify if leachate is a concern.

Outfall 024:

Water treatment plant backwash is discharged to one of two earthen ponds where the wastewater soaks into the ground or evaporates. The Board's standard permit conditions for WTPs are applied, TSS limits (30 mg/l average, 60 mg/l max) and the BPJ limit for steam electric power plants is removed since the power plant has been shut down.

Ash cooling and carrying water from the no.2 power house was discharged to the treatment pond after primary ash removal until 1994. Standard conditions for steam electric power plants, were previously applied including oil and grease limitations. These limits were technology based, so that they can be removed from the permit with the removal of the source of wastewater. The temperature limit is also removed since non-contact cooling water is no longer discharged to the outfall.

Ammonia is generated by bacteria in the pond's sediment. Ammonia limits were developed in a prior permit action and have become effective. Even though this outfall has not discharged recently the limitations remain in the permit. Mass limits are removed since concentration limits will be protective of the WQS.

Influent flow is estimated at 0.1 MGD and no flow has been reported from this outfall since January 1994. In October 1994 a ground water assessment was performed for the pond. The ponds are referred to as SWMU 31 in this report. Of those pollutants analyzed in pond sediment only arsenic, beryllium and cobalt exceeded the health based (criteria) numbers [HBNs] used by the consultant. After mathematically mixing estimated leakage from the pond with 1% of the New River, leakage concentrations were compared to estimated WLAs. Ground water monitoring is not required since the estimated concentrations of pollutants outside the mixing zone are at least an order of magnitude lower than the WLAs.

Monitoring for BOD, COD, sulfate and oxidized nitrogen is required since this outfall may discharge in the future and contribute to the plant wide loading. Sludge removal should be addressed in the facility O&M manual.

Outfall 026:

Limits for BOD, TSS and pH from the current permit were based on the secondary treatment regulation and are carried forward. The permittee previously requested that daily maximum limitations be used rather than weekly averages for ease of automated computations.

There have been documented pH problems in the STP influent which have resulted in 9 pH violations, all less than 6.0, from 1/89 through 12/90. More recently, influent pH was below 6 at times in April through July 1998. According to the permittee, leaking acid sewers that caused the problem in the early 90s have been repaired. Influent pH monitoring is required to verify that the problem does not recur.

Ammonia: Concentrations of ammonia reported for the past few years were sufficiently high to warrant evaluation of permit limits. Due to a faulty rotating arm on the trickling filter, ammonia effluent concentrations were abnormally high from August 1997 until February 1999. Effluent concentrations during this time had the potential to be toxic to aquatic life. Since the rotating arm has been repaired, effluent data collected when the arm was not functioning is not representative

6

Outfall 024

Filter backwash and sedimentation basin cleanout from the number 2 water filtration plant is routed to an unlined earthen lagoon. Soda ash and polyaluminum chloride is added to aid in flocculation in the sedimentation basin. No chemicals are added to the settling lagoon. In the past, storm water runoff and ash carrying water from the no.2 power house was also routed to the lagoon. This power house was placed in standby near the end of 1993. Since 1994, no discharge has been reported from the lagoon. Most of the wastewater soaks into the ground.

Outfall 026

The main sewage treatment plant has a design capacity of 1.0 MGD. It has been operated at significantly reduced flows for the past few decades. The plant consists of two primary sedimentation basins in series followed by a trickling filter, a final clarifier, chlorination and dechlorination. Sludge undergoes anaerobic digestion and drying on open beds prior to being landfilled on site. The trickling filter has been in need of repair for several years. The rotating arm began to malfunction in August 1997 and was not repaired until December 1998. Influent to the main STP comes from restrooms, the plant laundry, vehicle washing and steam cleaning and the main laboratory.

Outfall 028

Sanitary wastewater in the horseshoe area is routed to a 0.07 MGD imhoff tank. A four cell concrete basin then provides additional treatment. Chlorine disinfection and dechlorination are also present. Unused filtered water is routinely added prior to chlorination to provide adequate flow for disinfection. Reported effluent flow is not representative of sewage flow at this outfall. Sludge is not routinely removed from the treatment system.

Outfall 029

Process wastewater from the manufacture of nitroglycerin (NG), propellants, TNT and DNT and still bottoms from solvent recovery are routed to the bioplant for treatment. Mobile carbon columns are used to pretreat individual waste streams containing 2,4-dinitrotoluene since biological treatment may not completely remove this compound. The bioplant consists of a divided 7 million gallon equalization basin, several banks of rotating biological contactors (RBCs), and secondary clarification. Sludge is aerobically digested and pressed with a plate and frame press. Sludge is classified as K044 hazardous waste.

Storm Water Outfalls

There are over 100 storm water outfalls in the manufacturing area of the RFAAP. Sources of pollutants in storm water not already mentioned include controlled and uncontrolled air emissions. Some raw materials are ground or screened and may be emitted through vents. Grinding of 2-nitrodiphenylamine [CAS # 119-75-5], potassium nitrate, potassium sulfate and ethyl and methyl centralite (diethyldiphenylurea) takes place in the B-line area [bldg. 3524] which drains to SW outfall 3E. Potassium chlorate/perchlorate is ground in [bldg. 3691, SW outfall 004] three or four times per year. Exhaust air in these operations is filtered through bag houses. Screening of 2,4-dinitrotoluene occurs in drainage area 2A [bldg. 4932], exhaust air is filtered through 2 air conditioning type filters in series. Raw materials are also weighed in the grind

A. FINAL EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS - Radford Army Ammunition Plant

1. During the period beginning with the permit's effective date and lasting until the permit's expiration date, the permittee is authorized to discharge from outfall serial number 024.

   Such discharges of filter backwash shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTICS	DISCHARGE LIMITATION			
	Monthly Average	Weekly Average	Minimum	Maximum
Flow (MGD)	NL	NA	NA	NL
pH (SU)	NA	NA	6.0	9.0
Total Suspended Solids	30 mg/l	NA	NA	60 mg/l
Ammonia, as Nitrogen	3.14 mg/l	NA	NA	3.14 mg/l
Biochemical Oxygen Demand, 5 day, mg/l	NA	NA	NA	NL
Chemical Oxygen Demand, mg/l	NA	NA	NA	NL
Oxidized Nitrogen, mg/l	NA	NA	NA	NL
Sulfate, mg/l	NA	NA	NA	NL

NL - No limitation, monitoring only
NA - Not applicable

2. There shall be no discharge of floating solids or visible foam in other than trace amounts.

72/

----- Forwarded by Bob Thomson/R3/USEPA/US on 01/14/02 12:23 PM -----

Maryellen
Schultz   To: Bob
Thomson/R3/USEPA/US@EPA
cc:
01/14/02 12:15   Subject: Re:
Perchlorates(Document link: Bob Thomson)
PM

Rob,

No, I don't know of any method that includes procedures for soil. The only methods I am aware of (SW846 9058 and Method 314.0) are procedures for analyzing water.

Mary Ellen

Bob Thomson
To: Maryellen
Schultz/ESC/R3/USEPA/US@EPA
01/14/02   cc:
09:23 AM   Subject: Perchlorates

MaryEllen:

Is there an EPA-Region III accepted analytical method for perchlorates in soil??

25.

McKenna, Jim

From: McKenna, Jim
nt: Wednesday, December 12, 2001 8:00 PM
: 'msleeper@deq.state.va.us'; 'john e tesner'; Redder, Jerome
Cc: 'dhwillis@deq.state.va.us'; 'rob thomson'; 'Clemens, Drew M NAE'
Subject: RE: ...no subject...

Draft WPA 9 RTC for VADEQ.doc

Mark,

Attached file contains our responses to your comments below. Again I want to say anytime you can make it out here we would like to show you around. This wouldn't have to be just during fieldwork as a matter of fact it probably would be better if you could visit before and during that effort. Anyway, I'll be on vacation from 20 Dec 2001 to 3 Jan 2002.

Happy Holidays,
Jim

-----Original Message-----
From: McKenna, Jim
Sent: Wednesday, October 31, 2001 11:22 AM
: 'msleeper@deq.state.va.us'; McKenna, Jim; 'john e tesner'; Redder, rome
c: dhwillis@deq.state.va.us; 'rob thomson'; 'Clemens, Drew M NAE'
Subject: RE: ...no subject...

Mark,

Thanks for the feedback. I'm sending along to John Tesner and he will get with our consultant for answers. Note John Tesner does the technical project execution on these projects so it's ok to cc him on the emails that way he and the team can get answers, develop a response, etc. Like to get you out here as well. Let's work on it as we get closer to the fieldwork time.

Jim

-----Original Message-----
From: msleeper@deq.state.va.us [mailto:msleeper@deq.state.va.us]
Sent: Wednesday, October 31, 2001 11:17 AM
To: Jim_McKenna@atk.com
Cc: dhwillis@deq.state.va.us
Subject: ...no subject...

Hey Jim,

Back in the saddle, so I thought I would send you my comments on dendum
9. As discussed in our last conference call, I would like to send omments
back & forth via email and if we need to address a situation through official

letter head, we would do it after the emails. With that in mind here are my concerns:

1. I have the disadvantage of not seeing the site, of what is the piping to the lagoons made, it appears they are underground, and if so, have any samples been collected along their path?

2. Section 1.2.1, the nearest residential area is approximately 2 miles away (Fairlawn) from SWMU 31. Is this area on public water, if not, have any of these wells been sampled? Being in a karst environment, contamination in this area should be a concern.

3. Section 1.2.2.3, it appears there is some indecision of whether the wells are upgradient or downgradient. A dye test may clarify this. Is there any proposed time at which a dye test will be performed?

4. Who signs off on the weir design/construction?

5. Section 1.3.2.2, bedrock monitoring wells are to be positioned in or near large solution features or fractures and / or along photolinaments or faults. Table 1-15 lists the proposed bedrock monitoring well locations. Five out of nine wells are proposed to be placed near "no known geologic features". Are there geologic features close, but not in the specific area, to the area that can be utilized that will yield the same results? Can we add wells to span a larger area if the features can be located? Bedrock drilling is time consuming and expensive, I just want to make sure we don't cut our selves short. I think finding a geologic feature would be very beneficial.

6. Table 1-14, surface water and ground water will sampled for perchlorate. Will the sludge be sampled for perchlorate as well? If a detection for perchlorate is found, additional sampling may be necessary. My experience has shown vibracoring to be expensive. It may be beneficial to collect a sample while you're out there just in case.

That's it. Please let me know when the vibracoring will take place. It's cool stuff! If I can make it out there, I would love to see it.

Thanks,

Mark S. Leeper
Federal Facilities Program
Remedial Project Manager
VA Department of Environmental Quality
phone: 804.698.4308 fax: 804.698.4383

1. I have the disadvantage of not seeing the site, of what is the piping to the lagoons made, it appears they are underground, and if so, have any samples been collected along their path?

   Response: The piping is believed to be constructed of cast iron. Because these are direct connections between the ponds with no known sumps, the Army believes that constituents along the path of the piping would appear at greater concentrations in the ponds themselves.

2. Section 1.2.1, the nearest residential area is approximately 2 miles away (Fairlawn) from SWMU 31. Is this area on public water, if not, have any of these wells been sampled? Being in a karst environment, contamination in this area should be a concern.

   Response: Fairlawn is on public water. However to expand on the issue of offpost sampling, the following discussion is provided. The WPA 9 effort is designed to understand better the nature of karst and groundwater flow in the Horseshoe area. Geologic conditions surrounding SWMU 31 indicate a depositional environment suggesting groundwater locally flows to the New River. Additionally, there does not appear to be indications of lineaments in the area that would lead to off post migration of groundwater. Army policy does not allow for the sampling of off post wells until a pathway is established During the course of this groundwater study should the data confirm a completed groundwater pathway, the Army will immediately consult with the rest of the RFAAP team to assess the appropriate course of action.

3. Section 1.2.2.3, it appears there is some indecision of whether the wells are upgradient or downgradient. A dye test may clarify this. Is there any proposed time at which a dye test will be performed?

   Response: No dye tracing is currently proposed for this site. Well information is not definitive, but because these wells are fairly shallow and the river is in close proximity, shallow groundwater flow is believed to follow topography and flow towards the river.

4. Who signs off on the weir design/construction?

   Response: Inquiries have indicted that because the work is of such small scale and on a Federal facility that no permits or construction approval is necessary. As a courtesy, a joint permit application will be filed with the VA Marine Resources Division who will forward copies to the Corps of Engineers, the VDEQ, local wetlands board, and various other State agencies as appropriate.

5. Section 1.3.2.2, bedrock monitoring wells are to be positioned in or near large solution features or fractures and / or along photolinaments or faults. Table 1-15 lists the proposed bedrock monitoring well locations.

   Five out of nine wells are proposed to be placed near "no known geologic features". Are there geologic features close, but not in the specific area, to the area that can be utilized that will yield the same results? Can we add wells to span a larger area if the features can be located? Bedrock drilling is time consuming and expensive, I just want to make sure we don't cut ourselves short. I think finding a geologic feature would be very beneficial.

   Response: The discussion in Section 1.3.2.2 concerns existing bedrock wells. No new monitoring wells are planned at this time, however, as the groundwater study progresses the need and usefulness of additional bedrock monitoring wells will be reviewed. The section will be reviewed for clarity and revised accordingly.

6. Table 1-14, surface water and ground water will be sampled for perchlorate.

   Will the sludge be sampled for perchlorate as well? If a detection for perchlorate is found, additional sampling may be necessary. My experience has shown vibracoring to be expensive. It may be beneficial to collect a sample while you're out there just in case.

Response: At this time, the Army is not aware of an approved method for collecting and analyzing perchlorates in solid (soil, sediment) matrix.

2l.

ATK
ALLIANT TECHSYSTEMS

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

August 14, 2001

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

Subject: Work Plan Addendum 009: SWMU 31 and Horseshoe Area Groundwater Study
EPA ID# VA1 210020730

Dear Mr. Thomson:

Attached are our responses to your July 23, 2001 comment letter on the Work Plan Addendum 9 (WPA 9). Once we receive and evaluate comments from the Virginia Department of Environmental Quality (VDEQ) we will revise WPA 9 and resubmit. Receipt and ultimate resolution of VDEQ comments will likely impact the production of the final WPA 9 and may not occur within the timeframes discussed in your letter. Therefore we reserve our rights to request time extensions under the Permit.

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

Sincerely,

C. A. Jake

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

Enclosure

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

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

01-815-164
JJRedder

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

Coordination: for
J. McKenna

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

01-815-164
JJRedder

P3

Response to Comments from USEPA
Draft Work Plan Addendum 009: SWMU 31 and the Horseshoe Area Groundwater Study
Radford Army Ammunition Plant

Comment 1. Figure 1-2, Investigation Overview, Page 1-7

Comment: The abbreviation "LOC" should be defined and added to the list of acronyms and abbreviations on page v.

Response: **The acronym LOC will be defined as "level of concern" and be placed in the acronym list.**

Comment 2. Section 1.2.2.3, RCRA Facility Investigation - Parsons, 1996, Page 1-22

Comment: This section indicates that it has not been verified whether the monitoring wells for SWMU 31 are upgradient or downgradient. However, Figure 1-6 refers to them as "downgradient" and "upgradient" wells. The groundwater sampling proposed in Section 1.2.3.4 of the draft *Work Plan* should include investigations clearly establishing which wells are upgradient or downgradient. This would help in proper assessment of contamination migration and verify the implications of previous investigative results.

Response: **The terms 'upgradient" and "downgradient" were from a previous investigation report and will be removed from Figure 1-6. After reviewing the background literature, investigations and sample results, IT prepared a Current Conditions Report (CCR) that was submitted for review. This document provides a current understanding of the geology and hydrogeologic conditions at RFAAP and may contradict previous investigations regarding RFAAP. The complex conditions at RFAAP preclude using traditional hydrological assumptions (e.g. porous media flow). Wells installed in the past were probably installed based on traditional thoughts on groundwater flow (i.e. one well upgradient vs. three downgradient). The Current Conditions Report outlines the understanding of the hydrogeologic system and provides a listing of data gaps. In order to eliminate the data gaps, including gradient information, a step-wise approach is necessary in this setting. The future activities listed in the CCR include developing a water budget, river gauging, continuously monitoring groundwater in selected wells and springs, monitoring climatic influences and continued groundwater monitoring as required. This information will be used to evaluate hydraulically upgradient and downgradient wells at SWMU31. It should be noted that the near surface geology around SWMU 31 is most probably depositional sediment from the New River, therefore, it is possible that near surface hydrology may behave in a more "traditional" manner. This will also be addressed in future iterations of the CCR and the SWMU 31 RFI report.**

Comment 3. Section 1.2.2.4 (RCRA Facility Investigation - ICF KE, 1998), Page 1-23

Comment: **Section 1.2.2.4 (RCRA Facility Investigation - ICF KE, 1998)** on page 1-23 states that 11 metals were detected above the BTAG screening criteria in each lagoon, and that the risk driver from the screening ecological risk assessment (ERA) was lead. Several polycyclic aromatic hydrocarbons were also detected above BTAG screening values. Based on this information, the baseline ERA should be completed for the site. The section further states that the recommended management decision was to further evaluate chemicals in the lagoons associated with this ecological concern. It is unclear from the document how the proposed sampling discussed in Section 1.2.3 will increase understanding of current risk to ecological receptors at the site, as only additional sediment chemistry is proposed. Sediment toxicity testing on lagoon sediments would be useful in the baseline ERA to evaluate risk to benthic invertebrates from metals found in the sediment of the settling site. The scope of the baseline ERA should be defined in the baseline ERA problem formulation lagoons. Other site-specific tests may be needed to assess risk from other contaminants at the (Step 3 of the ERA process). These issues need to be discussed in this report.

Response: **The statement "11 metals were detected above the BTAG screening criteria in each lagoon"was based on a comparison of Lagoon sludge samples with BTAG soil screening levels. As discussed in Comment No. 5, sediment screening values should have been used. When more appropriate sediment screening values are used (e.g., Effects Range Low [ER-L] values from Long et al. [1995], as were used in the Screening Level Ecological Risk Assessment [SLERA; ICF-KE, 1999] for New River sediment samples), the number of sediment constituents of potential ecological concern (COPEC) drops, with antimony, arsenic, lead, nickel, zinc, and pyrene having maximum detected concentrations above the ER-L values. When Effects Range Medium (ER-M) screening values are used, only pyrene, detected in sludge sample 31SL3-2 at 2.9 ug/g, exceeds the ER-M screening value of 2.6 ug/g. It should be noted that ER-L and ER-M screening values are based on estuarine data from Puget Sound, and may not be appropriate for freshwater environments like the Lagoons. If other guidelines that may be more appropriate (such as Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, 1999, Canadian Council of Ministers on the Environment, Winnipeg) can be determined they will be used in place of ER-L and ER-M values.**

The statement that "the risk driver from the SLERA was lead" is based on data collected from the New River, not the Lagoons. This information will be clarified in the text. In the river, a sediment lead sample was recorded as high as 3,400 ug/g, compared with Lagoon sludge lead up to 55 ug/g. Based on the previously provided information, there may not be enough evidence to proceed directly to a baseline ecological risk assessment (BERA) that includes sampling for sediment toxicity testing. Whether or not to proceed beyond Step 2 of the ERAGS 8-step process (e.g., to a BERA) requires resolution of a scientific management decision point (SMDP) in concurrence with BTAG. These lagoons are man-made and part of an active unit and are not considered suitable ecological environment. The additional sampling that is recommended in the Work Plan (i.e., 12 sediment samples), including the analysis for total organic carbon (TOC), can be used to supplement the existing three (3) Lagoon sediment samples, and a more complete and accurate SLERA may be performed. TOC may act to bind chemical constituents, rendering them less bioavailable to ecological receptors. TOC levels may be used to adjust the sediment criteria that are based on normalization to the percent of TOC in the sample.

n

Comment 4. Table 1-7, 1998 RFI Detected Metals Results for Surface Water at SWMU 31 - Coal Ash Settling Lagoons, Page 1-23

Comment: The tap water Region III risk based concentrations (RBCs) assigned to aluminum, barium, manganese, nickel and zinc are incorrect. At Region III Superfund sites, RBCs for non-carcinogens are typically adjusted downward to correspond to a target hazard quotient (HQ) of 0.1. Thus, the correct RBC values for the above constituents should be an order of magnitude lower than those provided in the table. Revise this table to provide the correct Region III RBCs using the latest RBC table (dated May 8, 2001).

Response: **Table will be revised as requested.**

Comment 5. Table 1-8 and Table 1-9, Page 1-24

Comment: **Table 1-8 and Table 1-9** on page 1-24 compares detected metal concentrations and organic results in sludge/sediment collected in 1998 from the settling lagoons to BTAG screening values. The BTAG values used are the soil screening values. If there is standing water in the settling lagoons as depicted in pictures on pages 1-6 and 1-8, BTAG screening values for sediment should have been used. In addition, the use of soil screening values in this situation will overestimate risk, as the sediment screening values are higher than the soil numbers for most chemicals. Future comparisons should use the appropriate screening values depending on the type of habitat present.

Response: **Sediment screening values will be used for comparison of sediment chemical concentrations from lagoon samples.**

Comment 6. Table 1-11, 1998 RFI Detected Organic Results for Subsurface Soil at SWMU 31 - Coal Ash Settling Lagoons, Page 1-27

Comment: The table does not provide results for samples 31SB1A and 31SB1C. Provide the results for these samples or explain why they were excluded from the table.

Response: **Table 1-11 is for detected results. There were no detections of organics in either sample 31SB1A or 31SB1C, therefore they were not included in the table of detected results. This information will be added as a footnote to the table.**

Comment 7. Table 1-12, 1998 RFI Detected Metal Results for Groundwater at SWMU 31 - Coal Ash Settling Lagoons, Page 1-28

Comment: The tap water Region III RBCs assigned to aluminum, barium, cobalt, iron, manganese, and thallium are incorrect. At Region III Superfund sites, RBCs for non-carcinogens are typically adjusted downward to correspond to a target hazard quotient (HQ) of 0.1. Thus, the correct RBC values for the above constituents should be an order of magnitude lower than those provided in the table. Revise this table to provide the correct Region III RBCs using the latest RBC table (dated May 8, 2001). In addition, revise the table to indicate that iron and manganese exceed their corresponding tap water RBCs, and revise any conclusions accordingly.

Response: **Table will be revised using a HQ of 0.01, and to indicate that iron and manganese exceeded their corresponding Tap Water RBC. Conclusions will be modified accordingly.**

Comment 8: Section 1.2.3.3, Soil, Page 1-31

Comment: This section states that "one surface (0-2 ft bgs) and one subsurface (2-4 ft bgs) soil sample will be collected and analyzed for TCL VOCs, explosives, TCL PCBs, dioxins/furans, pH, and TOC." The draft *Work Plan* does not explain how only one sample at only one location will yield data fulfilling the data gaps. Since biased and judgmental sampling (i.e., non-statistical) is proposed, the draft *Work Plan* should provide a justification for number and location of all samples.

In addition, both samples are not proposed to be analyzed for TAL metals. Surface and subsurface soil samples should also be analyzed for TAL metals or justification for exclusion of the metals should be presented.

Response: **Because the main concern at SWMU 31 is the lagoons, the need for soil samples from around the lagoons is limited. In fact, the Army had not envisioned the collection of soil samples in this WP, but added them per request of EPA (conversation with S. Rotenberg, USEPA, July 2000). The location of the proposed soil sample between the lagoons and the New River (the probable direction of constituent migration) should, when combined with previous sampling efforts as discussed in the report, provide evidence of impacts to soil from metals and the analytical parameters that have not yet been sampled at SWMU 31. TAL metals were not included because 17 soil samples have already been collected from SWMU 31 and analyzed for metals. Text will be revised to clarify this point.**

Comment 9: Section 1.2.3.4, Groundwater, Page 1-32

Comment: It is stated in this section that "low flow techniques will be employed for purging and sampling the wells at the unit [SWMU 31]." Describe or provide a reference for the low flow purging and sampling techniques that will be employed.

Response: **A reference to the Master Work Plan (ICF Kaiser, April 1998) will be provided. The Master Work Plan has additional information regarding low flow sampling methods and references.**

Comment 10: Section 1.3.2.2, Proposed Data Collection Activities, Page 1-40

Comment: The fifth bullet under *"Bedrock monitoring wells"* states that "well locations are geographically spaced across the HSA." However, the wells selected as "optimum wells" (refer to Figure 1-10 and Table 1-15) are existing wells that were installed to study SWMU-specific groundwater conditions. No wells are, for example, proposed in the eastern half of the Horseshoe Area, except for the wells at SWMU 31. Revise the draft *Work Plan* to discuss how these wells will fulfill the objective of investigating groundwater on a "larger, regional scale instead of at individual sites" (Executive Summary, fourth sentence).

Response: **Installing wells on the sole basis of geographic locations will not necessarily fill data gaps or the work plan objectives. The intent of this data collection activity is to assess which wells have optimum hydraulic continuum in the bedrock and to monitor water level responses. The rationale for choosing these existing wells are: 1) wells screened in bedrock, 2) wells with water levels near or below the river level, 3) wells shown by a modified pump test to have interconnected porosity and be near photolineaments and fractures, and 4) characterize different hydrogeologic environments at the site. The existing wells are located in geographically different areas of the HSA (east, center, and west). They do not fit a perfect geographic distribution. The proposed existing monitoring wells will monitor water level fluctuations and selected field measurements (i.e. temperature and specific**

conductance). The proposed existing monitoring wells are the most optimum for meeting the above stated objectives. The wells will be used to monitor changes in recharge and discharge, if shown to be hydraulically connected to other nearby wells, or by demonstration of their pumping rates and transmissivity, an indication of their interconnectedness. Using these wells in conjunction with river and spring gauging, and monitoring other discharge or recharge events will be used to evaluate a site-wide water budget. This information will aid in future decision making and will be used to update the current conditions and site hydrogeologic conceptual model.

The water budget will be important in assessing potential groundwater recharge or discharge areas. Data will be required from river gauging, groundwater level monitoring, springs, stormwater outfalls, and weather monitoring. This information will be used to calculate water volumes for the input and output parameters for the water budget.

The Work Plan will be revised to clarify the objective of investigating groundwater on a larger, site-wide scale and eliminate references to geographic distribution.

Comment 11: Section 2.3.2, Regional Groundwater Study DQOs, Page 2-7

Comment: DQO Step 6 (*Specify Acceptable Limits on Decision Errors*), sub-item 2a includes the statements "... groundwater gradient impacts a specific area exist ..." and "... groundwater gradient impacts a specific area do not exist ..." The meaning of these statements is not clear. Revise the draft *Work Plan* to clarify the intent of these statements.

Response: **Step 6(2)a attempts to illustrate potential decision errors and their consequences. Groundwater flow in karst is difficult to adequately determine without using many different tools (e.g. dye tracing, surface and subsurface geophysics, water budget, etc.) to ascertain how groundwater moves through the bedrock. Water levels can be misleading in karst. This step highlights how incorrect decisions about groundwater gradients can impact project objectives. The text will be revised for clarity. Sample text: "Possible decision errors include deciding incorrectly the direction of groundwater gradients and therefore misjudging the potential impact of contaminated groundwater flow to sites (incorrectly) determined to be downgradient or upgradient of impacted groundwater".**

Comment 12: Table 2-7, Analyte List

Comment: Revise this table to provide the adjusted RBC values for non-carcinogens using the Region III RBC table dated May 8, 2001. At Region III Superfund sites, RBCs for non-carcinogens are typically adjusted downward to correspond to a target hazard quotient (HQ) of 0.1.

Response: **Table 2-7 will be revised as suggested.**

Comment 13

Comment: The three lagoons are not contiguous. In order to demonstrate that none of the SWMUs is releasing contaminants to a level that may cause environmental harm and/or high risk to human health, a separate monitoring well system for each lagoon will be necessary. There should be at least one upgradient well and two downgradient wells for each lagoon. Please note that the width of the secondary and the tertiary lagoons is between 300 to 400 feet.

Response: **The three lagoons are contiguous in that they are connected by piping and are considered to be a single unit processing the same waste stream. The secondary lagoon is for overflow from the primary lagoon, etc. There is currently a monitoring well topographically downslope from each lagoon screened in the river channel alluvium. The Army believes that these three wells, combined with the topographicly upslope well will provide sufficient data to characterize the lagoons and impact they may be having on groundwater.**

Comment 14

Comment: The well screen for all of the wells established for the three lagoons should be placed in the same hydrogeologic layer, i.e. unconsolidated. The current "upgradient" well, i.e. 31MW1 is a bedrock well. It also appears that 31MW2 is not on the same set of streamlines for the Primary lagoon. These issues need to be addressed in the revised *Work Plan*.

Response: **The current "upgradient" well is completed into the top of bedrock, but is screened across the bedrock-alluvium interface. The Army believes that the placement of well 31MW2 is within range of the groundwater flowlines from the primary lagoon to accurately monitor impacts to groundwater from the lagoon.**

Typographical and Miscellaneous Errors

Comment 15 Section 1.5 Sampling Program Design, Page 1-57

Comment: This section references Table 1-19 for the comparison of existing sampling strategies. This information is provided in Table 1-20 and not Table 1-19. Please correct this error.

Response: **Table numbers for tables 1-19 and 1-20 were switched. Table numbers will be corrected.**

Comment 16 Section 1.5.2, Required Materials and Equipment, Page 1-57

Comment: This section references Table 1-20 for the list of materials and equipment required to complete project activities. This information is provided in Table 1-19. Please correct this error.

Response: **Table numbers for tables 1-19 and 1-20 were switched. Table numbers will be corrected.**

Rec'd 7-31-01
Ltr# 01-90 RS.

C: Jake
Redder
McKenna
Barker
Davie
File

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

July 23, 2001

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
SWMU 31 and the Horseshoe Area Groundwater Study
Document submittal and review

Dear Mr. McKenna and Ms. Jake:

The U.S. Environmental Protection Agency (EPA) has reviewed the Army's draft *Work Plan Addendum 009: SWMU 31 and the Horseshoe Area Groundwater Study,* (dated 4/9/01) for the Radford Army Ammunition Plant (RFAAP). Outlined below, please find EPA's comments based upon that review:

1. **Figure 1-2, Investigation Overview, page 1-7**: The abbreviation "LOC" should be defined and added to the list of acronyms and abbreviations on page v.

2. **Section 1.2.2.3, RCRA Facility Investigation - Parsons, 1996, page 1-22**: This section indicates that it has not been verified whether the monitoring wells for SWMU 31 are upgradient or downgradient. However, Figure 1-6 refers to them as "downgradient" and "upgradient" wells. The

groundwater sampling proposed in Section 1.2.3.4 of the draft *Work Plan* should include investigations clearly establishing which wells are upgradient or downgradient. This would help in proper assessment of contamination migration and verify the implications of previous investigative results.

3. **Section 1.2.2.4 (RCRA Facility Investigation - ICF KE, 1998)** on page 1-23 states that 11 metals were detected above the BTAG screening criteria in each lagoon, and that the risk driver from the screening ecological risk assessment (ERA) was lead. Several polycyclic aromatic hydrocarbons were also detected above BTAG screening values. Based on this information, the baseline ERA should be completed for the site. The section further states that the recommended management decision was to further evaluate chemicals in the lagoons associated with this ecological concern. It is unclear from the document how the proposed sampling discussed in Section 1.2.3 will increase understanding of current risk to ecological receptors at the site, as only additional sediment chemistry is proposed. Sediment toxicity testing on lagoon sediments would be useful in the baseline ERA to evaluate risk to benthic invertebrates from metals found in the sediment of the settling site. The scope of the baseline ERA should be defined in the baseline ERA problem formulation lagoons. Other site-specific tests may be needed to assess risk from other contaminants at the (Step 3 of the ERA process). These issues need to be discussed in this report.

4. **Table 1-7, 1998 RFI Detected Metals Results for Surface Water at SWMU 31 - Coal Ash Settling Lagoons, page 1-23:** The tap water Region III risk based concentrations (RBCs) assigned to aluminum, barium, manganese, nickel and zinc are incorrect. At Region III Superfund sites, RBCs for non-carcinogens are typically adjusted downward to correspond to a target hazard quotient (HQ) of 0.1. Thus, the correct RBC values for the above constituents should be an order of magnitude lower than those provided in the table. Revise this table to provide the correct Region III RBCs using the latest RBC table (dated May 8, 2001).

5. **Table 1-8 and Table 1-9** on page 1-24 compares detected metal concentrations and organic results in sludge/sediment collected in 1998 from the settling lagoons to BTAG screening values. The BTAG values used are the soil screening values. If there is standing water in the settling lagoons as depicted in pictures on pages 1-6 and 1-8, BTAG screening values for sediment should have been used. In addition, the use of soil screening values in this situation will overestimate risk, as the sediment screening values are higher than the soil numbers for most chemicals. Future comparisons should use the

57

appropriate screening values depending on the type of habitat present.

6. **Table 1-11: 1998 RFI Detected Organic Results for Subsurface Soil at SWMU 31 - Coal Ash Settling Lagoons, page 1-27:** The table does not provide results for samples 31SB1A and 31SB1C. Provide the results for these samples or explain why they were excluded from the table.

7. **Table 1-12, 1998 RFI Detected Metal Results for Groundwater at SWMU 31 - Coal Ash Settling Lagoons, page 1-28:** The tap water Region III RBCs assigned to aluminum, barium, cobalt, iron, manganese, and thallium are incorrect. At Region III Superfund sites, RBCs for non-carcinogens are typically adjusted downward to correspond to a target hazard quotient (HQ) of 0.1. Thus, the correct RBC values for the above constituents should be an order of magnitude lower than those provided in the table. Revise this table to provide the correct Region III RBCs using the latest RBC table (dated May 8, 2001). In addition, revise the table to indicate that iron and manganese exceed their corresponding tap water RBCs, and revise any conclusions accordingly.

8. **Section 1.2.3.3, Soil, page 1-31:** This section states that "one surface (0-2 ft bgs) and one subsurface (2-4 ft bgs) soil sample will be collected and analyzed for TCL VOCs, explosives, TCL PCBs, dioxins/furans, pH, and TOC." The draft *Work Plan* does not explain how only one sample at only one location will yield data fulfilling the data gaps. Since biased and judgmental sampling (i.e., non-statistical) is proposed, the draft *Work Plan* should provide a justification for number and location of all samples.

   In addition, both samples are not proposed to be analyzed for TAL metals. Surface and subsurface soil samples should also be analyzed for TAL metals or justification for exclusion of the metals should be presented.

9. **Section 1.2.3.4, Groundwater, page 1-32:** It is stated in this section that "low flow techniques will be employed for purging and sampling the wells at the unit [SWMU 31]." Describe or provide a reference for the low flow purging and sampling techniques that will be employed.

10. **Section 1.3.2.2, Proposed Data Collection Activities, page 1-40:** The fifth bullet under "*Bedrock monitoring wells*" states that "well locations are geographically spaced across the HSA." However, the wells selected as "optimum wells" (refer to Figure 1-10 and Table 1-15) are existing wells that were installed to study SWMU-specific groundwater conditions. No

wells are, for example, proposed in the eastern half of the Horseshoe Area, except for the wells at SWMU 31. Revise the draft *Work Plan* to discuss how these wells will fulfill the objective of investigating groundwater on a "larger, regional scale instead of at individual sites" (Executive Summary, fourth sentence).

11. **Section 2.3.2, Regional Groundwater Study DQOs, page 2-7:** DQO Step 6 (*Specify Acceptable Limits on Decision Errors*), sub-item 2a includes the statements "... groundwater gradient impacts a specific area exist ..." and "... groundwater gradient impacts a specific area do not exist ..." The meaning of these statements is not clear. Revise the draft *Work Plan* to clarify the intent of these statements.

12. **Table 2-7, Analyte List:** Revise this table to provide the adjusted RBC values for non-carcinogens using the Region III RBC table dated May 8, 2001. At Region III Superfund sites, RBCs for non-carcinogens are typically adjusted downward to correspond to a target hazard quotient (HQ) of 0.1.

13. The three lagoons are not contiguous. In order to demonstrate that none of the SWMUs is releasing contaminants to a level that may cause environmental harm and/or high risk to human health, a separate monitoring well system for each lagoon will be necessary. There should be at least one upgradient well and two downgradient wells for each lagoon. Please note that the width of the secondary and the tertiary lagoons is between 300 to 400 feet.

14. The well screen for all of the wells established for the three lagoons should be placed in the same hydrogeologic layer, i.e. unconsolidated. The current "upgradient" well, i.e. 31MW1 is a bedrock well. It also appears that 31MW2 is not on the same set of streamlines for the Primary lagoon. These issues need to be addressed in the revised *Work Plan*.

Typographical and Miscellaneous Errors

15. **Section 1.5, Sampling Program Design, page 1-57:** This section references Table 1-19 for the comparison of existing sampling strategies. This information is provided in Table 1-20 and not Table 1-19. Please correct this error.

16. **Section 1.5.2, Required Materials and Equipment, page 1-57:** This section references Table 1-20 for the list of materials and equipment required to complete project activities. This information is provided in Table 1-19. Please correct this error.

This concludes EPA's review of the Army's draft *Work Plan Addendum 009: SWMU 31 and the Horseshoe Area Groundwater Study*, dated April, 2001 for the RFAAP. The referenced draft *Work Plan* 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
Sharon Wilcox, VDEQ-CERCLA

vd.

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

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-EHR (40)

21 ~~JUN~~ May 2001

MEMORANDUM FOR Radford Army Ammunition Plant (SMCRA-EN/Mr. Jim McKenna), P.O. Box 2, Route 114, Radford, VA 24141-0099

SUBJECT: Draft Work Plan Addendum 009: SMWU 31 and Horseshoe Area Groundwater Study, Radford Army Ammunition Plant, April 2001

1. The US Army Center for Health Promotion and Preventive Medicine (USACHPPM) 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 background study report.

2. The document is well written and the scope of work is clearly presented. Minor comments and recommendations are enclosed.

3. The scientists reviewing this document were Ms. Kim Fleischmann, Ground Water and Solid Waste Program; and Mr. Matthew Bazar, Environmental Health Risk Assessment Program. Mr. Bazar is our point of contact at (410) 436-7722, DSN 584-7722, or e-mail: matthew.bazar@amedd.army.mil.

FOR THE COMMANDER:

Encl

David L. Daughdrill
DAVID L. DAUGHDRILL
Program Manager
Environmental Health Risk Assessment

CF:
HQDA(DASG-HS-PE)(wo/encl)
USAMEDCOM (MCHO-CL-W)(w/encl)
AMC (AMCIS-A)(w/encl)
USACE (CENWO-HX-H)(w/encl)
USAEC (SFIM-AEC-ERO)(w/encl)

103/

COMMENTS AND RECOMMENDATIONS

US Army Center for Health Promotion and Preventive Medicine
~~Facility-Wide Background Study Report,~~ Radford Army Ammunition Plant, Virginia,
January 2001

1. Page 1-8, Section 1.2, K. Fleischmann
SWMU 31 - Coal Ash Settling Lagoons
Comment: The captions on the two photos on Page 1-8 state that the view is looking to the west. However, the view is actually looking from the west (to the east).
Recommendation: Replace "west" with "east" in the photo captions.

2. Page 1-9, Figure 1-3, K. Fleischmann
SWMU 31 Geologic Cross Section (A-A')
Comment: On the left side of the cross section, the symbol for the upper horizon is incorrect. The hachure lines are aligned opposite of the direction indicated in the legend.
Recommendation: Change the direction of the hachure lines on the cross section to match the legend.

3. Page 1-11, Figure 1-4, K. Fleischmann
SWMU 31 Geologic Cross Section (B-B')
Comment: The symbol for "Gravel (GM/SM), Brown, Sand and Silt" is labeled incorrectly either on the cross section or on the legend. The hachure lines on the cross section are aligned opposite of the direction on the legend.
Recommendation: Change the direction of the hachure lines on the cross section to match the legend.

4. Page 1-13, Figure 1-5, K. Fleischmann
SWMU 31 Conceptual Site Model
Comment: For clarification and completeness of the conceptual model, the flow direction of the New River should be provided.
Recommendation: Add the flow direction of the New River to the figure.

5. General Comment, K. Fleischmann
Comment: This is a well-written work plan for a very interesting project. The ground-water study for the Horseshoe Area seems to be comprehensive, but no mention is made regarding how the data will be presented. This project may be a good candidate for using a Geographic Information System (GIS).
Recommendation: Consider using GIS as a tool to analyze and present the data for the Horseshoe Area ground-water study. Data from past and future studies of the SWMUs in the Horseshoe Area also could be added to the GIS database, possibly providing a better understanding of contaminant movement.

WPA 9

ATK
ALLIANT TECHSYSTEMS

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

April 9, 2001

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

Subject: Work Plan Addendum 009: SWMU 31 and Horseshoe Area Groundwater Study
EPA ID# VA1 210020730

Dear Mr. Thomson:

Enclosed is a certified copy of the "Work Plan Addendum 009: SWMU 31 and Horseshoe Area Groundwater Study". Your six additional copies and Ms. Wilcox's copy will be sent under separate cover

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,

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

Enclosure

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

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

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

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

Coordination: J. McKenna
J. McKenna

01-815-74
JJRedder

Concerning Work Plan Addendum 009: SWMU 31 and Horseshoe Area Groundwater Study

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of t 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: Rodney K. Alston
PRINTED NAME: Rodney K. Alston
TITLE: LTC, CM, Commanding
Radford AAP

SIGNATURE:
PRINTED NAME: Ken Dolph
TITLE: Vice President Operations
Alliant Ammunition and Powder Company, LLC

ATK
ALLIANT TECHSYSTEMS

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

April 9, 2001

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

Subject: Work Plan Addendum 009: SWMU 31 and Horseshoe Area Groundwater Study
EPA ID# VA1 210020730

Dear Mr. Thomson:

Enclosed is a certified copy of the "Work Plan Addendum 009: SWMU 31 and Horseshoe Area Groundwater Study". Your six additional copies and Ms. Wilcox's copy will be sent under separate cover

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,

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

Enclosure

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

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

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

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

Coordination: J. McKenna
J. McKenna

01-815-74
JJRedder

Concerning Work Plan Addendum 009: SWMU 31 and Horseshoe Area Groundwater Study

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance wit system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of 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: Rodney K. Alston
PRINTED NAME: Rodney K. Alston
TITLE: LTC, CM, Commanding
Radford AAP

SIGNATURE:
PRINTED NAME: Ken Dolph
TITLE: Vice President Operations
Alliant Ammunition and Powder Company, LLC

1 of

McKenna, Jim

From: Jenkins, Joanne
Sent: Wednesday, April 04, 2001 9:02 AM
To: McKenna, Jim
Cc: Robert Davie
Subject: RE: NHPA, Work Plan Addenda 009 and 012

Jim,

Reference our meeting this date.

In accordance with 36 CFR Part 800 all RFAAP actions meet the definition of an undertaking ad are therefore subject to 106 review. However, this in itself doesn't warrant full initiation of the process. RFAAP can determine that a proposed action has "no potential to cause effect" on historic properties. If we determine that an action has "no potential to cause effect", then we have no further obligations under 106. Ground disturbing activities in areas where there are no archeological sites and the activity would not compromise the setting or feel of any other historic site in the are examples of activities that would be determined to have "no potential to cause effect".

The locations of the work identified in your request contain no archeological sites and will not compromise any other historic site. Therefore, a determination of "no potential to cause effect" is appropriate and work may proceed.

Joanne Jenkins
Industrial Specialist
Operations Division
DSN 931-7480

> -----Original Message-----
> **From:** McKenna, Jim
> **Sent:** Wednesday, April 04, 2001 8:40 AM
> **To:** Jenkins, Joanne
> **Subject:** NHPA, Work Plan Addenda 009 and 012
>
> Joanne,
>
> 1. There is sampling work identified in Work Plan Addendum 009 that will occur in the Horshoe Area near the water treatment plant and former power house as well as at 3 spring locations. The WPA has maps that show the locations.
>
> 2. There is sampling work identified in Work Plan Addendum 012 that will occur at various sites in the Horseshoe Area and the New River Unit. The WPA has maps that show the locations.
>
> Need you/us to review for possible interference with historic sites.
>
> Thanks,
> Jim

Delivery Order No. 0008
Environmental Services
Program Support
DACA31-94-D-0064

RADFORD ARMY AMMUNITION PLANT, VIRGINIA

Work Plan Addendum 009: SWMU 31 and Horseshoe Area Groundwater Study

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

Prepared by:
IT Corporation
2113 Emmorton Park Rd.
Edgewood, MD 21040

Draft Final Document

February 2002

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704–0188

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6. AUTHOR(S)
W. Barner, J. Parks, M. Thomas, D. Trumbo

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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2113 Emmorton Park Road
Edgewood, MD 21040

8. PERFORMING ORGANIZATION REPORT NUMBER
ESPS 08–36

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
USACE, Baltimore District
10 South Howard Street
Baltimore, MD 21201

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Report is contained in one volume.

12a. DISTRIBUTION/AVAILABILITY STATEMENT

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

The IT Group has been tasked to address environmental concerns at Radford Army Ammunition Plant (RFAAP). Scope of work activities include the collection of additional data at Solid Waste Management Unit (SWMU) 31 to finalize the risk management decisions, and assessment of groundwater gradients within the Horsehoe Area of RFAAP. This Work Plan is an addendum to the RFAAP Master Work Plan (MWP), and is to be used in conjunction with the MWP to perform investigation activities at SWMU 31 and within the Horeshoe Area of RFAAP. Definable features of work associated with these investigations include: environmental media (i.e., surface water, sludge/sediment, soil, and groundwater) sampling, river, spring, and monitoring well gauging, modified aquifer pump tests, and well surveying. Corresponding QA and Health and Safety requirements are discussed for associated activities, as appropriate.

14. SUBJECT TERMS
RFAAP, Master Work Plan, RCRA Facility Investigation, Horseshoe Area Groundwater Study

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None

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Standard Form 298 (Rev. 2–89)
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298–102

TABLE OF CONTENTS

LIST OF FIGURES

Figure

LIST OF TABLES

Table

LIST OF APPENDICES

Appendix

LIST OF ACRONYMS AND ABBREVIATIONS

ATK	Alliant Techsystems, Inc.
AWQC	Ambient Water Quality Criteria
bgs	below ground surface
BTAG	Biological Technical Assistance Group
CFR	Code of Federal Regulations
CMS	Corrective Measures Study
COD	Chemical Oxygen Demand
CVAA	cold vapor atomic absorption
DOD	Department of Defense
DQO	data quality objective
FID	flame ionization detector
ft	feet
GC/FID	gas chromatograph/flame ionization detector
GPS	Global Positioning System
HAZCOM	Hazard Communication
HBN	Health-Based Number
HRGC/HRMS	high-resolution gas chromatography and high-resolution mass spectrometry
HSA	Horseshoe Area
HSPA	Health and Safety Plan Addendum
HSP	Health and Safety Plan
ICP	inductively coupled plasma
IDM	investigative-derived material
LOC	Level of Concern
MCL	Maximum Contaminant Level
MHSP	Master Health and Safety Plan
mL	milliliter
MQAP	Master Quality Assurance Plan
MSDS	Material Safety Data Sheet
msl	mean sea level
MWP	Master Work Plan
NGVD	National Geodetic Vertical Datum
OSHA	Occupational Safety and Health Administration
PAH	polynuclear aromatic hydrocarbon
PPE	personal protective equipment and clothing
QA/QC	Quality Assurance/Quality Control
QAPA	Quality Assurance Plan Addendum
QAP	Quality Assurance Plan
QA	quality assurance
QC	quality control
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFAAP	Radford Army Ammunition Plant
RFI	RCRA Facility Investigation
SHSO	Site Health and Safety Officer
SOP	standard operating procedure
SOQ	Statement of Qualification
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
TOC	total organic carbon
TOX	total organic halides
TSDF	Transporter, storage, and disposal facility
TWA	time-weighted average

USACE	U.S. Army Corps of Engineers
UV	ultraviolet
VOC	volatile organic compound
VPDES	Virginia Pollutant Discharge Elimination System
WPA	Work Plan Addendum

EXECUTIVE SUMMARY

Work Plan Addendum (WPA) 009 has been revised from the original WPA 009 that was submitted to the U.S. Environmental Protection Agency (USEPA) and Virginia Department of Environmental Quality (VDEQ) on 3 December 1999. Since 1999 there have been several discussions and meetings among Radford Army Ammunition Plant (RFAAP), USEPA, and VDEQ. From these discussions, it became apparent that significant changes were required. The first major discussion was about the investigation of groundwater at RFAAP. Since groundwater flow at RFAAP is complex due to karst features, a consensus was reached to study groundwater on a larger, regional scale (i.e., the entire Horseshoe Area [HSA]) instead of at individual sites. An exception is SMWU 31, which is discussed below. Therefore, the new WPA 009 has been revised accordingly. Second, the original WPA 009 had site-specific work unrelated to this overall HSA groundwater effort (i.e., soil, surface water, or sediment data gap sampling). That work is being incorporated into a separate, new WPA 012 (with the exception of SWMU 31). The SWMU 31 data gap sampling effort is not large, and for expediency, it has been included in this WPA.

The geologic and hydrogeologic conditions at RFAAP are very complex due to the intense structural deformation that is observed throughout the area, with examples of faulting, complex folded and fractured bedrock, and the development of karst within the carbonate rocks that underlie the Installation. Groundwater movement through these rocks can be preferentially channeled through the numerous fractures, along bedding planes, and through solution-enhanced variations of each. Karst that is observed on-site include sinkholes (bowl-shaped depressions in the land surface), springs that discharge near the margin of the HSA and the New River, and enlarged fractures. This type of terrain challenges the sampling methodology and rationale that is typically used in non-karst terrains.

Given these hydrogeologic complexities, it is proposed that groundwater be evaluated on a larger scale (entire HSA) instead of at individual SWMUs. Traditional investigation procedures typically are not valid in karst regions. Several activities in support of this HSA-wide groundwater investigation have already occurred and include a thermal imaging flyover, spring surveys, and photolineament/fracture-trace analysis. Additional proposed data gathering activities are discussed in Section 1.3, "Regional Groundwater Study," of this report. A revised report of groundwater current conditions, incorporating information gathered in the aforementioned activities, is being prepared for review. A current conditions white paper was originally prepared and presented to USEPA in March 2000 as part of the response to comments generated by the review of the original WPA.

As discussed in Section 1.2, "SWMU 31 – Coal Ash Settling Lagoons," a thorough review of the SWMU has been conducted with respect to identifying additional data gaps and data needs. As previously described, SWMU 31 is located very near the New River over a relatively shallow unconfined aquifer consisting of unconsolidated alluvial sediment overlying the Elbrook Formation. Groundwater associated with SWMU 31 discharges to the river.

Given these conditions and in order to satisfy USEPA comments related to investigative activities previously performed at SWMU 31, groundwater will be collected and analyzed to better characterize site conditions, specifically, site groundwater before it discharges to the New River. This is not in conflict with the goals of the area-wide groundwater study discussed elsewhere in this report, rather the proposed sampling of groundwater at SWMU 31 acknowledges that groundwater flow in the vicinity of the SWMU is more predictable and does not appear to be significantly influenced by the prevailing karst setting.

1.0 Work Plan Addendum

IT Corporation has been tasked by the U.S. Army Corps of Engineers (USACE), Baltimore District, to perform Resource Conservation and Recovery Act (RCRA) Facility Investigation and Corrective Measures Study (CMS) activities in accordance with Contract No. DACA31-94-D-0064, Delivery Order 0008. Task objectives are to address data gaps at Solid Waste Management Unit (SWMU) 31—Coal Ash Settling Lagoons and further characterize hydrogeological conditions within the Horseshoe Area (HSA) of Radford Army Ammunition Plant (RFAAP). A location map depicting SWMU 31 and the HSA is presented on **Figure 1–1**.

1.1 OBJECTIVE AND SCOPE

This work plan is written as an addendum to the RFAAP Master Work Plan (MWP) (URS, 2002) and comprises the following three sections, consistent with the MWP:

- Section 1, Work Plan,
- Section 2, Quality Assurance Plan (QAP), and
- Section 3, Health and Safety Plan (HSP).

This Work Plan Addendum (WPA) presents site-specific activities for the following areas:

- SWMU 31–Coal Ash Settling Lagoons (Section 1.2), and
- Regional Groundwater Study (Section 1.3).

Analytical results obtained at SWMU 31 triggered a RCRA Facility Investigation to characterize the rate and extent of releases. Investigative activities specified in this plan are required to augment the existing conceptual site model and assess the need for and/or scope of corrective measures.

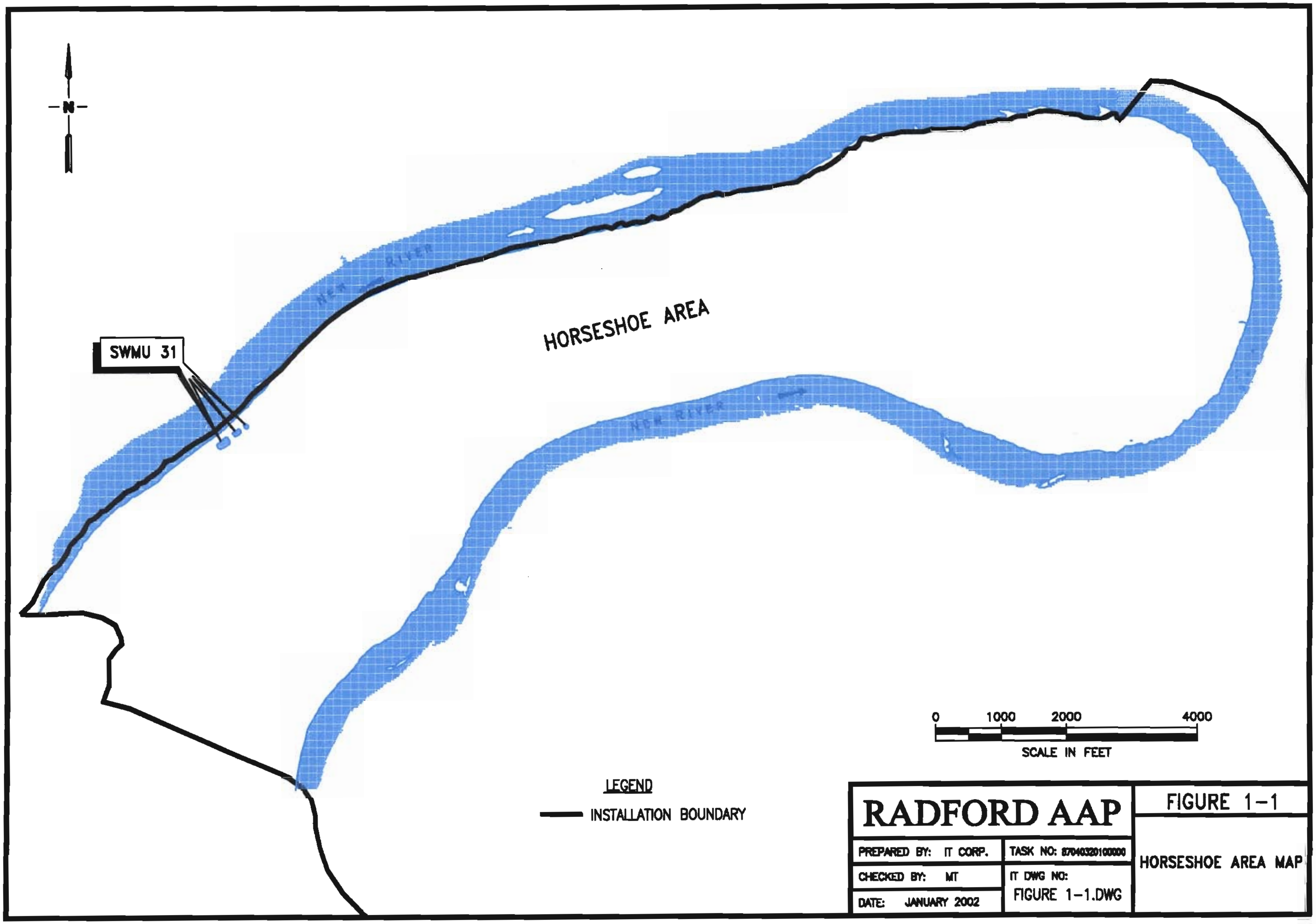
USACE, Baltimore District, and the Installation have approved the MWP as RFAAP's work plan for performing routine investigative activities. Routine investigative activities that will be performed as specified in the MWP are listed in **Table 1–1**.

Changes to the approved WPA will be documented using the Work Plan Revision Form (**Form 1-1**). Revisions must be reviewed and approved by USACE, Baltimore District, and RFAAP prior to implementation. Project personnel will be required to read this addendum and to sign and date a Worker Acknowledgment Form (**Form 1-2**). The Site Health and Safety Officer (SHSO) will retain this form onsite during investigation activities.

Table 1-1
Investigative Activities Discussed in the Master Work Plan

Subject	MWP Section	SOP(s) MWP Appendix A	Applicable Areas	
			SWMU 31	Horseshoe Area
Installation Description	2.0	NA	✓	✓
Environmental Setting	3.0	NA	✓	✓
Sample Management	5.1	50.1, 50.2, 50.3	✓	
Documentation	4.3	10.1, 10.2, 10.3, 10.4, 50.2	✓	✓
Boring Logs/Stratigraphic Characterization	5.2.5	10.3	✓	
Water Level/Well-Depth Measurement	NA	40.2	✓	✓
Monitoring Well Purge and Sampling	5.2.9, 5.2.9.3	30.2	✓	✓
Soil Sampling	5.2.8	30.1	✓	
Sediment Sampling	5.4	30.4, 30.5, 30.12*	✓	
Surface Water Sampling	5.3	30.3	✓	
Decontamination Requirements	5.12	80.1	✓	
IDM	5.13	70.1	✓	✓

*Currently not contained in MWP Appendix A but is contained in Appendix A of this Addendum.



RADFORD AAP

PREPARED BY: IT CORP.
CHECKED BY: MT
DATE: JANUARY 2002
TASK NO: 87040320100000
IT DWG NO: FIGURE 1-1.DWG

FIGURE 1-1

HORSESHOE AREA MAP

Form 1-1

Revision Form

Work Plan—Quality Assurance Plan—Health and Safety Plan Addendum

SITE DESIGNATION/LOCATION:
Radford Army Ammunition Plant
Radford, VA

Section:____________________________
Addendum:____________________________
Version:____________________________
Effective Date:____________________________

SUBJECT:

Approved By:
Field Operations Leader

____
Date ____________________________

Concurrence:
Project Manager

____
Date ____________________________
Sheet ____ of ____

Form 1–2

Worker Acknowledgment Form

Document: Master Work Plan/QAP/HSP and Addendum 009
Version: Draft
Project: Radford Army Ammunition Plant
Location: SWMU 31 and the Horseshoe Area

Prior to the initiation of field activities, I have been given an opportunity to read and question the contents of this Master Work Plan/QAP/HSP, this Site-Specific Addendum, and approved revisions through the number listed above. With my signature I certify that I have read, understood, and agree to comply with the information and directions set forth in these plans. I further certify that I am in full compliance with 29 CFR 1910.120 in regard to training and medical monitoring requirements.

Site Personnel:

Name (please print)	Signature	Date

1.1.1 Investigation Overview

Investigation program activities designed to achieve site-specific data quality objectives (DQOs) are presented in the following sections. Each program systematically establishes the rationale for investigative activities through an assessment of site characteristics and associated project objectives. Supplemental chemical and physical data obtained during the sampling and analysis phase will be used to refine site profiles and enhance the accuracy of risk management decisions. A diagram illustrating the investigation process is presented on **Figure 1–2.**

The investigation program focuses on problems identified through existing data and has been designed to provide a comprehensive framework for establishing consistency in the decision making process. The program clearly articulates project objectives, assumptions, and data use specifications. Program elements include:

- **Site Characteristics:** Brief site descriptions are included in the introductory paragraph for each investigation area to provide an overview of existing site conditions.
- **Preliminary Investigative Results:** Preliminary results will be integrated into risk management decisions. Investigation activities have been conducted in each of the study areas. Baseline Human Health and Ecological Risk Assessments have been conducted in applicable study areas.
- **Sampling Program:** Phase focused investigations will be performed to effectively utilize resources and achieve project DQOs. The sampling design program presented for each area has been structured to meet site-specific DQOs.
- **Quality Assurance/Quality Control (QA/QC):** Independent quality control (QC) checks are used to demonstrate investigation and laboratory accuracy, precision, and integrity. Section 2.0 of this addendum establishes requirements for documentation, data collection and reporting, management and tracking of electronic and hard copy data, and presentation format. The Quality Assurance Plan Addendum (QAPA) provides assurance that data of known and documented quality is generated to allow the Army to make accurate risk management decisions.
- **Health and Safety:** Site-specific training, personal protective equipment and clothing (PPE), and applicable monitoring requirements are presented in Section 3.0 of this addendum. These procedures were developed to provide the requirements for protection of site personnel including government employees, IT Corporation, regulators, subcontractors, and visitors, who are expected to be involved with site activities.

1.2 SWMU 31—COAL ASH SETTLING LAGOONS

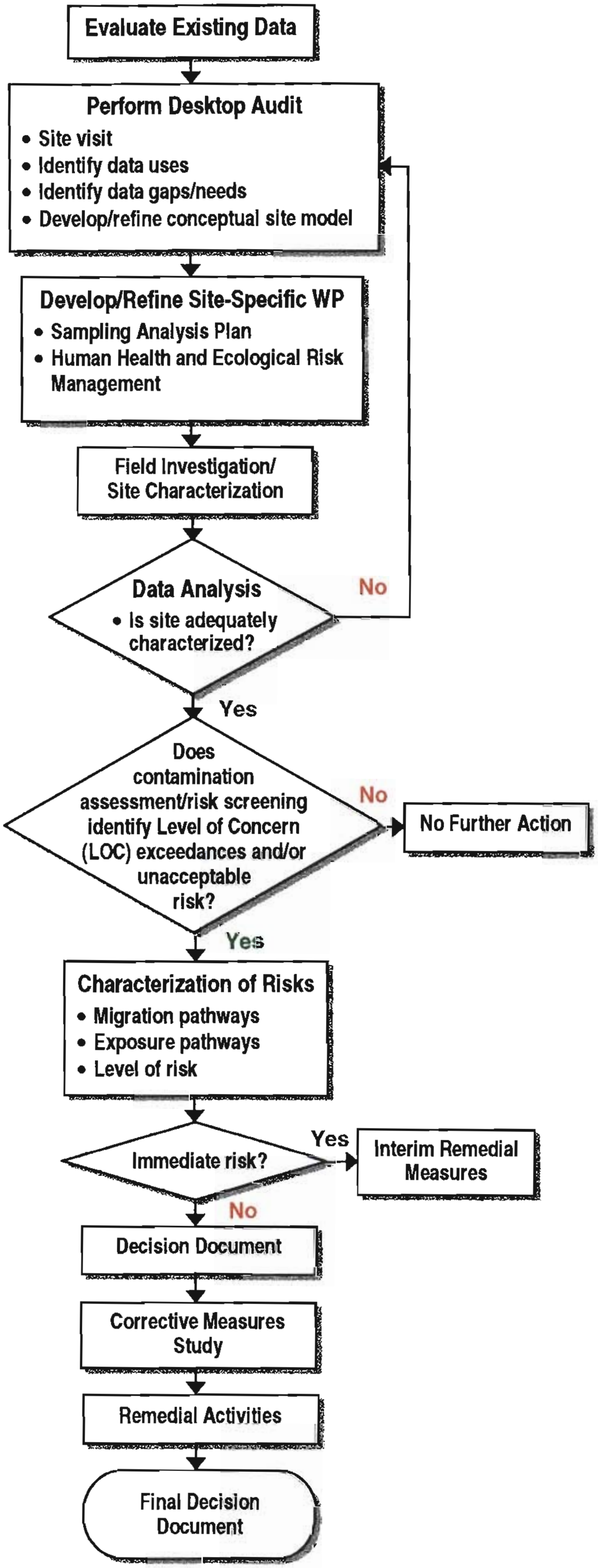
SWMU 31 is located in the northwest section of the HSA on a nearly level terrace adjacent to the New River at an approximate elevation of 1,700 feet (ft) mean sea level (msl). The New River flows from northeast to southwest along the northern boundary of the SWMU.

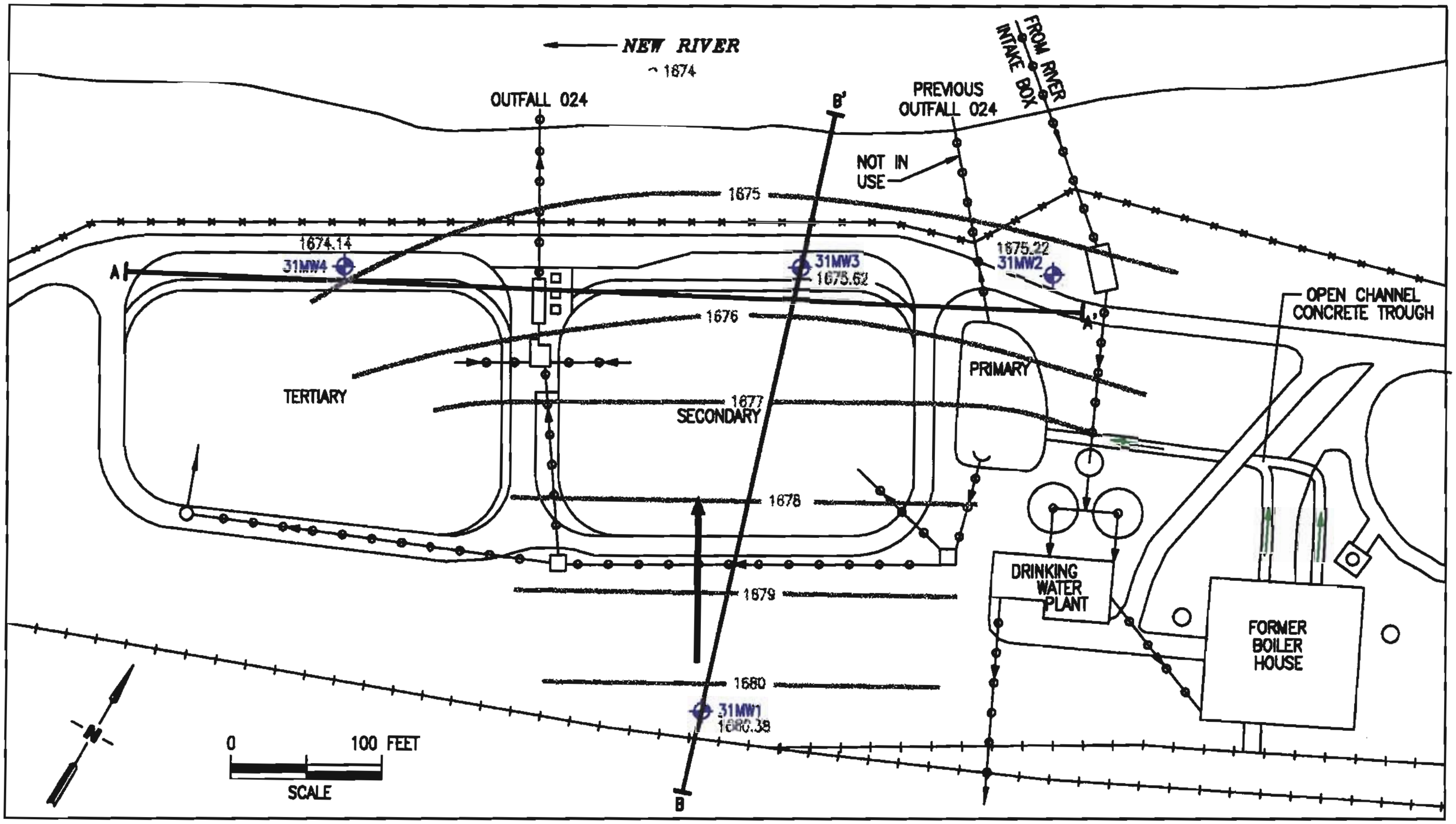
Primary Settling Lagoon. Drinking water plant and boiler in background.

SWMU 31 consists of three linearly connected unlined settling lagoons. The primary settling lagoon (approximately 100 ft long by 50 ft wide) was constructed in 1962 and received water carrying fly ash and bottom ash from Power House No. 2, which burned low sulfur coal to generate steam for HSA buildings. The secondary lagoon (approximately 150 ft wide by 200 ft long) and the tertiary lagoon (approximately 150 ft wide by 250 ft long) were constructed between 1978 and 1979 to receive the primary lagoon discharge **(Figure 1-3)**.

Facility representatives indicate that the water currently flowing into the primary settling lagoon consists of either overflow from the drinking water settling tanks or backwash from the cleaning of the filters at the drinking water settling tanks at Water Plant 4330. On average, 20,000 gallons of overflow water per day is released to the primary lagoon at a relatively constant flow rate. At a minimum, the filters require cleaning once every three days. This process involves passing 2,800 gallons of water per minute through the filters for 20 minutes to remove accumulated river sludge. The 56,000 gallons of turbid sludge-rich water yielded by this process is discharged to the primary settling lagoon.

Figure 1-2
Investigation Overview





LEGEND

⊕	EXISTING MONITORING WELL LOCATION
--1680--	GROUNDWATER CONTOUR
—●—●—	UNDERGROUND PIPELINE
—×—×—	FENCE
—+—+—	RAILROAD TRACKS
⟶	SURFACE WATER FLOW
➡	DIRECTION OF GROUNDWATER FLOW

NOTE: GROUNDWATER LEVELS MEASURED 4-18-00

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FIGURE 1-3

SWMU 31-
SITE MAP

Secondary Settling Lagoon (looking east).

Tertiary Settling Lagoon (looking east).

The effluent from the secondary and tertiary settling lagoons is designed to discharge to the New River through Outfall 024 following pH adjustment with sulfuric acid. However, facility representatives indicate that there has never been a discharge. Water discharged to the basin apparently evaporates or percolates through the basin into the surrounding soil.

The SWMU 31 vicinity displays the terraces characteristic of the unconsolidated alluvial sediment at RFAAP. This sediment layer is 25 to 28 ft thick along the New River. There is a general fining upwards textural sequence as silt and clay overlie gravel and silty sand. Below the gravel and sand, the bedrock interface consists of weathered limestone and dolostone of the Elbrook Formation. Cross-sections of SWMU 31 are presented on **Figures 1–4 and 1–5**. Cross-section locations are presented on **Figure 1–3**.

Groundwater is present within the relatively shallow unconfined aquifer consisting of unconsolidated alluvial sediment overlying the Elbrook Formation. Seasonal groundwater elevations have been observed to fluctuate 2 to 7 ft at this SWMU. Because the secondary and tertiary lagoons were excavated to the bedrock surface, the bottoms of the lagoons are essentially at or below the groundwater table. The groundwater gradient is northwest, toward the New River. Stabilized groundwater depths measured in April 2000 ranged from 23 to 34 ft below ground surface (bgs) (1,675 to 1,680 ft msl).

1.2.1 Conceptual Site Model

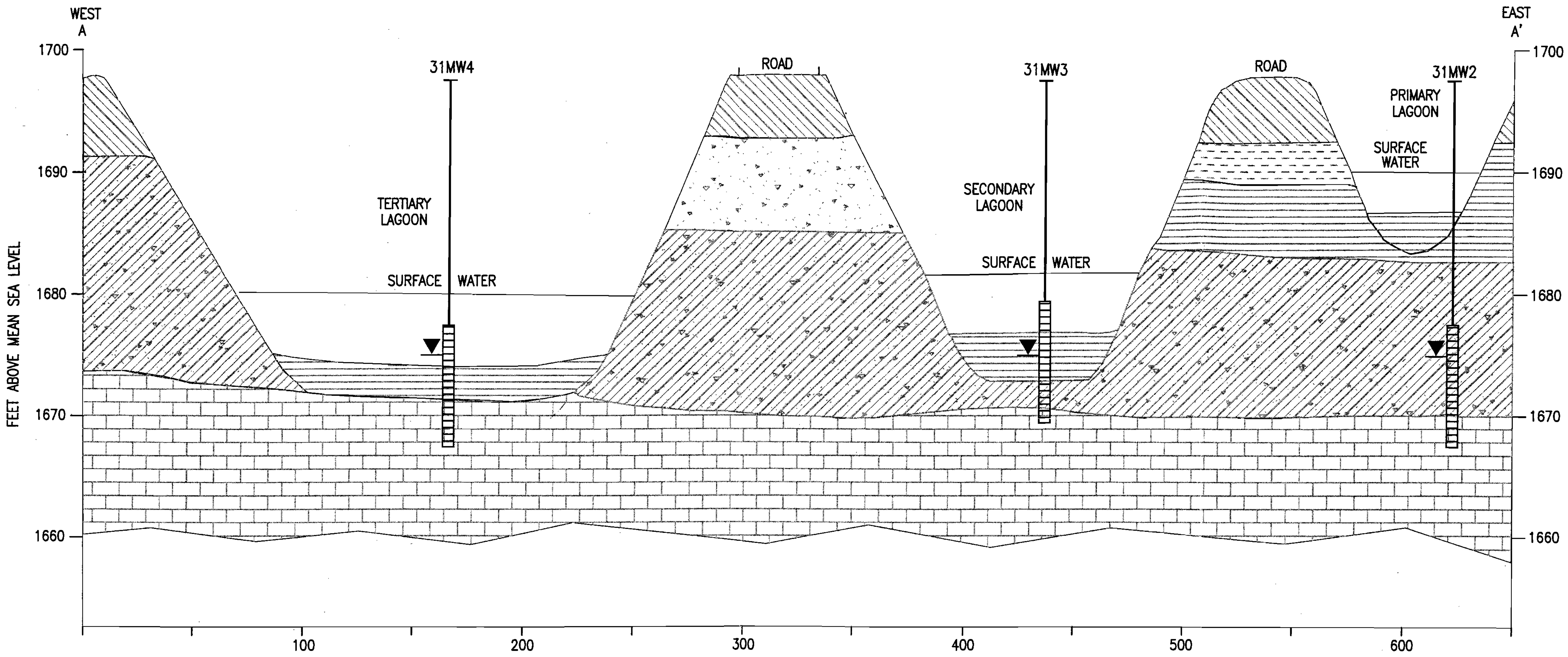
A site-specific CSM has been developed for SWMU 31 to assess potential contaminant sources, exposure pathways, and human and ecological receptors (**Figure 1–6**). Each media type (i.e., surface soil, subsurface soil, surface water, sediment, and groundwater) was evaluated to assess whether human (site worker) or biotic (terrestrial, aquatic, and benthic) receptors would be impacted by contamination. Three exposure routes, ingestion, inhalation, and dermal absorption, were evaluated for each media type. Site topography and physical land features, such as the lagoons and the New River, were used to approximate contaminant migration pathways.

Potentially affected media at this site include surface and subsurface soil, surface water, sediment, and groundwater. With the exception of the lagoons, the topography of the SWMU is level. Precipitation is expected to infiltrate into the ground and accumulate with surface water in the lagoons. The nearest residential development (Fairlawn) is approximately two miles from the Main Manufacturing Area; therefore, area residents are not considered SWMU 31 media receptors. **Table 1–2** presents the exposure pathways for each receptor. Each media type is described in more detail in the following paragraphs.

Surface water collecting in the settling lagoons is potentially contaminated by prior fly ash contaminated wastewater discharges from Power House No. 2. Site workers and biotic receptors could be potentially impacted through incidental ingestion and dermal absorption.

Sediment/sludge accumulating in the settling lagoons may be negatively affected from past Power House No. 2 fly ash contaminated wastewater discharges. Ingestion and dermal absorption are the primary exposure pathways for human receptors (site workers) and biota.

Surface soil is potentially contaminated by the discharge of fly ash from the boiler house smokestacks prior to the installation of scrubbers or from leaking pipes around the concrete sump that receives wastewater from the primary lagoon. Site workers and ecological receptors could be impacted though incidental ingestion of soil, dermal absorption through direct contact with contaminated soil, and the inhalation of dust.



LEGEND

▨ DARK BROWN SILT SOME CLAY (ML)

▨ BROWN SILT AND CLAY GRAVEL (GM/ML)

▤ BROWN CLAY AND SILT (CL)

▨ DARK BROWN SAND AND SILT, GRAVEL (GM/SM)

▦ LIMESTONE, GRAY WEATHERED (LMSN)

▤ SEDIMENT

▼ STATIC GROUNDWATER LEVEL

▥ WELL SCREEN INTERVAL

NOTE: 1. WATER LEVELS MEASURED APRIL 2000
2. CROSS SECTION PROFILE A–A' LOCATED ON FIGURE 1–3

HORIZ. SCALE: 0 50 100

VERT. SCALE: 0 10 20

SOURCE: PARSONS ENGINEERING SCIENCE, INC.

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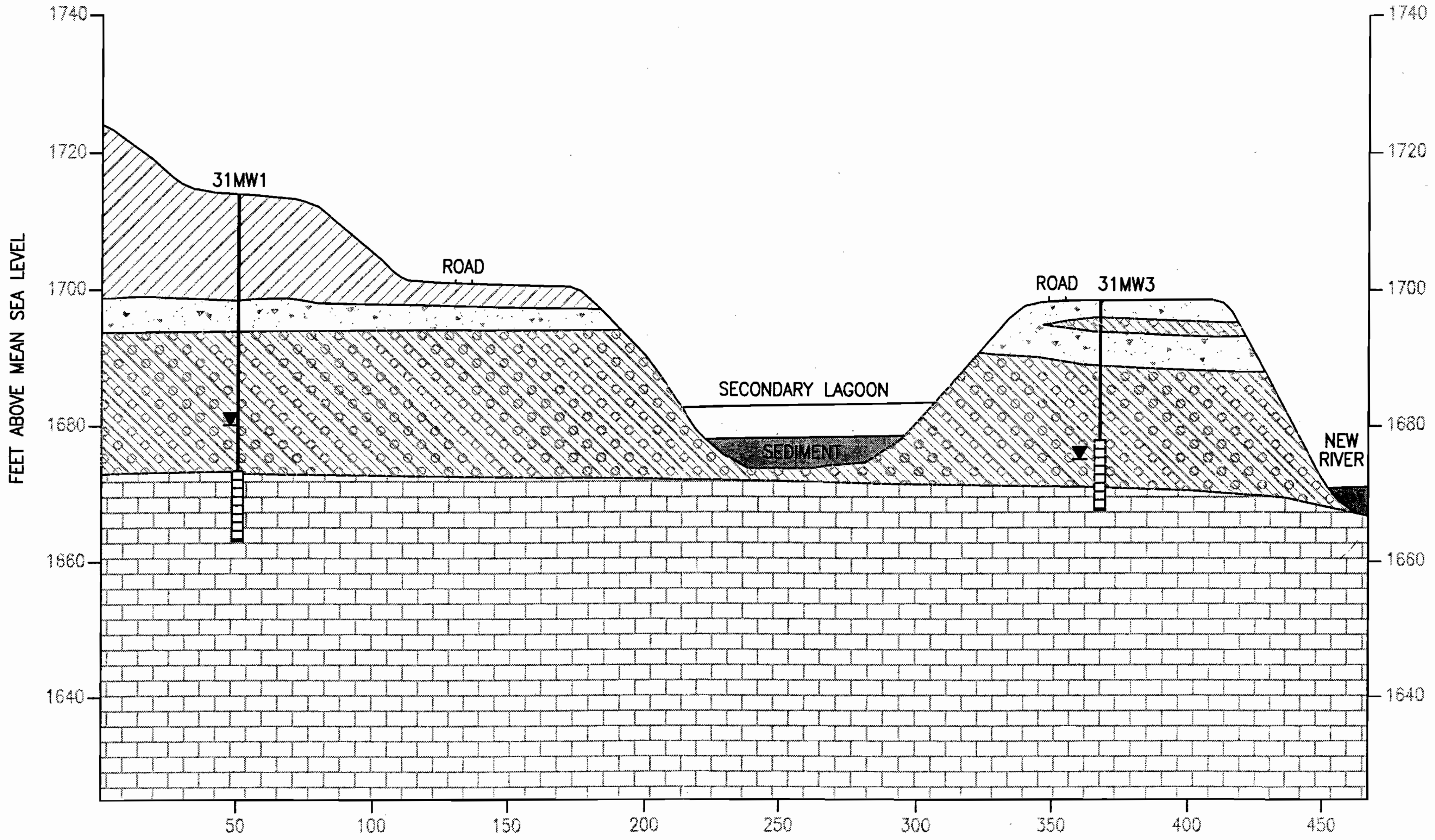
DATE: OCTOBER 2001

TASK NO: 866228200000000
IT DWG NO: FIGURE 1–4

FIGURE 1–4

SWMU 31 GEOLOGIC CROSS SECTION (A–A')

RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA



NOTE:
1. WATER LEVELS MEASURED APRIL 2000
2. CROSS SECTION PROFILE B–B' LOCATED ON FIGURE 1–3.

SOURCE: PARSONS ENGINEERING SCIENCE, INC.

LEGEND

▨ DARK BROWN, SILT AND CLAY (ML)

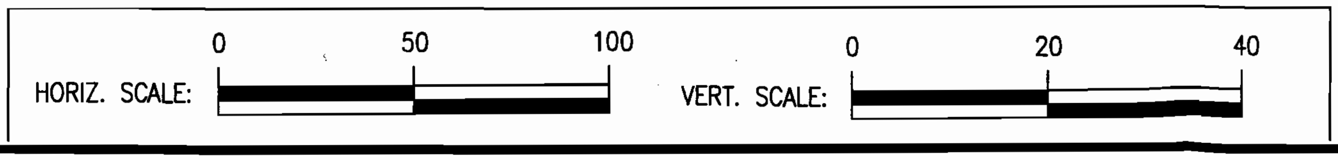
▨ GRAVEL (GM/SM) BROWN, SAND AND SILT

⁘ BROWN, SAND AND SILT (SM)

▦ GRAY, LIMESTONE, WEATHERED (LMSN)

▼ STATIC GROUNDWATER LEVEL

▤ WELL SCREEN INTERVAL



RADFORD AAP

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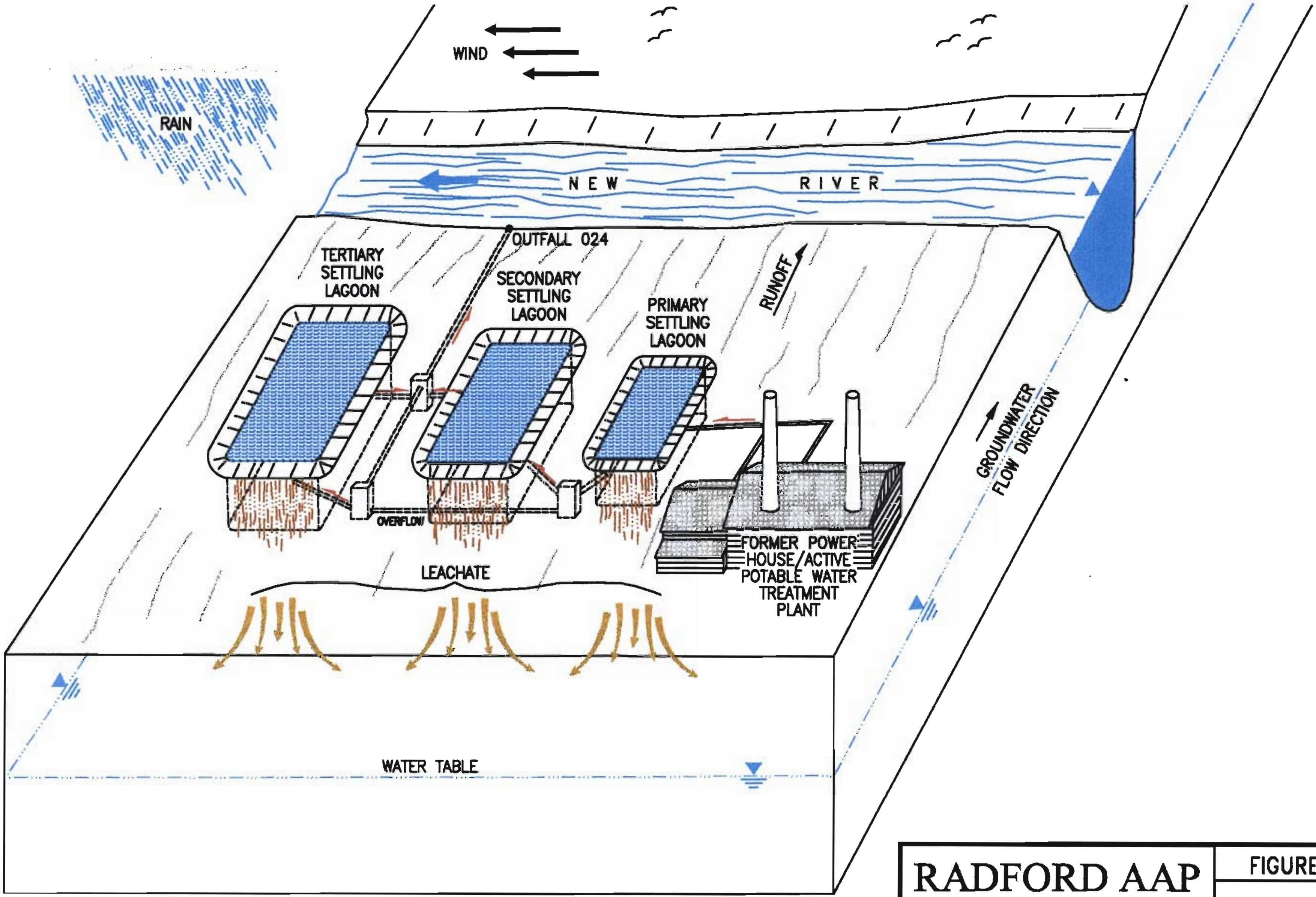
TASK NO: 86622820000000
IT DWG NO: FIGURE 1–5

FIGURE 1–5

SWMU 31 GEOLOGIC CROSS SECTION (B–B')

RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA



RADFORD AAP

FIGURE 1-6

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TASK NO: [illegible]
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IT DWG NO: FIGURE 1-6
DATE: OCTOBER 2001

SWMU 31
CONCEPTUAL SITE
MODEL

Table 1-2
SWMU 31—Potential Exposure Pathways and Receptors

Media	Potentially Affected Media	Exposure Pathways and Receptors				Comments
		Human	Biota			
		Site Workers	Terrestrial	Aquatic	Benthic	
Surface Soil	Yes	IN, INH, DA	IN, INH, DA	—	[illegible]	Inhalation of dust.
Surface Water	Yes	IN, DA	IN, DA	IN, DA	IN, DA	Water in settling ponds
Sediment	Yes - Sludge	IN, DA	IN, DA	IN, DA	IN, DA	
Subsurface Soil	Yes	IN, INH, DA	—	—	—	During construction activity.
Groundwater	Yes	IN, DA	[illegible]	—	[illegible]	Potential future use of groundwater.

NOTE: Refer to Figure 1-6 for conceptual model.
Abbreviations: IN = ingestion, INH = inhalation, DA = dermal absorption.

Subsurface soil is also potentially contaminated by fly ash settling in the lagoons and leaching from the sediment to the subsurface. Additionally, subsurface contamination may exist from fly ash wastewater leaking from the underground pipes connecting the lagoons. Site workers could be negatively impacted through the inhalation of dust during removal/construction activities. Incidental ingestion and dermal absorption may also affect site workers during construction activities that expose the subsurface soil.

Although groundwater is not currently in use for drinking water/irrigation purposes, it was considered a potential contaminant source, receiving leachate from subsurface soil and discharging to springs/New River. Ingestion and dermal absorption are the primary exposure pathways for human receptors (site workers) associated with sampling and analysis activities.

1.2.2 Previous Investigations

Previous investigation activities conducted at SWMU 31—Coal Ash Settling Lagoons include a RCRA Facility Assessment in 1987 (USEPA, 1987) (no samples collected), a VI in 1992 (Dames & Moore, 1992), an RFI in 1996 (Parsons, 1996), and an RFI in 1998 (ICF KE, 1999a). A graphical summary of investigation objectives, site characterization, and recommendations is presented on **Figure 1–7**.

Table 1–3 presents an overview of previous field sampling programs designed to meet investigation objectives, including medium sampled, sample identification, sample depth, and laboratory analyses. Corresponding sample locations and a summary of constituents exceeding levels of concern are presented on **Figure 1–8**.

1.2.2.1 RCRA Facility Assessment—USEPA, 1987. An assessment was conducted at the unit to evaluate potential hazardous waste or hazardous constituent releases to the site and implement corrective actions, as necessary. The assessment consisted of a preliminary review and evaluation of available site information, personnel interviews, and a visual inspection of the site. Environmental samples were not collected as part of the inspection. The visual inspection of the site suggested that there were no releases at the unit. However, chemical samples were required in accordance with the RFAAP 1989 RCRA permit.

1.2.2.2 Verification Investigation—Dames & Moore, 1992. Three composite sludge samples, one from each of the three settling lagoons, were collected for waste characterization. Samples were collected from the top one foot of sludge beneath the water/sludge interface at three locations in each lagoon. Samples were analyzed for metals and SVOCs. Analytical results indicated that three metals (arsenic, nickel, and silver) and five SVOCs (1,2-dichlorobenzene, 2-methylnaphthalene, fluorene, naphthalene, and phenanthrene) were detected above BTAG sediment criteria in one or more of the lagoons (**Table 1–4**). Five of the detected SVOCs were polynuclear aromatic hydrocarbons (PAHs) associated with petroleum products, such as commercial coal tar, gasoline, solvents, power plant emissions and coal ash and cinders.

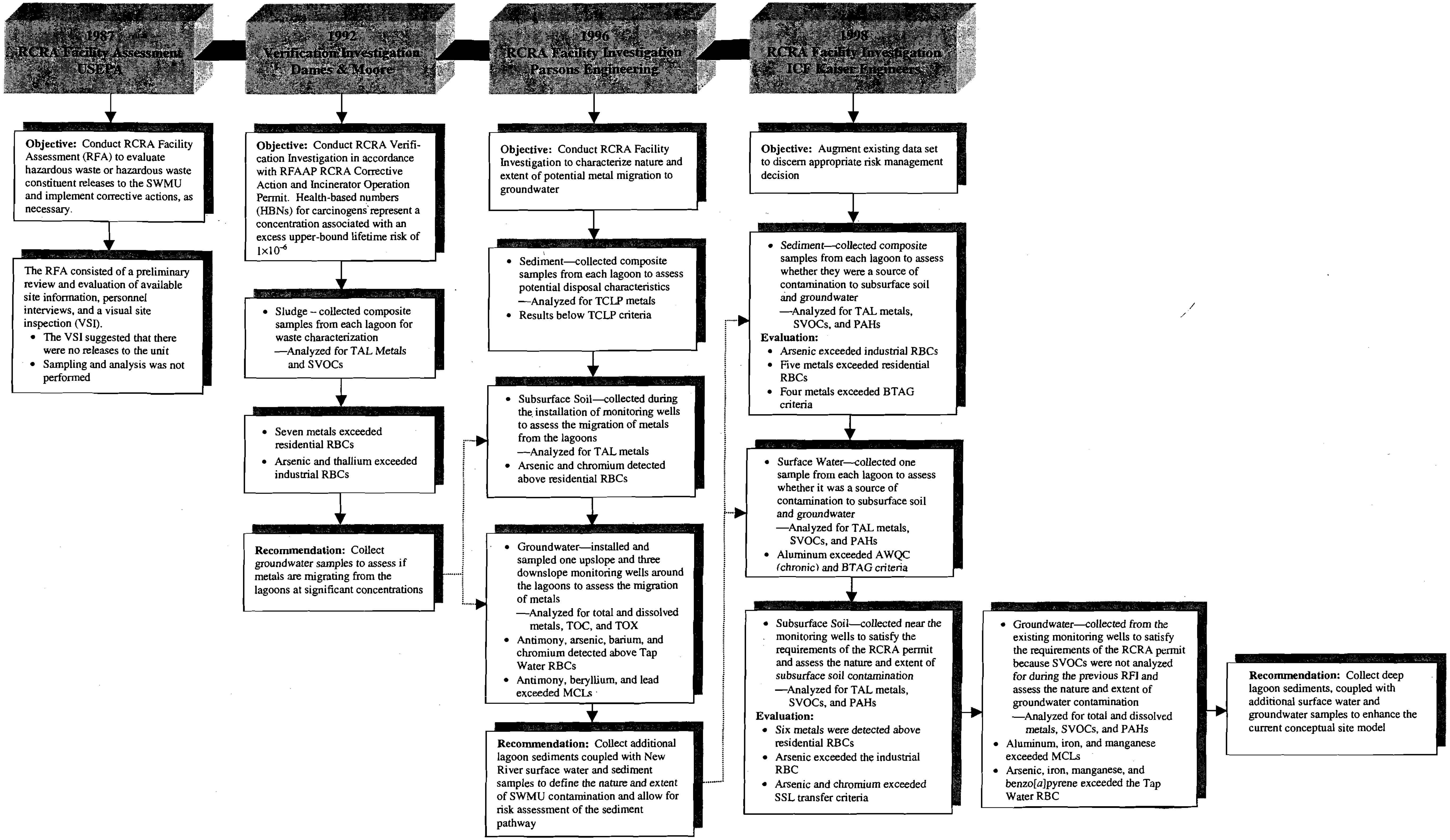
The report recommended that groundwater samples be collected to assess whether metals are migrating from the lagoons at significant concentrations.

1.2.2.3 RCRA Facility Investigation—Parsons, 1996. RFI objectives included the assessment of lagoon sludge disposal characteristics and migratory characteristics of metals from the lagoons. Investigative activities included the installation of four monitoring wells and the collection and analysis of sludge, subsurface soil, and groundwater samples.

Sediment. Two composite sediment samples representing the total sediment column were collected from each lagoon to assess potential disposal characteristics of the lagoon sediments. Sample results indicated that the lagoon sediments were within Toxicity Characteristic Leaching Procedure (TCLP) regulatory limits for each parameter. Sediment samples were collected for disposal classification purposes; therefore, analytical results are not suitable for use in a risk assessment.

Subsurface soil. Four soil borings were advanced and sampled for chemical analysis and stratigraphic characterization during the RFI. Soil boring 31MW1 was located topographically upslope from the secondary settling lagoon and was advanced into a wet zone of the bedrock to a depth of 52 ft bgs. Soil borings 31MW2, 31MW3, and 31MW4 were located topographically downslope of the lagoons and were advanced into the alluvial sediments overlying the bedrock to a maximum depth of 32 ft bgs. Two soil samples were collected from each of the four borings and analyzed to assess the migration potential of metals from the lagoons. Arsenic and chromium were detected above residential RBC criteria (**Table 1–5**).

Figure 1–7
SWMU 31 Flowchart of Investigative Activities



1987 RCRA Facility Assessment USEPA

Objective: Conduct RCRA Facility Assessment (RFA) to evaluate hazardous waste or hazardous waste constituent releases to the SWMU and implement corrective actions, as necessary.

The RFA consisted of a preliminary review and evaluation of available site information, personnel interviews, and a visual site inspection (VSI).

- The VSI suggested that there were no releases to the unit
- Sampling and analysis was not performed

1992 Verification Investigation Dames & Moore

Objective: Conduct RCRA Verification Investigation in accordance with RFAAP RCRA Corrective Action and Incinerator Operation Permit. Health-based numbers (HBNs) for carcinogens represent a concentration associated with an excess upper-bound lifetime risk of 1×10^{-6}

- Sludge – collected composite samples from each lagoon for waste characterization
  —Analyzed for TAL Metals and SVOCs

- Seven metals exceeded residential RBCs
- Arsenic and thallium exceeded industrial RBCs

Recommendation: Collect groundwater samples to assess if metals are migrating from the lagoons at significant concentrations

1996 RCRA Facility Investigation Parsons Engineering

Objective: Conduct RCRA Facility Investigation to characterize nature and extent of potential metal migration to groundwater

- Sediment—collected composite samples from each lagoon to assess potential disposal characteristics
  —Analyzed for TCLP metals
- Results below TCLP criteria

- Subsurface Soil—collected during the installation of monitoring wells to assess the migration of metals from the lagoons
  —Analyzed for TAL metals
- Arsenic and chromium detected above residential RBCs

- Groundwater—installed and sampled one upslope and three downslope monitoring wells around the lagoons to assess the migration of metals
  —Analyzed for total and dissolved metals, TOC, and TOX
- Antimony, arsenic, barium, and chromium detected above Tap Water RBCs
- Antimony, beryllium, and lead exceeded MCLs

Recommendation: Collect additional lagoon sediments coupled with New River surface water and sediment samples to define the nature and extent of SWMU contamination and allow for risk assessment of the sediment pathway

1998 RCRA Facility Investigation ICF Kaiser Engineers

Objective: Augment existing data set to discern appropriate risk management decision

- Sediment—collected composite samples from each lagoon to assess whether they were a source of contamination to subsurface soil and groundwater
  —Analyzed for TAL metals, SVOCs, and PAHs

Evaluation:
- Arsenic exceeded industrial RBCs
- Five metals exceeded residential RBCs
- Four metals exceeded BTAG criteria

- Surface Water—collected one sample from each lagoon to assess whether it was a source of contamination to subsurface soil and groundwater
  —Analyzed for TAL metals, SVOCs, and PAHs
- Aluminum exceeded AWQC (chronic) and BTAG criteria

- Subsurface Soil—collected near the monitoring wells to satisfy the requirements of the RCRA permit and assess the nature and extent of subsurface soil contamination
  —Analyzed for TAL metals, SVOCs, and PAHs

Evaluation:
- Six metals were detected above residential RBCs
- Arsenic exceeded the industrial RBC
- Arsenic and chromium exceeded SSL transfer criteria

- Groundwater—collected from the existing monitoring wells to satisfy the requirements of the RCRA permit because SVOCs were not analyzed for during the previous RFI and assess the nature and extent of groundwater contamination
  —Analyzed for total and dissolved metals, SVOCs, and PAHs
- Aluminum, iron, and manganese exceeded MCLs
- Arsenic, iron, manganese, and benzo[*a*]pyrene exceeded the Tap Water RBC

Recommendation: Collect deep lagoon sediments, coupled with additional surface water and groundwater samples to enhance the current conceptual site model

Table 1-3
Field Sampling Program for Previous Investigations at SWMU 31—Coal Ash Settling Lagoons

Investigation	Medium Sampled	Sample ID	Sample Depth (ft)	Laboratory Analyses
1992 VI Dames & Moore	Sludge	31SL1	0-1	Metals, SVOCs
		31SL2	0-1	
		31SL3	0-1	
1996 RFI Parsons	Sludge	31SE1	0-0.5	TCLP Metals, TOC (one sample per lagoon)
		31SE2	0-0.5	
		31SE3	0-0.5	
		31SE4	0-0.5	
		31SE5	0-0.5	
		31SE6	0-0.5	
	Subsurface Soil	31MW1A25	23-25	Metals
		31MW1B35	33-35	
		31MW2A12	10-12	
		31MW2B22	20-22	
		31MW3A10	5-10	
		31MW3B20	15-20	
		31MW4A12	10-12	
		31MW4B22	20-22	
	Groundwater	31MW1	42-52	
		31MW2	20-30	
		31MW3	22-32	
		31MW4	20-30	
1998 RFI ICF KE	Surface Water	31SW1	N/A	Metals, SVOCs, PAHs
		31SW2	N/A	
		31SW3	N/A	
	Sludge	31SL1-2	0-0.5	
		31SL2-2	0-0.5	
		31SL3-2	0-0.5	
	Subsurface Soil	31SB1A	22-23	
		31SB1C	10-12	
		31SB2A	12-14	
		31SB2B	20-22	
		31SB3A	10-12	
		31SB3B	18-20	
		31SB4A	10-12	
		31SB4B	20-24	
	Groundwater	31MW1-2	42-52	Total and dissolved metals, SVOCs, PAHs, TOC, TOX
		31MW2-2	20-30	
		31MW3-2	22-32	
		31MW4-2	20-30	

SITE ID	31SB3A		31SB3B	
DEPTH (ft)	10–12		18–20	
TAL Metals				
Aluminum	18,800		7,010	
Arsenic	**3.9**		**2.9**	
Chromium	30		16	
Iron	34,900		20,600	
Manganese	513		431	
Vanadium	56	J	22	J

SITE ID	31MW3	31MW3–2	
FRACTION	TOTAL	TOTAL	
SAMPLING DATE	JUL–95	01–APR–98	
DEPTH (ft)	23–33	20.5–30.5	
TAL Metals			
Aluminum	na	2,680	
Arsenic	nd	9.4	J
Beryllium	5.24	1.1	J
Chromium	89.1	11.4	B
Iron	na	7,080	
Lead	36.2	6.7	
Manganese	na	183	J
PAHs			
Benzo(a)pyrene	na	.061	

SITE ID	31MW2	31MW2–2	
FRACTION	TOTAL	TOTAL	
SAMPLING DATE	JUL–95	01–APR–98	
DEPTH (ft)	18–28	18.5–28.5	
TAL Metals			
Aluminum	na	2,670	
Arsenic	7.44	9.3	J
Beryllium	6	1.1	J
Chromium	97.3	nd	
Iron	na	7,080	
Lead	41.8	6.6	
Manganese	na	182	J
PAHs			
Benzo(a)pyrene	na	.024	J

SITE ID	31MW2A12	31MW2B22
DEPTH (ft)	10–12	20–22
TAL Metals		
Arsenic	nd	**3.67**
Chromium	35.5	30.6

SITE ID	31MW4A12	31MW4B22
DEPTH (ft)	10–12	20–22
TAL Metals		
Chromium	38.2	29.6

SITE ID	31MW4
FRACTION	TOTAL
SAMPLING DATE	JUL–95
DEPTH (ft)	20–30
TAL Metals	
Beryllium	5.26
Chromium	31.6

SITE ID	31SL2
DEPTH (ft)	0–1
SVOCs	
2–Methylnaphthalene	**0.13**

SITE ID	31MW3A10
DEPTH (ft)	5–10
TAL Metals	
Chromium	26.8

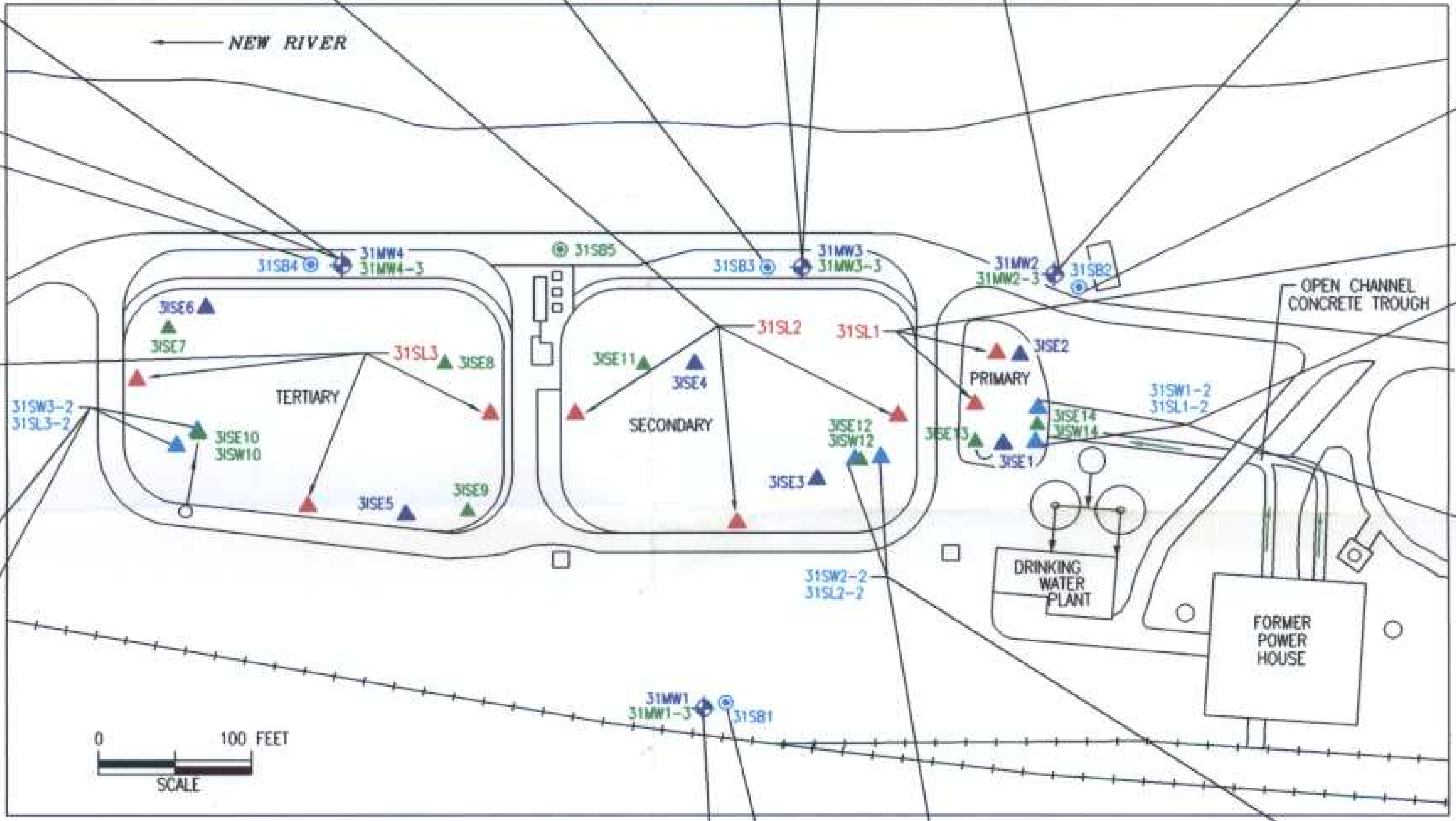
SITE ID	31SB2A	
DEPTH (ft)	12–14	
TAL Metals		
Aluminum	30,500	
Arsenic	**3.7**	
Chromium	34	
Iron	36,400	
Manganese	598	
Vanadium	71	J

SITE ID	31SB4A	31SB4B
DEPTH (ft)	10–12	20–24
TAL Metals		
Aluminum	15,400	12,400
Arsenic	**3.4**	**6.0**
Chromium	27	23
Iron	30,800	37,000
Manganese	502	502

SITE ID	31SL1
DEPTH (ft)	0–1
TAL Metals	
Arsenic	**9.8**
SVOCs	
2–Methylnaphthalene	**1.15**
Fluorene	**0.09**
Naphthalene	**0.56**
Phenanthrene	**0.74**

SITE ID	31SL1–2
DEPTH (ft)	0–0.5
TAL Metals	
Lead	**55**

SITE ID	31SL3
DEPTH (ft)	0–1
SVOCs	
1,2–Dichlorobenzene	**3.46**
2–Methylnaphthalene	**1.53**
Naphthalene	**1.33**
Phenanthrene	**1.18**



SITE ID	31SW1–2	
DEPTH (ft)	NA	
TAL Metals		
Aluminum	**738**	J

SITE ID	31SW3–2	
DEPTH (ft)	NA	
TAL Metals		
Aluminum	**585**	J

SITE ID	31SW2–2	
DEPTH (ft)	NA	
TAL Metals		
Aluminum	**297**	J

SITE ID	31SL2–2	
DEPTH (ft)	0–0.5	
TAL Metals		
Arsenic	**8.6**	J
Lead	**52**	
Nickel	**30.2**	J
Zinc	**180**	J

SITE ID	31SL3–2	
DEPTH (ft)	0–0.5	
TAL Metals		
Arsenic	**8.7**	
Lead	**53**	
Nickel	**32.6**	J
Zinc	**176**	J

SITE ID	31MW1	31MW1	31MW1	31MW1–2	
FRACTION	DISSOLVED	DISSOLVED	TOTAL	TOTAL	
SAMPLING DATE	18–JAN–95	JUL–95	JUL–95	06–APR–98	
DEPTH (ft)	42–52	42–52	42–52	40–50	
TAL Metals					
Aluminum	na	na	na	534	
Antimony	65.2	nd	nd	nd	
Barium	222	264	300	166	J
Beryllium	3.84	3.98	5.16	1.3	J
Iron	na	na	na	860	
SVOCs					
Bis(2–Ethylhexyl)phthalate	na	na	na	4.8	J

SITE ID	31SB1A		31SB1C	
DEPTH (ft)	22–23		10–12	
TAL Metals				
Aluminum	17,900		28,400	
Arsenic	**1.8**		**5.9**	
Chromium	32		**59**	
Iron	25,600		40,200	
Manganese	191		857	
Vanadium	17	J	59	J

LEGEND

- ▲ 1992 VI WASTE COMPOSITE SAMPLE (DAMES & MOORE)
- ▲ 1996 RFI WASTE SAMPLE (PARSONS ENGINEERING)
- ⌖ 1996 RFI MONITORING WELL (PARSONS ENGINEERING)
- ◉ 1998 RFI SOIL BORING (ICF KAISER)
- ▲ 1998 RFI SURFACE WATER/ SEDIMENT COMPOSITE SAMPLE (ICF KAISER)
- ▲ PROPOSED SURFACE WATER/SEDIMENT SAMPLE LOCATION
- ◉ PROPOSED SITE SCREENING SOIL BORING LOCATION
- 31MW1–3 PROPOSED GROUNDWATER SAMPLING LOCATION

NOTE:

SOLID MATRIX UNITS IN UG/G
AQUEOUS UNITS IN UG/L
B = BLANK CONTAMINATION
J = ESTIMATED CONCENTRATION
NA = NOT ANALYZED
ND = NOT DETECTED
DARK BORDER = VALUE EXCEEDS THE RESIDENTIAL RBC, TAP WATER RBC, OR AWQC (CHRONIC)
SHADING = VALUE EXCEEDS THE INDUSTRIAL RBC OR MCL
BOLD = VALUE EXCEEDS THE SSL TRANSFER CRITERION OR BTAG CRITERION

Sample Summary

Previous Investigation	Contractor	Total Metals				Dissolved Metals	TCL SVOCs				PAHs				TOC		TOX	TCLP Metals	Total
		SB	SW	SE	GW	GW	SB	SW	SE	GW	SB	SW	SE	GW	SE	GW	GW	SE	
1992 VI	D&M	––	––	3C	––	––	––	––	3C	––	––	––	––	––	––	––	––	––	6
1996 RFI	PES	8	––	––	4	8	––	––	––	––	––	––	––	––	3	––	––	6	29
1998 RFI	ICF Kaiser	8	3	3C	4	4	8	3	3C	4	8	3	3C	4	––	4	4	––	66

FILE: 1–8–1AXLS.dwg PLOT: 2–8–02

RADFORD AAP
PREPARED BY: IT CORP.
CHECKED BY: MT
DATE: OCTOBER 2001
TASK NO: [illegible]
IT DWG NO: 1–8–1–AXLS

FIGURE 1–8

SWMU 31–
PREVIOUS INVESTIGATIONS
SAMPLE RESULTS AND
PROPOSED SAMPLING
LOCATIONS

05003\151-1/1

Table 1-4
1992 VI Detected Results for Sediment at SWMU 31—Coal Ash Settling Lagoons
[Units in ug/g]

SITE ID FIELD ID SAMPLING DATE DEPTH (ft)	BTAG Sediment Criteria	31SL1 RVFS*27 25-FEB-92 0-1	31SL2 RVFS*28 25-FEB-92 0-1	31SL3 RVFS*114 10-MAR-92 0-1
Metals				
Aluminum	na	8770	18900	15900
Arsenic	8.2	***9.8***	4.6	6.5
Barium	na	80.8	149	118
Beryllium	na	2.3	1.4	2.3
Calcium	na	1780	3980	2130
Chromium	81†	11.1	34.2	16.2
Cobalt	na	8.2	16.1	11.0
Copper	34	26.4	27.4	32.8
Iron	na	7380	33300	10000
Lead	46.7	nd	19.7	nd
Magnesium	na	951	6620	1440
Manganese	na	134	664	347
Mercury	0.15	0.1	nd	nd
Nickel	20.9	18.7	***22.5***	***21.5***
Potassium	na	576	2650	1030
Selenium	na	nd	nd	0.9
Silver	1	nd	***1.2***	nd
Sodium	na	370	328	540
Thallium	na	nd	14.5	nd
Vanadium	na	21.2	64.5	33.6
Zinc	150	38.6	95.8	68.0
SVOCs				
1,2-Dichlorobenzene	0.035	nd	nd	***3.46***
2-Methylnaphthalene	0.07	***1.15***	***0.13***	***1.53***
Fluoranthene	0.6	0.2	nd	nd
Fluorene	0.019	***0.09***	nd	nd
Dibenzofuran	na	0.3	nd	nd
Naphthalene	0.16	***0.56***	0.09	***1.33***
Phenanthrene	0.24	***0.74***	0.08	***1.18***
SVOC TICs				
1-Methylnaphthalene	na	0.92	nd	nd
2,6,10,14-Tetramethylpentadecane	na	1.65	nd	nd
Cyclohexene oxide	na	nd	0.3	nd
Decane	na	0.6	nd	nd
Heneicosane	na	0.6	nd	nd
Heptadecane	na	0.9	nd	nd
Hexadecanoic acid, butyl ester	na	nd	nd	8.0
Octadecanoic acid, butyl ester	na	nd	nd	5.0
Tridecane	na	0.7	nd	nd
Total Unknown TICs	na	11.4	1.2	nd

* USEPA Region III (9/01)

† Chromium VI screening value (as per USEPA Region III)

na = not applicable

nd = not detected

bold/italics = value is equal to or exceeds the BTAG screening level

Table 1-5
1996 RFI Detected Results for Soil at SWMU 31—Coal Ash Settling Lagoons

[Units in ug/g]

SITE ID FIELD ID SAMPLING DATE DEPTH (ft)	Screening Level Residential RBC*	 Industrial RBC*	 SSL Transfers Soil to Groundwater*	31MW1 31MW1A25 16-DEC-94 23-25	31MW1 31MW1B35 16-DEC-94 33-35	31MW2 31MW2A12 14-DEC-94 10-12	31MW2 31MW2B22 14-DEC-94 20-22	31MW3 31MW3A10 14-DEC-94 5-10	31MW3 31MW3B20 14-DEC-94 15-20	31MW4 31MW4A12 15-DEC-94 10-12	31MW4 31MW4B22 15-DEC-94 20-22
Metals											
Arsenic	0.43	3.8	0.026	nd	nd	nd	***3.67***	nd	nd	nd	nd
Barium	550	14000	2100	26.9	55	109	87.6	134	75.1	119	76.4
Beryllium	16	410	1200	0.9	1.11	0.811	0.958	0.947	0.751	1.03	0.767
Chromium	610†	23†	42†	17.7	22.7	35.5	30.6	26.8	19.5	38.2	29.6
Lead	400	750	400	0.605	6.9	17.1	17.4	27	36	15.4	12.9
Mercury	2.3	61	na	nd	nd	nd	0.061	0.155	nd	nd	nd
Nickel	160	4100	na	22.6	29.1	10.8	20.5	12.6	13.3	17.6	16.8
Silver	39	1000	31	nd	0.021	nd	nd	nd	0.098	nd	nd

* USEPA Region III (09/01)

† Chromium VI screening value (as per USEPA Region III)

RBCs have a hazard quotient of 0.1 for non carcinogenic chemicals (as per USEPA Region III)

na = not applicable

nd = not detected

dark border = value is equal to or exceeds the Residential RBC

bold/italics = value is equal to or exceeds SSL Transfers

Table 1-6
1996 RFI Detected Results for Groundwater at SWMU 31—Coal Ash Settling Lagoons

[Units in ug/L]

SITE ID FRACTION SAMPLING DATE DEPTH (ft)	Screening Level		31MW1 DISSOLVED 18-JAN-95 42-52	31MW2 DISSOLVED 18-JAN-95 18-28	31MW3 DISSOLVED 18-JAN-95 23-33	31MW4 DISSOLVED 18-JAN-95 20-30	31MW1 TOTAL JUL-95 42-52	31MW2 TOTAL JUL-95 18-28	31MW3 TOTAL JUL-95 23-33	31MW4 TOTAL JUL-95 20-30	31MW1 DISSOLVED JUL-95 42-52	31MW2 DISSOLVED JUL-95 18-28	31MW3 DISSOLVED JUL-95 23-33	31MW4 DISSOLVED JUL-95 20-30
	TAP WATER RBC*	MCL												
Metals														
Antimony	1.5	6	[illegible]	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Arsenic	0.04	10	nd	nd	nd	nd	nd	7.44	nd	nd	nd	nd	nd	nd
Barium	260	2000	222	23.7	38.1	29.2	300	183	257	137	264	27	24.7	19.7
Beryllium	7.3	4	3.84	1.56	1.86	1.1	[illegible]	[illegible]	[illegible]	[illegible]	3.98	1.63	1.86	nd
Chromium	11†	100	nd	nd	nd	nd	nd	97.3	89.1	31.6	nd	nd	nd	nd
Lead	na	15	7.58	nd	nd	nd	7.58	[illegible]	[illegible]	11.3	nd	nd	nd	nd
Mercury	na	2	nd	nd	nd	nd	nd	nd	0.138	0.142	nd	nd	nd	nd
Nickel	73	na	nd	nd	nd	nd	nd	49.9	58.4	nd	nd	nd	nd	nd
Selenium	18	50	nd	nd	nd	nd	nd	nd	nd	nd	nd	5.4	nd	nd
Wet Chemistry														
TOC	na	na	2040	1320	1160	nd	nt	nt	nt	nt	nt	nt	nt	nt
TOX	na	na	15.4	15	25.3	15.6	nt	nt	nt	nt	nt	nt	nt	nt

* USEPA Region III (9/01)

† Chromium VI screening value (as per USEPA Region III)

RBCs have a hazard quotient of 0.1 for non carcinogenic chemicals (as per USEPA Region III)

na = not applicable

nd = not detected

nt = not tested

dark cell border = values is equal to or exceeds the Tap Water RBC

shading = value is equal to or exceeds the MCL

Groundwater. One upslope and three downslope groundwater monitoring wells were installed in the soil borings to a maximum depth of 52 ft bgs to assess the migration potential of metals from the settling lagoons. The sandy gravel layer was considerably drier upslope of the SWMU than near the river, so upslope monitoring well 31MW1 was installed approximately 15 ft deeper than the downslope wells in order to cross the bedrock interface where water was anticipated to accumulate. It has not been verified whether these wells are upgradient or downgradient because there has not been a dye trace performed to confirm their hydraulic position. However, water level measurements in the four wells and groundwater gradient contouring indicates that the four wells are screened in the shallow aquifer and that the groundwater gradient is to the north/northwest towards the New River. Groundwater samples were collected and sampled for total and dissolved metals, total organic carbon (TOC), and total organic halides (TOX). Antimony, arsenic, barium, and chromium were detected at concentrations above Tap Water RBC criteria. Antimony (31MW1), beryllium (every well), and lead (31MW2 and 31MW3) exceeded MCL criteria (**Table 1-6**).

The report recommended that additional lagoon sediments coupled with New River surface water and sediment samples be collected to define the nature and extent of SWMU contamination and allow for risk assessment of the sediment pathway.

1.2.2.4 RCRA Facility Investigation—ICF KE, 1998. The evaluation of the 1992 and 1996 data indicated potential environmental impacts from metals (aluminum, antimony, arsenic, beryllium, lead, iron, manganese, and thallium) and trace levels of PAHs. Although toxicity characteristics did not trigger material designation as hazardous waste, the following data gaps required further investigation:

- Composite samples were collected during the VI. Discrete samples are required for risk management decisions.
- SVOCs were not analyzed during the 1996 investigation.
- Surface water was not evaluated as a potential contamination pathway.

The 1998 investigation was performed to augment the existing data set and refine the contamination assessment that identified the following conditions:

- Surface water—aluminum exceeded the USEPA Ambient Water Quality Criteria (AWQC) in each settling lagoon.
- Sediment/sludge—three metals (arsenic, nickel, and silver) and five SVOCs (1,2-dichlorobenzene, 2-methylnaphthalene, fluorene, naphthalene, and phenanthrene) were detected above BTAG sediment criteria in one or more of the lagoons.
- Subsurface soil—arsenic was found to exceed industrial RBCs at 10-12 ft bgs adjacent to monitoring wells 31MW1 and 31MW3 and at 20-24 ft bgs adjacent to monitoring well 31MW4. Comparison against RFAAP facility-wide background concentrations indicated that arsenic values were below the established arsenic background point estimate of 15.8 µg/g.
- Groundwater—three metals (arsenic, iron, and manganese) and one PAH (benzo[*a*]pyrene) exceeded Tap Water RBCs in wells 31MW2 and 31MW3. Aluminum, iron, and manganese exceeded MCL criteria in at least two wells.

Data needs were supplemented through the sampling of surface water/sludge (discrete), subsurface soil, and groundwater samples for metal, SVOC, and PAH analyses.

Surface water/sludge. Three collocated surface water and sludge samples (31SW/SL1-2, 31SW/SL2-2, and 31SW/SL3-2), were collected to assess whether they were a contamination source for subsurface soil and groundwater. One surface water and one composite sludge sample was collected at the outfall of each lagoon and analyzed for metals, SVOCs, and PAHs. A summary of detected analytical results for surface water is presented in **Table 1-7**, and for sludge in **Tables 1-8 and 1-9**.

Table 1-7
1998 RFI Detected Metals Results for Surface Water at SWMU 31—Coal Ash Settling Lagoons

[Units in µg/L]

Metal	Screening Level		31SW1-2 14 May 98		31SW2-2 14 May 98		31SW3-2 14 May 98	
	AWQC (Chronic)	BTAG Aqueous						
Aluminum	87	25	***738***	J	***297***	J	***58.5***	J
Barium	na	10,000	20	J	18	J	18	J
Calcium	na	na	11,400		10,500		9,710	
Magnesium	na	na	4,350	J	4,040	J	3,670	J
Manganese	na	14,500	19	B	11	B	21	
Nickel	52	160	< 1		< 1		4	J
Potassium	na	na	1,150	J	1,210	J	1,110	J
Sodium	na	na	5,700	J	9,660	J	8,480	J
Zinc	120	30	5	J	3	J	3	J

NOTES.— Dark cell border = value is equal to or exceeds the AWQC. Bold/italics = value is equal to or exceeds the BTAG screening level.

Abbreviations: J = estimated concentration; B = blank contamination; na = not applicable.

Table 1-8
1998 RFI Detected Metals Results for Sludge at SWMU 31—Coal Ash Settling Lagoons

[Units in µg/g]

Metal	BTAG Sediment	31SL1-2 14 May 98 0-0.5 ft		31SL2-2 14 May 98 0-0.5 ft		31SL3-2 14 May 98 0-0.5 ft	
Aluminum	na	108,000		82,900		91,600	
Arsenic	8.2	< 7.9		***8.6***	J	***8.7***	
Barium	na	91	J	111	J	118	J
Beryllium	na	< 1		2	J	1	J
Calcium	na	2,760	J	3,580	J	3,980	J
Chromium	81†	27		38		41	
Cobalt	na	6	J	14	J	9	J
Iron	na	19,400		22,000		23,400	
Lead	46.7	***55***		***52***		***53***	
Magnesium	na	2,080	J	2,730	J	2,960	J
Manganese	na	422		614		669	
Nickel	20.9	16.5	J	***30.2***	J	***32.6***	J
Potassium	na	1,210	J	1,420	J	1,500	J
Vanadium	na	43.1	J	49.6	J	52.4	J
Zinc	150	134	J	***180***	J	***176***	J

*USEPA Region III (9/01).

† Chromium VI screening value (as per USEPA Region III).

NOTES.—(1) Bold/italics = value is equal to or exceeds the BTAG screening level

Abbreviations: J=estimated concentration; na = not applicable.

Table 1-9
1998 RFI Detected Organic Results for Sludge at SWMU 31—Coal Ash Settling Lagoons

[Units in μg/g]

PAH	BTAG Sediment	31SL1-2 14 May 98 0-0.5 ft	31SL2-2 14 May 98 0-0.5 ft	31SL3-2 14 May 98 0-0.5 ft
Benzo[*a*]pyrene	0.430	< 0.021	0.040	0.068
Benzo[*k*]fluoranthene	na	< 0.021	0.045	< 0.019
Chrysene	0.384	< 0.021	< 0.028	0.028
Fluoranthene	0.600	0.034 J	0.076	0.130
Phenanthrene	0.240	< 0.021	0.048 J	0.110 J

*USEPA Region III (9/01).
Abbreviations: J=estimated concentration.

Analysis of surface water results indicated that aluminum exceeded the USEPA AWQC (chronic) value. Although detected aluminum concentrations exceeded the Biological Technical Assistance Group (BTAG) screening criterion, concentrations were consistent with those detected in unimpacted freshwater creeks in the mid-Atlantic region (USAEC, 1995), as discussed in the Screening Ecological Risk Assessment (ICF KE, 1999b). SVOCs and PAHs were not detected in surface water samples.

Four metals (arsenic, lead, nickel, and zinc) were detected above BTAG sediment criteria in the secondary and tertiary lagoons. Lead also exceeded its BTAG sediment criterion in the primary lagoon. Although these four metals were reported above the BTAG screening criteria in lagoon sediments, the risk driver identified in New River sediments during the screening ERA was lead (ICF KE, 1999b). The recommended management decision was to further evaluate chemicals in the lagoons associated with this ecological concern. Five PAHs (benzo[a]pyrene, benzo[k]fluoranthene, chrysene, fluoranthene, and phenanthrene) were detected in at least one sludge sample below BTAG sediment criteria. No compounds were detected in the SVOC analyses.

Subsurface soil. Two soil samples were collected from each of four soil borings (31SB1, 31SB2, 31SB3, 31SB4) advanced near the existing wells to comply with RCRA permit requirements and to assess the nature and extent of contamination. Samples were analyzed for metals, SVOCs, and PAHs. A summary of detected analytical results for metals are presented in **Table 1–10**, and for organic constituents in **Table 1–11**. Six metals were detected above residential RBCs in the four borings. (NOTE: As per agreement with USEPA Region III, the RBC listed for chromium is the value for chromium VI). Arsenic was detected above the industrial RBC criterion at 10 to 12 ft bgs in borings 31SB1 and 31SB3, and at 20 to 24 ft bgs in boring 31SB4. Seven PAHs were detected at concentrations below residential RBCs in boring 31SB2. Di-*n*-butylphthalate was detected below the residential RBC in the three downslope borings.

Groundwater. During the previous investigation, samples were not analyzed for SVOCs, which were specified in the RCRA permit for this SWMU. In order to meet the requirements of the RCRA permit for assessing the nature and extent of contamination, groundwater samples were collected from the four existing SWMU 31 wells. Samples were analyzed for total and dissolved metals, SVOCs, PAHs, TOC, and TOX. A summary of detected analytical results for metals is presented in **Table 1–12**, and for organic constituents in **Table 1–13**. Aluminum, iron, and manganese were detected above the MCL in at least two wells. Arsenic, iron, and manganese exceeded Tap Water RBCs in wells 31MW2 and 31MW3. Thallium practical quantitation levels were above the Tap Water RBC and MCL. Benzo[*a*]pyrene was reported above the Tap Water RBC, but below the MCL in wells 31MW2 and 31MW3. Bis(2-ethylhexyl)phthalate was detected at the Tap Water RBC in well 31MW1.

The report recommended that deep lagoon sediments, coupled with additional surface water and groundwater samples be collected to enhance the current conceptual site model.

Table 1-10
1998 RFI Detected Metal Results for Subsurface Soil at SWMU 31—Coal Ash Settling Lagoons

[Units in µg/g]

Metal	Residential RBC*	Industrial RBC*	SSL Transfers Soil to Groundwater DAF 20*	31SB1A 25-Mar-98 22-23 ft	31SB1C 25-Mar-98 10-12 ft	31SB2A 24-Mar-98 12-14 ft	31SB2B 24-Mar-98 20-22 ft	31SB3A 24-Mar-98 10-12 ft	31SB3B 24-Mar-98 18-20 ft	31SB4A 24-Mar-98 10-12 ft	31SB4B 24-Mar-98 20-24 ft
Aluminum	7,800	200,000	na	17,900	28,400	30,500	5,300	18,800	7,010	15,400	12,400
Antimony	3.1	82	13	0.85 J	1.4 J	1.7 J	< 0.33	1.4 J	0.71 J	1.4 J	1.1 J
Arsenic	0.43	3.8	0.026	*1.8*	[illegible]	*3.7*	< 0.44	[illegible]	*2.9*	*3.4*	[illegible]
Barium	550	14,000	2,100	18 J	76 J	138 J	16 J	83 J	49 J	98 J	80 J
Beryllium	16	410	1,200	0.77 J	0.98 J	0.96 J	0.16 J	0.35 J	0.29 J	0.25 J	0.74 J
Calcium	na	na	na	38,700	969	4,570	175,000	725	826	1,090	1,550
Chromium	23	610	42†	32	*59*	34	7	30	16	27	23
Cobalt	160	4,100	na	6 J	22 J	14 J	1.5 J	14 J	8.1 J	14 J	9.3 J
Copper	310	8,200	11,000	< 0.11	17 J	17	6 J	17 J	9.3 J	15 J	13 J
Iron	4,700	120,000	na	25,600	40,200	36,400	4,490	34,900	20,600	30,800	37,000
Lead	400	750	400	0.52	19	13	3.1	18	12	13	19
Magnesium	na	na	na	23,600	2,490	4,720	107,000	4,630	1,850	4,710	3,370
Manganese	160	4,100	950	191	857	598	77	513	431	502	502
Nickel	160	4,100	na	42 J	21 J	19 J	3 J	18 J	10 J	16 J	18 J
Potassium	na	na	na	4,120 J	2,980 J	2,410 J	5,270 J	2,340 J	1,040 J	2,310 J	1,450 J
Sodium	na	na	na	180	161 B	203 J	404 J	200 J	177 J	230 J	178 J
Vanadium	55	1,400	5,100	17 J	59 J	71 J	11 J	56 J	22 J	48 J	34 J
Zinc	2,300	61,000	14,000	12 J	40 J	62 J	< 0.11	68 J	37 J	60 J	94 J

* USEPA Region III (9/01)
† Chromium VI screening value (as per USEPA Region III)
RBCs have a hazard quotient of 0.1 for non carcinogenic chemicals (as per USEPA Region III)
J = estimated concentration
B = blank contamination
dark border = value is equal to or exceeds Residential RBC
shading = value is equal to or exceeds Industrial RBC
bold/italics = value is equal to or exceeds SSL Transfers
lead values were provided by USEPA Region III

Table 1-11
1998 RFI Detected Organic Results for Subsurface Soil at SWMU 31—Coal Ash Settling Lagoons

[Units in μg/g]

Compound	Residential RBC*	Industrial RBC*	SSL Transfers Soil to Groundwater DAF 20*	31SB2A 24-Mar-98 12-14 ft	31SB2B 24-Mar-98 20-22 ft	31SB3B 24-Mar-98 18-20 ft	31SB4A 24-Mar-98 10-12 ft	31SB4B 24-Mar-98 20-24 ft
PAHs								
Benzo(a)pyrene	0.087	0.78	0.37	0.0087 J	0.0012 J	0.0018 UJ	0.0019 UJ	0.0019 UJ
Benzo(b)fluoranthene	0.87	7.8	4.5	0.0093 J	< 0.0038	0.0036 UJ	0.0037 UJ	0.0038 UJ
Benzo(k)fluoranthene	8.7	78	45	0.0033 J	< 0.0019	0.0018 UJ	0.0019 UJ	0.0019 UJ
Chrysene	87	780	150	0.0071 J	< 0.019	0.0018 UJ	0.0019 UJ	0.0019 UJ
Fluoranthene	310	8,200	6,300	0.0081 J	< 0.038	0.0036 UJ	0.0037 UJ	0.0038 UJ
Phenanthrene	230	6,100	680	0.0048 J	< 0.0019	0.0018 UJ	0.0019 UJ	0.0019 UJ
Pyrene	230	6,100	680	0.012 J	< 0.0019	0.0018 UJ	0.0019 UJ	0.0019 UJ
SVOCs								
Di-n-butylphthalate	780	20,000	5,000	< 0.42	0.076 J	0.081 J	0.11 J	0.07 J

* USEPA Region III (9/01)

RBCs have a hazard quotient of 0.1 for non carcinogenic chemicals (as per USEPA Region III)

Analytical results for 31SB1A, 31SB1C, and 31SB3A not included because organic constituents were not detected

J = estimated concentration

UJ = estimated non-detect

na = not applicable

Table 1-12
1998 RFI Detected Metal Results for Groundwater at SWMU 31—Coal Ash Settling Lagoons

[Units in µg/L]

Metal	Tap Water RBC*	MCL*	31MW1-2 Total 06-Apr-98 40-50 ft	31MW1-2 Dissolved 06-Apr-98 40-50 ft	31MW2-2 Total 01-Apr-98 18.5-28.5 ft	31MW2-2 Dissolved 01-Apr-98 18.5-28.5 ft	31MW3-2 Total 01-Apr-98 20.5-30.5 ft	31MW3-2 Dissolved 01-Apr-98 20.5-30.5 ft	31MW4-2 Total 06-Apr-98 19-29 ft	31MW4-2 Dissolved 06-Apr-98 19-29 ft
Aluminum	3,700	50	4,534	30 B	[illegible]	111 B	[illegible]	75 B	124 B	56 B
Arsenic	0.04	10	< 6.0	< 6.0	9.3 J	< 6.0	9.4 J	< 6.0	< 6.0	6.0 UJ
Barium	260	2,000	166 J	172 J	54 J	14 J	54 J	19 J	19 J	17 J
Beryllium	7.3	4	1.3 J	< 1.0	1.1 J	< 1.0	1.1 J	< 1.0	1.3 J	1.0 UJ
Calcium	na	na	73,800	71,800	25,000	19,900	25,100	18,600	18,100 J	17,200 J
Cobalt	73	na	2.1 J	3.1 J	3.8 J	3.5 J	3.6 J	2.9 J	2.8 J	1.0 J
Iron	2,200	300	[illegible]	< 18	[illegible]	148	[illegible]	79	141 B	18 UJ
Lead	na	15	2.7 B	< 2.0	6.6	2.0 UJ	6.7	2.0 UJ	2.0 UJ	2.0 UJ
Magnesium	na	na	51,800	51,600	12,000	6,540	12,000	7,350	6,600 J	6,270 J
Manganese	73	50	26.9 J	11.0 J	[illegible] J	12.7 J	[illegible] J	9.3 J	9.3 B	4.6 B
Potassium	na	na	31,900 J	25,400 J	1,800 J	1,100 J	1,810 J	986 J	1,060 J	1,010 J
Sodium	na	na	17,600 J	14,600 J	11,800 J	10,800 J	11,900 J	11,700 J	11,900 J	11,500 J
Thallium	0.26	2	6.0 B	< 6.0	< 6.0	< 6.0	< 6.0	< 6.0	< 6.0	6.0 UJ
Vanadium	26	na	1.2 B	< 1.0	17.3 J	2.6 B	17.4 J	2.2 B	2.9 B	1.9 B

* USEPA Region III (9/01)
RBCs have a hazard quotient of 0.1 for non carcinogenic chemicals (as per USEPA Region III)
na = not applicable
B = blank contamination
J = estimated concentration
UJ = estimated non detect
dark cell border = values is equal to or exceeds the Tap Water RBC
shading = value is equal to or exceeds MCL

Table 1-13
1998 RFI Detected Organic Results for Groundwater at SWMU 31—Coal Ash Settling Lagoons

[Units in µg/L]

Compound	Screening Level		31MW1-2 06 Apr 98 40-50 ft	31MW2-2 01 Apr 98 18.5-28.5 ft	31MW3-2 01 Apr 98 20.5-30.5 ft	31MW4-2 06 Apr 98 19-20 ft
	Tap Water RBC*	MCL*				
PAHs						
Benzo[*a*]pyrene	0.0092	0.2	< 0.05	0.024 J	0.06	< 0.05
Benzo[*a*]anthracene	0.092	na	< 0.05	0.022 J	< 0.05	< 0.05
Benzo[*b*]fluoranthene	0.092	na	< 0.1	0.027 J	0.07 J	< 0.1
Semivolatiles						
Bis(2-ethylhexyl)phthalate	4.8	6	4.8 J	< 10	< 10	< 10
Wet Chemistry						
Total organic carbon	na	na	100	100	100	100

*USEPA Region III (9/01).

NOTE.—Dark cell border = value is equal to or exceeds the Tap Water RBC.

Abbreviations: J=estimated concentration; na = not applicable.

1.2.3 Proposed RFI Activities at SWMU 31—Coal Ash Settling Lagoons

Additional investigative activities will be performed to augment the existing data and fill data gaps. Additional samples will be collected to further evaluate potential metal and PAH contamination identified from previous efforts. Environmental samples collected during previous investigations suggest potential impacts to sediments from metals and PAHs. Composite sludge samples collected during the VI identified arsenic and thallium as exceeding industrial RBCs. Although trace levels of PAHs were detected, concentrations were below residential RBC criteria. Results from in-situ TCLP sediment samples collected during the 1996 RFI to evaluate contamination migratory characteristics were reported below regulatory limits. Subsurface soil samples collected during the installation of monitoring wells were reported at concentrations above residential RBC criteria for arsenic and chromium. Antimony, arsenic, barium, and chromium were detected above Tap Water RBCs in the associated groundwater samples. Antimony, beryllium, and lead exceeded MCL criteria.

A data gap analysis for the SWMU indicated that there are data needs related to chemical groups that have not been investigated at this site. The chemical parameters needed include TCL VOCs, explosives, TCL pesticides/PCBs, herbicides, dioxins/furans, and perchlorate.

The field sampling program is summarized in **Table 1–14**. Proposed sample locations are presented on **Figure 1–8**. Specific site investigation elements include:

- Surface Water Sampling: One surface water sample will be collocated with deep sludge samples collected at each lagoon.
- Sludge/sediment Sampling: Deep sludge samples were not collected during previous investigations and will be collected from each lagoon.
- Soil Sampling: Three soil samples will be collected from one boring to address data gaps.
- Groundwater Sampling: Groundwater samples will be collected from the four existing wells to assess potential contaminant migration.

6

Table 1-14
RFI Field Sampling Program at SWMU 31—Coal Ash Settling Lagoons

Medium Sampled	Estimated Samples	Sample ID	Analyses
Surface Water	3	31SW10 31SW12 31SW14	TCL VOCs, TCL SVOCs, PAHs, TAL metals, explosives, TCL pesticides/PCBs, herbicides, perchlorate, hardness, TOC, TOX
Sludge/Sediment	12	31SE7 through 31SE14*	TCL SVOCs, PAHs, TAL metals, explosives, TOC, grain size; TCL VOCs, TCL pesticides/PCBs, herbicides, dioxins/furans, TCLP SVOCs, TCLP metals (1 sample per lagoon)
Soil	3	31SB5A 31SB5B 31SB5C	TCL VOCs, TAL metals, explosives, TCL pesticides/PCBs, herbicides, dioxins/furans, TOC, pH
Groundwater	4	31MW1-3 31MW2-3 31MW3-3 31MW4-3	TCL VOCs, TCL SVOCs, PAHs, total and dissolved TAL metals, explosives, TCL pesticides/PCBs, herbicides, perchlorate, hardness, TOC, TOX

*A sample identification suffix (A, B, C,...) will be used to indicate sample depth. Refer to Section 2.4.3 of the QAPA for sample identification protocols.

1.2.3.1 Surface Water. One surface water sample will be collocated with one deep sediment sample from each lagoon to supplement previous investigation data for this medium. Samples will be analyzed for TCL volatile organic compounds (VOCs), TCL SVOCs, PAHs, Target Analyte List (TAL) metals, explosives, TCL pesticides/PCBs, herbicides, perchlorate, hardness, TOC, and TOX. Water quality conditions will be measured using a Hydrolab or equivalent and will include temperature, dissolved oxygen, pH, specific conductivity, and turbidity.

1.2.3.2 Sludge/Sediment. Sludge/sediment borings will be advanced to bedrock within each lagoon using Vibracore methods to assess potential contaminant migration. Specific Vibracore sampling protocols are contained in standard operating procedure (SOP) 30.12, located in Appendix A. Based on approximate depths to bedrock in each lagoon (**Figures 1-4 and 1-5**), the following sludge/sediment samples will be collected:

Primary lagoon.

- One shallow (approximately 0 to 0.5 ft below the sludge/water interface)
- Two mid-levels (approximately 4 and 6 ft below the sludge/water interface)
- Two deep samples (approximately 2 and 4 ft above bedrock)

Secondary lagoon.

- One shallow (approximately 0 to 0.5 ft below the sludge/water interface)
- Two deep samples (approximately 2 and 4 ft above bedrock)

Tertiary lagoon.

- One shallow (approximately 0 to 0.5 ft below the sludge/water interface)
- Three deep samples (approximately 2 and 4 ft above bedrock)

Samples will be logged for stratigraphic characterization and analyzed for TCL SVOCs, PAHs, TAL metals, explosives, TOC, and grain size. One shallow sample collected from in front of each lagoon outfall will be analyzed for TCL VOCs, TCL pesticides/PCBs, herbicides, dioxins/furans, TCLP SVOCs, and TCLP metals.

1.2.3.3 Soil. One soil boring will be advanced using direct push methods to address chemical parameter data gaps. This boring will be positioned downslope between the secondary and tertiary lagoons to assess whether

SWMU-related activities have affected the soil. The location of the proposed boring between the lagoons and the New River (the probable direction of constituent migration) should, when combined with previous sampling efforts at the SWMU, provide evidence of impacts to soil from metals and the analytical parameters that have not yet been sampled at SWMU 31. One surface (0–0.5 ft bgs) and two subsurface (1-3 and 3-5 ft bgs) soil samples will be collected and analyzed for TCL VOCs, TAL metals, explosives, TCL pesticides/PCBs, herbicides, dioxins/furans, TOC, and pH.

1.2.3.4 Groundwater. Groundwater samples will be collected from the four existing wells located at the unit to assess potential contaminant migration and verify previous investigative results. Samples will be analyzed for TCL VOCs, TCL SVOCs, PAHs, total and dissolved TAL metals, explosives, TCL pesticides/PCBs, herbicides, perchlorate, hardness, TOC, and TOX. Low flow techniques will be employed for purging and sampling the wells following the procedures outlined in MWP SOP 30.2. Water quality conditions will be measured using a Hydrolab or equivalent flow through cell and will include temperature, dissolved oxygen, pH, specific conductivity, and turbidity.

1.3 REGIONAL GROUNDWATER STUDY

The geologic and hydrogeologic conditions at RFAAP are very complex due to the intense structural deformation that is observed throughout the area, with examples of faulting, complex folded and fractured bedrock, and the development of karst within the carbonate rocks that underlie the Installation. Groundwater movement through these rocks can be preferentially channeled through the numerous fractures, along bedding planes, and through solution-enhanced variations of each. Since groundwater flow at RFAAP is complex due to karst features, groundwater will be investigated on a larger, regional scale (i.e., the entire HSA), instead of at individual sites. Regional groundwater study activities will be conducted to refine the conceptualized understanding of the current geologic and hydrogeologic conditions. A brief description of the physiographic, geologic, and hydrogeologic conditions at RFAAP are summarized below.

Physiography and geology. Both the Main Manufacturing and HSA of RFAAP are situated within the New River Valley, which is one of a series of narrow valleys distinctive of the Valley and Ridge Province of the Appalachian Mountains. The New River Valley is approximately 25 miles long and varies from eight miles wide at the southeast end of the valley to approximately two miles at its northeast end. The New River Valley crosses the Valley and Ridge Province perpendicular to the regional strike of the bedrock, cutting into Cambrian and Ordovician limestone or dolostone. The residuum overlying the carbonate rocks is deep and rich with clay. The topography is karst, and the valley contains river floodplain and terrace deposits. Karst features include sinkholes, caverns, and springs formed by the dissolution of calcium carbonate by naturally occurring carbonic acid in rainwater. The greatest areas of karst features are controlled by bedrock stratigraphy and structure, and by the presence of major drainage systems (ICF KE, 1998).

Unconsolidated sediments make up most of the overburden deposits within the HSA. Alluvial plain deposits are present along the New River. These deposits occur as recent floodplain material and from geologically older terraces and are overlain by finer micaceous silts and clays. Sporadic cobbles and boulders occur throughout the HSA's alluvial strata. The thickness of the alluvial deposits varies from a few feet to 50 ft, with an average of 20 ft (ICF KE, 1998).

Rock type. The HSA is underlain by two major rock units: the Elbrook Formation and the McCrady/Price Formation. The Elbrook Formation is the major rock unit outcropping within the Main Manufacturing Area of RFAAP. This formation is composed of thickly bedded blue-gray dolostone interspersed with blue-gray to white limestone; brown, green, and red shale; argillaceous limestone and brecciated limestone. Because of the high calcium carbonate content of the Elbrook, karst features such as sinkholes, solution channels, pinnacled surfaces, and springs are common. The McCrady/Price Formation outcrops east of the Main Manufacturing Area along Stroubles Creek and consists of mottled red and green shale and mudstone interspersed with brownish-green siltstone and sandstone (ICF KE, 1998).

The Max Meadows tectonic breccia is of lesser prominence within the HSA than the Elbrook and McCrady/Price Formations; however, is abundant in the southeastern region of the HSA as evidence of the Pulaski fault surface. This breccia consists of poorly sorted, angular to sub-rounded clasts of massive dolostone, laminated dolostones, and finely laminated greenish-gray calcareous mudstones in a fine- to very fine-grained matrix of crushed dolostone. The breccia, which is most fine-grained along the fault contact (Schultz, 1986), is an integral part of the highly deformed rocks along the base of the Pulaski thrust sheet (ICF KE, 1998).

103

Hydrogeology. The hydrogeology within HSA is complex due to the karst nature of the aquifer contained within the limestone and dolestone of the Elbrook Formation. Groundwater movement within karst aquifers is primarily through conduits (caves and caverns) and along bedding planes and fractures enlarged by solution. Springs are common discharge areas for karst aquifers.

Dissolution by groundwater in most karst aquifers occurs selectively. Although a large number of pre-solution openings may exist, very few are actually enlarged during solutioning. This results in a sharp discontinuity in the scale of underground voids, creating large caves surrounded by a network of tiny openings that have been enlarged very little, if at all. The larger conduits will develop along the bedding plane partings or fractures that are initially the longest or that are oriented along the prevailing hydraulic gradient.

At locations where the groundwater flows into larger conduits, sinkholes and conduits evolve interdependently. Sinkholes develop in the land surface as a result of concentrated dissolution, collapse, and transport of overburden through the conduit by groundwater. Topographic maps of RFAAP show evidence of solution cavities and collapse structures (such as sinkholes) oriented along bedding planes within the less competent limestone units. Solution cavities are evident in some of the outcrops within the HSA.

1.3.1 Previous Groundwater Investigations

Previous HSA groundwater investigation activities are limited to data gathered during past groundwater sampling events and a dye trace study performed by Parsons Engineering in the vicinity of SWMU 48. A brief description of the groundwater investigations that have been conducted within the HSA are provided below.

- An RFA was conducted to assess water quality parameters of groundwater samples from monitoring wells in SWMUs 27, 29, and 53 (USEPA, 1987);
- A VI was performed in three portions of the HSA. The investigation included installation and/or sampling of groundwater monitoring wells within SWMUs 26, 32, 39, 54, 57, and 74 (Dames & Moore, 1992);
- An RFI was conducted in two portions of the HSA. The investigation included installation of groundwater monitoring wells and analysis of the associated groundwater samples from SWMUs 13, 28, 51, and 52 (Dames & Moore, 1992);
- A Phase II VI was performed at three neighboring SWMUs (SWMUs 27, 29, and 53) and for SWMU 39. The investigation included the collection and analysis of groundwater samples from these SWMUs and the installation and sampling of groundwater monitoring wells within SWMU 39 (Dames & Moore, 1994);
- An RFI was conducted at SWMUs 31, 48, and 49. The investigation included the installation of groundwater monitoring wells, analysis of the associated groundwater sample, and aquifer testing of selected wells (Parsons, 1996);
- A supplemental RFI (dye tracing study) was conducted in the vicinity of SWMU 48. The dye tracing was performed as a result of data gaps identified in assessing groundwater flow at SWMU 48 and to provide better identification of groundwater discharge points from SWMU clusters (Parsons, 1996).
- An RFI was conducted at SWMUs 31, 39, 48, and 49. The investigation included sampling and analysis of groundwater samples (ICF KE, 1999a).

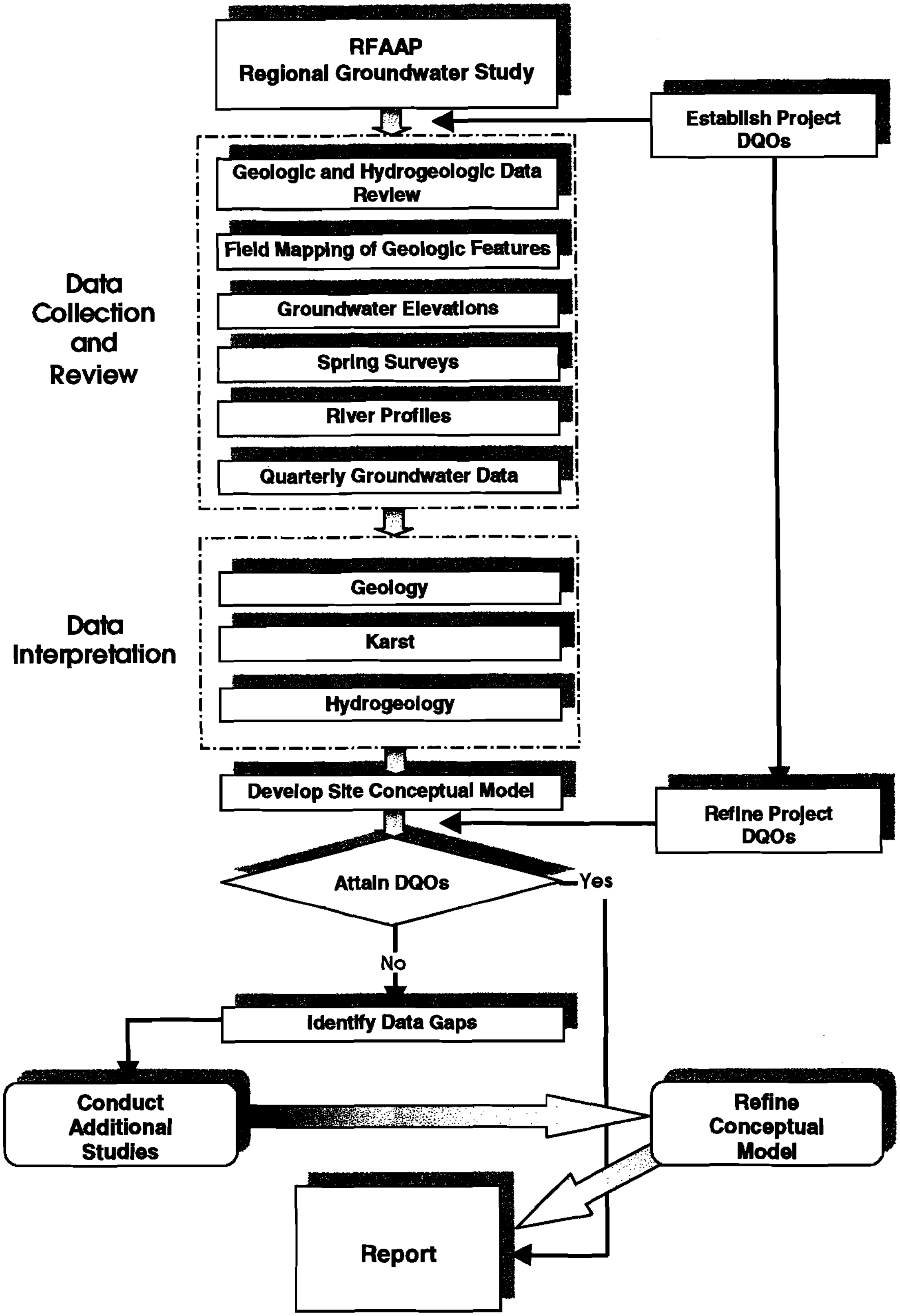
1.3.2 Regional Groundwater Study Program

The Regional Groundwater Study is designed to complement existing hydrogeologic data and has been structured to provide a comprehensive framework for establishing consistency in the decision making process, as depicted in **Figure 1-9**. The flowchart identifies study objectives, assumptions, and data use specifications.

1.3.2.1 Data Collection and Review. Consistent with the decision making process presented on **Figure 1-9**, a data collection and review effort was performed to attain Regional Groundwater Study DQOs. Activities performed to attain objectives included the following efforts, as summarized below:

- Geologic and Hydrogeologic Data Review
- Field Mapping of Geologic Features

Figure 1-9
Regional Groundwater Study Decision Making Process



- Groundwater Elevations
- Spring Surveys
- River Profiles
- Groundwater Data

Geologic and hydrogeologic data review. Previous geologic and hydrogeologic data were reviewed and a literature search was initiated to obtain and compile information on the geology, hydrogeology, chemical data, and other relevant data available for the facility and region. This information is required to understand the geologic and hydrogeologic conditions to aid in the development of the geologic and hydrogeologic current conditions model of the HSA.

Professional papers, geologic maps, graduate theses, and previous site reports pertaining to local and regional geology and hydrogeology were acquired and reviewed. Relevant information from these sources was used to help develop site current conditions.

Infrared (thermal) photography, aerial photography, and topographic maps were reviewed to aid in identifying the locations of springs, fracture traces, faults, karst features (i.e., sinkholes), and other pertinent geologic information that could be interpreted from these media for the Radford, Blacksburg, and RFAAP areas. A site map containing thermal data was used to identify potential springs, while the aerial photographs and topographic maps were useful in locating lineaments, fracture traces, faults, bedding plane orientations, and karst features. The linear features are placed into the category of photolineaments and can consist of fissures, faults, bedding plane orientations, and tonal changes, which could represent changes in bedrock or soil types. Karst features, such as sinkholes, were identified by circular expressions on the topographic maps and aerial photographs.

Field mapping of geologic features. A field-mapping project of the complex geological structural features at RFAAP was performed between April and November 2000 to supplement the work performed by Parsons Engineering in June 1995. This project was undertaken to augment the existing geologic data for the area and to address site-specific deficiencies in the geologic database.

The geology of outcrops at the HSA and nearby surrounding areas were observed for structural features including strike, dip, and fissure and joint set orientations. Features such as anticlines, synclines, folds, and faults were photographed, and bedrock orientations were measured. Study areas primarily included outcrops along the New River and railroad track outcrops from the Route 114 bridge to the downriver RFAAP property line. Roadcuts west of RFAAP, along Route 114, and other areas surrounding RFAAP were also mapped.

Groundwater elevations. A groundwater elevation survey was performed in April 2000 for 69 monitoring wells located at the HSA. The purpose of the groundwater elevation survey was to aid in identifying the groundwater gradient at the HSA. Groundwater contour maps were developed from the elevation survey data to project groundwater gradients in the eastern, central, and western portions of the HSA.

In general, it was concluded that regional groundwater gradients at the HSA flow radially from higher elevations to lower elevations at the New River. At a lesser scale, groundwater present in eastern end of the HSA also exhibited a radial pattern with the gradient moving away (in each direction) from the groundwater high point at well 28MW1 toward the New River. Water levels near SWMU 48 indicated preferential flow paths in bedrock along fractures or faults.

Groundwater gradients within the central HSA suggest groundwater flow is toward the north and to the south to the New River. There is a suspected fault in the area, most likely affecting groundwater movement. The gradient near SWMU 39 appears to be controlled by a fissure, based on narrowing of the contours around wells 39MW3, 39MW4, 39MW5, and 39MW6. No photolineaments were mapped in this area that would suggest a fracture. However, there are an insufficient number of wells located on the southern side of the fault to confirm the hypothesis that groundwater flow is fracture controlled. The groundwater gradient near SWMU 31 (western HSA) is to the northwest, toward the New River.

Because the monitoring wells were originally placed to sample groundwater and positioning is biased towards SWMUs, there are significant spatial gaps in the groundwater elevation data. Thus, it is difficult to assess accurate regional and local gradient characteristics, especially in the highly deformed and karstic bedrock.

Spring surveys. A spring survey was conducted along the HSA shoreline in the New River during March and November 2000. The purpose of the spring survey was to locate springs and seeps to verify the thermal flyover signatures, assist in identifying groundwater flow paths, and to measure flow rates and water quality parameters (e.g., specific conductance, temperature, turbidity, pH, and dissolved oxygen) at each spring.

In addition to locating and measuring water quality parameters at springs, water quality measurements were recorded at various locations in the river in an attempt to locate river bottom springs and to identify differences between spring and river waters. Each spring location was given an identification number and named in conjunction with an easily identifiable geographic or physical feature.

River profiles. A field effort was conducted in May 2000 to characterize the river bottom profile at five locations around the HSA. This effort also assisted in (1) assessing river flow velocity, (2) identifying areas in the New River along the HSA that were gaining or losing appreciable flow, (3) establishing points along the New River for future gauging stations.

Stations were named for easily identifiable geographic or physical features. A description of the five river profile locations is provided below:

- Railroad Bridge Profile—upstream side of the facility property where the railroad crosses the New River.
- Road Bridge Profile—approximately 9,800 ft downstream from the Railroad Bridge Profile and is the roadway that crosses to the HSA.
- River Bend Profile—approximately 12,500 ft downstream of the Road Bridge near the apex of the bend in the New River.
- Island Profile—near the large island, approximately 10,000 ft downstream from the River Bend Profile.
- Property Line Profile—downstream side of the facility property and approximately 9,800 ft downstream from the Island Profile.

Releases from Claytor Reservoir, which would add variation in river flow velocity measurements, were considered during profiling activities. However, river profile measurements were performed during periods of normalized flow.

River profile measurements exhibited a wide range of cross-sectional areas, velocities and depths throughout the HSA. The width of the New River ranges from 425 ft at the River Bend Profile to 750 ft at the Island Profile and Property Line Profile. The highest average velocity was measured at the Island Profile (3.7 ft/s). The lowest average flow through a cross-sectional area was at the Railroad Bridge Profile (1,460 ft^3/s); the highest was measured at the Island Profile (3,970 ft^3/s).

Profiling results indicated that the New River stream bed appears to be both a losing and gaining river along different reaches of the river. This is not unusual for a karst setting; however, a thorough evaluation of river gauging results will be required to confirm this hypothesis. Other influences can affect river profile measurements such as large boulders or highly irregular river bottom profiles. These variables can constrict stream flow above and below the transect (profile) and potentially produce misleading results.

Groundwater data. HSA groundwater analytical data were reviewed from site investigation and quarterly groundwater sampling events. Site investigation samples were collected on various occasions during the 1990s in support of the following HSA groundwater investigations:

- RFI, Dames & Moore, 1992, at HWMU 16 and SWMUs 13, 51
- VI, Dames & Moore, 1992 and 1994, at SWMUs 26, 39, 54
- RFI, Parsons Engineering Science, 1996, at SWMUs 31, 48/49, 54
- Supplemental RFI, Alliant Techsystems, 1997, at SWMU 54
- RFI, ICF Kaiser Engineers, 1998, at SWMUs 31, 39, 48/49

Quarterly data were collected by ATK over a period of 6 years (1994-1999) in accordance with VDEQ permit requirements. Chemical and elevation data were obtained quarterly during this period for monitoring wells located in the vicinity of HWMU 16 and SWMUs 13, 26, 29, 39, and 74.

The quarterly and site investigation data were compared against groundwater regulatory levels of concern associated with USEPA Region III RBCs and MCLs. Generally, the analytes exceeding regulatory limits in the data were chlorinated VOCs, metals, and explosives. The following analytes were detected above the RBCs and/or MCLs in groundwater; the low and high range of the concentrations and SWMU locations are also included:

VOCs

- 1,1,2,2-Tetrachloroethane (1.2–7.0 µg/L) SWMUs 48/49, HWMU 16
- 1,1,1-Trichloroethane (300–13,100 µg/L) HWMU 16
- 1,1,2-Trichloroethane (7.0–508 vg/L) HWMU 16
- 1,1-Dichloroethane (21,400 µg/L) HWMU 16
- 1,1-Dichloroethene (0.4–3.6 µg/L) SWMUs 26, 48/49, 74, HWMU 16
- 1,2-Dichloroethane (0.87–21,400 µg/L) SWMU 13
- 1,2-Dichloropropane (0.74 µg/L) SWMU 13
- Carbon Tetrachloride (0.3–180 µg/L) SWMUs 13, 48/49, 74, HWMU 16
- Chloroform (0.61–30 µg/L) SWMUs 13, 26, 48/49
- Methylene Chloride (5.6–6.6 µg/L) HWMU 16
- Trichloroethene (2–10 µg/L) SWMU 13
- Trichlorofluoromethane (1.9–6,500 µg/L) HWMU 16, SWMU 26
- Vinyl Chloride (0.1–3,000 µg/L) SWMU 74, HWMU 16

SVOCs

- Bis(2-ethylhexyl)phthalate (4.8–790 µg/L) SWMUs 13, 26, 31, 48/49, HWMU 16
- Benzo[*a*]pyrene (0.024–0.061 µg/L) SWMU 31
- Pentachlorophenol (3–28 µg/L) SWMU 74

Explosives

- 2,4-Dinitrotoluene (1,440 µg/L) HWMU 16
- 2,4,6-Trinitrotoluene (2.8–17.5 µg/L) SWMU 54
- RDX (2.82 µg/L) SWMU 13

Metals

- Aluminum (80–42,600 µg/L) SWMUs 13, 31, 39, 54, HWMU 16
- Antimony (7–111 µg/L) SWMUs 13, 31, 39, HWMU 16
- Arsenic (1–65.2 µg/L) SWMUs 13, 29, 31, 39, 74, HWMU 16
- Barium (2,450–8,380 µg/L) SWMUs 39, 74
- Beryllium (3.17–234 µg/L) SWMUs 31, 39, 48/49, 54, 74, HWMU 16
- Chromium (106–1,110 µg/L) SWMUs 13, 39, 74, HWMU 16
- Iron (310–72,100 µg/L) SWMUs 13, 31, 39, HWMU 16
- Lead (16–65 µg/L) SWMUs 13, 29, 31, 39, 74, HWMU 16
- Manganese (55.2–11,700 µg/L) SWMUs 13, 31, 39, 74, HWMU 16
- Nickel (1–3,080 µg/L) SWMUs 13, 31, 39, 48/49
- Thallium (3–6 µg/L) SWMUs 31, 39, HWMU 16

Miscellaneous

- Fecal coliform bacteria (2–30 MPN/mL) SWMU 39
- Ammonia (250–2,000 µg/L) SWMU 13
- Nitrate/Nitrite (2,400–12,000 µg/L) SWMU 13, HWMU 16
- pH (4.9–6.4, 8.6–9.36) SWMUs 29, 39, 51, 74, HWMU 16
- Total dissolved solids (515,000–805,000 µg/L) SWMU 26

1.3.2.2 Proposed Data Collection Activities. Additional data collection activities are proposed to augment the current data obtained and to assist in refining groundwater study DQOs. Data collection activities will consist of the following efforts:

- River, Spring, and Monitoring Well Gauging: Pressure transducers will be established in two New River gauging stations, three spring-box pools, and eight existing groundwater monitoring wells for continuous water level monitoring.

- Modified Aquifer Pump Tests: Short-term pump tests will be performed in approximately nine existing bedrock groundwater monitoring wells in the HSA to assess the suitability of the selected wells for long-term water level monitoring.
- Well Surveying: Twenty-five groundwater monitoring wells in the HSA will be surveyed to obtain survey-grade location coordinates and elevation information.

River, spring, and monitoring well gauging. River, spring, and monitoring well gauging activities are scheduled for one year to evaluate water table fluctuation and associated water quality data within the HSA. The purpose of this monitoring is to document seasonal changes in water levels within the shallow bedrock aquifer, monitor river and spring stage, and precipitation and barometric changes to develop a water budget for the HSA. This information will be useful in describing surface water and groundwater interactions (e.g., losing stream or gaining stream and the impact of New River stage to groundwater level) in the New River Basin as it pertains to RFAAP. Additionally, the relationship between these variables will be used to refine the conceptualized understanding of the geologic and hydrogeologic current conditions at the HSA.

River gauging. Two river locations have been selected for the installation of "gauging stations" containing pressure transducers upstream and downstream of the RFAAP property lines (**Figure 1–10**). The upstream location will entail retrofitting the existing gauging station at the roadway bridge as depicted on **Figure 1–11.** The downstream gauge will be attached to the Water Intake Structure No. 2 (**Figure 1–12**). Data interpretation activities will require obtaining volumetric flow data from Virginia Pollutant Discharge Elimination System (VPDES) permitted discharges to the New River.

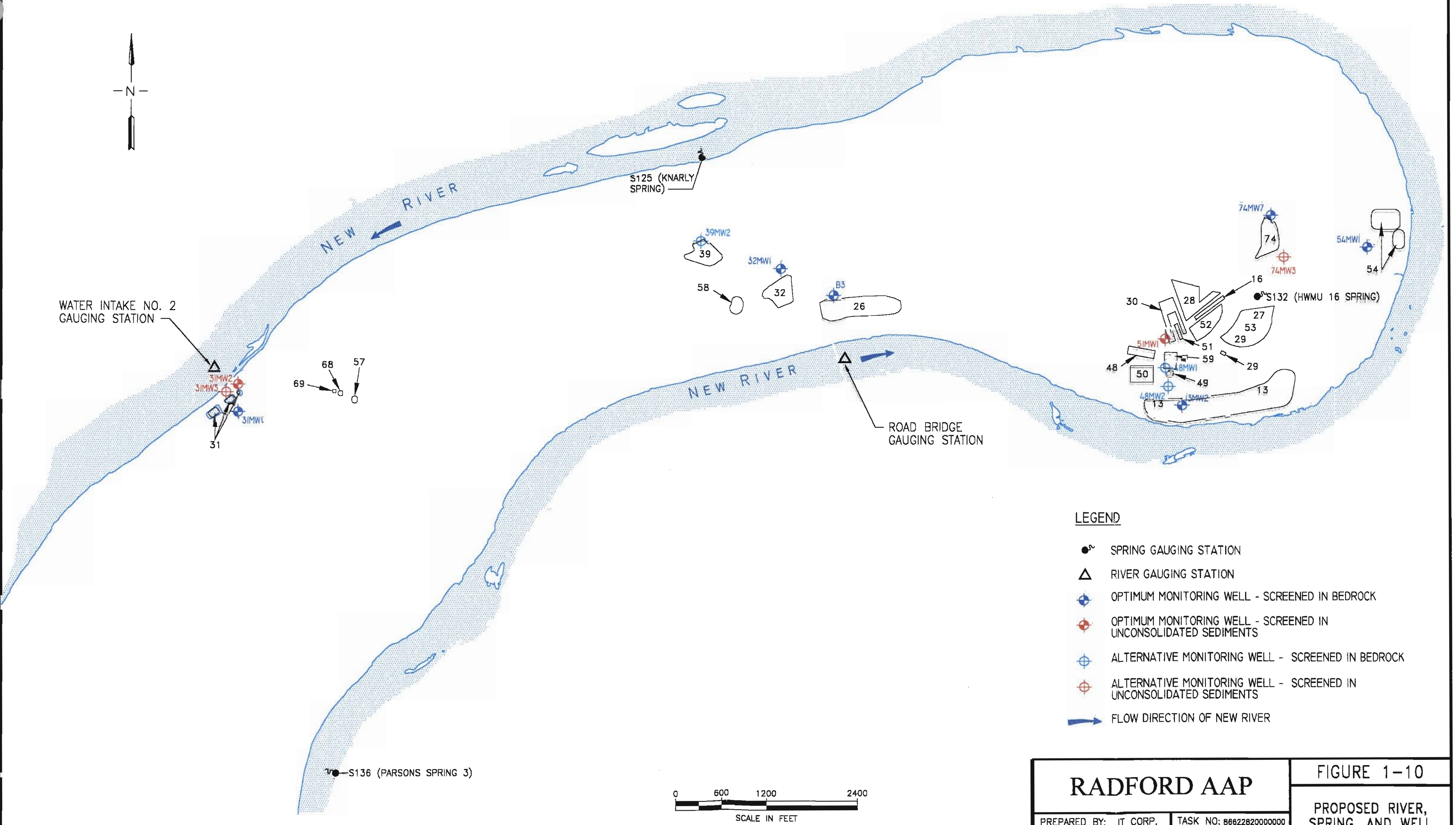
River gauging locations are acceptable to the Installation and USACE. Elements associated with the river location and design-specific attributes include:

- Construction of the downstream river gauge on Water Intake Structure No. 2 will be coordinated with the Installation and ATK. Special precautions will be taken during gauge installation because the intake is operational.
- Locations will be surveyed for both horizontal and vertical control and tied to the existing facility survey datum.
- Elevation profiles along the river bank and river bottom will be performed to provide elevation control.
- The river will be gauged using standard field methods to confirm and calibrate river flow measurements during several different seasons.

Spring gauging. Three spring locations have been selected for the installation of "spring-boxes" and "weirs" to continuously record the stage level within the spring-box pools. Refer to **Figure 1-10** for the proposed locations of these springs. Springs that will be monitored include the following:

- Spring S136 (Parsons Spring 3)—located approximately 700 ft downstream from the railroad bridge on the MMA. Spring S136, while located on the MMA, is critical for this project because of previous information regarding the spring and its discharge characteristics. This spring location reported a successful dye trace (Parsons 1996). Based on the flow velocity from the dye trace, the discharge volume, and the current knowledge on the geology, the recharge area for this spring can be estimated and used as a gauge for the other proposed spring monitoring locations. This spring is located about 10 ft above and approximately 20–30 ft back from the river.
- Spring S125 (Knarly Spring)—located approximately 1,100 ft northeast and just upstream of SWMU 39. This spring was previously located during the spring surveys and was depicted on thermal photography. It is one of the larger springs within the HSA and is part of a cluster of nearby springs. Spring S125 is the most convenient for adding a spring-box and weir because the location is several feet above the average river level and approximately 30 ft away from the river. This spring potentially could be in the recharge area for SWMU39 and several nearby sinkholes.

163



RADFORD AAP

PREPARED BY: IT CORP.	TASK NO: 866228200000000
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DATE: OCTOBER 2001	

FIGURE 1-10

PROPOSED RIVER, SPRING, AND WELL GAUGING LOCATIONS

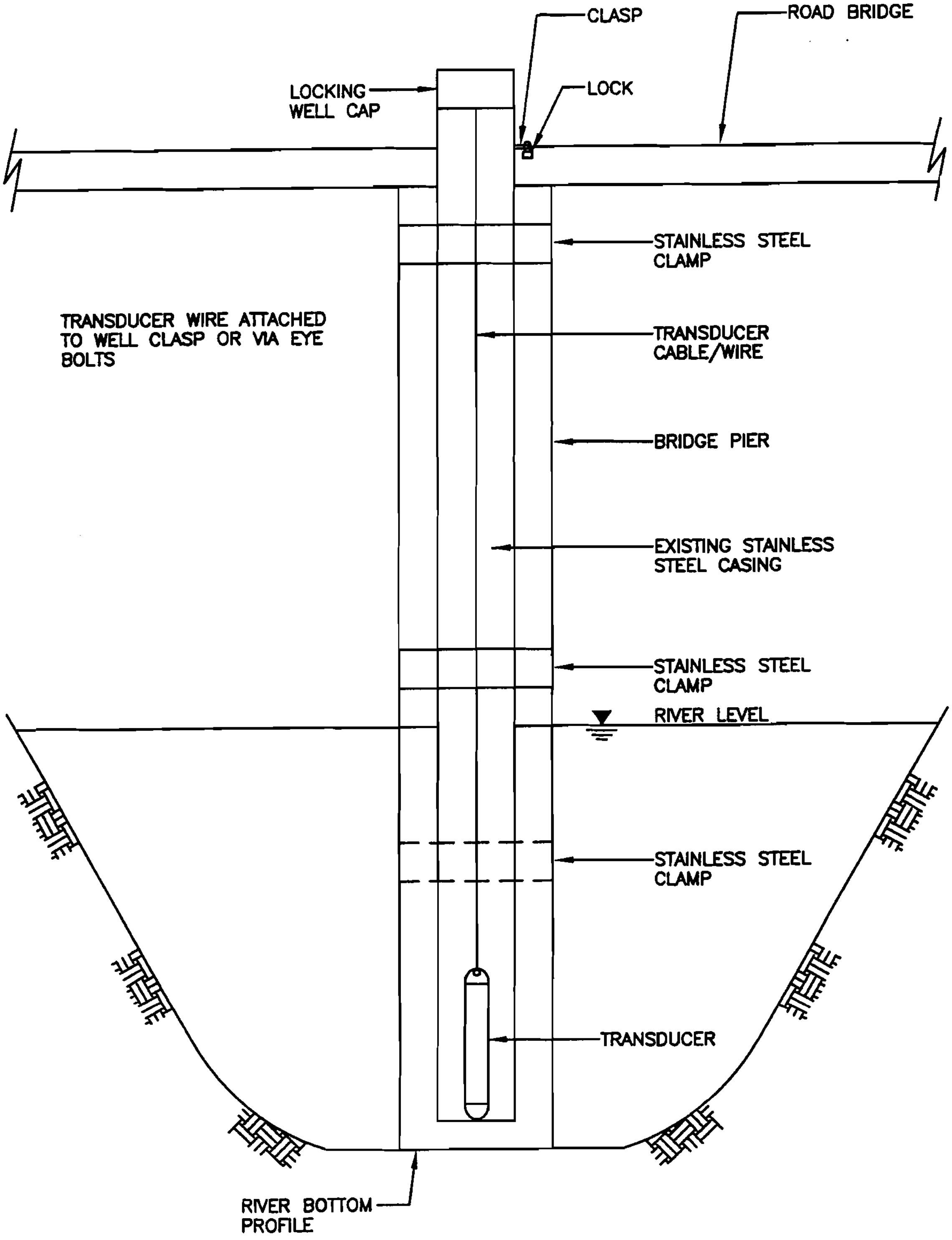

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FIGURE 1-11

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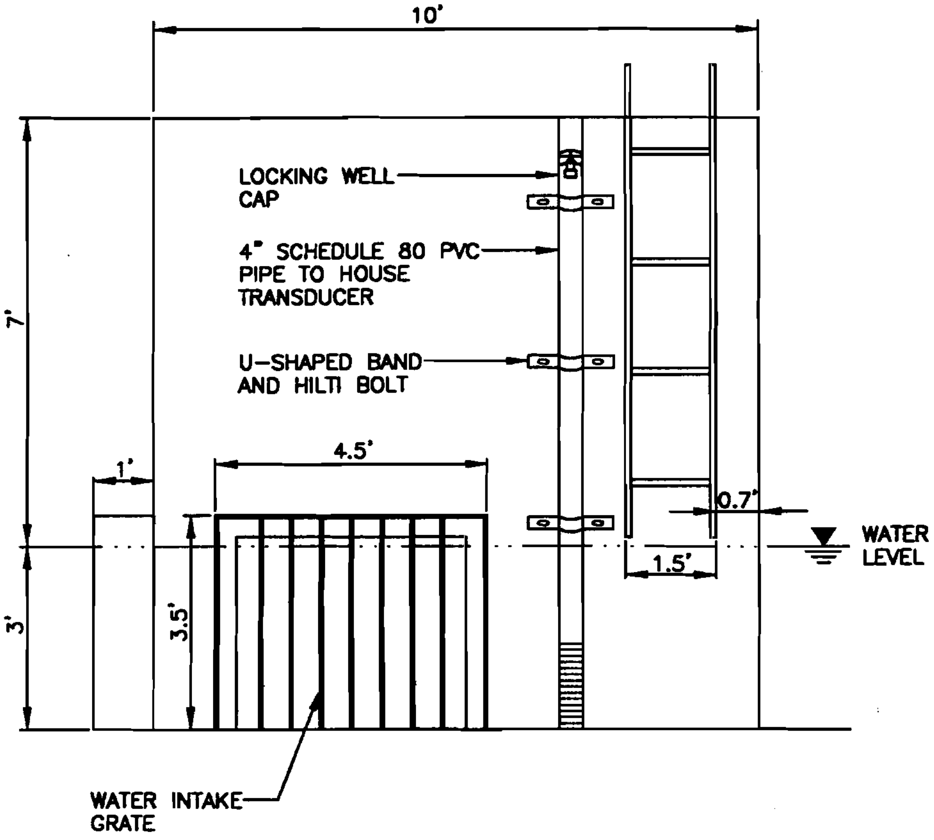
DATE: OCTOBER 2001
FIGURE 1-11.DWG

ROAD BRIDGE
GAUGING STATION
DIAGRAM

167



WATER INTAKE STRUCTURE
NO. 2 GAUGING STATION
WEST FACING VIEW
(DOWNSTREAM SIDE)
N.T.S.

RADFORD AAP		FIGURE 1-12
PREPARED BY: IT CORP.	TASK NO: [illegible]	WATER INTAKE STRUCTURE NO. 2 GAUGING STATION DIAGRAM
CHECKED BY: MT	IT DWG NO: FIGURE 1-12.DWG	
DATE: OCTOBER 2001		

- Spring S132 (HWMU 16 Spring)—located at HWMU 16 approximately 150 ft southwest of Building 4601-15. The location of this spring will assist greatly in assessing the recharge and discharge characteristics within the HSA alluvial/residuum sediments (approximately 40–60 ft thick). The spring is surrounded by monitoring wells where constituents of concern consisting of VOCs, metals, and explosives were detected during quarterly and site investigation groundwater sampling events. Spring S132 is located near several identified photolineaments mapped during geologic and hydrogeologic data collection and review activities.

Spring-boxes will be installed around Springs S136 and S125 and will be constructed with a weir notch on the outflow side to accommodate the expected flow rate of the spring. At spring S132, the spring-box will be installed downgradient of the spring to avoid affecting quarterly sampling activities. Pressure transducers will be placed within the spring-box pool, as depicted on **Figure 1-13**, to monitor stage on the same time frequency as the monitoring well and river gauging locations.

Proposed spring monitoring locations are acceptable to the Installation and USACE. Elements associated with the locations and design-specific attributes include:

- Construction of the spring-boxes will be coordinated with the Installation and USACE. Special precautions will be taken during construction activities to address sediment erosion and control. Sediment/silt fencing reinforced with straw bails will be used on the downstream side of the construction activities to minimize and reduce erosion and sedimentation releases.
- Locations of the spring-boxes will be surveyed for both horizontal and vertical control and tied to the existing facility survey datum.
- Final sizing of the spring-boxes will be established in the field.
- Coarse gravel will be placed at the weir outfall to mitigate possible bank erosion.
- Flow measurements will be recorded prior to each data-downloading period to calibrate stage measurements.

Monitoring well gauging. Pressure transducers will be installed in eight existing monitoring wells within the HSA (**Figure 1–14**). The proposed existing monitoring wells will monitor water level fluctuations and selected field measurements (i.e., temperature and specific conductance). The wells will be used to monitor changes in recharge and discharge, if shown to be hydraulically connected to other nearby wells, or by demonstration of their pumping rates and transmissivity, and indication of their interconnectedness. Using these wells in conjunction with river and spring gauging, and monitoring other discharge or recharge events will be used to evaluate a HSA-wide water budget. This information will aid in future decision making and will be used to update the current conditions and site hydrogeologic conceptual model.

Six existing shallow bedrock wells and two existing alluvial wells will be chosen for this study. Refer to **Figure 1-10** for the proposed locations of these wells within the HSA.

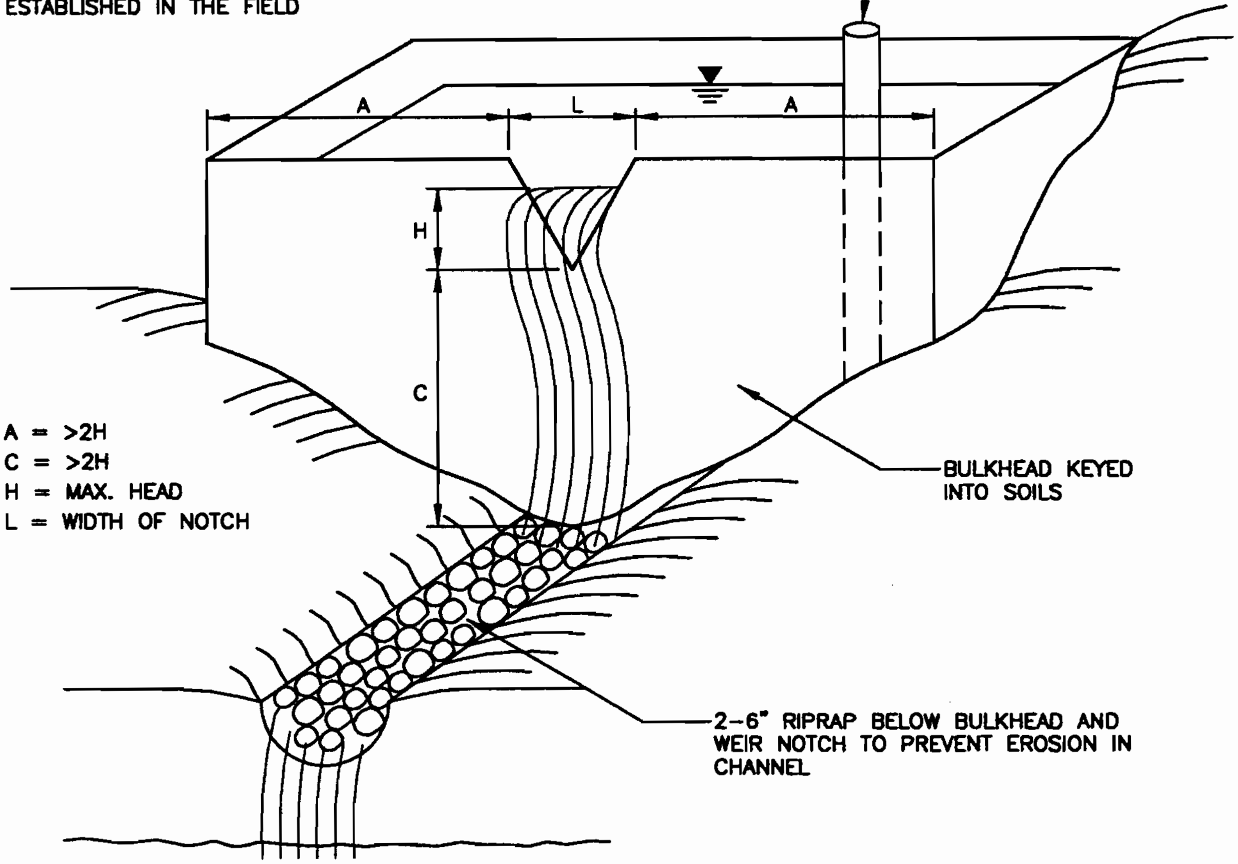
Bedrock monitoring wells. The following criteria were considered while selecting the existing bedrock monitoring wells for this study:

- Bedrock well screens are to be at or below the mean annual New River water level of approximately 1,676 ft msl.
- If possible, wells will be selected with large solution features or fractures noted in boring logs and confirmed through the modified pump tests.
- Wells located along photolineaments or faults.
- At least one control well location will be selected that is not influenced by fractures, conduits, or photolineaments and confirmed by a modified pump test.

Table 1–15 presents optimum well selection scenarios for bedrock monitoring well gauging locations. The final determination will be contingent upon modified pump tests conducted at approximately nine existing wells, including 31MW1, 39MW2, 32MW1, B3 (SWMU 26), 48MW1, 48MW2, 13MW2, 74MW7, and 54MW1.

SPRING BOX CAN BE CONSTRUCTED FROM STAINLESS STEEL OR 1/2" WOOD PLANKS COVERED WITH POLYETHYLENE SHEETING

EXACT DIMENSIONS WILL BE ESTABLISHED IN THE FIELD



PVC STANDPIPE TO HOUSE TRANSDUCER

BULKHEAD KEYED INTO SOILS

2–6" RIPRAP BELOW BULKHEAD AND WEIR NOTCH TO PREVENT EROSION IN CHANNEL

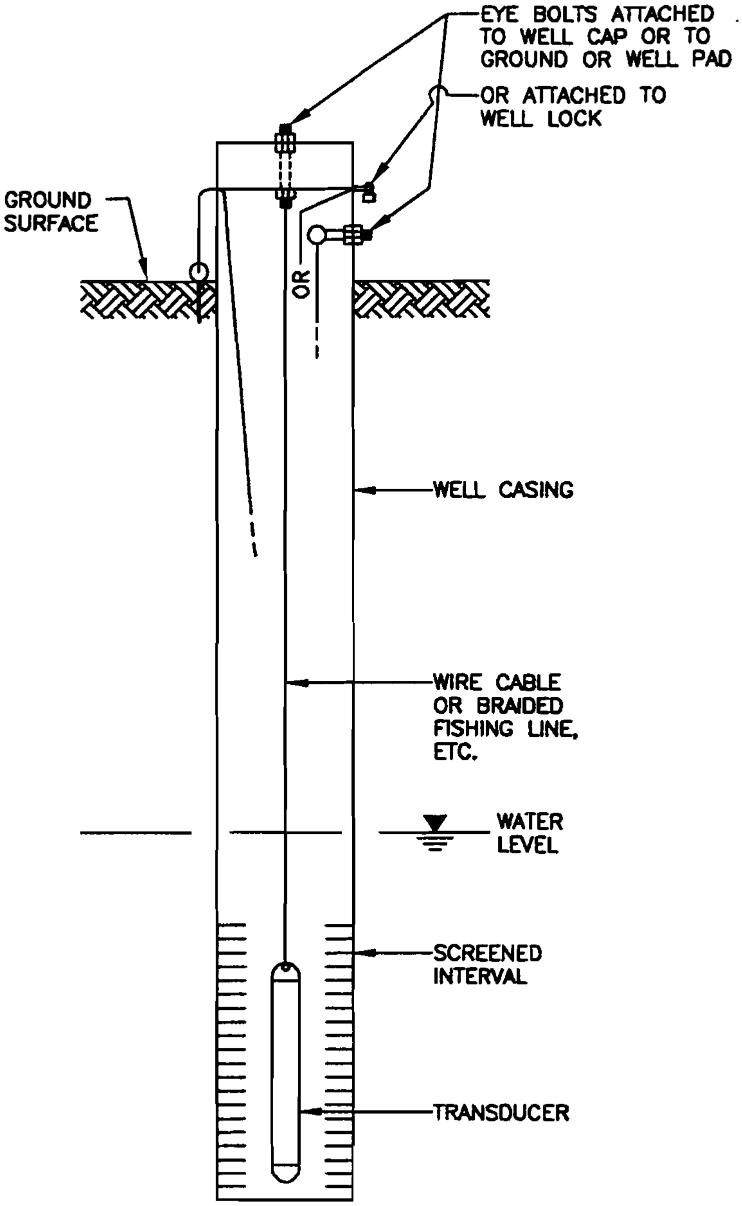
A = >2H
C = >2H
H = MAX. HEAD
L = WIDTH OF NOTCH

NOTE:
WOVEN FABRIC WILL BE PLACED IN AREAS OF DISTURBED EARTH. AREA WILL BE SEEDED AND COVERED WITH STRAW TO PROMOTE GROWTH AND MINIMIZE EROSION

FOR 90° NOTCH Q = 2.436H S/2
FOR 60° NOTCH Q = 1.408H S/2
Q = CFS

NOT TO SCALE

RADFORD AAP		FIGURE 1–13
PREPARED BY: IT CORP.	TASK NO: [illegible]	SPRING BOX GAUGING STATION DIAGRAM
CHECKED BY: MT	IT DWG NO:	
DATE: OCTOBER 2001	FIGURE 1–13.DWG	



RADFORD AAP

FIGURE 1-14

MONITORING WELL GAUGING STATION DIAGRAM

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TASK NO: [illegible]
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DATE: OCTOBER 2001

Alluvial monitoring wells. The following criteria were considered while selecting the existing alluvial monitoring wells for this study:

- Wells screened within the alluvial sediments.
- Wells located near the New River for the purpose of monitoring effects from river stage on the alluvial aquifer near the river.
- Wells screened near the top of bedrock, but not in the bedrock or screened across bedrock/alluvial interface.
- Wells geographically located within the HSA.
- Wells not used for quarterly monitoring by ATK are preferred, but not critical.

Table 1–16 presents optimum well selection scenarios for alluvial monitoring well gauging locations. Modified pump tests will not be performed in the alluvial wells because the purpose of these tests for this program is to assess the degree of interconnectivity of the fractures and/or conduits within the bedrock aquifer. The alluvial wells, which are typically under saturated conditions, will not require the same degree of investigation.

Modified pump tests. The purpose of the proposed modified pump tests is to assess the degree of interconnectivity of nine bedrock-screened wells to fractures and/or conduits in the bedrock aquifer. The pumping tests will provide information on the suitability of each well for long-term water level monitoring. Higher, sustained pumping rates presumably indicates the well is adequately connected to the fracture/conduit network. Additionally, these pump tests may provide useful information on hydraulic characteristics of the bedrock aquifer and for future monitoring well placement. As a rough estimate, the following sustained (minimum 2-hour test) pumping rates should indicate sufficient interconnectedness:

Well Size (i.d. in.)	Pumping Rate (gal/min.)
2.0	≥1.0
4.0	≥2–4.0

A modified 2-hour drawdown test will be performed to estimate the optimum-pumping rate. Using this information, a distance-drawdown and time-drawdown graph will be prepared and an estimated flow rate will be established. This will aid in selecting the optimal locations for monitoring long-term water levels.

Before beginning the pump tests, pressure transducers will be used to collect water level measurements from each well used in the tests. Nearby monitoring wells may also be monitored, if considered feasible. After the start of the test, water level measurements will be collected at the following intervals:

Pump Test Start (min.)	Measurements Frequency
0–10	Every min
11–20	Every 2.5 min
21–30	Every 5 min
30–end of test	Every 10 min

The volume of groundwater in borehole storage and in the filter pack will be calculated (sum–one well volume). The pump will be set near the bottom of the well. The discharge rate will begin at 2–4 gal/min, depending on the well diameter, until one well volume is removed. The pumping rate will be adjusted until a stable water level within the screened interval is achieved. The discharge rate will be checked every 15 min by timing the discharge into a fixed volume, such as a 5-gal bucket. Groundwater quality parameters, including temperature, specific conductivity, turbidity, and dissolved oxygen, will also be measured at 15-min intervals.

During the course of the pump test, measurements will be evaluated to identify potential anomalies in the drawdown curve. At the completion of the drawdown test, the pump will be shut off. Recovery measurements will be made using the same schedule of measurements as used for the drawdown test. Recovery monitoring will continue for approximately 30–60 min or until the water levels have recharged to within 90% of the static levels. The data will be reviewed to assess whether antecedent conditions (i.e., heavy precipitation/recharge events) have influenced the water levels following static water levels stabilization. Additional testing may be warranted contingent upon water quality anomalies.

Modified pump tests will be conducted in a manner to avoid Installation quarterly groundwater sampling activities. Pump testing equipment will be decontaminated in accordance with Installation requirements and MWP SOP 80.1. In the event that a dedicated pump is contained in a well selected for pump testing, the dedicated pump will be carefully removed, wrapped in polyethylene sheeting, and decontaminated prior to reinsertion.

Water generated during the aquifer testing will be temporarily stored in 55-gal drums or large tanks and staged at an Installation-approved location. The water will be tested to assess disposal characteristics and will be disposed of at the RFAAP wastewater treatment facility or transported to a proper facility offsite, depending on the results of the material profile. Refer to Section 1.4 for additional information regarding the handling and disposal of IDM.

Pressure transducer/data logger description. The pressure transducer selected for the study is a Solinst Levelogger. The Levelogger is a stainless steel, miniature, fully submersible, self-contained data-logger/pressure transducer for the automatic recording of water levels. The Levelogger measures 7/8 in. × 10.2 in. and weighs less than 11 oz. The measurement time interval can be set to record data every 0.5 sec to 99 hours. The unit can store 16,000 measurements.

The procedure for installing the transducers and collecting the data is as follows:

- Program transducer to correspond to the parameters of the transducer, the start day and time, and the frequency of measurement.
- Remove the well cap and check the headspace for organic vapors in accordance with MWP SOP 30.2.
- Manually measure and record the water level of each monitoring well point.
- Attach the transducer to a small-diameter cable, rope or fishing line of sufficient length to reach the bottom of the well or a pre-determined depth.
- Attach the transducer to the top of the well casing by clasp, eye-bolt, or some other means that secures the transducer and prevents tampering.
- Lower the transducer to the pre-established depth. If there is a dedicated pump in the well, the transducer will be lowered to a point either above or below the pump depending on the pump depth and water level. The location of the transducer will be selected as not to interfere with the operation of the pump. (NOTE: The operation of the transducer will not affect the operation of the pump. The pump may need to be temporarily removed if the transducer is placed below the pump.)
- On a monthly basis, the data from the transducers will be downloaded to a computer. Data will be retrieved from the transducer by removing it from the well or spring-box and placing it in an optical reader to download the memory. This can be done in an office or onsite with a portable computer. Before and after removing the transducer from the well or spring-box, the water level will be manually measured and recorded. The measurements will be checked with the information programmed into the transducer. If changes are required in programming the transducer, this will be completed at this time. Afterwards, the transducer will be placed back into the well or spring-box.

Hydrographs of the monitoring wells will be prepared each month. In addition, precipitation data (from an onsite weather station) and river and spring stage (from proposed river, spring, and USGS gauging stations) hydrographs will be prepared and compared to the monitoring well hydrographs. At the completion of the water level gauging program, a water budget for RFAAP will be prepared from the gauging data and weather data collected.

Well surveying. A thorough evaluation of the existing monitoring wells located in the HSA was completed in conjunction with Regional Groundwater Study data collection and review activities. Results of the evaluation indicated that 25 groundwater monitoring wells were void of survey-grade information required to accurately assess groundwater elevations and map monitoring well locations.

Table 1-15
Proposed Bedrock Monitoring Well Gauging Locations

Elements	31MW1	32MW1	B3(SWMU 26)	13MW2	54MW1	74MW7	39MW2 (Replaces B3(SWMU 26)	48MW2 (Replaces 13MW2)	48MW1 (Replaces 74MW7)
Top of screen	Top of bedrock	51 ft below top of bedrock	42 ft below top of bedrock	Top of bedrock	14 ft below top of bedrock	15 ft below top of bedrock	5 ft below top of bedrock	72 ft below top of bedrock	15 ft below top of bedrock
Well screen bottom depth (New River Stage is approximately 1676 ft msl)	1665.04 ft msl	1649.4 ft msl	1675.09 msl	1672.2 ft msl	1650.9 ft msl	1664.9 ft msl	1657.48 ft msl	1685.18 ft msl	1679.95 ft msl
Geographic Location	Northwest area of the HSA, 350 ft from the New River	Central portion of HSA, 1150 ft from the New River	Central portion of HSA, 600 ft from New River	Southeast corner of HSA, 270 ft from New River	Eastern portion of HSA, 570 ft from New River	Eastern portion of HSA, 1800 ft from New River	Central portion of HSA, 1050 ft from New River	Southeast corner of HSA, 450 ft from New River	Southeastern portion of HSA, 750 ft from New River
Boring Log Description	Well screened in weathered limestone	Flowing water encountered at 77 ft bgs, screen set from 72-87 ft bgs	Insufficient geologic description in boring log	Insufficient geologic description in boring log	Insufficient geologic description in boring log	Screen set in slightly weathered to weathered dolomite, no fractures noted	Insufficient geologic description in boring log	Screen set in alternating hard and soft, weathered dolomite	Screen set in weathered, soft dolomite
Well Location	Near a major fault or fracture trace	Near a major photolineament	Near a fault and photolineament	No known geologic features near well.	No known geologic features near well.	Near the junction of two photolineaments	No known geologic features near well.	No known geologic features near well.	No known geologic features near well.

Table 1-16
Proposed Alluvial Monitoring Well Gauging Locations

Elements	31MW2	31MW3	WC1-B (SWMU 16)	51MW1	74MW3	74MW6
Bottom of screen	Top of rock	Top or rock	Top of rock	Top of rock	Top of rock	Top of rock
Well screen bottom depth (New River Stage is approximately 1676 ft msl)	1670.55 ft msl, 28 ft bgs	1668.22 ft msl, 30 ft bgs	1739.95 ft msl, 73 ft bgs	1788.13 ft msl, 35 ft bgs	1700.40 ft msl, 31 ft bgs	1702.40 ft msl, 31 ft bgs
Geographic Location	Northwest area of HSA, 70 ft from New River	Northwest area of HSA, 50 ft from New River	Southeast area of HSA, 1500 ft from New River	Southeast area of HSA, 1100 ft from New River	Eastern portion of HSA, 1550 ft from New River	Eastern portion of HSA, 1800 ft from New River
Boring Log Description of Screened Interval	Sand and silt, some clay, limestone pebbles	Silt, some sand, little clay, gravel, limestone pebbles	Silt, medium stiff, trace m-f sand: residuum. Bottom foot in highly fractured dolomite with calcite healed joints	Insufficient geologic description in boring log (1 ft into bedrock)	Silty sand with limestone fragments and quartz cobbles. Bottom foot in weathered ls/ds, some calcite infilling	Silty sand with gravel, c sand, qtz cobbles, "riverjack." Bottom foot in weathered ls/ds, fractured, some calcite infilling
Well Location	Near a major fault or fracture trace	Near a major fault or fracture trace	Near a fault and photolineament	Near a photolineament	Near a photolineament	Near a fault
Well Sampled by ATK?	No	No	Yes	No	Yes	Yes

A surveying contractor will be obtained to provide survey-grade information for the groundwater monitoring wells presented in **Table 1–17**. Monitoring well survey coordinates will be recorded in the U.S. State Plane (Virginia South) Coordinate System (measured in U.S. survey feet) using the North American Datum of 1927. Elevations of the ground surface and the top of the PVC casing will be measured within 0.01 ft using the National Geodetic Vertical Datum (NGVD) of 1929. Location coordinates and elevations will be used to refine the data collection and review phase of the Regional Groundwater Study decision making process.

1.4 MATERIAL HANDLING AND DISPOSAL

Activities conducted during this investigation will comply with the relevant Occupational Safety and Health Administration (OSHA) and USEPA regulations regarding the identification, handling, and disposal of nonhazardous investigative-derived material (IDM) and hazardous materials. In addition, activities will be performed in accordance with Installation safety rules, protocols, and MWP SOP 70.1. Material disposal will be documented in the field logbook. Specific compliance issues that may be confronted during investigative activities include:

- Material Characterization—Materials will be sampled prior to disposal to assess waste characteristics, in accordance with 40 Code of Federal Regulations (CFR) 264 and Virginia Hazardous Waste Management Regulations. Material characterization analyses will be performed by a USACE-approved laboratory using USEPA-approved SW-846 Methods (USEPA, 1996). **Table 1-18** gives the suspected nature (hazardous vs. nonhazardous) of the materials that are expected to be produced during investigation activities.
- Handling and disposal of nonhazardous materials—Following analysis, solid nonhazardous materials will be segregated by material and disposed offsite. Aqueous nonhazardous material will be disposed of at the RFAAP wastewater treatment facility.
- Handling and disposal of hazardous materials—Hazardous materials are not expected to be encountered during this investigation.
- Handling and disposal of hazardous waste—Hazardous waste is not expected to be encountered during investigation activities.

Table 1-17
Horseshoe Area Monitoring Wells Requiring Survey Information

Site ID	Well ID	Date Installed	Survey Data Required
HWMU 16	16-5	10/23/85	Coordinates and Elevation
	CDH2	NA	Coordinates
SWMU 26	B1	08/05/80	Coordinates and Elevation
	B1R	08/15/80	Coordinates and Elevation
	B2	08/06/80	Coordinates and Elevation
	B3	08/05/80	Coordinates and Elevation
	B4	08/04/80	Coordinates and Elevation
	BDH2	NA	Coordinates and Elevation
	BDH3	NA	Coordinates and Elevation
SWMU 29	FAL2	10/18/84	Coordinates and Elevation
	FAL3	10/19/84	Coordinates and Elevation
	WELL7	NA	Coordinates and Elevation
	WELL8	NA	Coordinates and Elevation
	WELL9	NA	Coordinates and Elevation
SWMU 39	39MW4	09/25/97	Coordinates and Elevation
	39MW5	09/25/97	Coordinates and Elevation
	39MW6	09/25/97	Coordinates and Elevation
SWMU 54	54MW1A	09/17/91	Coordinates and Elevation
	54MW4	12/03/97	Coordinates and Elevation
SWMU 74	74MW2	02/25/93	Coordinates
	74MW3	02/23/93	Coordinates
	74MW4	02/20/93	Coordinates
	74MW5	02/22/93	Coordinates
	74MW6	02/24/93	Coordinates
	74MW7	02/25/93	Coordinates

NA = not available.

Miscellaneous IDM—Miscellaneous IDM will include decontamination sludge and used PPE. IDM will be disposed of in accordance with federal, state, and Installation requirements.

- Accumulation and storage—IDM will not be stored at RFAAP for greater than 90 days. Containerized material will be stored in an Alliant Techsystems, Inc. (ATK) -approved area.
- General disposal—Analytical results, including analytical methods and detection limits, will generally be submitted to ATK seven (7) working days prior to submitting a material profile for approval unless directed otherwise. The material profile will be submitted to ATK ten (10) working days prior to material disposal. ATK will be contacted again seven (7) working days prior to material disposal.
- Transporter, storage, and disposal facility (TSDF)—A list of TSDFs previously used for RFAAP disposal activities will be obtained from ATK at the beginning of the project. Previously used TSDFs will have priority over TSDFs that have no work history with the Installation. A copy of the proposed TSDF's most recent state or federal inspection will be provided to ATK upon selection for Installation approval. In the event ATK finds that the proposed TSDF is unsuitable, a new TSDF will be selected for approval.
- Manifest—A hazardous waste manifest will be prepared as requested. In the event that the IDM is a hazardous waste, 9VAC20-60-370 will be complied with. ATK will provide an authorized signature before shipment.

1.4.1 Nonhazardous Materials

Specific information on nonhazardous materials that are expected to be encountered at the site, including description, estimated quantity, and final disposition, are presented in **Table 1-18.** Handling and disposal of nonhazardous materials associated with investigation activities include the following:

- Soil cuttings from sludge/soil borings at SWMU 31.
- Purge water produced during monitoring well sampling at SWMU 31.
- Decontamination sludge, containing water and sludge collected during investigation activities.
- Miscellaneous PPE items (e.g., Tyvek, nitrile/latex gloves, booties, etc.).

1.4.2 Hazardous Materials

Hazardous materials are not expected to be encountered during this investigation.

1.5 SAMPLING PROGRAM DESIGN

The primary objective of the sampling program is to collect samples representative of existing site conditions. **Table 1–19** presents a comparison of existing sampling strategies that were evaluated for potential use during this investigation. Investigation objectives will be accomplished through the use of non-statistical sampling strategies, including biased and judgmental sampling.

Biased sampling will be used to evaluate potentially known sources of contamination. Sampling locations will be selected based on existing information for surface water, sediment, and background dioxin sampling at SWMU 31–Coal Ash Settling Lagoons. Judgmental sampling involves subjective selection of sampling locations that appear to be representative of average conditions. Judgmental sampling will generally bias the data obtained toward higher contaminant concentrations because samples will be collected from areas of suspected contamination. This sampling strategy will be used to position sample locations.

1.5.1 Sample Location Position Information

Sample location coordinates will be obtained using a Trimble Pathfinder Pro XRS Global Positioning System (GPS). The Pathfinder Pro XRS system is capable of obtaining real-time position information with submeter accuracy. Horizontal position information will be recorded in the U.S. State Plane Coordinate System (measured in U.S. survey feet) using the North American Datum 1927. Elevations will be measured using the NGVD of 1929.

1.5.2 Required Materials and Equipment

Table 1-20 lists materials and equipment required to complete project activities, including calibration and maintenance schedules.

Table 1-18
Handling and Disposal of Nonhazardous Materials

Area	Material	Description	Quantity	Concern	Action	Expected Nature of Material
SWMU 31	Sediment cuttings	From 8 borings	Approx. 2 55-gal drum	COCs	Collect IDM samples for TCLP metals	Nonhazardous. Concentrations in sediment are not expected to exceed TCLP limits.
	Purge water	From 4 wells	Approx. 2 55-gal drums	COCs	Collect IDM samples for TCLP metals, COD, and pH	Nonhazardous. Concentrations in groundwater are not expected to exceed TCLP, COD, or pH limits.
	Soil cuttings	From 1 boring	Approx. 1 55-gal drums	COCs	Collect IDM sample for TCLP metals	Nonhazardous. Concentrations in soil are not expected to exceed TCLP limits.
Miscellaneous	Decontamination water	Aqueous IDM	Approx. 3 55-gal Drums	IDM	Collect IDM samples for TCLP metals, COD, and pH	Nonhazardous. Concentrations are not expected to exceed TCLP, COD, or pH limits.
	PPE	Miscellaneous IDM	Approx. 3 55-gal drums	IDM	None	Nonhazardous material. Will be disposed as IDM.

Table 1-19
Sampling Strategies

SAMPLING STRATEGY	DESCRIPTION	APPLICATION	LIMITATIONS
Classic Statistical Sampling Strategies			
Simple Random Sampling	Representative sampling locations are chosen using the theory of random chance probabilities.	Sites where background information is not available and no visible signs of contamination is present.	May not be cost-effective because samples may be located too close together. Does not take into account spatial variability of media.
Stratified Random Sampling	Site is divided into several sampling areas (strata) based on background or site survey information.	Large sites characterized by a number of soil types, topographic features, past/present uses, or manufacturing storage areas.	Often more cost-effective than random sampling. More difficult to implement in the field and analyze results. Does not take into account spatial variability of media.
Systematic Grid Sampling	Most common statistical strategy; involves collecting samples at predetermined , regular intervals within a grid pattern.	Best strategy for minimizing bias and providing complete site coverage. Can be used effectively at sites where no background information exists. Ensures that samples will not be taken too close together.	Does not take into account spatial variability of media.
Hot-Spot Sampling	Systematic grid sampling strategy tailored to search for hot spots.	Sites where background information or site survey data indicate that hot spots may exist.	Does not take into account spatial variability of media. Tradeoffs between number of samples, chance of missing a hot spot, and hot spot size/shape must be weighed carefully.
Geostatistical Approach	Representative sampling locations are chosen based on spatial variability of media. Resulting data are analyzed using kriging, which creates contour maps of the contaminant concentrations and the precision of concentration estimates.	More appropriate than other statistical sampling strategies because it takes into account spatial variability of media. Especially applicable to sites where presence of contamination is unknown.	Previous investigation data must be available and such data must be shown to have a spatial relationship.
Non-Statistical Sampling Strategies			
Biased Sampling	Sampling locations are chosen based on available information.	Sites with known contamination sources.	Contaminated areas can be overlooked if they are not indicated by background information or visual signs of contamination. Best-used if combined with a statistical approach, depending on the project objectives.
Judgmental Sampling	An individual subjectively selects sampling locations that appear to be representative of average conditions.	Homogenous, well-defined sites.	Not usually recommended due to bias imposed by individual, especially for final investigations.

Table 1-20
Equipment List and Maintenance Schedules

Materials and Equipment	Calibration and Maintenance Schedules
Provided by Subcontractors	
Geoprobe	Decontamination before/after each use Maintenance before coming to site, as needed onsite
Vibracore	Maintenance before coming to site, as needed onsite
Acetate liners	Dedicated items
Steam cleaning apparatus	Maintenance before coming to site, as needed onsite
IDM Drums	Replace as needed
Lab materials	Dedicated items
Pre-labeled sample jars	Certified pre-cleaned
Bubble wrap	Dedicated item
Preservatives	Dedicated items
Provided by IT Corporation	
Soil/sediment sampling equipment	
bowls, trowels	Decontamination before/after each use
Water quality equipment	
Hydrolab or equivalent	Daily calibration
Groundwater sampling equipment	
Grundfos submersible pumps	Decontamination before/after each use
Tygon tubing	Decontamination before/after each use
Bailers, rope	Disposed of after each use
Decontamination equipment	
Liquinox	Replace as needed
Brushes	Replace as needed
Buckets	Replace as needed
Water	Replace as needed
PPE	
Tyvek	Disposed of after each use
Gloves	Disposed of after each use
Rubber booties	Disposed of after each use
Air monitoring equipment	
PID	Daily calibration

2.0 Quality Assurance Plan Addendum

2.1 OBJECTIVE AND SCOPE

This QAPA establishes function-specific responsibilities and authorities for ensured data quality for investigative activities at RFAAP. Specific QC requirements include DQOs, internal QC checks, and analytical procedures during the investigations at SWMU 31 and the HSA. This QAPA is designed to be used in conjunction with the Master Quality Assurance Plan (MQAP). **Table 2-1** provides a list of general quality assurance (QA) measures that will be implemented as specified in the MQAP.

Table 2-1
Quality Assurance Measures Discussed in the MWP

Quality Assurance Measure	Section in MQAP (Volume II)	SOP No. (MWP Appendix A)
Project Organization and Responsibilities	2.0	—
Lines of Authority	2.2	—
Chemical Data Measurements	3.2	—
Levels of Concern (LOC)	3.3	—
Documentation Requirements	5.6	10.1, 10.2, 10.3, 10.4, 50.2
Chain-of-Custody	5.7	10.4, 50.2
Calibration Procedures	7.0	40.1, 90.1
Data Reduction, Validation, Reporting, and Management	9.0	60.1
Corrective Action	10.0	—
Quality Assessments	11.0	—

2.2 PROJECT ORGANIZATION

2.2.1 Contractor and Subcontractor Responsibilities

Contractor and subcontractor personnel responsibilities for implementing the technical, quality, and health and safety programs are described in Section 2.1 of the MQAP. **Figure 2-1** presents the identification and the organization of IT Corporation project management personnel. Statements of Qualification (SOQs) for IT Corporation personnel are provided in Appendix B. SOQs for subcontractor personnel will be included when subcontractors have been selected.

2.2.2 Key Points of Contact

The names and points of contact for IT Corporation personnel and subcontractors are provided in **Table 2-2.**

2.3 DATA QUALITY OBJECTIVES

Quality assurance is defined as the overall system of activities for assuring the reliability of data produced. The system integrates the quality planning, assessment, and corrective actions of various groups in the organization to provide the independent QA program necessary to establish and maintain an effective system for collection and analysis of environmental samples and related activities. The program encompasses the generation of complete data with its subsequent review, validation, and documentation.

The overall QA objective is to develop and implement procedures for sample and data collection, evaluation, and reporting that will allow reviewers to assess whether the field and laboratory procedures meet the criteria and endpoints established in the DQOs. DQOs are qualitative and quantitative statements that outline the decison making process and specify the data required to support risk management decisions. DQOs specify the level of uncertainty that will be accepted in results derived from environmental data. The DQO process used for developing RFAAP data quality criteria and performance specifications for decison making is consistent with the *Guidance For The Data Quality Objectives Process*, EPA QA/G-4, September 1994.

Figure 2-1
IT Corporation Organizational Chart

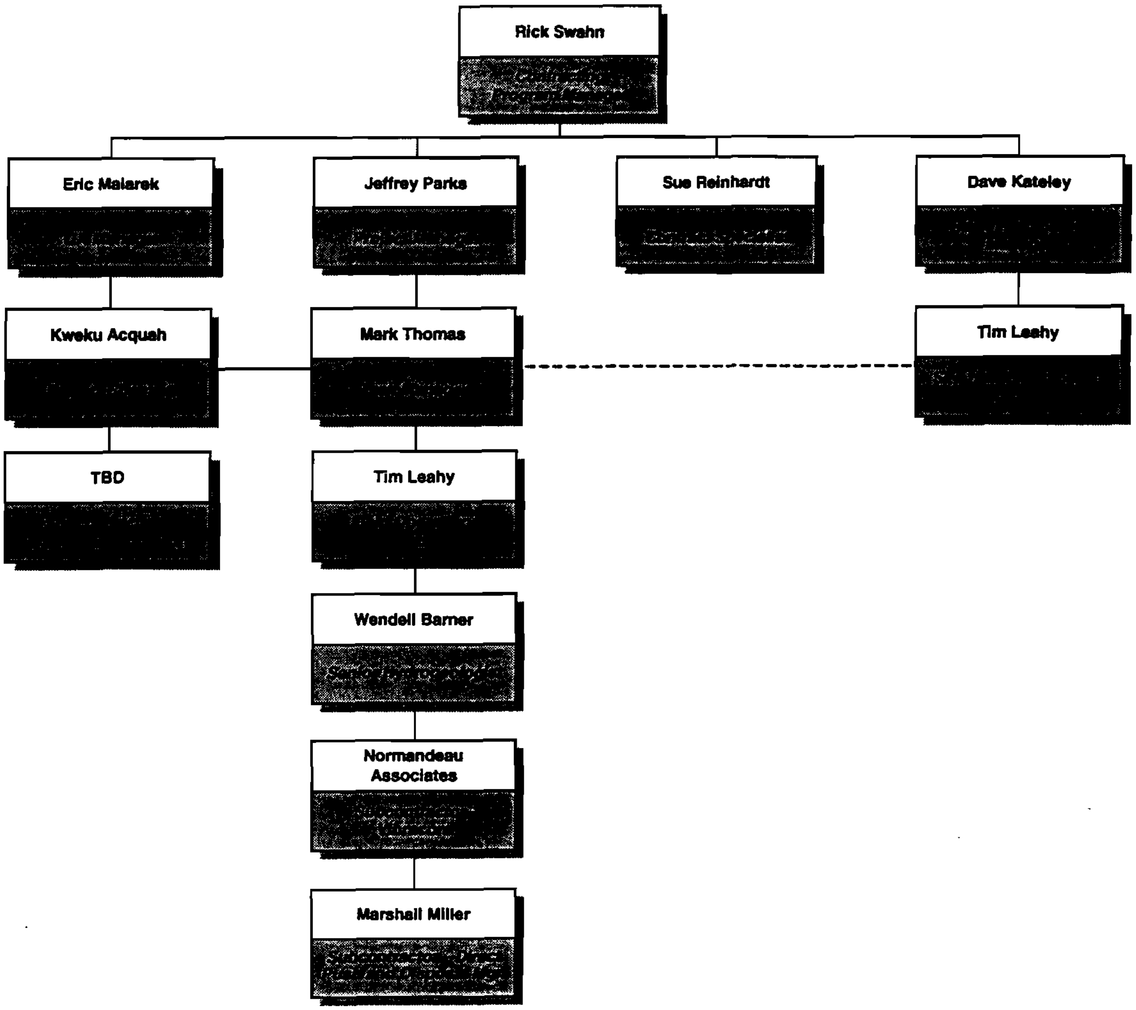

Table 2-2
Contractor and Subcontractor Key Points of Contact

Contractor	Key Point of Contact
Contracting Program Manager, Rick Swahn e-mail: RSwahn@theitgroup.com	IT Corporation 2113 Emmorton Park Rd Edgewood, MD 21040 Tel (410) 612-6356; Fax (410) 612-6351
Project Manager, Jeffrey Parks e-mail: JNParks@theitgroup.com	IT Corporation 2113 Emmorton Park Rd Edgewood, MD 21040 Tel (410) 612-6326; Fax (410) 612-6351
Project Contract Specialist, Susan Reinhardt e-mail: SReinhardt@theitgroup.com	IT Corporation 2113 Emmorton Park Rd Edgewood, MD 21040 Tel (410) 612-6366; Fax (410) 612-6351
Quality Assurance Manager, Eric Malarek e-mail: EMalarek@theitgroup.com	IT Corporation 2113 Emmorton Park Rd Edgewood, MD 21040 Tel (410) 612-6322; Fax (410) 612-6351
Health and Safety Manager, Dave Kateley e-mail: DKateley@theitgroup.com	IT Corporation 2113 Emmorton Park Rd Edgewood, MD 21040 Tel (410) 612-6313; Fax (410) 612-6351
Task Manager, Mark Thomas e-mail: MAThomas@theitgroup.com	IT Corporation 2113 Emmorton Park Rd Edgewood, MD 21040 Tel (410) 612-6375; Fax (410) 612-6351
Project Chemist, Kweku Acquah e-mail: KAcquah@theitgroup.com	IT Corporation 2113 Emmorton Park Rd Edgewood, MD 21040 Tel (410) 612-6335; Fax (410) 612-6351
Field Operations Leader/Site Health and Safety Officer, Tim Leahy e-mail: TLeahy@theitgroup.com	IT Corporation 2113 Emmorton Park Rd Edgewood, MD 21040 Tel (410) 612-6357; Fax (410) 612-6351
Senior Hydrogeologist, Wendell Barner e-mail: WBarner@theitgroup.com	IT Corporation 2790 Mosside Blvd. Monroeville, PA 15146-2792 Tel (412) 380-4094; Fax (412) 373-8968
Subcontractor	**Key Point of Contact**
Analytical Laboratory TBD	TBD
Direct Push and Disposal Management Marshall Miller	Chuck Cline Route 720, Industrial Park P.O. Box 848 Bluefield, VA 24605-0848 Tel (540) 322-5467; Fax (540) 322-1510
Vibracore Normandeau Associates	Rich Kling 3450 Schuylkill Rd. Spring City, PA 19475-1124 Tel (610) 948-4712; Fax (610) 948-4752

2.3.1 RFI DQOs

The RFI DQO process consists of the seven steps below. DQO elements common to investigative areas are included in italics following each process step. Site-specific DQOs are included in **Table 2-3**.

Table 2-3
Site-Specific RFI Data Quality Objectives

DQO Element	Investigation Area: SWMU 31	
Problem statement	Characterize the nature and extent of contamination	Characterize investigative-derived material
Decision inputs	TAL Metals TCL SVOCs TCL VOCs PAHs Explosives TCL Pesticides/PCBs Herbicides Perchlorate Dioxins/furans Hardness TOC TOX pH	TCLP Metals TCLP SVOCs COD (aqueous) pH (aqueous)
Study boundary	1. 600'L x 270'W 2. In-situ 3. NA	1. 600'L x 270'W 2. In-situ 3. NA

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

   (1) The planning team consists of the Installation, USACE, USEPA, ATK, VDEQ, and the IT Corporation.

   (2) The Army is the primary decision-maker.

   (3) Refer to Table 2-3.

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

   (1) Are existing conditions adverse to human health or the environment?

   (2) Resultant alternative actions include:

      (2a) Additional data is required

      (2b) There are no impacts to human health or the environment.

      (2c) Significant impacts to human health or the environment exist.

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

   (1) Refer to Table 2-3.

   (2) Samples will be analyzed using USEPA SW-846 methodology. Refer to Section 2.5.

   (3) Screening levels will include USEPA Region III RBCs.

   (4) Field sampling will be performed in accordance with the MWP (URS 2002). Analytical methods are contained in Section 2.5.

18

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

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

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

   *(1) Parameters of interest are listed in the decision inputs. Refer to **Table 2-3**.*

   (2) Screening levels will include USEPA Region III RBCs.

   (3) Decision rules will be developed as appropriate.

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

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

   (2) Decision errors include:

   (2a) Deciding that human health or environmental impacts exist when they do not and (II) deciding that human health or environmental impacts do not exist when they actually do. The consequences of deciding that human health or environmental impacts exist when they do not will result in unnecessary remedial actions. The consequences of deciding that human health or environmental impacts do not exist when they do will result in liabilities associated with future damages and environmental clean-up costs. Additionally, public opinion will be compromised.

   (2b) The true state when the most severe decision error occurs (human health or environmental impacts do not exist when they actually do) is that human health or environmental impacts do exist. The true state when the less severe decision error occurs (human health or environmental impacts exist when they do not) is that human health or environmental impacts do not exist.

   (2c) The null hypothesis (H_0) is: human health or environmental impacts do exist. The alternative hypothesis (Ha) is human health or environmental impacts do not exist.

   (2d) The false positive decision error occurs when H_0 is erroneously rejected corresponding to decision error I. The false negative decision error occurs when Ha is erroneously accepted corresponding to decision error II. Project-specific Type I and II error rates are 0.05 and 0.2, respectively.

   (3,4) The consequence of decision errors and acceptable probability will be assessed.

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

   (1) This addendum contains the proposed RFI sampling program. A phased focus approach has been adopted for site characterization to optimize resource utilization and minimize decision errors. DQO refinement will be an iterative process throughout the project life cycle.

   (2) Non-statistical sampling procedures are proposed. Biased and judgmental sampling will be performed to verify previous data results.

   (3) The mathematical equations will be established during the refinement process.

   (4) This addendum contains the proposed RFI sampling design program based on cost and project DQOs.

   (5) Refer to Section 1.5.

2.3.2 Regional Groundwater Study DQOs

The Regional Groundwater Study DQO process consists of the seven steps below. DQO elements common to investigative areas are included in italics following each process step. Site-specific DQOs are included in **Table 2-4**.

Table 2-4
Groundwater Study Data Quality Objectives

DQO Element	Investigation Area: Horseshoe Area	
Problem statement	Characterize the nature and extent of groundwater contamination at SWMUs, HWMUs, and the HSA	Characterize investigative-derived material
Decision inputs	Geologic conditions, fracture traces and photo-lineaments, modified aquifer testing, groundwater elevation surveying, river and well gauging, and water budget assessment	TCLP Metals COD (aqueous) pH (aqueous)
Study boundary	1. Various SWMUs, HWMUs, and HSA 2. In-situ	1. Various SWMUs, HWMUs, and HSA 2. In-situ

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

   (1) The planning team consists of the Installation, USACE, USEPA, ATK, VDEQ, and the IT Corporation.

   (2) The Army is the primary decision-maker.

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

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

   (1) Principal study questions include:

      (1a) What is the character of the groundwater gradient through identified monitoring points and geologic media, and what is the potential downgradient discharge boundary?

      (1b) Do concentrations of contaminants in groundwater exceed acceptable levels?

      (1c) Do existing monitoring points adequately intercept groundwater gradients and potential groundwater contamination?

   (2) Resultant alternative actions include:

      (2a) Additional data are required.

      (2b) There are no groundwater gradients to specific downgradient receptors.

      (2c) Groundwater gradients to specific downgradient receptors exist.

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

   (1) Identification of data that will be required to make the decision:

      (1a) Previous or existing investigations and results.

      (1b) Geologic data including photolineaments, fracture traces and structural geologic data.

      (1c) Water budget for RFAAP.

   (2) Information source determination:
      (2a) Previous investigations.
      (2b) Quarterly monitoring.
      (2c) Literature review.
      (2d) Professional judgment.
      (2e) River gauging and hydrographs.
      (2f) Aquifer testing.
      (2g) Monitoring well gauging.
      (2h) Well and river surveying.
   (3) Establish basis for Action Levels:
      (3a) Federal MCLs for groundwater quality monitoring.
      (3b) Accepted industry practices.
   (4) Identification of sampling and analysis methods that can meet data requirements:
      (4a) Field sampling will be performed in accordance with the MWP (URS 2002). Analytical methods are contained in Section 2.5.

4. **Define the Boundaries:** Define decision statement spatial and temporal boundaries. This step specifies (1) the spatial boundary, (2) population characteristics, applicable geographic areas and associated homogeneous characteristics, and (3) constraints on data collection.
   (1) Spatial boundary is the Horseshoe Area of RFAAP.
   (2) Geographic areas include various SWMUs and HWMUs.
   (3) Temporary contraints on collecting surface water data are high flow conditions in the New River.

5. **Develop a Decision Rule:** Define the (1) parameters of interest, (2) action levels, and (3) develop a decision rule.
   (1) Parameters of interest include water quality, elevation, and volumetric flow data.
   (2) Action levels for groundwater are MCLs.
   (3) Results of actions will be used to update current conditions and target additional studies if required and refine Conceptual Groundwater Model.

6. **Specify Acceptable Limits on Decision Errors:** Specify the decision-maker's tolerable limits on decision errors. This step of the process includes (1) parameter range of interest, (2) decision errors, (3) potential parameter values, and (4) the probability tolerance for decision errors are identified during this phase.
   (1) Parameter ranges are defined as detection limits for analytical results, professional judgment for other geologic and hydrologic data collected.
   (2) Decision errors include:
      (2a) Deciding incorrectly the direction of groundwater gradients and therefore misjudging the potential impact of contaminated groundwater flow to sites (incorrectly) identified as being downgradient or upgradient of impacted groundwater.
      (2b) The true state when the most severe decision error occurs (groundwater gradient impacts do not exist when they actually do) is that groundwater gradient impacts do exist. The true state when the less severe decision error occurs (groundwater gradient impacts exist when they do not) is that groundwater gradient impacts do not exist.
      (2c) The null hypothesis (H_0) is: groundwater gradient impacts do exist. The alternative hypothesis (Ha) is: groundwater gradient impacts do not exist.

(3,4) The consequence of decision errors and acceptable probability will be presented in a final report.

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

   (1) This addendum contains the proposed Regional Groundwater Study design program. A phased focus approach has been adopted for site characterization to optimize resource utilization and minimize decision errors. DQO refinement will be an iterative process throughout the project life cycle.

   (2) Identify potential monitoring points based on existing river, spring, and well survey data.

   (3) The mathematical equations will be established during the refinement process.

   (4) This addendum contains the proposed Regional Groundwater Study program based on cost and project DQOs.

   (5) Refer to Section 1.5.

2.4 SAMPLE MANAGEMENT

2.4.1 Number and Type

The estimated number and type of samples proposed during RFI sampling activities are included in **Table 2-5.**

Table 2-5
Estimated Number and Location of RFI Samples

Sample	SWMU 31
Groundwater	4
Surface water	3
Sediment	12
Surface soil	1
Subsurface soil	2
Total Environmental	**22**
Trip blank	2
Rinse blank	3
MS	3
MSD	3
Field duplicate	5
Total QC	**16**
Investigative-Derived Material (aqueous)	2
(solid)	2
Total IDM	**4**
Total Samples	**42**

2.4.2 Sample Containers, Preservation, and Holding Times

Parameter, container and preservation requirements, and holding times are presented in **Table 2-6** and should follow SOP 50.3 (Appendix A, MWP).

Table 2-6
Parameter, Container, Preservation Requirements, and Holding Times

Parameter	Sample Container*		Preservation Requirement	Holding Time
	Solid	Aqueous		
TCL VOCs	3 5-g EnCore sampler, zero headspace	3 40-mL vials with Teflon septum, zero headspace	Cool: 4 ± 2°C, HCl to pH<2 for aqueous, no addition of sodium bisulfate for solids	Aqueous: Analysis: 14 days Solid: Preparation: 2 days Analysis: 14 days
TCL SVOCs Explosives PAHs TCL Pesticides TCL PCBs Herbicides	8-oz wide-mouth glass with Teflon cap	2 1-L amber glass with Teflon-lined cap	Cool: 4 ± 2°C	Aqueous: Extraction: 7days Analysis: 40 days Solid: Extraction: 14 days Analysis: 40 days
TAL Metals Hardness	8-oz wide-mouth glass with Teflon cap	1-L polyethylene	Cool: 4 ± 2°C, HNO_3 to pH<2 for aqueous	Metals: 180 days Mercury: 28 days
TCLP Metals	8-oz wide-mouth glass with Teflon cap	1-L amber glass or polyethylene	Cool: 4 ± 2°C	TCLP Extraction: 180 days ICP Mercury: 28 days Sample Analysis: 180 days ICP Mercury: 28 days
TCLP SVOCs	8-oz wide-mouth glass with Teflon cap	2-L amber glass	Cool: 4 ± 2°C	Aqueous: TCLP Extraction: 7 days Extraction: 7 days Analysis: 40 days Solid: TCLP Extraction: 14 days Extraction: 7 days Analysis: 40 days
Perchlorate	NA	250-mL amber glass or polyethylene	Cool: 4 ± 2°C	28 days
Dioxins/furans	8-oz wide-mouth glass with Teflon cap	2 1-L amber glass with Teflon-lined cap	Cool: 4 ± 2°C	Aqueous: Extraction: 30 days Analysis: 45 days Solid: Extraction: 30 days Analysis: 45 days
Total Organic Carbon	4-oz wide-mouth glass with Teflon septum	2 40-mL vials with Teflon septum, zero headspace	Cool: 4 ± 2°C, HCl or H_2SO_4 to pH<2 for aqueous	28 days
Total Organic Halides	4-oz wide-mouth glass with Teflon cap	250-mL amber glass with Teflon septum	Cool: 4 ± 2°C, H_2SO_4 to pH<2 for aqueous	28 days
Chemical Oxygen Demand	NA	250-mL glass	Cool: 4 ± 2°C, HCl or H_2SO_4 to pH<2 for aqueous	28 days

*Like sample containers and preservatives may be combined per laboratory.
TCL=Target Compound List; TCLP=Toxicity Characteristics Leaching Procedures.

2.4.3 Sample Identification

The sample identification number will be in a similar manner with past nomenclature at RFAAP. The sample identification will consist of an alphanumeric designation related to the site location, media type, and sequential order according to the sampling event. The sample identification number should not exceed eight characters for subsequent entry into ERIS. Samples will be coded in the following order to ensure a unique identification.

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

  31 = SWMU 31

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

  DW = IDM
  MW = Monitoring Well
  SB = Soil Boring
  SE = Sediment
  SW = Surface Water

- **Sampling Location Number.** The next one or two characters will be the number of the sampling location (e.g., 1, 2, 3,..., 9, 10, 11, ...).
- **Sample Depth.** At sites where there are several samples to be collected at different depths, the sequential collection order will be followed by a letter in alphabetic order indicating shallow to deep depths (e.g., A, B, C,...), where A would be the shallow sample.
- **Duplicate.** Duplicate samples will be identified with a "D" designation. A record of the samples that correspond to the duplicates will be kept in the field logbook.

Sample Identification Examples:

1. A surface water sample collected at SWMU 31 at sample location 10 would be identified as 31SW10. The field duplicate for the same sample would be 31SW10D.
2. The first shallow soil sample at location 5 at SWMU 31 collected at a point would be identified as 31SB1A. The field duplicate for the same sample would be 31SB1AD.
3. The second soil sample depth collected at soil boring location 5 (with two depths) at SWMU 31 would be identified as 31SB1B. The duplicate for the same sample would be 31SB1BD.
4. A groundwater sample collected at SWMU 31 from monitoring well 31MW2 would be identified as 31MW2-3. The field duplicate for the same sample would be 31MW2-3D.

- **Quality Control Samples:** QC samples will be identified by date (mo,day,yr), followed by QC sample type, and sequential order number at one digit. The QC sample types include:

  R = Rinse Blank
  T = Trip Blank

For example, the second rinse blank collected on 7 April 2002, would be identified as 040702R2.

2.5 ANALYTICAL PROCEDURES

2.5.1 Laboratory Procedures for Chemical Analyses

A USACE-approved laboratory will perform RFI analytical activities. Analytical compound lists and reporting limits to be used are given in **Table 2-7**. They will be in accordance with USEPA approved methods for the analysis of TAL metals, TCLP metals, TCLP SVOCs, TCL VOCs, TCL SVOCs, explosives, PAHs, TCL pesticides/PCBs, herbicides, perchlorate, dioxins/furans, pH, hardness, Chemical Oxygen Demand (COD), TOC, and TOX. The following sections briefly describe the analytical methodologies to be used in the RFAAP site investigation.

Table 2-7
Analyte List

Parameter	Effect	Quantitation Limits		Drinking Water MCLs (µg/L)	Tap Water RBCs (µg/L)	Region III Soil Risk Based Concentration September 2001		SSL Transfers Soil to Groundwater (DAF 20) (mg/kg)	Region III BTAG Screening Levels			USEPA Water Quality Criteria (µg/L)				Background
		Aqueous (µg/L)	Soil (mg/kg)			Residential (mg/kg)	Industrial (mg/kg)		Aqueous (µg/L)	Soil (mg/kg)	Sediment (mg/kg)	Freshwater		Human Health Risk for Consumption of:		Soil (mg/kg)
												Acute	Chronic	Water & Organisms	Organisms Only	
Metals																
Aluminum	N	200	40	50	3,700	7,800	200,000	NA	25	1	NA	750	87	NA	NA	40,041
Antimony	N	60	12	6	1.5	3.1	82	13	30	0.48	150	NA	NA	14	4,300	NA
Arsenic	C	10	2	10	0.04	0.43	3.8	0.026	48	328	8.2	340	150	0.018	0.14	15.8
Barium	N	200	40	2,000	260	550	14,000	2,100	10,000	440	NA	NA	NA	1,000	NA	209
Beryllium	N	5	1	4	7.3	16	410	1,200	5.3	0.02	NA	NA	NA	NA	NA	1.02
Cadmium	N	5	1	5	1.8	3.9	100	27	0.53	3	1.2	4.3	2.2	NA	NA	0.69
Calcium	NA	5,000	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	N	10	2	100	11	23	610	42	2	0.02	81	16	11	NA	NA	65.3
Cobalt	N	50	10	NA	73	160	4,100	NA	35,000	0.1	NA	NA	NA	NA	NA	72.3
Copper	N	25	5	1,000	150	310	8,200	11,000	6.5	15	34	13	9	1,300	NA	53.5
Iron	N	100	20	300	2,200	4,700	120,000	NA	320	3,260	NA	NA	1,000	300	NA	50,962
Lead	NA	3	0.6	15	NA	400	750	400	3.2	2	46.7	65	2.5	NA	NA	26.8
Magnesium	NA	5,000	1,000	NA	NA	NA	NA	NA	NA	4,400	NA	NA	NA	NA	NA	NA
Manganese	N	15	3	50	73	160	4,100	950	14,500	330	NA	NA	NA	50	100	2,543
Mercury	N	0.2	0.1	2	NA	2.3	61	NA	0.012	0.058	0.15	1.4	0.77	0.05	0.051	0.13
Nickel	N	40	8	NA	73	160	4,100	NA	160	2	20.9	470	52	610	4,600	62.8
Potassium	NA	5,000	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	N	5	1	50	18	39	1,000	19	5	1.8	NA	NA	5	170	11,000	NA
Silver	N	10	2	100	18	39	1,000	31	0.0001	0.0000098	1	3.4	NA	NA	NA	NA
Sodium	NA	5,000	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	N	10	2	2	0.26	0.55	14	3.6	40	0.001	NA	NA	NA	1.7	6.3	2.11
Vanadium	N	50	10	NA	26	55	1,400	5,100	10,000	0.5	NA	NA	NA	NA	NA	108
Zinc	N	20	4	5,000	1,100	2,300	61,000	14,000	30	10	150	120	120	9,100	69,000	202

Table 2–7
Analyte List (Continued)

Parameter	Effect	Quantitation Limits		Drinking Water MCLs (µg/L)	Tap Water RBCs (µg/L)	Region III Soil Risk Based Concentration September 2001		SSL Transfers Soil to Groundwater (DAF 20) (mg/kg)	Region III BTAG Screening Levels			USEPA Water Quality Criteria (µg/L)			
		Aqueous (µg/L)	Soil (mg/kg)			Residential (mg/kg)	Industrial (mg/kg)		Aqueous (µg/L)	Soil (mg/kg)	Sediment (mg/kg)	Freshwater		Human Health Risk for Consumption of:	
												Acute	Chronic	Water & Organisms	Organisms Only
Inorganic															
Cyanide	N	10	0.4	200	73	160	4,100	150	5.2	0.005	NA	22	5.2	700	220,000
Perchlorate	NA	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
pH	NA	±0.1	±0.1	6.5-8.5	NA	NA	NA	NA	NA	NA	NA	NA	6.5-9	5-9	NA
Organic															
Total Organic Carbon	NA	1,000	1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Organic Halides	NA	5	1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Explosives															
Cyclotrimethylene-trinitramine (RDX)	C	0.5	0.2	NA	0.61	5.8	52	NA	NA	NA	NA	NA	NA	NA	NA
Cyclotetramethylene-tetranitramine (HMX)	N	0.5	2.1	NA	180	390	10,000	NA	NA	NA	NA	NA	NA	NA	NA
1,3-Dinitrobenzene	N	0.5	0.2	NA	0.37	0.78	20	0.037	1,200	NA	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	N	0.5	0.2	NA	7.3	16	410	0.57	230	NA	NA	NA	NA	0.11	9.1
2,6-Dinitrotoluene	N	0.5	0.2	NA	3.7	7.8	200	0.25	230	NA	NA	NA	NA	NA	NA
Dinitrotoluene Mix	C	0.5	0.2	NA	0.09	0.94	8.4	NA	230	NA	NA	NA	NA	NA	NA
TETRYL	N	0.5	0.2	NA	37	78	2,000	NA	NA	NA	NA	NA	NA	NA	NA
Nitrobenzene	N	0.5	0.2	NA	0.35	3.9	100	0.023	27,000	NA	NA	NA	NA	17	1,900
Nitroglycerin	C	2.5	1.1	NA	4.8	0.3	2.7	NA	NA	NA	NA	NA	NA	NA	NA
1,3,5-Trinitrobenzene	N	0.5	0.2	NA	110	230	6,100	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trinitrotoluene	C	0.5	0.2	NA	2.2	21	190	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitrotoluene	C	0.5	0.2	NA	6.1	78	2,000	NA	NA	NA	NA	NA	NA	NA	NA
3-Nitrotoluene	C	0.5	0.2	NA	12	160	4,100	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitrotoluene	C	0.5	0.2	NA	6.1	78	2,000	NA	NA	NA	NA	NA	NA	NA	NA
4-Amino-2,6-dinitrotoluene	C	0.5	0.2	NA	0.22	0.47	12	NA	NA	NA	NA	NA	NA	NA	NA
2-Amino-4,6-dinitrotoluene	C	0.5	0.2	NA	0.22	0.47	12	NA	NA	NA	NA	NA	NA	NA	NA

Table 2-7
Analyte List (Continued)

Parameter	Effect	Quantitation Limits		Drinking Water MCLs (µg/L)	Tap Water RBCs (µg/L)	Region III Soil Risk Based Concentration September 2001		SSL Transfers Soil to Groundwater (DAF 20) (mg/kg)	Region III BTAG Screening Levels			USEPA Water Quality Criteria (µg/L)			
		Aqueous (µg/L)	Soil (mg/kg)			Residential (mg/kg)	Industrial (mg/kg)		Aqueous (µg/L)	Soil (mg/kg)	Sediment (mg/kg)	Freshwater		Human Health Risk for Consumption of:	
												Acute	Chronic	Water & Organisms	Organisms Only
SVOCs															
1,2-Dichlorobenzene	N	10	0.33	600	27	700	18,000	0.46	763	0.1	0.035	NA	NA	2,700	17,000
1,2,3-Trichlorobenzene	NA	10	0.33	NA	NA	NA	NA	NA	50	0.1	0.040	NA	NA	NA	NA
1,2,4-Trichlorobenzene	N	10	0.33	70	19	78	2,000	7.5	50	0.1	0.040	NA	NA	260	940
1,3-Dichlorobenzene	N	10	0.33	NA	18	230	6,100	0.087	763	NA	NA	NA	NA	400	2,600
1,4-Dichlorobenzene	C	10	0.33	75	0.47	27	240	0.0071	763	0.1	0.11	NA	NA	400	2,600
2-Chloronaphthalene	N	10	0.33	NA	49	630	16,000	32	NA	NA	NA	NA	NA	1,700	4,300
2-Chlorophenol	N	10	0.33	NA	3	39	1,000	NA	970	0.1	NA	NA	NA	120	400
2-Methylnaphthalene	N	10	0.33	NA	12	160	4,100	22	NA	NA	0.07	NA	NA	NA	NA
2-Methylphenol	N	10	0.33	NA	180	390	10,000	NA	NA	0.1	0.063	NA	NA	NA	NA
2-Nitroaniline	NA	50	1.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitrophenol	NA	10	0.33	NA	NA	NA	NA	NA	150	0.1	NA	NA	NA	NA	NA
2,4-Dichlorophenol	N	50	1.6	NA	11	23	610	1.2	365	0.1	NA	NA	NA	93	790
2,4-Dimethylphenol	N	10	0.33	NA	73	160	4,100	6.7	2,120	0.1	0.029	NA	NA	540	2,300
2,4-Dinitrophenol	N	10	0.33	NA	7.3	16	410	NA	150	0.1	NA	NA	NA	70	14,000
2,4-Dinitrotoluene	N	10	0.33	NA	7.3	16	410	0.57	230	NA	NA	NA	NA	0.11	9.1
2,4,5-Trichlorophenol	N	10	0.33	NA	370	780	20,000	NA	63	0.1	NA	NA	NA	2,600	9,800
2,4,6-Trichlorophenol	C	10	0.33	NA	6.1	58	520	NA	970	0.1	NA	NA	NA	2.1	6.5
1,2,4-Trimethylbenzene	N	10	0.33	NA	1.2	390	10,000	NA	NA	NA	NA	NA	NA	NA	NA
1,3,5-Trimethylbenzene	N	10	0.33	NA	1.2	390	10,000	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	N	10	0.33	NA	3.7	7.8	200	0.25	230	NA	NA	NA	NA	NA	NA
3-Nitroaniline	NA	50	1.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3,3'-Dichlorobenzidine	C	20	0.65	NA	0.15	1.4	13	0.0049	NA	NA	NA	NA	NA	0.04	0.077
4-Bromophenylphenylether	NA	10	0.33	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloro-3-methylphenol	NA	20	0.65	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 2–7
Analyte List (Continued)

Parameter	Effect	Quantitation Limits		Drinking Water MCLs (µg/L)	Tap Water RBCs (µg/L)	Region III Soil Risk Based Concentration September 2001		SSL Transfers Soil to Groundwater (DAF 20) (mg/kg)	Region III BTAG Screening Levels			USEPA Water Quality Criteria (µg/L)			
		Aqueous (µg/L)	Soil (mg/kg)			Residential (mg/kg)	Industrial (mg/kg)		Aqueous (µg/L)	Soil (mg/kg)	Sediment (mg/kg)	Freshwater		Human Health Risk for Consumption of:	
												Acute	Chronic	Water & Organisms	Organisms Only
4-Chloroaniline	N	20	0.65	NA	15	31	820	0.97	NA	NA	NA	NA	NA	NA	NA
4-Chlorophenylphenylether	NA	10	0.33	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Isopropyltoluene	NA	10	0.33	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3+4-Methylphenol	N	10	0.33	NA	18	39	1,000	NA	NA	0.1	0.67	NA	NA	NA	NA
4-Nitroaniline	C	50	1.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitrophenol	N	50	1.6	NA	29	63	1,600	2	150	0.1	NA	NA	NA	NA	NA
4,6-Dinitro-2-methylphenol	N	50	1.6	1.6	0.37	0.78	20	NA	NA	NA	NA	NA	NA	13.4	765
Acenaphthylene	NA	10	0.33	NA	NA	NA	NA	NA	NA	0.1	0.044	NA	NA	NA	NA
Acenaphthene	N	10	0.33	NA	37	470	12,000	100	520	0.1	0.016	NA	NA	1,200	2,700
Anthracene	N	10	0.33	NA	180	2,300	61,000	470	0.1	0.1	0.853	NA	NA	9,600	110,000
Benz[*a*]anthracene	C	10	0.33	NA	0.092	0.87	7.8	1.5	6.3	0.1	0.261	NA	NA	0.0044	0.049
Benzo[*b*]fluoranthene	C	10	0.33	NA	0.092	0.87	7.8	4.5	NA	0.1	3.20	NA	NA	0.0044	0.049
Benzo[*a*]pyrene	C	10	0.33	0.2	0.0092	0.087	0.78	0.37	NA	0.1	0.430	NA	NA	0.0044	0.049
Benzo[*g,h,i*]pyrene	NA	10	0.33	NA	NA	NA	NA	NA	NA	0.1	0.670	NA	NA	NA	NA
Benzo[*k*]fluoranthene	C	10	0.33	NA	0.92	8.7	78	45	NA	0.1	NA	NA	NA	0.0044	0.049
Bis(2-chloroethoxy)methane	NA	10	0.33	NA	NA	NA	NA	NA	11,000	NA	NA	NA	NA	NA	NA
Bis(2-chloroethyl)ether	C	10	0.33	NA	0.0096	0.58	5.2	0.00004	NA	NA	NA	NA	NA	0.031	1.4
Bis(2-chloroisopropyl)ether; 2,2'-oxybis(1-chloropropane)	C	10	0.33	NA	0.26	9.1	82	0.0017	NA	NA	NA	NA	NA	1,400	170,000
Bis(2-ethylhexyl)phthalate	C	10	0.33	6	4.8	46	410	2,900	30	NA	1.30	NA	NA	1.8	5.9
Bromobenzene	NA	10	0.33	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
N-Butylbenzene	N	10	0.33	NA	24	310	8,200	NA	NA	NA	NA	NA	NA	NA	NA
sec-Butylbenzene	N	10	0.33	NA	24	310	8,200	NA	NA	NA	NA	NA	NA	NA	NA
tert-Butylbenzene	N	10	0.33	NA	24	310	8,200	NA	NA	NA	NA	NA	NA	NA	NA
Butylbenzylphthalate	N	10	0.33	NA	730	1,600	41,000	17,000	3	NA	0.063	NA	NA	3,000	5,200
Carbazole	C	10	0.33	NA	3.3	32	290	0.47	NA	NA	NA	NA	NA	NA	NA

Table 2–7
Analyte List (Continued)

Parameter	Effect	Quantitation Limits		Drinking Water MCLs (µg/L)	Tap Water RBCs (µg/L)	Region III Soil Risk Based Concentration September 2001		SSL Transfers Soil to Groundwater (DAF 20) (mg/kg)	Region III BTAG Screening Levels			USEPA Water Quality Criteria (µg/L)			
												Freshwater		Human Health Risk for Consumption of:	
		Aqueous (µg/L)	Soil (mg/kg)			Residential (mg/kg)	Industrial (mg/kg)		Aqueous (µg/L)	Soil (mg/kg)	Sediment (mg/kg)	Acute	Chronic	Water & Organisms	Organisms Only
Chrysene	C	10	0.33	NA	9.2	87	780	150	NA	0.1	0.384	NA	NA	0.0044	0.049
Di-*n*-butylphthalate	N	10	0.33	NA	370	780	20,000	5,000	0.3	NA	1.40	NA	NA	2,700	12,000
Di-*n*-octylphthalate	N	10	0.33	NA	7.3	160	4,100	2,400,000	0.3	NA	6.20	NA	NA	NA	NA
Dibenz[*a,h*]anthracene	C	10	0.33	NA	0.0092	0.087	0.78	1.4	NA	0.1	0.063	NA	NA	0.0044	0.049
Dibenzofuran	N	10	0.33	NA	2.4	31	820	8	NA	NA	NA	NA	NA	NA	NA
Diethylphthalate	N	10	0.33	NA	2,900	6,300	160,000	450	3	NA	0.20	NA	NA	23,000	120,000
Dimethylphthalate	N	10	0.33	NA	37,000	78,000	2,000,000	NA	3	NA	0.07	NA	NA	313,000	2,900,000
Fluoranthene	N	10	0.33	NA	150	310	8,200	6,300	3,980	0.1	0.600	NA	NA	300	370
Fluorene	N	10	0.33	NA	24	310	8,200	140	430	0.1	0.019	NA	NA	1,300	14,000
Hexachlorobenzene	C	10	0.33	1	0.042	0.4	3.6	0.052	3.68	NA	0.022	NA	NA	0.00075	0.00077
Hexachlorobutadiene	C	10	0.33	NA	0.86	8.2	73	1.8	9.3	NA	0.011	NA	NA	0.44	50
Hexachlorocyclopentadiene	N	10	0.33	50	22	47	1,200	180	5.2	NA	NA	NA	NA	240	17,000
Hexachloroethane	C	10	0.33	NA	4.8	46	410	0.36	540	NA	NA	NA	NA	1.9	8.9
Indeno[1,2,3-*cd*]pyrene	C	10	0.33	NA	0.092	0.87	7.8	13	NA	0.1	0.600	NA	NA	0.0044	0.049
Isophorone	C	10	0.33	NA	70	670	6,000	0.41	117,000	NA	NA	NA	NA	36	2,600
Isopropylbenzene	NA	10	0.33	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosodi-*n*-propylamine	C	10	0.33	NA	0.0096	0.091	0.82	0.000047	NA	NA	NA	NA	NA	0.005	1.4
N-Nitrosodiphenylamine	C	10	0.33	NA	14	130	1,200	0.76	5,850	NA	0.028	NA	NA	5	16
N-Propylbenzene	N	10	0.33	NA	24	310	8,200	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	N	10	0.33	NA	0.65	160	4,100	0.15	100	0.1	0.160	NA	NA	NA	NA
Nitrobenzene	N	10	0.33	NA	0.35	3.9	100	0.023	27,000	NA	NA	NA	NA	17	1,900
Pentachlorophenol	C	50	1.6	1	0.56	5.3	48	NA	13	0.1	0.36	19	15	0.28	8.2
Phenanthrene	NA	10	0.33	NA	NA	NA	NA	NA	6.3	0.1	0.240	NA	NA	NA	NA
Phenol	N	10	0.33	NA	2,200	4,700	120,000	130	79	0.1	0.42	NA	NA	21,000	4,600,000
Pyrene	N	10	0.33	NA	18	230	6,100	680	NA	0.1	0.665	NA	NA	960	11,000

Table 2–7
Analyte List (Continued)

Parameter	Effect	Quantitation Limits		Drinking Water MCLs (µg/L)	Tap Water RBCs (µg/L)	Region III Soil Risk Based Concentration September 2001		SSL Transfers Soil to Groundwater (DAF 20) (mg/kg)	Region III BTAG Screening Levels			USEPA Water Quality Criteria (µg/L)			
		Aqueous (µg/L)	Soil (mg/kg)			Residential (mg/kg)	Industrial (mg/kg)		Aqueous (µg/L)	Soil (mg/kg)	Sediment (mg/kg)	Freshwater		Human Health Risk for Consumption of:	
												Acute	Chronic	Water & Organisms	Organisms Only
Dioxins/Furans															
2,3,7,8-TCDD	C	0.00001	0.000001	0.00003	0.00000045	0.0000043	0.000038	0.0000086	0.00001	0.010	NA	NA	NA	0.000000013	0.000000014
1,2,3,7,8-PeCDD	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,7,8-HxCDD	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,6,7,8-HxCDD	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,7,8,9-HxCDD	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,6,7,8-HpCDD	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OCDD	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,3,7,8-TCDF	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,7,8-PeCDF	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,3,4,7,8-PeCDF	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,7,8-HxCDF	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,6,7,8-HxCDF	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,3,4,6,7,8-HxCDF	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,7,8,9-HxCDF	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,6,7,8-HpCDF	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,7,8,9-HpCDF	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
OCDF	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total TCDD	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PeCDD	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total HxCDD	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total HpCDD	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total TCDF	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PeCDF	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total HxCDF	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total HpCDF	NA	0.00001	0.000001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 2–7
Analyte List (Continued)

Parameter	Effect	Quantitation Limits		Drinking Water MCLs (µg/L)	Tap Water RBCs (µg/L)	Region III Soil Risk Based Concentration September 2001		SSL Transfers Soil to Groundwater (DAF 20) (mg/kg)	Region III BTAG Screening Levels			USEPA Water Quality Criteria (µg/L)			
												Freshwater		Human Health Risk for Consumption of:	
		Aqueous (µg/L)	Soil (mg/kg)			Residential (mg/kg)	Industrial (mg/kg)		Aqueous (µg/L)	Soil (mg/kg)	Sediment (mg/kg)	Acute	Chronic	Water & Organisms	Organisms Only
PAHs															
Acenaphthylene	NA	1	0.033	NA	NA	NA	NA	NA	NA	0.1	0.044	NA	NA	NA	NA
Acenaphthene	N	0.1	0.017	NA	37	470	12,000	100	520	0.1	0.016	NA	NA	1,200	2,700
Anthracene	N	0.05	0.0017	NA	180	2,300	61,000	470	0.1	0.1	0.853	NA	NA	9,600	110,000
Benz[*a*]anthracene	C	0.05	0.0017	NA	0.092	0.87	7.8	1.5	6.3	0.1	0.261	NA	NA	0.0044	0.049
Benzo[*b*]fluoranthene	C	0.1	0.0033	NA	0.092	0.87	7.8	4.5	NA	0.1	3.20	NA	NA	0.0044	0.049
Benzo[*a*]pyrene	C	0.05	0.0017	0.2	0.0092	0.087	0.78	0.37	NA	0.1	0.430	NA	NA	0.0044	0.049
Benzo[*g,h,i*]pyrene	NA	0.01	0.0033	NA	NA	NA	NA	NA	NA	0.1	0.670	NA	NA	NA	NA
Benzo[*k*]fluoranthene	C	0.05	0.0017	NA	0.92	8.7	78	45	NA	0.1	NA	NA	NA	0.0044	0.049
Chrysene	C	0.05	0.0017	NA	9.2	87	780	150	NA	0.1	0.384	NA	NA	0.0044	0.049
Dibenz[*a,h*]anthracene	C	0.1	0.0033	NA	0.0092	0.087	0.78	1.4	NA	0.1	0.063	NA	NA	0.0044	0.049
Fluoranthene	N	0.1	0.0033	NA	150	310	8,200	6,300	3,980	0.1	0.600	NA	NA	300	370
Fluorene	N	0.01	0.0033	NA	24	310	8,200	140	430	0.1	0.019	NA	NA	1,300	14,000
Indeno[1,2,3-*cd*]pyrene	C	0.05	0.0017	NA	0.092	0.87	7.8	13	NA	0.1	0.600	NA	NA	0.0044	0.049
Naphthalene	N	0.1	0.017	NA	0.65	160	4,100	0.15	100	0.1	0.160	NA	NA	NA	NA
Phenanthrene	NA	0.05	0.0017	NA	NA	NA	NA	NA	6.3	0.1	0.240	NA	NA	NA	NA
Pyrene	N	0.05	0.0017	NA	18	230	6,100	680	NA	0.1	0.665	NA	NA	960	11,000
VOCs															
Acetone	N	5	0.005	NA	61	780	20,000	2.5	9,000,000	NA	NA	NA	NA	NA	NA
Acrolein	N	50	0.050	NA	0.0042	160	4,100	NA	21.0	NA	NA	NA	NA	320	780
Acrylonitrile	C	50	0.050	NA	0.037	1.2	11	NA	2600	NA	NA	NA	NA	0.059	0.66
Benzene	C	1	0.005	5	0.32	12	100	0.0018	5,300	0.1	NA	NA	NA	1.2	71
Bromochloromethane	NA	1	0.005	NA	NA	NA	NA	NA	11,000	3,000	NA	NA	NA	NA	NA
Bromodichloromethane	C	1	0.005	80	0.17	10	92	0.0011	11,000	450	NA	NA	NA	0.56	46
Bromoform	C	1	0.005	80	8.5	81	720	0.067	NA	NA	NA	NA	NA	4.3	360

Table 2–7
Analyte List (Continued)

Parameter	Effect	Quantitation Limits		Drinking Water MCLs (µg/L)	Tap Water RBCs (µg/L)	Region III Soil Risk Based Concentration September 2001		SSL Transfers Soil to Groundwater (DAF 20) (mg/kg)	Region III BTAG Screening Levels			USEPA Water Quality Criteria (µg/L)			
		Aqueous (µg/L)	Soil (mg/kg)			Residential (mg/kg)	Industrial (mg/kg)		Aqueous (µg/L)	Soil (mg/kg)	Sediment (mg/kg)	Freshwater		Human Health Risk for Consumption of:	
												Acute	Chronic	Water & Organisms	Organisms Only
Bromomethane	N	1	0.005	NA	0.85	11	290	0.041	NA	NA	NA	NA	NA	48	4,000
2-Butanone	N	5	0.005	NA	190	4,700	120,000	8	3,220,000	NA	NA	NA	NA	NA	NA
Carbon disulfide	N	5	0.005	NA	100	780	20,000	19	2	NA	NA	NA	NA	NA	NA
Carbon tetrachloride	C	1	0.005	5	0.16	4.9	44	0.0021	35,200	0.3	NA	NA	NA	0.25	4.4
Chlorobenzene	N	1	0.005	100	11	160	4,100	0.8	50	0.1	NA	NA	NA	680	21,000
Chloroethane	C	1	0.005	NA	3.6	220	2,000	0.019	NA	NA	NA	NA	NA	NA	NA
Chloroform	C	1	0.005	80	0.15	100	940	0.00089	1,240	0.3	NA	NA	NA	5.7	470
Chloromethane	C	1	0.005	NA	2.1	49	440	0.01	NA	NA	NA	NA	NA	NA	NA
2-Chlorotoluene	N	1	0.005	NA	1.2	160	4,100	NA	NA	NA	NA	NA	NA	NA	NA
4-Chlorotoluene	NA	1	0.005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Chloroethyl vinyl ether	NA	50	0.050	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromo-3-chloropropane	C	5	0.005	0.2	0.047	0.46	4.1	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	C	1	0.005	NA	0.00075	0.0075	0.067	NA	18,000	5	NA	NA	NA	NA	NA
Dibromomethane	N	1	0.005	NA	6.1	78	2,000	NA	11,000	NA	NA	NA	NA	NA	NA
Dichlorodifluoromethane	N	1	0.005	NA	35	1,600	41,000	NA	11,000	NA	NA	NA	NA	NA	NA
Dibromochloromethane	C	1	0.005	80	0.13	7.6	68	0.00083	11,000	NA	NA	NA	NA	0.41	34
1,1-Dichloroethane	N	1	0.005	NA	80	780	20,000	4.5	160,000	0.3	NA	NA	NA	NA	NA
1,2-Dichloroethane	C	1	0.005	5	0.12	7	63	0.001	20,000	870	NA	NA	NA	0.38	99
1,1-Dichloroethene	C	1	0.005	7	0.044	1.1	9.5	0.00036	11,600	NA	NA	NA	NA	0.057	3.2
cis-1,2-Dichloroethene	N	1	0.005	70	6.1	78	2,000	0.35	11,600	0.3	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	N	1	0.005	100	12	160	4,100	0.82	11,600	0.3	NA	NA	NA	700	140,000
1,2-Dichloropropane	C	1	0.005	5	0.16	9.4	84	0.0021	NA	NA	NA	NA	NA	0.52	39
1,3-Dichloropropane	NA	1	0.005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,2-Dichloropropane	NA	1	0.005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloropropene	NA	1	0.005	NA	NA	NA	NA	NA	244	0.3	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	C	1	0.005	NA	0.44	6.4	57	0.0031	244	0.3	NA	NA	NA	10	1,700

Table 2–7
Analyte List (Continued)

Parameter	Effect	Quantitation Limits		Drinking Water MCLs (µg/L)	Tap Water RBCs (µg/L)	Region III Soil Risk Based Concentration September 2001		SSL Transfers Soil to Groundwater (DAF 20) (mg/kg)	Region III BTAG Screening Levels			USEPA Water Quality Criteria (µg/L)			
		Aqueous (µg/L)	Soil (mg/kg)			Residential (mg/kg)	Industrial (mg/kg)		Aqueous (µg/L)	Soil (mg/kg)	Sediment (mg/kg)	Freshwater		Human Health Risk for Consumption of:	
												Acute	Chronic	Water & Organisms	Organisms Only
trans-1,3-Dichloropropene	C	1	0.005	NA	0.44	6.4	57	0.0031	244	0.3	NA	NA	NA	10	1,700
Ethylbenzene	N	1	0.005	700	130	780	20,000	15	32,000	0.1	0.010	NA	NA	3,100	29,000
2-Hexanone	N	5	0.005	NA	150	310	8,200	NA	428,000	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	N	5	0.005	NA	14	630	16,000	NA	460,000	100	NA	NA	NA	NA	NA
Methylene chloride	C	5	0.005	5	4.1	85	760	0.019	11,000	0.3	NA	NA	NA	4.7	1,600
Styrene	N	1	0.005	100	160	1,600	41,000	57	NA	0.1	NA	NA	NA	NA	NA
1,1,1,2-Tetrachloroethane	C	1	0.005	NA	0.41	25	220	NA	2,400	0.3	NA	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	C	1	0.005	NA	0.053	3.2	29	0.00068	2,400	0.3	NA	NA	NA	0.17	11
Tetrachloroethene	C	1	0.005	5	1.1	12	110	0.048	840	0.3	0.057	NA	NA	0.8	8.85
Toluene	N	1	0.005	1,000	75	1,600	41,000	8.8	17,000	0.1	NA	NA	NA	6,800	200,000
1,1,1-Trichloroethane	N	1	0.005	200	320	2,200	57,000	60	9,400	0.3	0.031	NA	NA	NA	NA
1,1,2-Trichloroethane	C	1	0.005	5	0.19	11	100	0.00078	9,400	0.3	0.031	NA	NA	0.6	42
Trichloroethene	C	1	0.005	5	1.6	58	520	0.015	21,900	0.3	NA	NA	NA	2.7	81
Trichlorofluoromethane	N	1	0.005	NA	130	2,300	61,000	NA	11,000	NA	NA	NA	NA	NA	NA
1,2,3-Trichloropropane	C	1	0.005	NA	0.0053	0.32	2.9	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl acetate	N	5	0.005	NA	41	7,800	200,000	1.7	NA	NA	NA	NA	NA	NA	NA
Vinyl chloride	C	5	0.005	2	0.015	0.09	7.9	0.00033	11,600	0.3	NA	NA	NA	2	525
m- & *p*-Xylene	N	1	0.005	10,000	1,200	16,000	410,000	250	6,000	0.1	0.040	NA	NA	NA	NA
o-Xylene	N	1	0.005	10,000	1,200	16,000	410,000	230	6,000	0.1	0.040	NA	NA	NA	NA
Xylene (total)	N	1	0.005	10,000	1,200	16,000	410,000	170	6,000	0.1	0.040	NA	NA	NA	NA
Pesticides															
Aldrin	C	0.050	0.0017	NA	0.0039	0.038	0.34	0.0077	3.0	0.10	NA	3	NA	0.00013	0.00014
Alpha-BHC	C	0.050	0.0017	NA	0.011	0.10	0.91	0.00089	NA	NA	NA	NA	NA	0.0039	0.013
beta-BHC	C	0.050	0.0017	NA	0.037	0.35	3.2	0.0031	NA	NA	NA	NA	NA	0.014	0.046
delta-BHC	NA	0.050	0.0017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gamma-BHC (Lindane)	C	0.050	0.0017	0.2	0.052	0.49	4.4	0.0043	0.08	0.10	NA	0.95	NA	0.019	0.063
alpha-Chlordane	NA	0.050	0.0017	2	NA	NA	NA	NA	0.0043	0.10	NA	2.4	0.0043	0.0021	0.0022

Table 2-7
Analyte List (Continued)

Parameter	Effect	Quantitation Limits		Drinking Water MCLs (µg/L)	Tap Water RBCs (µg/L)	Region III Soil Risk Based Concentration September 2001		SSL Transfers Soil to Groundwater (DAF 20) (mg/kg)	Region III BTAG Screening Levels			USEPA Water Quality Criteria (µg/L)			
		Aqueous (µg/L)	Soil (mg/kg)			Residential (mg/kg)	Industrial (mg/kg)		Aqueous (µg/L)	Soil (mg/kg)	Sediment (mg/kg)	Freshwater		Human Health Risk for Consumption of:	
												Acute	Chronic	Water & Organisms	Organisms Only
gamma-Chlordane	NA	0.050	0.0017	2	NA	NA	NA	NA	0.0043	0.10	NA	2.4	0.0043	0.0021	0.0022
Dieldrin	C	0.10	0.0033	NA	0.0042	0.040	0.36	0.0022	0.0019	0.10	16	0.24	0.056	0.00014	0.00014
4,4'-DDD	C	0.10	0.0033	NA	0.28	2.7	24	11	0.60	0.10	2.2	NA	NA	0.00083	0.00084
4,4'-DDE	C	0.10	0.0033	NA	0.20	1.9	17	35	1050	0.10	1.58	NA	NA	0.00059	0.00059
4,4'-DDT	C	0.10	0.0033	NA	0.20	1.9	17	1.2	0.001	0.10	NA	1.1	0.001	0.00059	0.00059
Endosulfan I	N	0.050	0.0017	NA	22	47	1200	2.0	0.056	NA	NA	0.22	0.056	110	240
Endosulfan II	N	0.10	0.0033	NA	22	47	1200	2.0	0.056	NA	NA	0.22	0.056	110	240
Endosulfan sulfate	NA	0.10	0.0033	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	110	240
Endrin	N	0.10	0.0033	2	1.1	2.30	0.61	0.54	0.0023	0.10	NA	0.086	0.036	0.76	0.81
Endrin aldehyde	NA	0.10	0.0033	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.76	0.81
Endrin ketone	NA	0.10	0.0033	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor	C	0.050	0.0017	0.4	0.015	0.14	1.3	0.84	0.0038	NA	NA	0.52	0.0038	0.00021	0.00021
Heptachlor epoxide	C	0.050	0.0017	0.2	0.0074	0.070	0.63	0.025	0.0038	0.10	NA	0.52	0.0038	0.001	0.00011
Methoxychlor	N	0.50	0.017	40	550	1200	31000	NA	0.03	0.10	NA	NA	0.03	100	NA
Toxaphene	C	3.0	0.17	3.0	0.061	0.58	5.2	0.63	0.0002	NA	NA	0.73	0.0002	0.00073	0.00075
PCBs															
Aroclor-1016	C	1	0.033	0.5	0.96	5.5	82	4.2	0.014	0.1	0.022	NA	0.014	0.00017	0.00017
Aroclor-1221	C	2	0.067	0.5	0.033	0.32	2.9	NA	0.014	0.1	0.022	NA	0.014	0.00017	0.00017
Aroclor-1232	C	1	0.033	0.5	0.033	0.32	2.9	NA	0.014	0.1	0.022	NA	0.014	0.00017	0.00017
Aroclor-1242	C	1	0.033	0.5	0.033	0.32	2.9	NA	0.014	0.1	0.022	NA	0.014	0.00017	0.00017
Aroclor-1248	C	1	0.033	0.5	0.033	0.32	2.9	NA	0.014	0.1	0.022	NA	0.014	0.00017	0.00017
Aroclor-1254	C	1	0.033	0.5	0.033	0.32	2.9	1.1	0.014	0.1	0.022	NA	0.014	0.00017	0.00017
Aroclor-1260	C	1	0.033	0.5	0.033	0.32	2.9	NA	0.014	0.1	0.022	NA	0.014	0.00017	0.00017
Herbicides															
2,4-D	N	4	0.080	70	37	78	2000	0.90	NA	NA	NA	NA	NA	100	NA
2,4-DB	N	4	0.080	NA	29	63	1600	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (Silvex)	N	1	0.020	50	29	63	1600	2.1	NA	NA	NA	NA	NA	10	NA
2,4,5-T	N	1	0.020	NA	37	78	2000	0.20	NA	NA	NA	NA	NA	NA	NA
Dalapon	N	2	0.040	200	110	230	6100	0.71	NA	NA	NA	NA	NA	NA	NA
Dicamba	N	2	0.040	NA	110	230	6100	0.45	NA	NA	NA	NA	NA	NA	NA
Dichloroprop	NA	4	0.080	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dinoseb	N	1	0.012	7.0	3.7	7.8	200	0.017	NA	NA	NA	NA	NA	NA	NA
MCPA	N	400	8.0	NA	1.8	3.9	100	NA	NA	NA	NA	NA	NA	NA	NA
MCPP	N	400	8.0	NA	3.7	7.8	200	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorophenol	C	1	0.010	1.0	0.56	5.3	48	NA	13.0	0.10	0.36	NA	NA	NA	NA

Table 2–7
Analyte List (Continued)

Parameter	Effect	Quantitation Limits		Drinking Water MCLs (µg/L)	Tap Water RBCs (µg/L)	Region III Soil Risk Based Concentration September 2001		SSL Transfers Soil to Groundwater (DAF 20) (mg/kg)	Region III BTAG Screening Levels			USEPA Water Quality Criteria (µg/L)			
												Freshwater		Human Health Risk for Consumption of:	
		Aqueous (µg/L)	Soil (mg/kg)			Residential (mg/kg)	Industrial (mg/kg)		Aqueous (µg/L)	Soil (mg/kg)	Sediment (mg/kg)	Acute	Chronic	Water & Organisms	Organisms Only
Waste Characterization				**TCLPRL (µg/L)**											
TCLP SVOCs															
1,4-Dichlorobenzene	NA	100	NA	7,500,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylphenol (*o*-cresol)	NA	100	NA	200,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	100	NA	130	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3-Methylphenol (*o*-cresol)	NA	100	NA	200,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol (*o*-cresol)	NA	100	NA	200,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	NA	100	NA	130	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobutadiene	NA	100	NA	500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloroethane	NA	100	NA	3,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrobenzene	NA	100	NA	2,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorophenol	NA	250	NA	100,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyridine	NA	100	NA	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	NA	250	NA	400,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	100	NA	2,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TCLP Metals															
Arsenic	NA	100	NA	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Barium	NA	2000	NA	100,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	50	NA	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	NA	100	NA	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	30	NA	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	2	NA	200	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	NA	50	NA	1,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Silver	NA	100	NA	5,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Miscellaneous															
Chemical Oxygen Demand (COD)	NA	3,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES: (1) Referenced RBCs and SSLs are from the USEPA Region III RBC table dated 9/25/01. (2) Referenced MCLs are from USEPA 40 CFR 141 and 142. (3) Referenced BTAG values are from the USEPA Region III BTAG Screening Levels table dated 8/9/95. (4) Referenced TCLP limits (TCLPRLs) are from USEPA 40 CFR 261.4. (5) The RBC levels for noncarcinogenic chemicals are presented with a hazard quotient of 0.1 to allow for cumulative effects, multiple contaminated media, and multiple routes of exposure. (6) The SSLs for soil to groundwater migration contains a default value of 20 for the dilution attenuation factor (DAF). (7) Lead values were provided by USEPA Region III.

NA = not applicable.

2.5.2 Inorganics

Samples for disposal will undergo TCLP extraction by USEPA SW-846 Method 1311. Samples are separated by phase, particle size reduced (for solids), and extracted for 18 hours in an extraction fluid. The final liquid extract is separated from the solid material and combined with the initial liquid phase (if applicable). The sample TCLP extract is then treated as an aqueous sample for analysis.

Samples will be analyzed for USEPA TAL and TCLP metals using a combination of the following methodologies to achieve project DQOs: inductively coupled plasma (ICP) and cold vapor atomic absorption (CVAA).

Trace metals will be analyzed using USEPA SW-846 Method 3010A/6010B for aqueous samples and Method 3050B/6010B for solid samples. Total hardness may be calculated from the calcium and magnesium concentrations using method SM 2340B. The ICP method involves 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 are nebulized and the aerosol that is produced is transported to the plasma torch where excitation occurs. Characteristic atomic-line emission spectra are produced by a radio-frequency ICP. A background correction technique is utilized to compensate for variable background contribution for the determination of trace elements.

Mercury will be analyzed using CVAA according to USEPA SW-846 Method 7470A for aqueous samples and Method 7471A for solid samples. A sample aliquot is initially digested with nitric acid to free combined mercury. The mercury is then reduced to its elemental state and aerated from the solution into a closed system. The mercury vapor is passed through a cell positioned in the path of the mercury light source and the measured abundance is proportional to the concentration of mercury in the sample.

Aqueous samples will be analyzed for perchlorate using ion chromatographic method USEPA SW-846 9056 modified. The method modification is adopted from the *State of California Department of Health Services Sanitation and Radiation Laboratories Branch Determination of Perchlorate by Ion Chromatography*. The perchlorate is measured by the peak height or area generated from the sample elution through an anion separator column with a conductivity detector. The sample eluant contains a support resin, p-cyanophenol to deactivate potential active sites. Samples with large particulates should be filtered to avoid damage to the column and flow systems.

pH will be analyzed using USEPA SW-846 Method 9040B for aqueous samples and Method 9045C for solid samples. A sample pH is directly measured electrometrically using either a glass electrode in combination with a reference potential or a combination electrode. For solids, samples are mixed 1:1 with reagent water prior to measurement.

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

2.5.3 Organics

Samples for disposal will undergo TCLP extraction by USEPA SW-846 Method 1311. Samples are separated by phase, particle size reduced (for solids), and extracted for 18 hours in an extraction fluid. The final liquid extract is separated from the solid material and combined with the initial liquid phase (if applicable). The sample TCLP extract is then treated as an aqueous sample for analysis.

Samples will be analyzed for TCL VOCs using USEPA SW-846 Method 5030B/8260B for aqueous samples and USEPA SW-846 5035/8260B for solid matrices using purge and trap technology. Samples are to be collected using an EnCore sampling device and subsequently sent to the laboratory for analysis. No sodium bisulfate should be added to the solid samples. Initially, the extract should be screened on a gas chromatograph/flame ionization detector (GC/FID) to ascertain the approximate concentration of organic constituents in the sample. An inert gas is bubbled through a mixture of reagent water and soil sample or through either a 5 milliliters (mL) (surface water) or a 25 mL (groundwater) sample contained in a specifically designed purging chamber at 40°C for soil and ambient temperature for water. The vapor is swept through a sorbent column where the purgeable compounds are trapped. After purging is completed for both soil and aqueous samples, the sorbent column is 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.

Samples will be analyzed for semivolatiles and TCLP SVOCs using USEPA SW-846 Method 8270C. Soil samples will be extracted using soxhlet extraction according to USEPA SW-846 Method 3540C. Aqueous samples will be extracted using a continuous liquid-liquid extraction technique according to USEPA SW-846 Method 3520C. Soil samples should be screened to assess the appropriate analytical level. Gel Permeation Chromatography will be used to clean the samples. The extract is injected into a gas chromatograph programmed to separate the compounds, which are then detected with a mass spectrometer.

Samples will be analyzed for explosives using USEPA SW-846 Method 8330. Aqueous samples of low concentration are extracted by a salting-out extraction procedure with acetonitrile and sodium chloride. The small volume of acetonitrile that remains undissolved above the salt water is drawn off and transferred to a smaller volumetric flask. It is back extracted by vigorous stirring with a specific volume of salt water. After equilibration, the phases are allowed to separate and the small volume of acetonitrile residing in the narrow neck of the volumetric flask is removed. The concentrated extract is diluted with reagent grade water, and an aliquot is separated on a C-18 reverse phase column. The wavelength is set at 254 nanometers and confirmed on a cyanide reverse column. Solid samples are extracted using acetonitrile in an ultrasonic bath, then filtered and chromatographed similarly to aqueous samples.

Samples will be analyzed for PAHs using USEPA SW-846 Method 8310. Soil samples will be extracted using extraction using USEPA SW-846 Method 3540C. Aqueous samples will be extracted using a continuous liquid-liquid extraction technique according to USEPA SW-846 Method 3520C. A 1 to 25 µL aliquot of the extract is injected into a high performance liquid chromatography, and compounds in the effluent are detected by ultraviolet (UV) and fluorescence detectors. Since these detectors are 2D in nature, data generated will be considered estimated.

Samples will be analyzed for TCL pesticides and PCBs using USEPA SW-846 Methods 8081A and 8082, respectively. Aqueous and solid samples will be prepared for analysis using extraction techniques. Solid samples will be extracted using soxhlet method USEPA SW-846 Method 3540C for samples. Aqueous samples will be extracted using a continuous liquid-liquid extraction technique by USEPA SW-846 Method 3520C. The extract will be injected into a gas chromatograph programmed to separate the compounds, which are then detected with an ECD detector. Sulfur cleanups will be employed to aid in the quantification based upon the matrix interferences.

Samples will be analyzed for herbicides according to USEPA SW-846 Method 8151A. Aqueous and solid samples are extracted with diethyl ether and then esterified with either diazomethane or pentafluorobenzyl bromide. The derivatives are determined by gas chromatography with an electron capture detector (GC/ECD). The results are reported as acid equivalents. Soil and waste samples are extracted and esterified with diazomethane or pentafluorobenzyl bromide. Sample concentrations are confirmed on dissimilar columns.

Samples will be analyzed for dioxins/furans using USEPA SW-846 Method 8290. The analytical method used for the analysis of approximately 17 dioxins and furans calls for the use of 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 dibenzofurans in water, soil, and waste samples of various media. Measurements of toxicity are required for the analysis.

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

Samples will be analyzed for TOX using USEPA SW-846 Method 9020B. Aqueous samples are passed through a conditioned column containing activated carbon, which adsorbs the organohalides. The activated carbon is then combusted to convert the organohalides to hydrogen halide, which is trapped and titrated electrolytically using a microcoulometric detector. Soil samples are combusted directly.

2.6 INTERNAL QUALITY CONTROL CHECKS

This section discusses the internal QC components that will be used by IT Corporation during operations at RFAAP. The internal quality components include the field QC samples and the laboratory QC elements to be followed.

2.6.1 Field Quality Control Samples

Rinse blanks, trip blanks, and field duplicates will be collected during the acquisition of environmental samples at RFAAP. **Table 2-8** presents guidelines for the collection of QC samples that will be taken in conjunction with environmental sampling at SWMU 31. Field and analytical QC acceptance criteria for RFI activities are summarized in **Tables 2-9 and 2-10**, respectively.

Table 2-8
Field Quality Control Samples

Control	Purpose of Sample	SWMU 31		Collection Frequency
		Aqueous	Solid	
Duplicate Sample	Ensure precision in sample homogeneity during collection and analysis	2	3	1 per 10 (10%) of field samples per matrix
Rinse Blank	Ensure the decontamination of sampling equipment has been adequately performed; to assess cross contamination and/or incidental contamination to the sample container	1	2	1 per 20 (5%) of field samples per matrix per equipment type
Temperature Blank	Verify sample cooler temperature during transport	3	3	1 temperature blank per cooler
Trip Blank	Assess whether cross-contamination occurs during shipment or storage with aqueous VOC samples	2	NA	1 trip blank per cooler containing aqueous VOC samples

NA=not applicable.

Table 2-9
Field Quality Control Elements Acceptance Criteria for RFI Activities

Item	DQO	Parameter	Frequency of Association	Criteria Requirement
Field Duplicate	P	Inorganics	1 per 10 samples per matrix	RPD ≤ 20% Aqueous RPD ≤ 35% Solid
		Organics	1 per 10 samples per matrix	RPD ≤ 50% Aqueous RPD ≤ 100% Solid
Trip Blank	A,R	VOCs in water	1 per cooler with aqueous VOCs	No target analytes above MRL; 5% of decision limit
Rinse Blank	A,R	All	1 per 20 samples per matrix per equipment type	No target analytes above MRL; 5% of decision limit
Chain-of-Custody Forms	R	All	Every sample	Filled out correctly to include signatures; no missing or incorrect information.
Field Logbook	R	All	Every sample	Filled out correctly to include analytical parameters; map file data; and applicable coding information.
Field Instrument Calibration Logs	A	All	Every measurement	Measurements must have associated calibration reference

A = Accuracy P = Precision R = Representativeness

2.6.2 Laboratory Quality Control Elements

The laboratory QC elements are summarized in **Table 2-10**. Laboratory analytical goals are summarized in **Tables 2-11 through 2-23** for the parameters specified in Section 2.5.

Table 2-10
Analytical Quality Control Elements of a Quality Assurance Program

Item	DQO	Parameter	Frequency of Association	Criteria Requirement
Analytical Method	C	All	Each analysis	Method analysis based on USEPA methods as defined in Section 2.5.
Chemical Data Packages	A,P,C	All	Each lot/batch	Pass peer review and formal QA/QC check.
Laboratory Chain of Custody	R	All	Each sample container	No deficiencies
Laboratory System Controls	A,R	All	During laboratory operations	Custody of sample within laboratory fully accounted for and documented
Holding Time	A,P,R	All	Each analysis	No deficiencies (USEPA Region III Modifications)
Method Blanks	A	All	Each lot/batch	No target analytes detected in the method blanks or <5% of the LOC
Matrix Spikes and Duplicates	A,P	All	Each lot/batch	Must meet USEPA criteria as defined in Tables 2-11 to 2-21.
Surrogates	A	Organics	Organic fractions, including QC samples	Required to meet the stricter of the USEPA criteria.
Serial dilution	A	Metals	Each lot/batch	Must meet USEPA criteria as defined in Table 2-15.

A = Accuracy C = Comparability R = Representativeness P = Precision

Table 2-11
Quality Control Method Criteria for Volatile Organic Compounds by USEPA SW-846 8260B

Procedure	Frequency	Acceptance Criteria			Corrective Action
Initial Calibration 5-pt curve	Set-up, major maintenance, and quarterly	RRF > 0.30 for SPCCs; except bromoform >0.25. RSD ≤ 30% for CCCs response factors.			If RSD of the average RRF for calibration check compounds > 30%, the initial calibration must be repeated. Data reviewer should review and judge the target compounds against the acceptance criteria.
Continuing calibration check	Every 12 hours	%Difference for RF of CCCs of continuing calibration compounds ±25% from initial calibration. RRF > 0.30 for SPCCs; except bromoform >0.25.			Samples cannot begin until this criterion is met. Data reviewer should review and judge the target compounds against the acceptance criteria.
Method blanks	Every 12 hours	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.			Document source of contamination.
Tuning BFB	Prior to calibration	Must meet tuning criteria.			Re-tune, re-calibrated.
LCS (Advisory Limits)	Every batch	Water: 80–120%. Solids: 75–125%. Or as specified QC limits.			Qualify associated data biased high or biased low as appropriate.
Internal Standards	Every sample	Standards Bromochloromethane 1,4-difluorobenzene chlorobenzene	Retention time ±30 seconds of last CC Area changes by a factor of two (-50% to +100%)		Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples with standards outside criteria.
Surrogate (Advisory Limits)	Every sample	Standards	Solid	Aqueous	If surrogate compounds do not meet criteria, there should be a re-analysis to confirm that the non-compliance is due to the sample matrix effects rather than laboratory deficiencies.
		4-bromofluorobenzene	75–125%	80–120%	
		1,2-dichloroethane-d_4	75–125%	80–120%	
		toluene-d_8	75–125%	80–120%	
Matrix Spike and Duplicate (Advisory Limits)	1 per 20 per matrix	Standards	Solid %Rec. %RPD	Aqueous %Rec. %RPD	If MS/MSD results do not meet criteria, the reviewer should review the data in conjunction with other QC results to identify whether the problem is specific to the QC samples or systematic.
		1,1-dichloroethane	70–130% ≤30	70–130% ≤30	
		trichloroethene	70–130% ≤30	70–130% ≤30	
		benzene	70–130% ≤30	70–130% ≤30	
		toluene	70–130% ≤30	70–130% ≤30	
		chlorobenzene	70–130% ≤30	70–130% ≤30	

Sources: Analytical Method, USEPA 1996; Advisory Limits, USACE 1998.

Table 2-12
Quality Control Method Criteria for Semivolatile Organic Compounds by USEPA SW-8270C

<table>
<tr><th>Procedure</th><th>Frequency</th><th colspan="5">Acceptance Criteria</th><th>Corrective Action</th></tr>
<tr><td>Initial calibration curve (5-pt curve)</td><td>Set-up, major maintenance</td><td colspan="5">RRF > 0.05 for SPCCs; RSD ≤30% for CCC compounds.</td><td>Must meet criteria prior to sample analysis. Data reviewer should review and judge the target compounds against the acceptance criteria.</td></tr>
<tr><td>Continuing calibration standard</td><td>12 hours</td><td colspan="5">RRF > 0.05 for SPCCs. The percent difference for CCCs must be ≤30%. If this criteria is met, the relative response factors of the compounds are calculated.</td><td>If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, calibration must be repeated. Data reviewer should review and judge the target compounds against the acceptance criteria.</td></tr>
<tr><td>Internal standards</td><td>Every sample</td><td colspan="5">Retention time ±30 seconds of last CC
Area changes by a factor of two (-50% to +100%)</td><td>Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples with standards outside criteria.</td></tr>
<tr><td>Tuning DFTPP</td><td>12 hours</td><td colspan="5">Must meet tuning criteria.</td><td>Re-tune, re-calibrate.</td></tr>
<tr><td>Method blanks</td><td>Per extraction batch</td><td colspan="5">No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.</td><td>Document source of contamination.</td></tr>
<tr><td>LCS (Advisory Limits)</td><td>Every batch</td><td colspan="5">60–120%% or as specified QC limits</td><td>Qualify associated data biased high or biased low as appropriate.</td></tr>
<tr><td rowspan="9">Surrogate spikes (Advisory Limits)</td><td rowspan="9">Every sample</td><td>Standards</td><td colspan="2">Aqueous (%Rec.)</td><td colspan="2">Solid (%Rec.)</td><td rowspan="9">If two base/neutral or acid surrogates are out of specification, or if one base/neutral or acid extractable surrogate has a recovery of less than 10%, then there should be a re-analysis to confirm that the non-compliance is due to sample matrix effects rather than laboratory deficiencies.</td></tr>
<tr><td>nitrobenzene-d_5</td><td colspan="2">45–135%</td><td colspan="2">45–135%</td></tr>
<tr><td>2-fluorobiphenyl</td><td colspan="2">45–135%</td><td colspan="2">45–135%</td></tr>
<tr><td>p-terphenyl-d14</td><td colspan="2">45–135%</td><td colspan="2">45–135%</td></tr>
<tr><td>phenol-d5</td><td colspan="2">45–135%</td><td colspan="2">45–135%</td></tr>
<tr><td>2-fluoroprophenol-d6</td><td colspan="2">45–135%</td><td colspan="2">45–135%</td></tr>
<tr><td>2,4,6-tribromophenol</td><td colspan="2">45–135%</td><td colspan="2">45–135%</td></tr>
<tr><td>2-chlorophenol</td><td colspan="2">45–135%</td><td colspan="2">45–135%</td></tr>
<tr><td>1,2-dichlorobenzene</td><td colspan="2">45–135%</td><td colspan="2">45–135%</td></tr>
<tr><td rowspan="13">Matrix spike and duplicate (Advisory Limits)</td><td rowspan="13">1 per 20 samples per matrix</td><td rowspan="2">Standards</td><td colspan="2">Aqueous</td><td colspan="2">Solid</td><td rowspan="13">If MS/MSD results do not meet criteria, the reviewer should review the data in conjunction with other QC results to identify whether the problem is specific to the QC samples or systematic.</td></tr>
<tr><td>Rec.</td><td>%RPD</td><td>Rec.</td><td>%RPD</td></tr>
<tr><td>Phenol</td><td>45–135%</td><td>≤50</td><td>45–135%</td><td>≤60</td></tr>
<tr><td>2-chlorophenol</td><td>45–135%</td><td>≤50</td><td>45–135%</td><td>≤60</td></tr>
<tr><td>1,4-dichlorobenzene</td><td>45–135%</td><td>≤50</td><td>45–135%</td><td>≤60</td></tr>
<tr><td>n-nitroso-di-n-propylamine</td><td>45–135%</td><td>≤50</td><td>45–135%</td><td>≤60</td></tr>
<tr><td>1,2,4-trichlorobenzene</td><td>45–135%</td><td>≤50</td><td>45–135%</td><td>≤60</td></tr>
<tr><td>4-chloro-3-methylphenol</td><td>45–135%</td><td>≤50</td><td>45–135%</td><td>≤60</td></tr>
<tr><td>acenaphthene</td><td>45–135%</td><td>≤50</td><td>45–135%</td><td>≤60</td></tr>
<tr><td>4-nitrophenol</td><td>45–135%</td><td>≤50</td><td>45–135%</td><td>≤60</td></tr>
<tr><td>2,4-dinitrotoluene</td><td>45–135%</td><td>≤50</td><td>45–135%</td><td>≤60</td></tr>
<tr><td>pentachlorophenol</td><td>45–135%</td><td>≤50</td><td>45–135%</td><td>≤60</td></tr>
<tr><td>pyrene</td><td>45–135%</td><td>≤50</td><td>45–135%</td><td>≤60</td></tr>
</table>

Sources: Analytical Method, USEPA 1996; Advisory Limits, USACE 1998.

Table 2-13
Quality Control Method Criteria for Polynuclear Aromatic Hydrocarbons by USEPA SW-846 8310

Procedure	Frequency of QC Procedure	Acceptance Criteria					Corrective Action
Initial calibration curve 5-pt curve	Set-up, major maintenance	%RSD<20% of the response factor from the initial curve.					Must meet criteria prior to sample analysis
Continuing calibration (calibration check)	Daily	%D recovery ± 15% of the response factor from the initial curve.					If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, initial calibration must be repeated.
Independent reference standard (LCS)	1 per batch	70-130% or as specified QC limits.					Qualify associated data biased high or biased low as appropriate.
Method blanks	1 per batch	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.					Document source of contamination.
Surrogate spikes (Advisory Limits)	Every sample	Standards	Aqueous %R		Solid %R		If surrogate compounds do not meet criteria, there should be a re-analysis to confirm that the non-compliance is due to the sample matrix effects rather than laboratory deficiencies.
		p-Terphenyl	50-110%		30-124%		
Matrix spike and duplicate (Advisory Limits)	1 per 20 samples per matrix	Standards	Aqueous %R	RPD	Solid %R	RPD	Data reviewer may use the MS and MSD results in conjunction with other QC sample results to assess the need for some qualification of the data.
		acenaphthene	49-109	≤30	0-124	≤50	
		acenaphthylene	53-103	≤25	0-139	≤50	
		anthracene	44-124	≤40	0-126	≤50	
		benzo(a)pyrene	45-121	≤38	27-151	≤62	
		benzo(k)fluoranthene	41-123	≤41	22-132	≤55	
		fluorene	40-110	≤35	25-123	≤49	
		naphthalene	21-117	≤48	0-122	≤50	
		phenanthrene	52-116	≤32	0-155	≤50	

Sources: Analytical Method, USEPA 1996; Advisory Limits, USACE 1998.

221

Table 2-14
Quality Control Method Criteria for Explosives by USEPA SW-846 8330

Procedure	Frequency	Acceptance Criteria			Corrective Action
Initial calibration curve 5-pt curve	Set-up, major maintenance	%RSD<20% of the response factor from the initial curve.			Must meet criteria prior to sample analysis
Continuing calibration standard	Daily	%D recovery ± 15% of the response factor from the initial curve.			If criteria are not met, re-analyze the daily standard. If the daily standard fails a second time, perform a new initial curve.
Independent reference standard (LCS)	1 per batch	60-120% or as specified QC limits.			Qualify associated data biased high or biased low as appropriate.
Instrument Blank	12 hours, after analytical run and highly contaminated samples.	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.			Demonstrated "clean." Affected sample will be re-analyzed.
Method blanks	Per extraction batch	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.			Identify source of contamination. Take appropriate action and document. If preparation is in error, re-prep sample. If samples cannot be re-prepared, qualify the sample. Document actions taken.
Surrogate spikes (Advisory Limits)	Every sample	Standards 4-nitroaniline	Aqueous %Rec. 60–140%	Solid %Rec. 50–150%	Examine each QC element (LCS, MB, ICV, CCV, etc.). If surrogate is out for the QC samples, check quantitation, then re-analyze (if still out of control). If QC passes, qualify samples after checking preparation steps. 2. If re-analysis of original extracts is out of control, re-extract and re-analyze samples. Follow step 1. If still out of control or samples cannot be re-extracted, qualify data.
Matrix spike and duplicate samples (Advisory Limits)	1 per 20 samples per matrix	Standards RDX 135TNB NB 246TNT 24DNT	Aqueous %Rec. RPD 50–140% ≤50 50–140% ≤50 50–140% ≤50 50–140% ≤50 50–140% ≤50	Solid %Rec. %RPD 50–140% ≤50 50–140% ≤50 50–140% ≤50 50–140% ≤50 50–140% ≤50	Investigate to identify cause and document actions taken; data are acceptable. Data reviewer may use the MS and MSD results in conjunction with other QC sample results to assess the need for some qualification of the data.
Standard spikes	1 low spike and 2 high spikes per sample lot.	LWL<%Rec<UWL LWL: lower warning limit UWL: upper warning limit			Investigate to identify cause and document actions taken; data are acceptable.

Sources: Analytical Method, USEPA 1996; Advisory Limits, USACE 1998.

Table 2-15
Quality Control Method Criteria for Metals by USEPA SW-846 6010B/7470A/7471A

Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action
Initial calibration curve (3-pt curve Hg) (1-pt curve low level ICP)	Daily or major maintenance, instrument modification, replacement of the torch, replacement of the mirror	r > 0.995 for each element r: linear correlation coefficient	If r < 0.995 for an element, the standards for that element must be prepared again and/or the lower/upper range standard must be used.
Continuing calibration verification (CCV)	Every 10 samples or 2 per 8 hr and end of run.	Recovery ±10% of true value for ICP Recovery ±20% of true value for Hg	Reanalyze CCV. If the CCV fails second time, the analysis must be terminated, the problem corrected, the instrument re-calibrated, and the calibration re-verified prior to continuing sample analyses.
Highest mixed standard	Before sample analysis	Recovery ±5% of true value for ICP NA for Hg	If criteria are not met, reanalyze the daily standards. If the daily standard fails a second time, initial calibration must be repeated.
Interference check	Beginning and end of each sample analytical run or 2 per 8 hr.	Recovery ±20% of true value.	Terminate the analysis, correct the problem, re-calibrate, re-verify the calibration, and reanalyze the samples.
Continuing calibration blank (CCB)	Every 10 samples, end of analytical run	Concentration < 3 X s of the background mean (ICP). No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.	If the average in not within criteria, terminate the analysis, correct the problem, re-calibrate, and reanalyze each sample analyzed since the last acceptable CCB.
Serial Dilution (ICP)	1 per 20 samples per matrix for samples >10x IDL	Difference between diluted and undiluted sample <10%.	Chemical or physical interference should be suspected. Investigate to identify cause.
Preparation blank	1 per batch per matrix	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.	Documented source of contamination.
Laboratory Control Sample (Advisory Limits)	1 per 20 samples	80%≤%Rec.≤120%	Qualify associated data biased high or biased low as appropriate.
Matrix spike and duplicate and sample duplicate (Advisory Limits)	1 per 20 samples per matrix	75%≤%Rec.≤125%; %RPD<25%; If spike(s) outside of limits, analyze PDS. PDS limits are 75–125% for 6010B 80%≤Rec.≤120; %RPD<20% for 7000 methods. PDS limits are 85–115% for 7000 methods.	If matrix spike recovery does not meet criteria (except Ag), a post digestion spike is required for each method except GFAA. Qualify results in accordance with Regional criteria.

Sources: Analytical Method, USEPA 1996; Advisory Limits, USACE 1998.

Table 2-16
Quality Control Method Criteria for Dioxins/Furans by USEPA SW-8290

Procedure	Frequency	Acceptance Criteria					Corrective Action
Initial calibration curve (5-pt curve)	Set-up, major maintenance	%RSD ±20% for standard compounds, %RSD ±30% for reference compounds. Isotopic ratio must be within the established control limits. The signal to noise ratio must be ≥2.5 for each selected ion current profile.					Must meet criteria prior to sample analysis. Data reviewer should review and judge the target compounds against the acceptance criteria.
Continuing calibration standard	12 hours	The percent difference must be ±20% for each standard compounds and ±30% for reference compounds.					If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, calibration must be repeated. Data reviewer should review and judge the target compounds against the acceptance criteria.
Internal standards	Every sample	Retention time ±30 seconds of last CC Area changes by a factor of two (-50% to +100%)					Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples with standards outside criteria.
Tuning PFK	12 hours	Must meet tuning criteria with resolving power of ≥ 10000.					Re-tune, re-calibrate.
Method blanks	Per extraction batch	No target analytes.					Document source of contamination.
LCS	Every batch	Specified QC Limits					Qualify associated data biased high or biased low as appropriate.
Surrogate spikes	Every sample	Specified QC Limits					Investigate to identify cause and document actions taken; data are acceptable.
Matrix spike and duplicate	1 per 20 samples per matrix (Advisory Limits)	Standards	Aqueous		Solid		If MS/MSD results do not meet criteria, the reviewer should review the data in conjunction with other QC results to identify whether the problem is specific to the QC samples or systematic.
			Rec.	%RPD	Rec.	%RPD	
		2,3,7,8-TCDD	70-130%	≤20	70-130%	≤20	
		2,3,7,8-TCDF	70-130%	≤20	70-130%	≤20	
		1,2,3,4-TCDD	70-130%	≤20	70-130%	≤20	
		1,2,3,7,8- PeCDD	70-130%	≤20	70-130%	≤20	
		1,2,3,7,8-PeCDF	70-130%	≤20	70-130%	≤20	
		1,2,3,6,7,8-HxCDD	70-130%	≤20	70-130%	≤20	
		1,2,3,4,7,8-HxCDD	70-130%	≤20	70-130%	≤20	
		1,2,3,7,8,9-HxCDD	70-130%	≤20	70-130%	≤20	
		1,2,3,6,7,8-HxCDF	70-130%	≤20	70-130%	≤20	
		1,2,3,4,7,8-HxCDF	70-130%	≤20	70-130%	≤20	
		1,2,3,7,8,9-HxCDF	70-130%	≤20	70-130%	≤20	
		2,3,4,6,7,8-HxCDF	70-130%	≤20	70-130%	≤20	
		1,2,3,4,6,7,8-HpCDD	70-130%	≤20	70-130%	≤20	
		1,2,3,4,6,7,8-HpCDF	70-130%	≤20	70-130%	≤20	
		1,2,3,4,7,8,9-HpCDF	70-130%	≤20	70-130%	≤20	
		OCDD	70-130%	≤20	70-130%	≤20	
		OCDF	70-130%	≤20	70-130%	≤20	

Sources: Analytical Method, USEPA 1996; Advisory Limits, USACE 1998.

Table 2-17
Quality Control Method Criteria for Total Organic Carbon by USEPA SW-846 9060A

Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action
Initial calibration curve 5-pt curve	Major maintenance, instrument modification, per manufacturer's specifications	$r > 0.995$ r: linear correlation coefficient	If $r < 0.995$, the standards must be prepared again.
Initial calibration standard (calibration verification)	1 per batch	Recovery ±10% of true value.	If criteria are not met, reanalyze the daily standards. If the daily standard fails a second time, initial calibration must be repeated.
Continuing calibration verification (CCV)	Every 10 samples, end of analytical run	Recovery ±10% of true value.	Reanalyze CCV. If the CCV fails second time, the analysis must be terminated, the problem corrected, the instrument re-calibrated, and the calibration re-verified prior to continuing sample analyses.
Continuing calibration blank (CCB)	Every 10 samples, end of analytical run	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.	If not within criteria, terminate the analysis, correct the problem, re-calibrate, and reanalyze each sample analyzed since the last acceptable CCB.
Preparation blank	1 per 20 samples per matrix	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.	Documented source of contamination.
Laboratory Control Sample (Advisory Limits)	1 per 20 samples	90%≤%Rec.≤110% or ± 3 standard deviations of the mean from historical data points.	Qualify associated data biased high or biased low as appropriate.
Matrix spike and duplicate (Advisory Limits)	1 per 20 samples per matrix	75%≤%Rec.≤125% or ± 3 standard deviations of the mean from historical data points.	If matrix spike recovery does not meet criteria (except Ag), a post digestion spike is required for each method except GFAA. Qualify results in accordance with Regional criteria.

Sources: Analytical Method, USEPA 1996; Advisory Limits, USACE 1998.

Table 2-18
Quality Control Method Criteria for Total Organic Halides by USEPA SW-846 9020B

Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action
Initial calibration curve	Major maintenance, instrument modification, per manufacturer's specifications	Recovery ±5% of true value.	If criteria are not met, reanalyze the daily standards. If the daily standard fails a second time, initial calibration must be repeated.
Daily and Initial calibration standard (calibration verification)	Initial calibration, every eight samples or instrument maintenance	Recovery ±3% of calibration-standard true value.	If criteria are not met, reanalyze the daily standards. If the daily standard fails a second time, initial calibration must be repeated.
Continuing calibration verification (CCV)	Every 10 samples, end of analytical run	Recovery ±10% of true value.	Reanalyze CCV. If the CCV fails second time, the analysis must be terminated, the problem corrected, the instrument re-calibrated, and the calibration re-verified prior to continuing sample analyses.
Continuing calibration blank (CCB)	Every 10 samples, end of analytical run	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.	If not within criteria, terminate the analysis, correct the problem, re-calibrate, and reanalyze each sample analyzed since the last acceptable CCB.
Preparation blank	1 per 20 samples per matrix	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.	Documented source of contamination.
Laboratory Control Sample (Advisory Limits)	1 per 20 samples	90%≤%Rec.≤110% or ± 3 standard deviations of the mean from historical data points.	Qualify associated data biased high or biased low as appropriate.
Matrix spike and duplicate (Advisory Limits)	1 per 20 samples per matrix	75%≤%Rec.≤125% or ± 3 standard deviations of the mean from historical data points.	If matrix spike recovery does not meet criteria (except Ag), a post digestion spike is required for each method except GFAA. Qualify results in accordance with Regional criteria.

Sources: Analytical Method, USEPA 1996; Advisory Limits, USACE 1998.

Table 2-19
Quality Control Method Criteria for Perchlorate by USEPA SW-846 9056 Modified

Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action
Initial calibration curve 5-pt curve	Major maintenance, instrument modification, per manufacturer's specifications	r > 0.995 (advisory) r: linear correlation coefficient Predicted response within ±10%	If outside criteria, the standards must be prepared again.
Initial calibration standard (calibration verification)	1 per batch	Recovery ±10% of true value.	If criteria are not met, reanalyze the daily standards. If the daily standard fails a second time, initial calibration must be repeated.
Continuing calibration verification (CCV) or Instrument Performance Check (IPC)	Every 10 samples, end of analytical run	Recovery ±10% of true value.	Reanalyze CCV or IPC. If the CCV or IPC fails second time, the analysis must be terminated, the problem corrected, the instrument re-calibrated, and the calibration re-verified prior to continuing sample analyses.
Continuing calibration blank (CCB)	Every 10 samples, end of analytical run	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.	If not within criteria, terminate the analysis, correct the problem, re-calibrate, and reanalyze each sample analyzed since the last acceptable CCB.
Preparation Reagent blank	1 per 20 samples or batch	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.	Documented source of contamination.
Laboratory Control Sample (Advisory Limits)	1 per 20 samples	75%≤%Rec.≤125% or ± 3 standard deviations of the mean from historical data points.	Qualify associated data biased high or biased low as appropriate.
Laboratory Fortified Spike (Advisory Limits)	1 per batch	75%≤%Rec.≤125% or ± 3 standard deviations of the mean from historical data points.	If matrix spike recovery does not meet criteria (except Ag), a post digestion spike is required for each method except GFAA. Qualify results in accordance with Regional criteria.
Matrix spike and duplicate (Advisory Limits)	1 per 10 samples per batch	75%≤%Rec.≤125% or ± 3 standard deviations of the mean from historical data points.	If matrix spike recovery does not meet criteria (except Ag), a post digestion spike is required for each method except GFAA. Qualify results in accordance with Regional criteria.

Sources: Analytical Method, USEPA 1996; Advisory Limits, USACE 1998.

Table 2-20
Quality Control Method Criteria for TCL Pesticides and PCBs by USEPA SW-846 8081A and 8082

Procedure	Frequency of QC Procedure	Acceptance Criteria					Corrective Action
Initial calibration curve Single/multi-component (5pt)	Set-up, major maintenance	%RSD<20% of the response factor from the initial curve. Lab may use first or higher order regression fit ($r \geq 0.99$) if %RSD > 20%.					Must meet criteria prior to sample analysis
Continuing calibration standard	12 hours or every 20 samples	%D recovery ± 15% of the response factor from the initial curve.					If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, initial calibration must be repeated.
Independent reference standard (calibration check)	Weekly	Recovery ± 25%					Initiate investigation and document actions taken.
Endrin/4,4-DDT Breakdown	Per batch	endrin/4,4-DDT degradation ≤15%.					If criterion is not met, system must be deactivated and the affected sample reanalyzed if endrin or 4,4-DDT or their degradation products are detected in the samples.
Instrument blank	12 hours, after analytical run and highly contaminated samples.	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.					Demonstrated "clean". Affected sample will be reanalyzed.
Method blanks	Per extraction batch	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.					Document source of contamination.
Surrogate spikes	Every sample (Advisory Limits)	Surrogate	Aqueous %R		Solid %R		Investigate to determine cause, correct the problem, and document actions taken; re-extract and re-analyze sample. If still out, qualify.
		Dibutylchlorendate	60-150		60-150		
		2,4,5,6-Tetrachloro- m-xylene	60-150		60-150		
Matrix spike and duplicate	1 per 20 samples per matrix (Advisory Limits)	Standards	Aqueous %R	RPD	Solid %R	RPD	Data reviewer may use the MS and MSD results in conjunction with other QC sample results to determine the need for some qualification of the data. Specific method cleanups may be used to eliminate or minimize sample matrix effects.
		gamma-BHC	56-123	≤15	46-127	≤50	
		heptachlor	40-131	≤20	35-130	≤31	
		aldrin	40-120	≤22	34-132	≤43	
		dieldrin	52-126	≤18	31-134	≤38	
		endrin	56-121	≤21	42-139	≤45	
		4,4'-DDT	38-127	≤27	23-132	≤50	
		Aroclor-1016	40-140	≤50	40-140	≤50	
		Aroclor-1260	40-140	≤50	40-140	≤50	

Sources: Analytical Method, USEPA 1996; Advisory Limits, USACE 1998.

Table 2-21
Quality Control Method Criteria for Herbicides by USEPA SW-846 8151A

Procedure	Frequency of QC Procedure	Acceptance Criteria						Corrective Action
Initial calibration curve 5-pt curve	Set-up, major maintenance	%RSD<20% of the response factor from the initial curve. Lab may use first or higher order regression fit (r ≥ 0.99) if %RSD > 20%.						Must meet criteria prior to sample analysis
Continuing calibration (calibration check)	Daily	%D recovery ± 15% of the response factor from the initial curve.						If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, initial calibration must be repeated.
Independent reference standard (LCS)	Every batch for all compounds (advisory limits)	70-130% or as lab specified QC limits.						%R are outside criteria, sample batch should be re-calibrated and re-analyzed. If still outside criteria, qualify associated data biased high or biased low as appropriate.
Method blanks	1 per batch	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.						Document source of contamination.
Surrogate spikes	Every sample	Standards	Aqueous %R		Solid %R			Investigate to determine cause, correct the problem, and document actions taken; re-extract and re-analyze sample. If still out, qualify.
		2,4-dichlorophenyl-acetic acid	70-130%		70-130%			
Matrix spike and duplicate	1 per 20 samples per matrix (Advisory Limits)	Standards	Aqueous %R	RPD	Solid %R	RPD		Data reviewer may use the MS and MSD results in conjunction with other QC sample results to determine the need for some qualification of the data. Specific method cleanups may be used to eliminate or minimize sample matrix effects.
		2,4-D	50-150	≤25	50-150	≤35	≤35	
		2,4,5-TP	50-150	≤25	50-150	≤35		
		Pentachlorophenol	50-150	≤25	50-150			

Sources: Analytical Method, USEPA 1996; Advisory Limits, USACE 1998.

Table 2-22
Quality Control Method Criteria for Chemical Oxygen Demand by USEPA Method of Chemical Analysis of Water and Wastes 410.4

Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action
Initial calibration curve 5-pt curve	Major maintenance, instrument modification, per manufacturer's specifications	r > 0.995 (advisory) r: linear correlation coefficient Predicted response within ±10%	If outside criteria, the standards must be prepared again.
Initial calibration standard (calibration verification)	1 per batch	Recovery ±10% of true value.	If criteria are not met, reanalyze the daily standards. If the daily standard fails a second time, initial calibration must be repeated.
Continuing calibration verification (CCV)	Every 10 samples, end of analytical run	Recovery ±10% of true value.	Reanalyze CCV. If the CCV fails second time, the analysis must be terminated, the problem corrected, the instrument re-calibrated, and the calibration re-verified prior to continuing sample analyses.
Continuing calibration blank (CCB)	Every 10 samples, end of analytical run	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.	If not within criteria, terminate the analysis, correct the problem, re-calibrate, and reanalyze each sample analyzed since the last acceptable CCB.
Preparation Reagent blank	1 per 20 samples or batch per matrix	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.	Documented source of contamination.
Laboratory Control Sample (Advisory Limits)	1 per 20 samples per matrix	75%≤%Rec.≤125% or ± 3 standard deviations of the mean from historical data points.	Qualify associated data biased high or biased low as appropriate.
Matrix spike and duplicate (Advisory Limits)	1 per 10 samples per batch, per matrix	75%≤%Rec.≤125% or ± 3 standard deviations of the mean from historical data points.	If matrix spike recovery does not meet criteria, qualify results in accordance with Regional criteria.

Sources: Analytical Method, USEPA 1983; Advisory Limits, USACE 1998.

Table 2-23
Quality Control Method Criteria for Hardness by SW-846 6010B/7470A/7471A/GFAA (7000)/SM 2340B

Procedure	Frequency of QC Procedure	Acceptance Criteria	Corrective Action
Initial calibration curve (5-pt curve Hg) (3-pt curve GFAA) (1-pt curve ICP)	Daily or major maintenance, instrument modification, replacement of the torch, replacement of the mirror	r > 0.995 for all elements r: linear correlation coefficient	If r < 0.995 for any element, the standards for that element must be prepared again and/or the lower/upper range standard must be used.
Initial calibration verification (ICV) and continuing calibration verification (CCV). ICV or CCV must be at low level end of calibration.	Every 10 samples or 2 per 8 hr and end of run.	Recovery ±10% of true value for ICP Recovery ±20% of true value for Hg and GFAA	Reanalyze ICV/CCV. If the ICV/CCV fails second time, the analysis must be terminated, the problem corrected, the instrument re-calibrated, and the calibration re-verified prior to continuing sample analyses.
Highest mixed standard	Before sample analysis	Recovery ±5% of true value for ICP NA for Hg and GFAA	If criteria are not met, reanalyze the daily standards. If the daily standard fails a second time, initial calibration must be repeated.
Interference check (ICP)	Beginning and end of each sample run or 2 per 8 hr.	Recovery ±20% of true value for ICP. NA for Hg and GFAA	Terminate the analysis, correct the problem, re-calibrate, re-verify the calibration, and reanalyze the samples.
Continuing calibration blank (CCB)	Every 10 samples, end of analytical run	Concentration < 3 times MDL (ICP). No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.	If the not within criteria, terminate the analysis, correct the problem, re-calibrate, and reanalyze all samples analyzed since the last acceptable CCB.
Serial Dilution	1 per 20 samples per matrix for samples >10x IDL	Difference between diluted and undiluted sample <10%. Analyze one 25x dilution test for Hg and GFAA, else if samples <10x MDL, perform recovery test (85-115%).	Chemical or physical interference should be suspected. Investigate to determine cause.
Preparation blank	1 per batch per matrix	No target analytes below 5% of the decision limit, 5% of the sample concentrations, or the MDL, whichever is higher.	Documented source of contamination.
Laboratory Control Sample	Every batch for all compounds (advisory limits)	Recovery ±10% of true value.	%R are outside criteria, sample batch should be re-calibrated and re-analyzed. If still outside criteria, qualify associated data biased high or biased low as appropriate.
Matrix spike and duplicate and sample duplicate	1 per 20 samples per matrix (Advisory Limits)	75%≤%Rec.≤125%; %RPD<20%; If spike(s) outside of limits, analyze PDS.	If matrix spike recovery does not meet criteria (except Ag), a post digestion spike is required for all methods except GFAA. Qualify results in accordance with Regional criteria.

Sources: Analytical Method, USEPA 1983; Advisory Limits, USACE 1998.

251

3.0 Health and Safety Plan Addendum

3.1 OBJECTIVE AND SCOPE

This site-specific Health and Safety Plan Addendum (HSPA) was developed to provide the requirements for protection of site personnel including government employees, IT Corporation, regulators, subcontractors, and visitors, who are expected to be involved with the following site activities:

- Surface water sampling at SWMU 31
- Soil/sediment boring advancement/sampling at SWMU 31
- Groundwater sampling at SWMU 31
- Regional groundwater study activities at the HSA

This addendum addresses site-specific training, PPE, and air monitoring requirements. General health and safety issues that are also applicable to this scope of work are addressed in Volume III of the MWP, as shown in **Table 3-1**.

Table 3-1
Health and Safety Issues Discussed in the MWP

Health and Safety Issue	Section in MHSP
Site Safety and Health Documentation	1.4
Safety Statement	1.5
Personnel H&S Responsibilities	2.1
Hazard Assessment and Control	3.0
Training Plan, General	4.0
Medical Surveillance Plan	5.0
Site Safety and Control	6.0
Personal Protective Equipment	7.0
Personnel and Equipment Decontamination	8.0
Monitoring Plan	9.0
Emergency Response and Contingency Plan	10.0

IT Corporation and subcontractor personnel performing field activities and site visitors will read this HSPA and will be required to follow its protocols as minimum standards. This HSPA is written for the site-specific conditions at SWMU 31 and the HSA and must be amended if conditions change. A copy of this HSPA will be available at each work site.

3.2 TRAINING PLAN

Training will be used to review important topics outlined in this addendum and to inform IT Corporation personnel and subcontractor personnel of the hazards and control techniques associated with SWMU 31 and the HSA.

3.2.1 Project-Specific Hazard Analysis

The following hazards must be recognized and controlled during applicable investigation activities:

Physical hazards.

- Heat/cold stress—refer to Sections 3.2.1 and 3.2.2 of the MHSP;
- Manual lifting—refer to Section 3.2.4 of the MHSP; and
- Slips, trips, and falls—refer to Section 6.1.1 of the MHSP.

Biological hazards. Refer to Section 3.3 of the MHSP.

- Insect bites and stings;
- Tick bites;
- Snake bites; and
- Plants.

Chemical hazards.

- Chemicals of concern in site-specific media.

3.2.2 Hearing Conservation Training

Site personnel involved in heavy equipment operation in addition to other operations involving exposure to noise levels exceeding 85 dBA 8-hour time-weighted average (TWA), shall be trained according to 29 CFR 1910.95. This training shall address the effects of noise on hearing, the purpose, advantages, disadvantages, and selection of hearing protection devices, and the purpose and explanation of audiometric test procedures.

3.2.3 Hazard Communication Training

In order to comply with the requirements of the OSHA Hazard Communication (HAZCOM) Standard, 29 CFR 1910.1200, IT Corporation will have a written HAZCOM Program in place. The written HAZCOM program addresses training (including potential safety and health effects from exposure), labeling, current inventory of hazardous chemicals on site, and the location and use of Material Safety Data Sheets (MSDSs). The SHSO will arrange HAZCOM training for site personnel at the time of initial site assignment. Whenever a new hazardous substance is introduced into the work area or an employee changes job locations where new chemicals are encountered, supplemental HAZCOM training shall be scheduled and presented. HAZCOM training shall be documented by the SHSO using a HAZCOM Employee Training Record. This documentation and IT Corporation's HAZCOM program (HS060 in IT Corp. 1999) will be maintained onsite for the duration of the project, and later incorporated in the employees' personal training file.

3.2.4 Confined Space Entry Training

Confined space entry training will not be required for fieldwork, as there will be no confined spaces encountered during this investigation.

3.2.5 Daily Safety Meetings

Each day before starting investigative activities, contractor and subcontractor personnel will be given a safety briefing by the SHSO. This briefing will identify the anticipated site activities and the potential hazards that may be encountered during that day's activities.

The safety briefing may also be used to review use of safety equipment, emergency medical procedures, emergency notification signals, accident prevention, and relevant sections of the work plan. As needed, these topics will be reviewed daily to ensure that site operations are conducted in a safe manner. A daily debriefing will also be held, if needed. Records of safety meetings documenting the date, attendees, and discussion topics covered will be maintained.

3.3 SITE SAFETY AND CONTROL

Site safety is the responsibility of site personnel. Personnel onsite will be required to follow safe work practices contained in this section, and immediately notify the SHSO of conditions that do not comply with the Master Health and Safety Plan (MHSP). These provisions are intended to be the minimum safe practices that site personnel will follow.

3.4 PERSONAL PROTECTIVE EQUIPMENT AND CLOTHING

PPE will be required during fieldwork. The minimum and initial level of PPE for these activities will be Modified Level D, consisting of Tyvek, steel-toed boots, nitrile/latex gloves, safety glasses, and a hard hat. An organic vapor level between 1 and 5 ppm above background, as measured by a PID, will cause the level of PPE to be upgraded to Level C. The initial selection of PPE is based on a hazard assessment, including the review of existing analytical data and related toxicological information with respect to the proposed field activities. PPE assignments are subject to change based upon site conditions and task variation. The SHSO will review the required level of protection and safety equipment for each task with the sampling crew. The decisions on which protective level is most appropriate will be made by the SHSO.

In accordance with 29 CFR 1910.134, personnel working onsite will be required to participate in IT Corporation's written respiratory protection program (HS601 in IT Corp. 1999). Personnel slated for fieldwork will have a qualitative fit test performed at least once per year or more frequently as required by law. Site personnel will be trained on the use, limitations, maintenance, inspection, and cleaning of respirators.

3.5 MONITORING PLAN

During sampling activities, the SHSO will monitor the site initially and continuously for potentially hazardous airborne contaminants using a PID, which will be used to detect organic vapors. The PID will be calibrated in accordance with the manufacturer's calibration instructions. Draeger tubes may be used to monitor for specific contaminants based on the readings from the other instruments, as appropriate. The action levels for volatile organics at sustained concentrations in the breathing zone are as follows:

PID Readings	Action
Background to (background + 1 ppm)	Continue work, monitor
(Background + 1 ppm) to (background + 5 ppm)	Upgrade to Level C PPE
>(Background + 5 ppm)	Stop work, investigate

4.0 References

Dames & Moore. 1992. *Final Draft Verification Investigation.* Prepared for U.S. Army Toxic and Hazardous Materials Agency, Radford Army Ammunition Plant, October 1992.

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URS. 2002. *Master Work Plan Update, Draft, Radford Army Ammunition Plant.* Prepared for the U.S. Army Corps of Engineers (USACE), Baltimore District.

U.S. Army Corps of Engineers (USACE). 1998. *Shell for Analytical Chemistry Requirements.* December.

U.S. Army Environmental Center (USAEC). 1995. *Reference Sampling and Analysis Program at the U.S. Army Aberdeen Proving Ground, Soil, Sediment, and Surface Water Data Report.*

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Appendix A

Standard Operating Procedures

STANDARD OPERATING PROCEDURE 30.12
VIBRACORE DEEP SEDIMENT SAMPLING

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for obtaining representative deep sediments sampling using the Vibrecore sediment sampling method. These procedures and guidelines were developed in conjunction with the procedures set forth in *Technical Practice for Vibracore Sediment Sampling* (Normandeau Associates). Sediments include solid matter derived from rocks or biological materials which settled from the water column. This procedure can be applied to the collection of sediment samples from areas of deposition such as streams, rivers, ditches, lakes, ponds, and lagoons.

2.0 MATERIALS

- Photoionization Detector (PID)
- Stainless steel, Polytetrafluoroethelyne (PTFE), or PTFE-lined sampling tray or bowl
- Stainless steel or PTFE dip sampler, scoops, trowels, spoons, ladles
- Portable vibracore with marsh buggy, barge, boat, or truck (as needed based on site conditions)
- Aluminum core barrels and liners
- Sample bottles
- Rubber boots/waders
- Plastic sheeting
- Personal flotation devices (PFDs), as applicable
- PPE (personal protective equipment)
- Cooler with ice

3.0 OPERATING PROCEDURE

Portable vibratory coring uses a vibrating head assembly clamped onto a core barrel up to 30 feet in length to obtain a virtually undisturbed core sample in sand, silt, or clay. A plastic sample liner can be fitted into the core barrel to enable collection of continuous sediment samples up to 3 inches in diameter. The vibracore sampling assembly can routinely collect 10 to 20 foot continuous core samples in loosely consolidated, wet, or submerged media.

For all samples, mark the sampling location on a site map. Photograph (optional, recommended) and describe each location. Place a numbered stake immediately adjecent to the sample location.

1. Don personal protective equipment in accordance with the site safety and health plan.
2. Assemble and test the vibracore according to manufacturer's instructions and assemble the core liner, core cutter and catcher.
3. Measure and record the length of the vibracore unit from the bottom to the top of the core barrel.
4. Clamp the vibrating head assembly onto the core barrel and raise the unit off the deck until the coring assembly is vertical.
5. For submerged sediments the progress of the vibracore will be measured at the surface of the water/air interface. To determine the sediment/water interface ("0" feet of penetration), slowly lower the vibracore and core barrel into the water until the bottom of the core barrel is at the sediment/water interface. Measure the depth of water. The water/air interface at 0 feet penetration is determined by subtracting the water depth from the measured length of the core barrel. Operate the vibracore unit until the desired depth is obtained. Measure and record the length of core barrel extending above the water. The difference between these two measurements is the penetration depth.
6. For exposed sediments, 0 feet of penetration can be obtained visually when the core barrel contacts the surface.
7. Lower the assembly unit at a rate not to exceed 1 ft/sec.
8. Activate the vibracore and begin lowering the unit to allow penetration into the sediment. A noticeable decrease in penetration will indicate that either a sediment clay layer has been reached, or that the unit has contacted an impervious object or material. With the latter, a second or third coring attempt may be necessary. Record the final penetration depth and time on vibracore sampling log.
9. Slowly winch the vibracore out of the sediment and up to the surface of the water. It may be necessary to activate the vibracore for a short time to withdraw the core barrel from the sediment when collecting deep samples (i.e., 15 feet or deeper).
10. Place the core barrel on the deck of the barge or boat. Remove the cutter head and core catcher from the end of the core barrel. Cap and tape both ends of the core barrel and clearly label the core with the sample ID number and core orientation ("top" on one end and "bottom" on the other).
11. If possible, maintain the core sample in a vertical position until the core is delivered to the sample processing area.
12. Lay the sample tube horizontally on the sample logging table, remove end caps, and drain excess water.

13. Cut the core barrel off on the end labeled "surface" just above sediment and replace the cap. Measure the length of the core sample recovered and record as core recovery in the sampling log. Cut the sample tube lengthwise with a clean stainless steel knife and separate the whole core into two lengthwise halves. Cut away the smeared edges of the core with a clean putty knife.
14. Log and photograph the core and record the data in the sample logbook

3.1 SAMPLING PROCEDURES

1. Make a sketch of the sample area, showing nearby features and permanent structures that could be used to locate the sample points on a map. Whenever possible, include measured distances from such identifying features. Include depth and width of waterway, rate of flow, type and consistency of sediment, and the point and depth of sample collection (e.g.,along shoreline ,mid-channel).
2. Start downstream and work upstream to prevent contamination of unsampled areas.
3. Collect the sediment sample.
4. Ensure that all field observations are recorded in the sample logbook. The following data should be recorded :

   Sample location

   Sample depth

   Characteristics of the surficial sediment

   - texture
   - color
   - biological structures (shells, macrophytes)
   - presence of debris (wood chips, wood fibers)
   - presence of oily sheen
   - odor

   Changes in sediment characteristics

   Penetration depth

   Comments related to sample quality

   - leakage
   - winnowing
   - disturbance

5. Screen the sediment sample with the PID following procedures outlined in the Master Health and Safety Plan.
6. Collect samples for VOC analysis first.
7. Transfer the remaining sample into a stainless steel bowl and thoroughly homogenize with a stainless steel spoon or trowel.
8. The sample will then be placed in the appropriate sample containers, wiped clean and dry, sealed, labeled, and stored in a temperature controlled chest (4 ± 2°C).
9. Decontaminate equipment according to SOP 80.1.

3.2 LABELLING AND PACKAGING

Refer to SOPs 50.1 and 50.2.

3.3 INVESTIGATIVE DERIVED WASTE

Dispose of all sampling wastes in properly labeled containers. Refer to SOP 50.1.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

- Both surface water and sediment samples are to be collected at the same location.
- Collect the surface water sample first (SOP 30.3). Sediment sampling usually results in disturbance of the sediments which may influence the analytical results of the surface water samples.
- If sampling from a boat or near water bodies with a depth of four feet or more, the sampling team shall wear personal flotation devices (life jackets).
- Collect samples first from those areas that are suspected of being the least contaminated, thus minimizing the risk of cross contamination.
- Cap and label core as soon as possible.

6.0 REFERENCES

EPA/540/P-87/001. *A Compendium of Superfund Field Operations Methods.*

Normandeau Associates, *Technical Practice for Vibracore Sediment Sampling.*

yes

Appendix B

Statement of Qualifications

STATEMENTS OF QUALIFICATIONS

Rick Swahn – Program Manager, is a registered professional geologist with more than sixteen years experience managing large Army HTRW environmental projects throughout the USACE North Atlantic District (NAD), most of them cost reimbursable. Mr. Swahn has managed as well as performed all aspects of these projects to include preliminary assessments, site investigations, RI/FS studies, proposed plan and ROD decision documents, remedial action planning and design, and military installation compliance activities. Throughout his career, Mr. Swahn's responsibilities have included scoping, estimating, scheduling, and managing numerous multi-tasked, multi-disciplined projects most budgeted in the multi-million dollar range. Currently, Mr. Swahn is managing the preparation of an EE/CA decision document of the Colonie FUSRAP site, located in Albany, NY for the NAD under the Baltimore TERC.

Jeffrey Parks - Project Manager, is a registered professional geologist with over 19 years of personnel and project management, geologic, hydrogeologic, and hazardous waste management experience. Mr. Parks' expertise is in HTRW projects, RI/FSs, RFIs, RCRA permitting and remedial actions. He is currently responsible for senior management of U.S. Army Corps of Engineers remedial investigation, feasibility study, and remediation projects. He has just completed and submitted a RCRA Part B, Subpart X permit application for open burning and open demolition for a U.S. Army Arsenal in New Jersey. Mr. Parks has been the senior hydrogeologist and project manager for USEPA-funded uncontrolled hazardous waste sites, and for soil and groundwater investigations for the Washington D.C. Department of Public Works and the Washington Metropolitan Area Transit Authority, and a team member of the Federal Aviation Authority-expedited response action group. Mr. Parks is the Technical Manager for Scientists in IT's Edgewood office and Assistant Manager of Hydrogeology for IT's Northern Division. Responsibilities included guidance for scientists in addition to project staffing, mentoring, and yearly progress evaluations.

Mark Thomas – Task Manager, is a biologist and has been involved in the environmental field for the past eleven years. His academic background includes a strong emphasis on both wildlife and fisheries management. Mr. Thomas has gained considerable and valuable experience during his tenure with ICF Kaiser and the IT Corporation. He has served as the Field Operations Leader, Field Team Leader and Site Health and Safety Officer for the sampling of sediment, sludge, surface soil, subsurface soil, surface water, groundwater, air, fish, and crabs. Mr. Thomas is skilled in the areas of technical report writing, water quality analysis, Global Positioning System (GPS) and LORAN operation, necropsy techniques, and motor boat operation, navigation, and maintenance. Mr. Thomas is also experienced in the collection and identification of estuarine fish, plants, and invertebrates. Before joining the IT Corporation, Mr. Thomas was employed by the Maryland Department of Natural Resources under the Fisheries Division where he gained valuable field sampling and research experience.

Timothy Leahy – Field Team Leader & Site Health and Safety Officer, is a geologist with eight years experience in the environmental field. Mr. Leahy has been employed by the IT Corporation for one year. His prior work experience includes seven years as a geologist at Dames and Moore, where he gained considerable and valuable experience with CERCLA RI/FSs at military installations in the northeastern United States. He has served as a Field Manager, Field Team Leader, Geologist and Site Health and Safety Officer on these projects. His academic background includes a MS in geology, specializing in geochemistry, from Dartmouth College in Hanover, New Hampshire and a BA in geology from the University of Pennsylvania in Philadelphia, PA. Mr. Leahy is skilled in the areas of technical analysis and report writing, monitoring well design and installation, and geologic field methods. He has recently completed the design of a field program to characterize and delineate groundwater contamination at a regional level for the central industrial area at Picatinny Arsenal in northern New Jersey.

Dave Kateley – Health and Safety Manager, has over twenty years of experience in environmental management. He has served as a Site Safety Officer, Hazardous Materials Specialist, Construction Superintendent/Site Safety Officer, and Construction Engineer. Mr. Kateley acted as the Safety Officer at the Hunter Army Airfield tank removal and site remediation project at Fort Drum, New York. The project demanded close interactions with the U.S. Army Corps of Engineers and implementation of all related safety concerns. Duties included daily safety meetings, site sampling, and keeping all records and logs pertaining to the safety program. As a Construction Superintendent and Site Safety Officer, Mr. Kateley supervised the construction of the out buildings and fencing at the G Street Superfund project on Aberdeen Proving Grounds, Edgewood Area. He incorporated procedures dealing with Superfund and hazardous waste sites, as in air monitoring, donning/doffing levels A through C PPE, and writing the Site Specific Safety Plan. As a Construction Engineer, Mr. Kateley was responsible for all construction layout procedures, including the use of transits and building levels for grade and line. He also coordinated subcontract work for various multi-million dollar contracts.

Eric Malarek – Quality Assurance Manager, is a chemist for the IT Corporation. His primary responsibilities include project chemical management, consulting, and technical support for a variety of public and private environmental projects. He has over 10 years of professional experience in the environmental testing field including laboratory management, quality assurance and quality control, data management, field sampling, and methods development. This includes three years of managing a laboratory and seven years as Quality Assurance Officer. His experience with the laboratory covers environmental analysis for sample matrices including groundwater, surface water, drinking water, soil, sediment, sludge, and waste. His familiarity with laboratory methods includes CLP Statements of Work, USEPA 500- and 600-Series Organic Methods, SW-846 Test Methods for Evaluating Solid Waste, Standard Methods for the Examination of Water and Wastes, and Methods for Chemical Analysis of Water and Waste. As QA Officer, he has written and implemented FLDEP Laboratory Quality Assurance Plans and Site-Specific Quality Assurance Project Plans. He has served as the Laboratory CLP Coordinator for Inorganics with the USEPA CLP Program. Mr. Malarek has performed system and performance audits and implemented corrective action procedures. In addition, he was involved in data reduction, review, and validation to ensure date integrity to meet the data quality objectives. He also was employed by the USEPA to perform inorganic analysis on environmental samples. He holds a Bachelor's degree in Chemistry from Rutgers University and a MBA degree from the University of Central Florida.

Wendell Barner – Senior Hydrogeologist, is a registered professional geologist in five states, has more than 17 years of geological, engineering, and environmental consulting experience, and is currently the Geology and Hydrogeology Group Manager at IT Corporation's corporate office located in Monroeville, PA. His primary expertise is in karst hydrogeology and he has performed numerous RI/FS and RCRA facility investigations in karst regions throughout the United States and at international locations. Mr. Barner has authored and presented more than 16 papers on karst hydrogeology at regional and international conferences and symposiums. His experience with interdisciplinary environmental projects combines a wide-variety of responsibilities and experience including hazardous waste site characterization, groundwater-tracing studies, geologic and hydrogeologic data acquisition and analysis, and addressing aquifer remediation through the evaluation of various technologies including natural attenuation. He has worked on a number of DoD, DoE, RCRA, and CERCLA facilities, in USEPA Regions I, III, IV, V, VII, and IX, and in over 20 U.S. states and territories. Other responsibilities include project management, managing multi-PRP groups, supervising and mentoring junior staff, procuring and scheduling subcontractors, client development and proposal preparation. Other experience includes compliance monitoring, landfill and monitoring design, land planning and development, design of small wastewater treatment and disposal systems, design of stormwater systems, and land surveying.

Kweku Acquah – Project Chemist, is a chemist with the IT Corporation, Edgewood, Maryland office. His primary responsibility includes project chemical data management and validation, consulting, and technical support for a variety of environmental projects. He has over twenty years of industrial experience in various capacities with responsibilities for process and quality control management, research and development, instrumental and wet chemical analysis, laboratory management, environmental compliance, environmental site assessment and characterization, chemical waste characterization, lab-packing, manifesting and coordinating hazardous waste disposal activities. He has worked for such reputable companies as General Electric Company in Liverpool, NY, Polaroid Corporation in New Bedford and Norwood, MA, SGS/Commercial Testing & Engineering in Dundalk, MD, Chem Clear of Baltimore (Clean Harbor) in Baltimore, MD and Chemical Waste Management at DOD sites at APG, Aberdeen, MD, Bermuda, Puerto Rico and the US Virgin Islands. He holds a Bachelor's degree in Chemistry and Environmental Science from Syracuse University and also undertook some graduate studies in Analytical Chemistry and Economics at Northeastern University in Boston, MA.

Sue Reinhardt - Contract Specialist, has twelve years of experience in finance, contracts, and business planning. She holds a B.B.A. in finance from James Madison University, Harrisonburg, Virginia, and a M.S.B. in International Business from Johns Hopkins University, Baltimore, Maryland. At the IT Corporation, Ms. Reinhardt is currently working under two multi-task order projects for the U.S. Army. The contracts total over $50 M and work is performed at various Army installations in the U.S. Ms. Reinhardt is the contract, subcontract, and financial manager for these programs. Ms. Reinhardt also provides the property and warehouse management for these programs. In addition, she provides business unit financial support for the Abingdon/Edgewood office. Ms. Reinhardt has recently increased her responsibilities by assisting the Director of Finance in the EEG Southeast reporting capacity.