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DELIVERY ORDER NO. 0060
ENVIRONMENTAL SERVICES
PROGRAM SUPPORT
CONTRACT DACA31-00-D-0011

RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

WORK PLAN ADDENDUM NO. 15
Soil Sampling Investigation for SWMUs 8 and 36

FINAL
March 2003

PREPARED BY:

URS

5540 Falmouth Street, Suite 201
Richmond, Virginia 23230
(804) 965-9000 main
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COMMONWEALTH *of* VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

W. Tayloe Murphy, Jr.
Secretary of Natural Resources

Street address: 629 East Main Street, Richmond, Virginia 23219
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Robert G. Burnley
Director

(804) 698-4000
1-800-592-5482

21 April 2003

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

RE: Work Plan Addendum 015 (WPA 15)

Dear Mr. McKenna:

This office has reviewed the referenced draft document and concurs with WPA 15. No revisions to the document are required.

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

April 14, 2003

In reply
Refer to 3HS13

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

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

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

Re: Radford Army Ammunition Plant
SWMUS 8 and 36
Document submittal and review

Dear Mr. McKenna and Ms. Jake:

The U.S. Environmental Protection Agency (EPA) has reviewed the Army's draft final *Work Plan Addendum 15* submittal for the investigation of SWMUs 8 and 36, located at the Radford Army Ammunition Plant (RFAAP), as well as the Army's response to EPA's 3/10/03 comments pertaining to the review of the original draft document. Outlined below, please find EPA's comment based upon the review of the above:

1. Figure 1-10 depicts both an eastern and a western lagoon present at SWMU 8, with the eastern lagoon having been replaced with a concrete tank. Based upon the Army's response, a 1998 draft RCRA Interim Remedial Action closure report was submitted for the eastern lagoon, but was never reviewed or approved. The Army should incorporate the 1998 RCRA closure report into the draft RFI report for SWMU 8. Thus, all of the data collected for SWMU 8 can be evaluated under the SSP. This consolidation will help facilitate the

expeditious completion of the RFI for SWMU 8.

This concludes EPA's review of the Army's draft final *Work Plan Addendum 15: SWMUs 8 and 36*, located at the RFAAP. Based upon our review and comment above, *Work Plan Addendum 15* is approved, and the requirement for the consolidation of the 1998 draft RCRA closure report into the draft RFI for SWMU 8 noted. In accordance with Part II.(E)(5) of RFAAP's Corrective Action Permit, *Work Plan Addendum 15* 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

McKenna, Jim

rom: McKenna, Jim
ent: Friday, April 11, 2003 7:37 AM
o: Redder, Jerome; 'Thomson.Bob@epamail.epa.gov'
Cc: 'John.E.Tesner@nab02.usace.army.mil'; 'msleeper@deq.state.va.us'
Subject: RE: SWMU 8 [illegible]

I agree also.

-----Original Message-----
From: Redder, Jerome
Sent: Thursday, April 10, 2003 4:32 PM
To: 'Thomson.Bob@epamail.epa.gov'; McKenna, Jim
Cc: John.E.Tesner@nab02.usace.army.mil; msleeper@deq.state.va.us
Subject: RE: SWMU 8

The eastern lagoon was and is a VPDES permitted facility.

The report was not reviewed or approved by EPA.

I agree with your approach. My first sentence is clarification.
Jerry

---Original Message-----
om: Thomson.Bob@epamail.epa.gov [mailto:Thomson.Bob@epamail.epa.gov]
Sent: Thursday, April 10, 2003 4:00 PM
To: Redder, Jerome; McKenna, Jim
Cc: John.E.Tesner@nab02.usace.army.mil; msleeper@deq.state.va.us
Subject: SWMU 8

Radford Folks:

In reviewing WPA 15, it was mentioned that a closure report for the eastern lagoon of SWMU 8 was submitted in 12/1998.

Two questions:

(1) was the eastern lagoon at SWMU 8 a permitted facility ?
(2) was the 1998 closure report ever reviewed and approved by EPA ?

I am assuming that the answer to both questions is no. My suggestion (and it will be included in the WPA 15 approval letter) will be to include the 1998 Closure report for the SWMU 8 eastern lagoon in the draft report for SWMU 8 so that both the eastern and western lagoons can dealt with in the final report, i.e. and closed out together in one cument.

If you have any objections to this, please let me know ASAP, as I will

McKenna, Jim

From: McKenna, Jim
ent: Friday, April 11, 2003 6:57 AM
o: 'Thomson.Bob@epamail.epa.gov'
Cc: Redder, Jerome; John.E.Tesner@nab02.usace.army.mil
Subject: RE: Radford MWP

Importance: High

Rob, You are correct. Understand your situation but we need to get final approval on the MWP. Thanks, Jim.

-----Original Message-----
From: Thomson.Bob@epamail.epa.gov [mailto:Thomson.Bob@epamail.epa.gov]
Sent: Thursday, April 10, 2003 11:00 AM
To: McKenna, Jim
Cc: Redder, Jerome; John.E.Tesner@nab02.usace.army.mil
Subject: Radford MWP

Gentlemen:

I found two copies of the final MWP (Sept. 2002) for Radford that were recently sent to me. I am assuming that they were sent in reply to the March 10, 2003 comments on WPA 15.

ill forward a copy of the final MWP to EPA-Ft. Meade for their use in viewing future WPAs for Radford.

Thanks for your patience....Rob

(I just picked up another site - Letterkenny Army Depot - so things are busy for me)

Jim:

I will forward the QA review checklist on to EPA Ft. Meade.

One question: I know that EPA-Ft. Meade had requested a copy of the final RFAAP MWP for use in reviewing individual Addendum Work Plans (see General comment 1 of the March 10, 2003 comments on WPA 15). Does the Army know if the RFAAP MWP was sent to EPA-Ft. Meade ??

Thanks...Rob

ATK
ALLIANT TECHSYSTEMS

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

March 31, 2003

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

Subject: Work Plan Addendum 15 Soil Sampling Investigation for Solid Waste Management Units 8 and 36, Final March 2003, Radford Army Ammunition Plant EPA ID# VA1 210020730

Dear Mr. Thomson:

Enclosed is one certified copy of Work Plan Addendum 15 Soil Sampling Investigation for Solid Waste Management Units 8 and 36, Final Radford Army Ammunition Plant for your approval. Your additional two copies will be sent under separate cover as well as additional copies to the Virginia Department of Environmental Quality (VDEQ), U.S. Army Environmental Center, U.S. Army Center for Health Promotion and Preventive Medicine.

As Work Plan Addendum 15 has been revised to address your review comments of March 10, 2003 and your conference call the same date with Mssrs. Jim McKenna and John Tenser, it is being submitted as a final document. The responses are enclosed as Attachment 1.

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

w/o enclosure

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

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

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

03-815-54
JMcKenna/JJRedder

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

Tony Perry
U.S. Army Environmental Center
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Powell, TN 37849

Dennis Druck
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Aberdeen Proving Ground, MD 21010-5403

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

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

Coordination: J. McKenna

03-815-54
JMcKenna/JJRedder

Concerning the following:

Work Plan Addendum 15
Soil Sampling Investigation for Solid Waste Management Units 8 and 36
Final March 2003
Radford Army Ammunition Plant

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

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

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

03-815-54
JMcKenna/JJRedder

Attachment 1

Response to EPA Comments dated 10 March 2003
on
Work Plan Addendum (WPA) 015, Soil Sampling Investigation for SWMU's 8 and 36 December 2002

Comment 1

Previous EPA review comments have noted that several sections in WPA 15 are referenced as being in either Appendix A of Master QAP, or in some other document. The Army has responded that an overarching document which provides comprehensive discussions of standard procedures, protocols, and methodologies for completion of RFAAP site investigations exists, and is referred to as the Radford Army Ammunition Plant Master Work Plan (MWP). It includes the Master QAP. For future reference for the EPA review team located in Fort Meade, please forward to the Region an additional copy of the final RAAP MWP for EPA-Fort Meade's use in future reviews.

Response

Two additional copies of the RFAAP Master Work Plan will be provided to USEPA for use by the review team located in Fort Meade.

Comment 2

One of the key personnel at this site, who should be listed on the signature page, is the data validator. They need to be listed by name, affiliation, and their qualifications need to be listed.

Response

Will add the data validator to the information presented in Section 2.2.2 and will list their name, affiliation, and qualifications.

Comment 3

Site background information needs to be more specific about what the settling lagoons were used for. The process which produced the sludge needs to be stated, for instance; if the sludge was a by product of ammunition production, were the explosives based on nitrates, or perchlorates? Were heavy metals used such as fulminate of mercury? Were more exotic explosives used at the site, like heavy metal azides? Detailed information on the process which produced the problem will allow the investigation to be designed for those specific compounds.

Response

Additional site background information regarding the previous processes relevant to the settling lagoons will be included to assist with identification of Potential Constituents of Concern, assessment of site boundaries, and approximation of potential waste source volume.

Comment 4

Section 2. Whenever a mass spectral analysis is requested using SW-846 methods, such as 8270C and 8260B, the laboratory should submit a Tentatively Identified Compound (TIC) list with each analysis. The TIC analysis can identify unknown and unexpected compounds at all stages of investigation and needs to be requested from the laboratory before samples are submitted. It is unclear in the draft WPA 15 how TICs will be addressed.

Therefore, please include language similar to that outlined below in the final WPA 15:

"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.

Response

The text within the Work Plan will be modified to include the suggested language.

Comment 5

Precision, accuracy and representativeness all reference sections in the master QAP which give the definition of the terms. The reviewer is well aware of the definitions. The QAP is supposed to assign values for those terms for each analyte which will meet the project specific quality needs for the project. "Test Methods for Evaluating Solid Waste," SW-846 is a guidance document. Therefore all analytical parameters have to be specified when using this document. Parameters which need to be specified include; the specific analytes, their required detection limits, the calibration precision requirements, the percentage deviation and the matrix spike matrix spike duplicate, precision; the entire analytical suite needs to be defined when referencing most methods in SW-846.

Response

The full analyte list covering this investigation is found in Tables 2-5 through 2-11. Additional discussion regarding precision, accuracy and representativeness are included in the Master QAP specifically in Sections 3 and 8 that are beyond definitions of the terms. Further, information regarding MS/MSD's are contained in the USACE shell document which is referenced in the Master QAP. Regardless, additional opportunity exists to supplement Section 2 with the requested information. Text and tables will be added.

Comment 6

Completeness goals need to be established for the entire event, not just the field activities.

Response

Completeness goals are included in the Master QAP section 3.2.4.

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Comment 7
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. It is not clear in the draft WPA 15 how this is to be accomplished. Therefore, please include language similar to that outlined below in the final WPA 15:

> "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."

Response
The text within the Work Plan will be modified to include the suggested language.

Comment 8
The plan should identify a project quality assurance (QA) officer who is a government employee. It has been determined that the responsibilities of this position are too critical to be detailed to a subcontractor.

Response
The project QA officer for the Army for Radford AAP IR program projects is Mr. Marc Randrianarivelo, USACE Baltimore District. Mr. Randrianarivelo will be added to Section 2.2.2.

Comment 9
All SW-846 methods which use an extraction, or work-up method, need to have that extraction method specified as it is associated with the respective analytical method.

Response
This comment was one of several draft comments attached to an e-mail from EPA dated 9 April 2002 on the Master Work Plan (MWP). RFAAP responded to these draft comments via e-mail on 18 April 2002. EPA acknowledged RFAAP's response in an e-mail dated 8 May 2002. This comment was not included in EPA's final set of comments transmitted via letter dated 22 May 2002. Since this comment has been offered again during the WPA 15 review, RFAAP's original response on 18 April is included but revised to include the WPA 15-specific section. It is as follows:

The analytical preparatory method citations for the SW-846 methods may be found in Section 2.5 of WPA 15 and Section 6.0 of the Master QAP.

Comment 10
Regional guidance recommends the use of a document control header for QAPPs and FSPs. Document control headers consist of identification of each page of the document with a section number, revision number, revision date, and page number.

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Response
The presentation of document information in the footer of RFAAP documents represents an evolutionary process managed by the RFAAP project team. The current format represents an optimized and standardized presentation that accelerates document revision and production. The process by which documents are conveyed to both EPA and VDEQ is enumerated in the RFAAP's RCRA permit. This process is followed for all submittals and is believed to provide the tracking and documentation desired by both the Installation and regulatory community. The existing format has been successfully used for the 14 previous work plan addenda and is preferred.

Specific Comments

Comment 1

Section 1.1, Introduction, on page 1-1 states that the soil sampling at SWMUs 8 and 36 is designed to assess appropriate disposal methods for soil excavated during future construction. Given this future scenario, it may be appropriate to evaluate subsurface soil for potential ecological risk to determine if soil removed during future construction activities would present ecological risk if spread on the surface.

Response
The SWMU 8 western lagoon shown in photograph No. 1 in Appendix B is planned for removal and subsequent replacement with a concrete settling tank similar to that constructed at the eastern lagoon. Similarly SWMU 36, the existing drying beds will be replaced with a concrete tank for sludge drying. This lagoon, the drying beds and the immediate surrounding area where any subsurface soil would be placed are man-made structures that are part of an active treatment unit and/or construction project. Further, a significant amount of soil is likely to be removed from both SWMU's 8 and 36 as a result of construction. Plans call for this soil to be disposed off-site. SWMU 8 and 36 are not considered a suitable ecological environment.

Comment 2

Section 1.2.4 Conceptual Site Model: There are no future residential or trespasser scenarios in the draft WPA 15. Please discuss what precludes these receptors in the final WPA 15.

Response
Current and future land-use scenarios at RFAAP are limited to industrial operations. Consistent with the SSP, both industrial and residential scenarios will be considered. The risk screening will consider the industrial worker scenario. This scenario is considered more conservative than the trespasser scenario, therefore, negating the need to consider the trespasser scenario separately.

Comment 3

Section 1.2.4 Conceptual Site Model: There is no groundwater or leachate pathway. The draft Work Plan indicates that water does not flow overland into the river. Also, it reports that there is insufficient data to conclude that groundwater discharges to the river. What happens to the water that infiltrates the SWMU? This pathway must be identified and evaluated. Essentially, there is a data gap if there is insufficient data to conclude where groundwater is flowing from the site.

If further investigation concludes that the groundwater pathway is complete to the New River or tributaries, the data from the New River collected as part of the New River and Tributaries Study (1997) should be evaluated to determine if it is sufficient data to characterize ecological risk in the New River from this site.

Response
The purpose of WPA 15 is to screen and assess whether COPC's exist at the proposed construction areas of SWMU's 8 & 36. Subsurface soil below the sludge layer will be sampled as part of WPA 15. The conceptual site model, as presented, assumes that COPC's do not exist at these CaSO4 settling lagoon and drying beds.

This is a reasonable assumption given that CaSO4 sludge is no longer considered a RCRA listed hazardous waste and that the purpose of these engineered treatment units was to neutralize acidic wastewater. COPC's should not have been present in this wastewater stream. A possible pathway may exist to groundwater via infiltration of water that may collect in the lagoons. That groundwater may be hydraulically connected to the New River. This pathway will be added to the CSM. Further evaluation of groundwater pathways, if necessary, is proposed subsequent to the screening effort and the report of results.

Comment 4

Section 1.2.5, Data Gap Analysis, on page 1-21 identifies data gaps associated with previous samples, and lists the chemicals that will be analyzed in proposed samples. Analysis of soil samples should include pH, total organic carbon (TOC), and grain size on a subset of the soil samples (at least one per lagoon) to identify soil characteristics and evaluate the bioavailability to ecological receptors.

Response

The planned field activities will be modified to incorporate pH, total organic carbon, and grain size analyses. Collection of this data is SOP for RFAAP investigations, however, another data source was presumed available for this project. Upon review , this data source did not contain the complete suite of parameters.

Comment 5

Section 1.3: The draft Work Plan proposes to take discrete and composite samples. Please note that composite samples cannot be used in a risk assessment. The UCL cannot be calculated with composite data. If the purpose of the data is to use it in a risk assessment, then discrete samples must be taken instead.

Response

Discrete samples (surface and subsurface) are planned for this WPA and will be used to perform a Risk Screening. Composite samples will be collected for assessment of the RCRA hazardous waste characteristics of sludge/soil potentially removed as part of the planned future construction at SWMUs 8 and 36.

Comment 6

Figure 1-10 shows the proposed sampling locations for the site. It is unclear why no sampling is proposed for the eastern lagoon at SWMU 8. An explanation should be provided in the final WPA 15. The figure also shows that only one discrete soil sample is proposed for each of the three drying beds at SWMU 36. Given the size of these drying beds (200 feet long by 50 feet wide), one soil sample is inadequate. At least three discrete soil samples should be collected in each drying bed.

Response

Figure 1-10 will be revised to indicate that the eastern lagoon of SWMU 8 has been replaced with a concrete tank. The eastern lagoon was previously replaced with a concrete settling tank in October 1999 and is not included as part of this soil sampling investigation. Soil sampling and a report of results was prepared at the time of construction. A report titled "Closure Report for the Eastern Lagoon of SWMU 8" was submitted to EPA on 14 December 1998.

Regarding the number of samples, the purpose of this WPA is to screen for the presence of COPC's at SWMU's 8 and 36. Characterization may ensue depending on the results of this effort, however, it is unlikely that COPC's exist at this site given that CaSO4 sludge is no longer considered a RCRA listed hazardous waste and that the purpose of these engineered treatment units was to neutralize acidic wastewater. COPC's should not have been present in this wastewater stream. Additional sampling beyond that proposed, appears to be more in line with a characterization effort than the screening effort of WPA 15. Further, a significant amount of soil is likely to be removed from both SWMU's 8 and 36 as a result of construction and disposed off-site. If COPC's were identified as part of this sampling, any further sampling should occur post-removal in order to assess whether COPC's were still present at the SWMU's.

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Comment 7
Photo 1 in Appendix B shows standing water in SWMU 8 (western lagoon). Because this surface water represents a potential exposure pathway to amphibians, and is a drinking water source for upper trophic level receptors, surface water should be collected from any lagoon that has standing water and evaluated in the ecological risk assessment. In addition to the chemical analysis, surface water should be analyzed for basic water quality parameters (i.e., pH, hardness, conductivity) so that site-specific water quality criteria can be calculated for certain metals.

Response
The SWMU 8 western lagoon shown in photograph No. 1 in Appendix B is planned for removal and subsequent replacement with a concrete settling tank similar to that constructed at the eastern lagoon. This lagoon is a man-made structure that is part of an active treatment unit. It is not considered a suitable ecological environment.

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

March 10, 2003

In reply
Refer to 3HS13

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

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

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

Re: Radford Army Ammunition Plant
SWMUS 8 and 36
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 15* for the investigation of SWMUs 8 and 36, located at the Radford Army Ammunition Plant (RFAAP). Outlined below, please find EPA's comments based upon that review:

General Comments

1. Previous EPA review comments have noted that several sections in WPA 15 are referenced as being in either Appendix A of Master QAP, or in some other document. The Army has responded that an overarching document which provides comprehensive discussions of standard procedures, protocols, and methodologies for completion of RFAAP site investigations exists, and is referred to as the Radford Army Ammunition Plant Master Work Plan (MWP). It includes the Master QAP. For future reference for the EPA review team

16

located in Fort Meade, please forward to the Region an additional copy of the final RAAP MWP for EPA-Fort Meade's use in future reviews.

2. One of the key personnel at this site, who should be listed on the signature page, is the data validator. They need to be listed by name, affiliation, and their qualifications need to be listed.

   Response (Army's response is okay)
   Will add the data validator to the information presented in Section 2.2.2 and will list their name, affiliation, and qualifications.

3. Site background information needs to be more specific about what the settling lagoons were used for. The process which produced the sludge needs to be stated, for instance; if the sludge was a by product of ammunition production, were the explosives based on nitrates, or perchlorates? Were heavy metals used such as fulminate of mercury? Were more exotic explosives used at the site, like heavy metal azides? Detailed information on the process which produced the problem will allow the investigation to be designed for those specific compounds.

   Response (Army's response is okay)
   Additional site background information regarding the previous processes relevant to the settling lagoons will be included to assist with identification of Potential Constituents of Concern, assessment of site boundaries, and approximation of potential waste source volume.

4. Section 2. Whenever a mass spectral analysis is requested using SW-846 methods, such as 8270C and 8260B, the laboratory should submit a Tentatively Identified Compound (TIC) list with each analysis. The TIC analysis can identify unknown and unexpected compounds at all stages of investigation and needs to be requested from the laboratory before samples are submitted. It is unclear in the draft WPA 15 how TICs will be addressed.

   Therefore, please include language similar to that outlined below in the final WPA 15:

   > *"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.

5. Precision, accuracy and representativeness all reference sections in the master QAP which give the definition of the terms. The reviewer is well aware of the definitions. The QAP is supposed to assign values for those terms for each analyte which will meet the project specific quality needs for the project. "Test Methods for Evaluating Solid Waste," SW-846 is a guidance document. Therefore all analytical parameters have to be specified when using this document. Parameters which need to be specified include; the specific

analytes, their required detection limits, the calibration precision requirements, the percentage deviation and the matrix spike matrix spike duplicate, precision; the entire analytical suite needs to be defined when referencing most methods in SW-846.

Response (Army's response is okay)
The full analyte list covering this investigation is found in Tables 2-5 through 2-11. Additional discussion regarding precision, accuracy and representativeness are included in the Master QAP specifically in Sections 3 and 8 that are beyond definitions of the terms. Further, information regarding MS/MSD's are contained in the USACE shell document which is referenced in the Master QAP. Regardless, additional opportunity exists to supplement Section 2 with the requested information. Text and tables will be added.

6. Completeness goals need to be established for the entire event, not just the field activities.

Response (Army's response is okay)
Completeness goals are included in the Master QAP section 3.2.4.

7. 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. It is not clear in the draft WPA 15 how this is to be accomplished. Therefore, please include language similar to that outlined below in the final WPA 15:

> *"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."

8. The plan should identify a project quality assurance (QA) officer who is a government employee. It has been determined that the responsibilities of this position are too critical to be detailed to a subcontractor.

   Response (Army's response is okay)
   The project QA officer for the Army for Radford AAP IR program projects is Mr. Marc Randrianarivelo, USACE Baltimore District. Mr. Randrianarivelo will be added to Section 2.2.2.

9. All SW-846 methods which use an extraction, or work-up method, need to have that extraction method specified as it is associated with the respective analytical method. Please specify <u>or reference</u> the analytical preparatory method citations for the SW-846 methods in the final WPA 15.

10. Regional guidance recommends the use of a document control header for QAPPs and FSPs. Document control headers consist of identification of each page of the document with a section number, revision number, revision date, and page number.

Specific Comments

1. <u>Section 1.1, Introduction, on page 1-1</u> states that the soil sampling at SWMUs 8 and 36 is designed to assess appropriate disposal methods for soil excavated during future construction. Given this future scenario, it may be appropriate to evaluate subsurface soil for potential ecological risk to determine if soil removed during future construction activities would present ecological risk if spread on the surface.

2. <u>Section 1.2.4 Conceptual Site Model</u>: There are no future residential or trespasser scenarios in the draft WPA 15. Please discuss what precludes these receptors in the final WPA 15.

3. <u>Section 1.2.4 Conceptual Site Model</u>: There is no groundwater or leachate pathway. The draft Work Plan indicates that water does not flow overland into the river. Also, it reports that there is insufficient data to conclude that groundwater discharges to the river. What happens to the water that infiltrates the SWMU? This pathway must be

identified and evaluated. Essentially, there is a data gap if there is insufficient data to conclude where groundwater is flowing from the site.

If further investigation concludes that the groundwater pathway is complete to the New River or tributaries, the data from the New River collected as part of the New River and Tributaries Study (1997) should be evaluated to determine if it is sufficient data to characterize ecological risk in the New River from this site.

4. Section 1.2.5, Data Gap Analysis, on page 1-21 identifies data gaps associated with previous samples, and lists the chemicals that will be analyzed in proposed samples. Analysis of soil samples should include pH, total organic carbon (TOC), and grain size on a subset of the soil samples (at least one per lagoon) to identify soil characteristics and evaluate the bioavailability to ecological receptors.

5. Section 1.3: The draft Work Plan proposes to take discrete and composite samples. Please note that composite samples cannot be used in a risk assessment. The UCL cannot be calculated with composite data. If the purpose of the data is to use it in a risk assessment, then discrete samples must be taken instead.

6. Figure 1-10 shows the proposed sampling locations for the site. It is unclear why no sampling is proposed for the eastern lagoon at SWMU 8. An explanation should be provided in the final WPA 15. The figure also shows that only one discrete soil sample is proposed for each of the three drying beds at SWMU 36. Given the size of these drying beds (200 feet long by 50 feet wide), one soil sample is inadequate. At least three discrete soil samples should be collected in each drying bed.

7. Photo 1 in Appendix B shows standing water in SWMU 8 (western lagoon). Because this surface water represents a potential exposure pathway to amphibians, and is a drinking water source for upper trophic level receptors, surface water should be collected from any lagoon that has standing water and evaluated in the ecological risk assessment. In addition to the chemical analysis, surface water should be analyzed for basic water quality parameters (i.e., pH, hardness, conductivity) so that site-specific water quality criteria can be calculated for certain metals.

This concludes EPA's review of the Army's draft *Work Plan Addendum 15: SWMUs 8 and 36*, located at the RFAAP. The referenced draft *Work Plan* is disapproved by EPA in its current form, and 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 15*, 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 draft document and submit a revised draft copy to EPA for review within 60 days of the receipt of EPA comments on the draft document. Part II, Section E.4.f. of the Permit allows for an additional 20 days for issuing the revised draft document to EPA, provided that timely notice is given, i.e. within 10 days. Additional time extensions can be requested under Part II, Section F. of the permit.

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

Sincerely,

Robert Thomson

Robert Thomson, PE
Federal Facilities Branch

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

McKenna, Jim

om: McKenna, Jim
nt: Friday, February 07, 2003 2:55 PM
o: 'Thomson.Bob@epamail.epa.gov'; Redder, Jerome
Cc: John.E.Tesner@nab02.usace.army.mil
Subject: RE: WP Addendum 15 QAPP Comments 2nd time

Importance: High

Draft RTC EPA WPA15.doc

Rob,

Attached file contains our responses to Ft. Meade's "draft" comments on WPA 15.

Noticed that we've seen several of these comments during the Master Work Plan (MWP) review from last summer and in December 2002 we responded to BTAG comments on the MWP. My concern is that the MWP is not officially approved by EPA but it forms the basis for any WPA. As we have to push forward with new work plan addenda I'm uncomfortable with the MWP being in a state of limbo. If there are MWP issues that we can help you with, I suggest we have a conference call as soon as we can after I get back on 18 February.

Thanks,
m

Please cc Jerry Redder and John Tesner while I'm out.

-----Original Message-----
From: Thomson.Bob@epamail.epa.gov [mailto:Thomson.Bob@epamail.epa.gov]
Sent: Thursday, January 23, 2003 11:08 AM
To: McKenna, Jim; Redder, Jerome
Cc: John.E.Tesner@nab02.usace.army.mil
Subject: WP Addendum 15 QAPP Comments 2nd time

Would be nice if I actually attached the attachment..........

Attached, please find Ft. Meade's comments on the review of the draft Work Plan Addendum 15 for Radford. The comments pertain to QA/QC issues with the Work Plan only, and are being sent to Radford in advance of written comments as a "heads-up".

nments from the BTAG, Tox, and Hydro have not been received yet. When ey are, all comments will be combined into a single written review response from EPA.

Rob

ee attached file: WPAddendum15reviewMead.doc)

Response to EPA Comments on Work Plan Addendum (WPA) 015,
Dated December 2002 (23059)
Draft Comments dated 21 January 2003
From Michael Mahoney via Rob Thomson
Received via e-mail 23 January 2003

Comment 1a

Several sections are referenced as being in either Appendix A of Master QAP, or some other document. Rather than request each of these documents, it is recommended that the FSP, referenced in the QAP, be sent to the QA Team for review. A FSP has to be a stand-alone document and will have to contain all its references.

Response

The Army has developed, in conjunction with USEPA and VDEQ, an overarching document that provides comprehensive discussions of standard procedures, protocols, and methodologies for completion of RFAAP site investigations. This document is called the Radford Army Ammunition Plant Master Work Plan (MWP). It includes the Master QAP. RFAAP, USEPA and VDEQ designed the MWP to be used to develop site specific Work Plan Addenda (WPA) in conjunction with other referenced pertinent guidance documents to delineate the project activities and objectives as well as describe information for individual SWMUs, HWMUs, or AOCs. This MWP/WPA arrangement is incorporated into RFAAP's RCRA permit and has been demonstrated to expedite regulatory review and approval. The MWP was commented on by EPA in May 2002. A response to comments was generated in June 2002 and the document revised accordingly.

Comment 1b

Several issues are inter-related in detailing the accountability of the responsible personnel at this site. A signature page listing all responsible personnel is required for the document. This sign-off page provides the legal groundwork for responsibility and accountability. It proves the signatory people have reviewed a copy of the proposed action, and agreed to implement the plan as written.

Response

This comment was one of several draft comments attached to an e-mail from EPA dated 9 April 2002. RFAAP responded to these draft comments via e-mail on 18 April 2002. EPA acknowledged RFAAP's response in an e-mail dated 8 May 2002. This comment was not included in EPA's final set of comments transmitted via letter dated 22 May 2002. Since this comment has been offered again, RFAAP's original response on 18 April is included and is as follows:

Documents certified to USEPA by Radford are done in accordance with the Installation's RCRA permit (October 2000) and are signed by the permittees; the Installation Commander and Vice President of Alliant Techsystems (Operating Contractor). The Army believes that this provides the desired responsibility and accountability.

Comment 1c

One of the key personnel at this site, who should be listed on the signature page, is the data validator. They need to be listed by name, affiliation, and their qualifications need to be listed.

Response

Will add the data validator to the information presented in Section 2.2.2 and will list their name, affiliation, and qualifications.

Comments 1d

Site background information needs to be more specific about what the settling lagoons were used for. The process which produced the sludge needs to be stated, for instance; if the sludge was a by product of ammunition production, were the explosives based on nitrates, or perchlorates? Were heavy metals used such as fulminate of mercury? Were more exotic explosives used at the site, like heavy metal azides? Detailed information on the process which produced the problem will allow the investigation to be designed for those specific compounds.

Response

Additional site background information regarding the previous processes relevant to the settling lagoons will be included to assist with identification of Potential Constituents of Concern, assessment of site boundaries, and approximation of potential waste source volume.

Comment 2

[Section 2] Whenever a mass spectral analysis is requested using SW-846 methods. such as 8270C and 8260B, the laboratory should submit a Tentatively Identified Compound (TIC) list with each analysis. The TIC analysis can identify unknown and unexpected compounds at all stages of investigation and needs to be requested from the laboratory before samples are submitted.

Response

This comment was one of several draft comments attached to an e-mail from EPA dated 9 April 2002. RFAAP responded to these draft comments via e-mail on 18 April 2002. EPA acknowledged RFAAP's response in an e-mail dated 8 May 2002. This comment was not included in EPA's final set of comments transmitted via letter dated 22 May 2002. Since this comment has been offered again, RFAAP's original response on 18 April is included and is as follows:

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

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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.

Comment 3a

Precision, accuracy and representativeness all reference sections in the master QAP which give the definition of the terms. The reviewer is well aware of the definitions. The QAP is supposed to assign values for those terms for each analyte which will meet the project specific quality needs for the project. "Test Methods for Evaluating Solid Waste," SW-846 is a guidance document. Therefore all analytical parameters have to be specified when using this document. Parameters which need to be specified include; the specific analytes, their required detection limits, the calibration precision requirements, the percentage deviation and the matrix spike matrix spike duplicate, precision; the entire analytical suite needs to be defined when referencing most methods in SW-846.

27

Response

The full analyte list covering this investigation is found in Tables 2-5 through 2-11. Additional discussion regarding precision, accuracy and representativeness are included in the Master QAP specifically in Sections 3 and 8 that are beyond definitions of the terms. Further, information regarding MS/MSD's are contained in the USACE shell document which is referenced in the Master QAP. Regardless, additional opportunity exists to supplement Section 2 with the requested information. Text and tables will be added.

Comment 3b

Completeness goals need to be established for the entire event, not just the field activities.

Response

Completeness goals are included in the Master QAP section 3.2.4.

Comment 4

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.

Response

This comment was one of several draft comments attached to an e-mail from EPA dated 9 April 2002. RFAAP responded to these draft comments via e-mail on 18 April 2002. EPA acknowledged RFAAP's response and added a comment in an e-mail dated 8 May 2002. This comment was included in EPA's final set of comments transmitted via letter dated 22 May 2002. RFAAP responded to the additional comment made in the 8 May 20002 e-mail and transmitted those responses with the revised MWP on 10 July 2002. Since this comment has been offered again, RFAAP's response on 10 July 2002 is included and is as follows:

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

The plan should identify a project quality assurance (QA) officer who is a government employee. It has been determined that the responsibilities of this position are too critical to be detailed to a subcontractor.

> **Response**
>
> The project QA officer for the Army for Radford AAP IR program projects is Mr. Marc Randrianarivelo, USACE Baltimore District. Mr. Randrianarivelo will be added to Section 2.2.2.

Comment 6

For a project of this size and scope, there should be provisions for laboratory and field oversight to be incorporated into the event. The quality assurance oversight plan should include an annual on site laboratory inspection and performance testing (PT) samples for the laboratory. Ideally, the PT samples will take the form of "double blind" samples. Regional policy recommends the use of PT samples to monitor laboratory performance at the beginning of the project and at regular intervals. The QAPP should (1) describe the acquisition, preparation and introduction of PT samples into the sample stream, (2) identify the personnel responsible for the task, (3) address the evaluation of PT results, and (4) provide details on oversight and corrective action for non-compliant PT samples. In addition, the QAPP should state that the results of the PT samples will be reported to EPA.

> **Response**
>
> This comment was one of several draft comments attached to an e-mail from EPA dated 9 April 2002. RFAAP responded to these draft comments via e-mail on 18 April 2002. EPA acknowledged RFAAP's response in an e-mail dated 8 May 2002. This comment was not included in EPA's final set of comments transmitted via letter dated 22 May 2002. Since this comment has been offered again, RFAAP's original response on 18 April is included and is as follows:
>
> *It should be noted that laboratories used for Radford AAP IR Program projects are required to be part of the USACE laboratory validation program. The USACE laboratory validation process consists of three major sequential steps: (1) review of general qualifications, (2) analysis of performance evaluation (PE) samples, and (3) on-site laboratory inspection. The validation provides a parameter, method, and matrix-specific approval. The period of validation is 18 months. For further information regarding this program, please refer to USACE document EM200 1-1 or you can speak to Joseph Solsky, Omaha District (402) 697-2573 for further details.*
>
> *Further, ~25% QA/QC samples are included as part of this and other Radford projects. It is the Army's opinion that this level of QA/QC is sufficient to achieve the intent of both RCRA and CERCLA guidance as it relates to these investigations. It is agreed that lab and field oversight is required for this project. Provisions for such audits are referenced in Section 2.1of WPA 9 and 12 and detailed in Sections 11.3 and 11.4 of the MWP.*

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Comment 7
All SW-846 methods which use an extraction, or work-up method, need to have that extraction method specified as it is associated with the respective analytical method.

> **Response**
> This comment was one of several draft comments attached to an e-mail from EPA dated 9 April 2002. RFAAP responded to these draft comments via e-mail on 18 April 2002. EPA acknowledged RFAAP's response in an e-mail dated 8 May 2002. This comment was not included in EPA's final set of comments transmitted via letter dated 22 May 2002. Since this comment has been offered again, RFAAP's original response on 18 April is included but revised to include the WPA 15-specific section. It is as follows:
>
> *The analytical preparatory method citations for the SW-846 methods may be found in Section 2.5 of WPA 15 and Section 6.0 of the Master QAP.*

Comment 8
Regional guidance recommends the use of a document control header for QAPPs and FSPs. Document control headers consist of identification of each page of the document with a section number, revision number, revision date, and page number.

> **Response**
> The presentation of document information in the footer of RFAAP documents represents a evolutionary process managed by the RFAAP project team. The current format represents an optimized and standardized presentation that accelerates document revision and production. The existing format is preferred.

McKenna, Jim

From: McKenna, Jim
Sent: Wednesday, January 08, 2003 11:29 AM
To: 'rob thomson'
Cc: 'mark leeper'; Redder, Jerome; 'john e
Subject: FW: SWMU 8&36 EPA Checklist

Rob,

Attached file contains the checklist for the Work Plan Addendum No. 15, Soil Sampling Investigations for SWMUs 8 and 36. My understanding is this checklist would expedite work plan addenda review. Along those same lines I thought we could have a conference call during the week of January 27 with the EPA and VDEQ project teams to go over WPA 15 and maybe clarify any questions or concerns the team members may have. As this sampling effort is to support a construction project starting this year we are anxious to get the sampling work started.

Thanks,
Jim

-----Original Message-----
From: John.E.Tesner@nab02.usace.army.mil [mailto:John.E.Tesner@nab02.usace.army.mil]
Sent: Wednesday, January 08, 2003 11:09 AM
To: Jim_McKenna@ATK.com
Cc: darren_renne@urscorp.com
Subject: SWMU 8&36 EPA Checklist

Jim-
SAB for your use.
JT
<<qappprepcklist_SMWU 8_36.rtf>>

31

ATK
ALLIANT TECHSYSTEMS

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

December 20, 2002

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

Subject: Soil Sampling Investigation for SWMUs 8 and 36, Radford Army Ammunition Plant WP-15
EPA ID# VA1 210020730

Dear Mr. Thomson:

Enclosed is one certified copy of Soil Sampling Investigation for SWMUs 8 and 36, Radford Army Ammunition Plant for your review and comment or approval. Your five additional five copies will be sent under separate cover as well as additional copies to the Virginia Department of Environmental Quality (VDEQ), U.S. Army Environmental Center, U.S. Army Center for Health Promotion and Preventive Medicine.

This work plan addenda is being submitted in accordance with our correspondence dated July 12, 2002 where we notified your office of upcoming construction activity at these sites.

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

w/o enclosure

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

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

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

02-815-177
JMcKenna/JJRedder

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

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

Katie Watson
Engineering & Environment, Inc.
4428 Northgate Drive
Knoxville, TN 37938

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

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

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

Coordination: McKenna
J. McKenna

02-815-177
JMcKenna/JJRedder

Concerning: ***Soil Sampling Investigation for SWMUs 8 and 36, January 2003, Radford Army Ammunition Plant***

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

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

SIGNATURE: J.C. Betteken
PRINTED NAME: for Anthony Miano
TITLE: Vice President Operations
Alliant Ammunition and Powder Company, LLC

02-815-177
JMcKenna/JJRedder

McKenna, Jim

rom: McKenna, Jim
ent: Friday, December 20, 2002 7:26 AM
o: 'john e tesner'; Redder, Jerome
Subject: FW: NHPAP Work Plan Addenda 15 and 16

John, Jerry. FYI

-----Original Message-----
From: Jenkins, Joanne
Sent: Friday, December 20, 2002 7:22 AM
To: McKenna, Jim
Cc: Davie, Robert
Subject: RE: NHPAP Work Plan Addenda 15 and 16

With this added information I feel we can safely say that there is no potential to cause effect.

Joanne Jenkins
Industrial Specialist
Government Staff
DSN 931-7480. COM 540-639-7480

-----Original Message-----
From: McKenna, Jim
Sent: Tuesday, December 17, 2002 6:28 AM
To: Jenkins, Joanne
Cc: Davie, Robert
Subject: RE: NHPAP Work Plan Addenda 15 and 16
Importance: High

I have some more information to share which needs to be considered.

The sites under investigation are/were waste disposal units and were created from significant earth disturbances with waste materials disposed in and/or on them. So the site boundary only is the waste handling/disposal unit and does not encompass any area that may have been undisturbed by plant activities. Also the soil sampling equipment will travel over existing, active roads to get to the sites. Based on the information contained in these work plans we can make the assessment locally that the sampling effort will not disturb any cultural resources that may exist any more than current operations. With this in mind, I respectfully request that the decision for SHPO review be reconsidered.

Thanks,
Jim

-----Original Message-----
From: Jenkins, Joanne
Sent: Monday, December 16, 2002 10:24 AM
To: McKenna, Jim
Cc: Davie, Robert
Subject: RE: NHPAP Work Plan Addenda 15 and 16

I have checked the location of the sites you furnished. I don't have any concerns about SWMU 57, 68, 69, 75, 76 and Areas A & F. I do however have concerns about SWMU 8 and 36 as they are located at the bio plant. I also have concerns about SWMU 37, 38, 46 and Area Q. These are located in an area where there is potential for historical sites. These need to be reviewed by the SHPO.

Joanne Jenkins

Industrial Specialist
COM 540-639-7480 DSN 931-7480

-----Original Message-----
From: **McKenna, Jim**
Sent: Monday, December 16, 2002 8:08 AM
To: Jenkins, Joanne
Cc: Davie, Robert
Subject: NHPAP Work Plan Addenda 15 and 16
Importance: High

Joanne:

1. Work Plan Addendum 15 identifies sampling work that will occur at Solid Waste Management Units (SWMUs) 8 and 36 in the Main Manufacturing Area. The WPA has maps that show sampling locations.

2. Work Plan Addendum 16 identifies sampling work that will occur at SWMUs 37, 38, 46 75, and 76 in the Main Manufacturing Area and SWMUS 13, 57 68 and 69 in the Horseshoe Area and Areas of Concern (AOC) A, F and Q in the Main Manufacturing Area. The WPA has maps that show sampling locations.

Need you/us to review for possible interference with historical sites.

Thanks,
Jim

36

ATK
ALLIANT TECHSYSTEMS

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

July 12, 2002

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

Subject: Notification of Construction at SWMUs 8 and 36, Radford Army Ammunition Plant
EPA ID# VA1 210020730

Dear Mr. Thomson:

We are notifying the Environmental Protection Agency, Region III and the Virginia Department of Environmental Quality of construction activities at SWMUs 8 and 36. These activities will lead to excavation of the calcium sulfate at these areas so that a new settling tank and new drying beds can be constructed at SWMUs 8 and 36 respectively. Construction start up is expected in October 2002.

As the calcium sulfate is not classified as a hazardous waste under the Hazardous Waste Identification Rule and limited sampling has shown non-detectable quantities for the TAL and TCL analytes, we do not consider these activities as an Interim Measure under the RCRA permit. Similar to SWMU 6, our planned action is to confirm the existing data by executing a sampling and reporting effort for SWMUs 8 and 36 that is consistent with the Site Screening Process from our RCRA permit. Once this effort is procured we will send in a work plan addendum for your review and action. We are proceeding with this plan of action unless notified by your office to do otherwise.

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

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

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

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

02-815-101
JMcKenna/JJRedder

copy in 21b

JMcKenna/JJRedder

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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

Coordination: J. McKenna
J. McKenna

bc:
Administrative File
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S. J. Barker-ACO Staff
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C. A. Jake
J. J. Redder
Env. File

02-815-101
JMcKenna/JJRedder

DELIVERY ORDER NO. 0060
ENVIRONMENTAL SERVICES
PROGRAM SUPPORT
CONTRACT DACA31-00-D-0011

RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA

WORK PLAN ADDENDUM NO. 15
Soil Sampling Investigation for SWMUs 8 and 36

FINAL
March 2003

PREPARED BY:

URS

5540 Falmouth Street, Suite 201
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PREFACE

A two-stage approach has been developed to facilitate and streamline Resource Conservation Recovery Act (RCRA) site investigations at Radford Army Ammunition Plant (RFAAP) pursuant to the Permit for Corrective Action and Waste Minimization (October 2000). The approach consists of a single Facility-wide Master Work Plan and multiple site-specific Work Plan Addenda.

The Master Work Plan provides comprehensive discussions of standard procedures, protocol, and methodologies that are to be followed during execution of field investigations at RCRA sites within the RFAAP. The Master Work Plan is a generic plan designed to streamline site-specific work plan addenda development, review, and approval.

Each Work Plan Addendum describes the site-specific information for each RCRA site, providing detailed data on past site operations, possible constituents of potential concern, sampling strategy, etc. Each addendum, through reference to the Master Work Plan, is developed as a concise document, focused on site-specific investigations.

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MASTER WORK PLAN ADDENDUM NO. 15
SOIL SAMPLING INVESTIGATION FOR SWMUs 8 AND 36
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LIST OF ABBREVIATIONS AND ACRONYMS

%	Percent
μL	Microliter
μm	Micrometer
AES	Atomic Emission Spectroscopy
ASTM	American Society for Testing and Materials
ATK	Alliant TechSystems
bgs	Below Ground Surface
BRA	Baseline Risk Assessment
BTAG	Biological Technical Assistance Group
$CaSO_4$	Calcium Sulfate
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
cm/sec	Centimeters Per Second
CN	Cyanide
CNCl	Cyanogen Chloride
COPC	Constituent of Potential Concern
COR	Contracting Officer's Representative
CSM	Conceptual Site Model
dBA	Decibels on the A-Weighted Scale
DC	Direct Current
DQO	Data Quality Objective
ECD	Electron Capture Detector
ELCD	Electrolytic Conductivity Detector
EM	Electromagnetic
EPIC	Environmental Photographic Interpretation Center
ERA	Ecological Risk Assessment
ERIS	Environmental Restoration Information System
ft	Feet
GC	Gas Chromatography
gm	Gram
GPS	Global Positioning System
HAZCOM	Hazard Communication
HBN	Health-based Number
HHRA	Human Health Risk Assessment
HMX	Cyclotetramethylenetetranitramine
HPLC	High Performance Liquid Chromatography
HQ	Hazard Quotient
HRGC/HRMS	High-resolution Gas Chromatography/High-resolution Mass Spectrometry
HSP	Health and Safety Plan
HSPA	Health and Safety Plan Addendum
HSWA	Hazardous and Solid Waste Amendments
HTRW	Hazardous, Toxic, and Radioactive Waste
Hz	Hertz
ICP	Inductively Coupled Plasma
IDM	Investigation-derived Material

LIST OF ABBREVIATIONS AND ACRONYMS (CONTINUED)

MDL	Method Detection Limit
meg	Milliequivalents Per Gram
mg	Milligram
mg/kg	Milligram Per Kilogram
mg/L	Milligram Per Liter
MHSP	Master Health and Safety Plan
mm	Millimeter
MMA	Main Manufacturing Area
MQAP	Master Quality Assurance Plan
MS	Mass Spectrometer
MS/MSD	Matrix Spike/Matrix Spike Duplicate
MSDS	Material Safety Data Sheet
msl	Mean Seal Level
MWP	Master Work Plan
nm	Nanometer
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbon
PAO	Phenyl Arsine Oxide
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated Dibenzo-p-dioxins
PCDF	Polychlorinated Dibenzofurans
PID	Photoionization Detector
PM	Project Manager
ppb	Parts Per Billion
PPE	Personal Protective Equipment
ppm	Parts Per Million
ppq	Parts Per Quadrillion
ppt	Parts Per Trillion
QA	Quality Assurance
QC	Quality Control
QA/QC	Quality Assurance / Quality Control
QAP	Quality Assurance Plan
QAPA	Quality Assurance Plan Addendum
RBC	Risk-based Concentration
RCRA	Resource Conservation and Recovery Act
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
RFA	RCRA Facility Assessment
RFAAP	Radford Army Ammunition Plant
RFI	RCRA Facility Investigation
RL	Reporting Limit
SAP	Sampling and Analysis Plan
SHSO	Site Health and Safety Officer
SOP	Standard Operating Procedure
SOW	Statement of Work
SSP	Site Screening Process

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LIST OF ABBREVIATIONS AND ACRONYMS (CONTINUED)

SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
T	Trip Blank
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TEF	Toxicity Equivalence Factor
TEQ	Toxicity Equivalent Concentration
TOC	Total Organic Content
TOX	Total Organic Halogen
TWA	Time Weighted Average
URS	URS Group, Inc.
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
UV	Ultraviolet
VDEQ	Virginia Department of Environmental Quality
VI	Verification Investigation
VOC	Volatile Organic Compound
VPDES	Virginia Pollutant Discharge Elimination System
WPA	Work Plan Addendum

1.0 WORK PLAN ADDENDUM

In accordance with Contract Number DACA31-00-D-0011, Delivery Order No. 60, URS Group, Inc. (URS) has been tasked by the United States Army Corps of Engineers (USACE), Baltimore District to perform a Soil Sampling Investigation at Solid Waste Management Unit (SWMU) 8, the Calcium Sulfate ($CaSO_4$) Treatment/Disposal Area, and SWMU 36, $CaSO_4$ Drying Beds at the Radford Army Ammunition Plant (RFAAP), Radford, Virginia (Figure 1-1). This Soil Sampling Investigation Work Plan for SWMUs 8 and 36 is presented as Work Plan Addendum No. 15. It incorporates, by reference, the elements of the RFAAP Master Work Plan (MWP; URS 2002).

1.1 INTRODUCTION

The project objectives of the Soil Sampling Investigation at SWMUs 8 and 36 are:

- To assess the presence or absence of hazardous substances, contaminants, hazardous wastes, or hazardous constituents at SWMUs 8 and 36 and to provide data for performing human health and ecological risk screening in order to evaluate if there is a potential threat to human health or the environment; and
- To assess whether soil or other residual material removed from SWMUs 8 and 36 as a result of possible future construction activities would potentially be a RCRA hazardous waste.

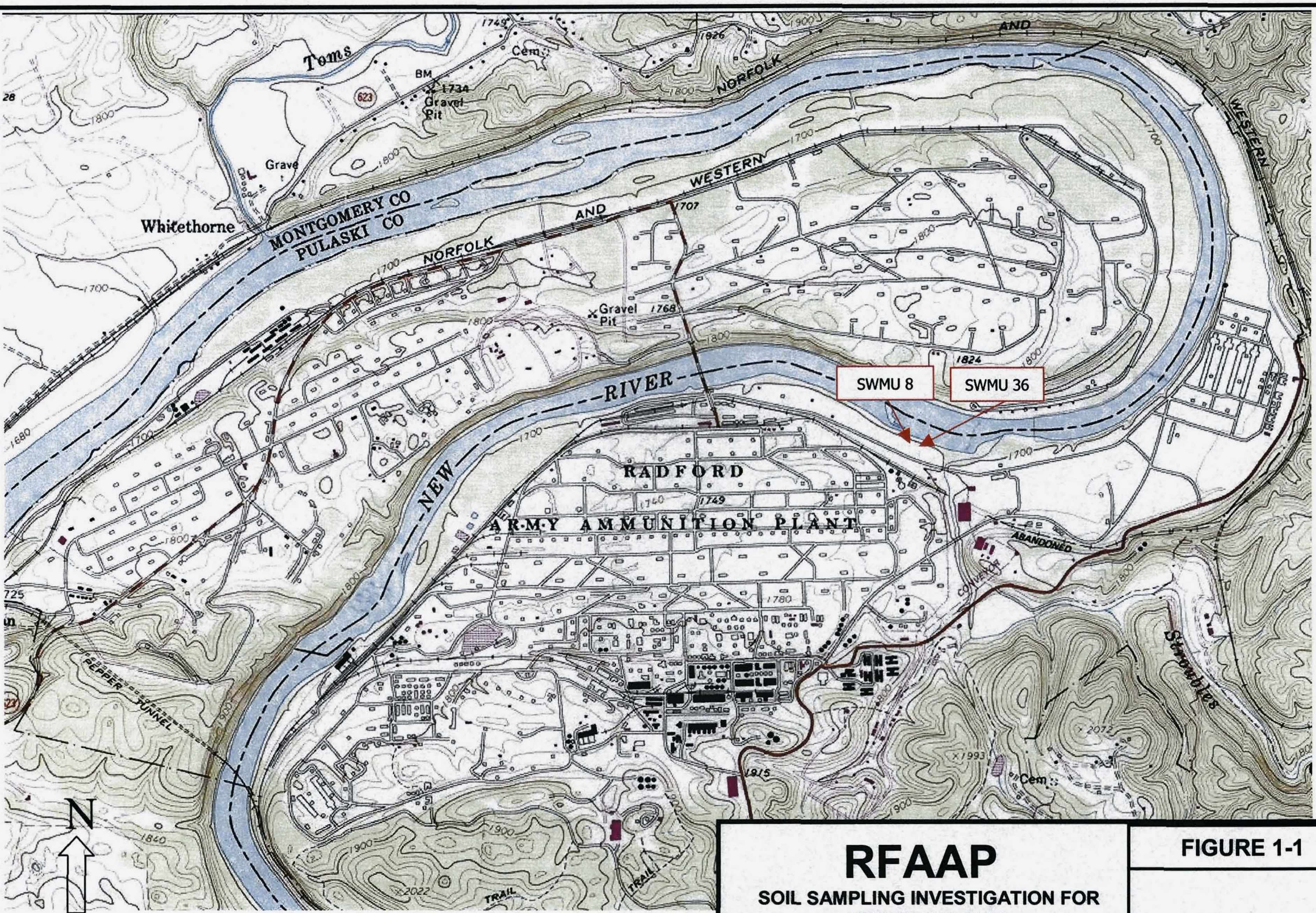
SWMU 8 originally consisted of two unlined, below-grade earthen $CaSO_4$ settling lagoons (eastern and western), both approximately 200 feet long and 50 feet wide. The Eastern Lagoon has been replaced with a concrete tank and the Western Lagoon is still in its original state. SWMU 36 consists of three $CaSO_4$ drying beds, each approximately 50 feet wide by 200 feet long.

The Soil Sampling Investigation at SWMUs 8 and 36 is designed to:

- Collect and chemically analyze surface and subsurface soil samples;
- Provide data that can be used to evaluate residual risk of soil through screening in accordance with the United States Environmental Protection Agency (USEPA) Site Screening Process (SSP); and
- Provide data that can be used to evaluate subsurface soil with respect to Resource Conservation and Recovery Act (RCRA) hazardous waste characteristics and to assess appropriate disposal method(s) for soil excavated during future construction.

Consistent with the MWP, this addendum is composed of the following sections:

- Section 1, Work Plan Addendum (WPA);
- Section 2, Quality Assurance Plan (QAP) Addendum (QAPA); and
- Section 3, Health and Safety Plan (HSP) Addendum (HSPA).



RFAAP

SOIL SAMPLING INVESTIGATION FOR SWMUs 8 AND 36

FIGURE 1-1

SITE LOCATION MAP

Date: January 2003

Prepared by: *URS Corp./BAC*

Scale: 1" = 2000'

File Name: *Figure 1-1.ppt*

This WPA specifically addresses sections and Standard Operating Procedures (SOPs) contained in the MWP for the investigation at SWMUs 8 and 36. Relevant SOPs are included in Appendix A of this WPA. The MWP will be maintained on site and referenced during field activities.

Investigative activities that will be performed as specified in the MWP are listed in Table 1-1. The investigative activities performed as part of this WPA will be conducted in accordance with the MWP and the SOPs contained therein and included herein as Appendix A.

Changes to the approved WPA will be documented using the Work Plan Revision Form (Form 1-1). Revisions must be reviewed and approved by the USACE Contracting Officer's Representative (COR) and the RFAAP designee prior to implementation.

Project personnel will be required to read this WPA and to sign and date a Worker Acknowledgement Form (Form 1-2). The Site Health and Safety Officer (SHSO) will retain this form on site during investigative activities. Appropriate health and safety precautions must be taken to protect site workers during activities with the potential for handling hazardous materials, energetics, and/or their degradation compounds.

The investigation program focuses on obtaining the data needed to attain the project objectives. The program articulates project objectives, assumptions, and data use specifications. Program elements include:

- **Description of Current Conditions:** This section includes a site description of SWMUs 8 and 36 and natural features that may affect migration and exposure pathways. Subsequent to the SWMU descriptions, a summary of previous investigations is provided. These sections review previous site investigations emphasizing the usability of collected data and screening of historical data with respect to current relevant criteria (i.e., current Risk-based Concentrations (RBCs) and USEPA Region III Biological Technical Assistance Group Screening Levels (BTAGs)) to identify constituents of potential concern (COPCs). This section also presents a Conceptual Site Model (CSM) and a Data Gap Analysis;

- **Planned Field Activities:** A site investigation will be performed to collect representative samples from SWMUs 8 and 36 and achieve project Data Quality Objectives (DQOs). This section presents a Sampling and Analysis Plan (SAP) that describes the number, types, and locations of samples to be collected, sample analyses, and the rationale for the sampling plan;

- **Quality Assurance/Quality Control:** Independent quality control (QC) checks are used to demonstrate investigation and laboratory accuracy, precision, and integrity. The QAPA provides assurance that data of known and documented quality are generated to allow the Installation to accurately evaluate each SWMU in accordance with the project objectives; and

- **Health and Safety:** Site-specific training, work practices and procedures, personal protective equipment and clothing (PPE), and applicable monitoring requirements are presented as the HSPA in Section 3.0 of this WPA. These requirements provide the procedures for protection of site personnel, including government employees, regulators, contractors, and visitors, that are expected to be involved with site activities.

Table 1-1
Applicable MWP Activities and Related SOPs
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

Subject	MWP Section	Standard Operating Procedures (SOPs) MWP Appendix A and Appendix A to WPA No. 15	
Installation Description	2.0		Not Applicable
Environmental Setting	3.0		Not Applicable
Documentation	4.3	10.1 10.2 10.3 10.4	Field Logbook Surface Water, Groundwater, and Soil/Sediment Field Logbooks Boring Logs Chain-of-custody Form
Sample Management	5.1	50.1 50.2	Sample Labels Sample Packaging
Decontamination Requirements	5.12	80.1	Decontamination
Investigation-derived Material	5.13	70.1	Investigation-derived Material
Air Monitoring		90.1	Photoionization Detector (HNu Model PI-101 and HW-101)
Subsurface Investigation	5.2 5.8	20.3 20.11 30.1 30.6 30.7 30.9	Well and Boring Abandonment Drilling Methods and Procedures Soil Sampling Containerized Material Sampling Strategies Collection of Soil Samples by USEPA SW-846

Form 1-1
Work Plan Revision Form
Work Plan – Quality Assurance Plan – Health and Safety Plan – Addendum No. 15
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

SITE DESIGNATION / LOCATION:

Radford Army Ammunition Plant

Radford, VA

SUBJECT:

Section: ____________________

Addendum: ____________________

Version: ____________________

Effective Date: ____________________

Approved by:

Field Operations Leader

____

Date: ____________________

Concurrence:

Project Manager

____

Date ____________________

Sheet _____ of _____

Form 1-2
Worker Acknowledgement Form
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

Document: Master Work Plan/QAP/HSP and Work Plan Addendum No. 15

Version: Draft

Project: Radford Army Ammunition Plant

Location: Main Manufacturing 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 20 CFR 1910.120 concerning training and medical monitoring requirements.

Site Personnel:

Name (please print)	Signature	Date

1.2 DESCRIPTION OF CURRENT CONDITIONS

1.2.1 Site Background – Environmental Setting

The environmental setting for the RFAAP is presented in Section 3.0 of the MWP. Project-specific information is presented below and in Section 1.2.3, Previous Investigations.

Physiography – SWMUs 8 and 36 are situated on the south bank of the New River in the northeast section of the RFAAP Main Manufacturing Area (MMA). Topography near SWMUs 8 and 36 slopes gently northward with elevations ranging from 1,700 to 1,705 feet (ft) above mean sea level (msl; Figure 1-2). To the north, the RFAAP Installation perimeter fence separates these SWMUs from the New River and prevents access by trespassers attempting to enter RFAAP from the New River. Beyond the perimeter fence, the area is wooded and the topography steeply slopes to the New River.

SWMU 8 originally consisted of two unlined, below-grade earthen $CaSO_4$ Settling Lagoons (Eastern and Western Lagoons). The Eastern Lagoon has been replaced with a concrete settling tank. The Western Lagoon is approximately 200 ft long, 150 ft wide, and 10 ft deep (Dames and Moore 1992) and contains a series of weirs and gates.

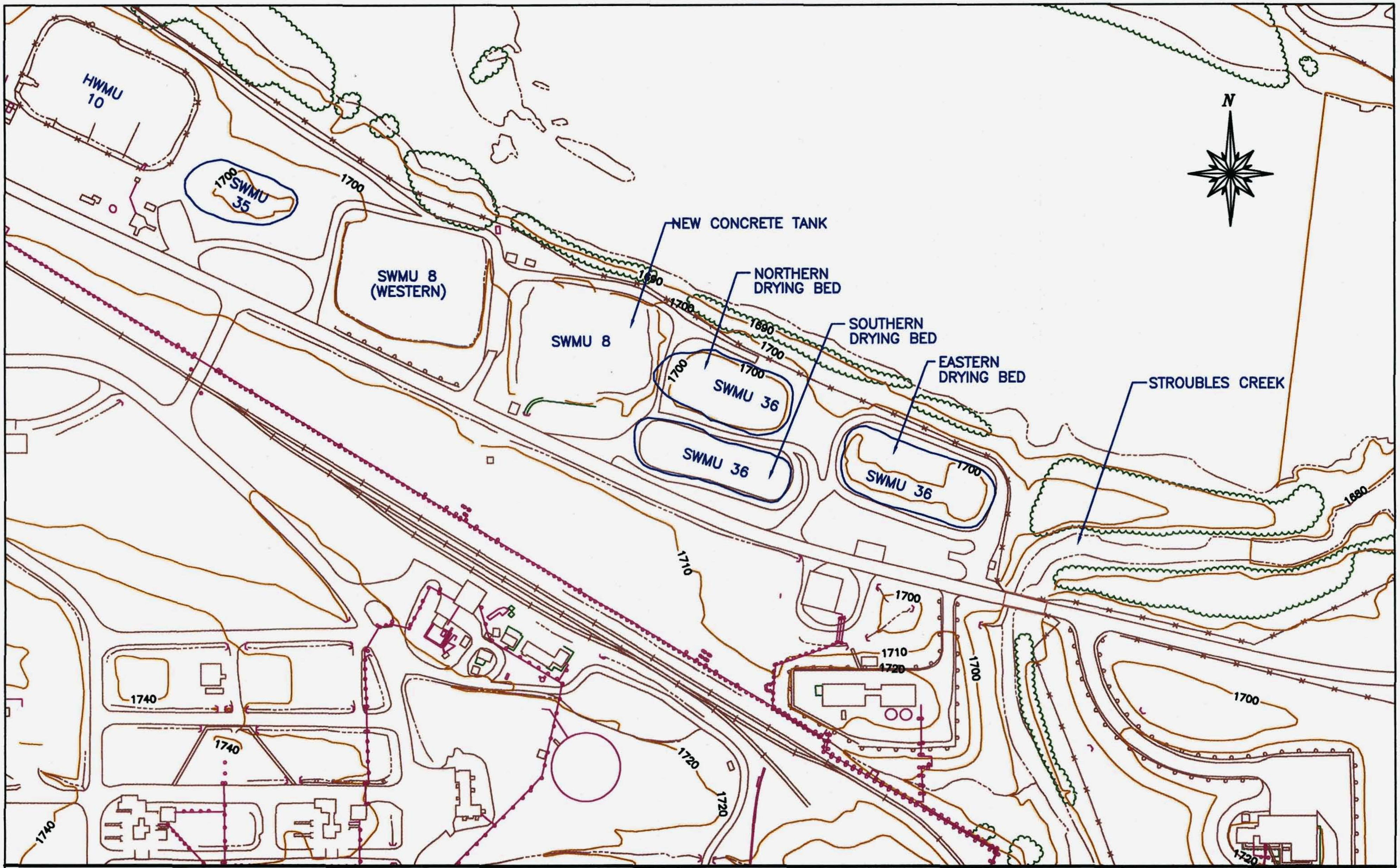
SWMU 36 is located immediately east of, and adjacent to SWMU 8 (Figure 1- 3). SWMU 36 consists of three separate unlined $CaSO_4$ drying beds that were excavated into natural grade. The northern bed, located closest to the New River, and the adjacent southern bed are each approximately 200 feet long, 50 feet wide, and 10 feet deep. The eastern bed is approximately 60 feet wide by 200 feet long; however, the depth of this bed is unknown. The drying beds are densely vegetated and enclosed with vegetated earthen berms.

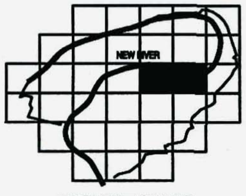
Surface Water – Based on topography, surface runoff does not flow out of the immediate SWMU areas. Stroubles Creek flows east along SWMU 36, approximately 100 feet east of the eastern drying bed at SWMU 36. The New River flows southeast approximately 70 to 80 feet to the north of both sites. Other than existing manholes to the south of the SWMUs, other surface water bodies, drainage ditches, catch basins or flow paths do not appear to be present in the SWMU 8 and 36 area.

Geology and Soil – Geology and soil near SWMUs 8 and 36 were previously explored as part of a site investigation conducted by NUS Corporation in 1980. Boring data indicate the presence of soil and unconsolidated alluvium and can be divided into three strata: two upper strata consisting of 1) fine to medium silty sand with possible clay lenses and 2) a stratum identified downgradient of SWMU 8 consisting of silty clay and a discontinuous lower stratum consisting of poorly graded, micaceous, brown, sandy, gravel with increasing gravel content at depth overlying bedrock.

A subsurface exploration program was conducted by Froehling & Robertson, Inc., in 2002 (F&R 2002) and consisted of fourteen standard penetration test borings, two offset borings, and four hand auger borings. The test borings were advanced though the overburden to a planned termination depth or auger refusal. Representative portions of the split-spoon soil samples were evaluated in general accordance with techniques outlined in the American Society for Testing and Materials (ASTM) D 2488 identification procedure. Soil cuttings were observed and classified by an F&R representative in the field in general accordance with the Unified Soil Classification System. Soil descriptions are based on visual descriptions and should be considered approximate.

The F&R test borings encountered surficial soil, fill material, and/or sludge material underlain by alluvial soil and auger refusal material. Materials described as fill were encountered to a depth ranging from 2 to 13 ft below ground surface (ft bgs). Fill materials were described as sandy clays, sandy silts, and clayey





VICINITY MAP
N.T.S.

0 200
1 inch = 200 feet

RFAAP

SOIL SAMPLING INVESTIGATION FOR SWMUs 8 AND 36

Date: NOVEMBER 2002

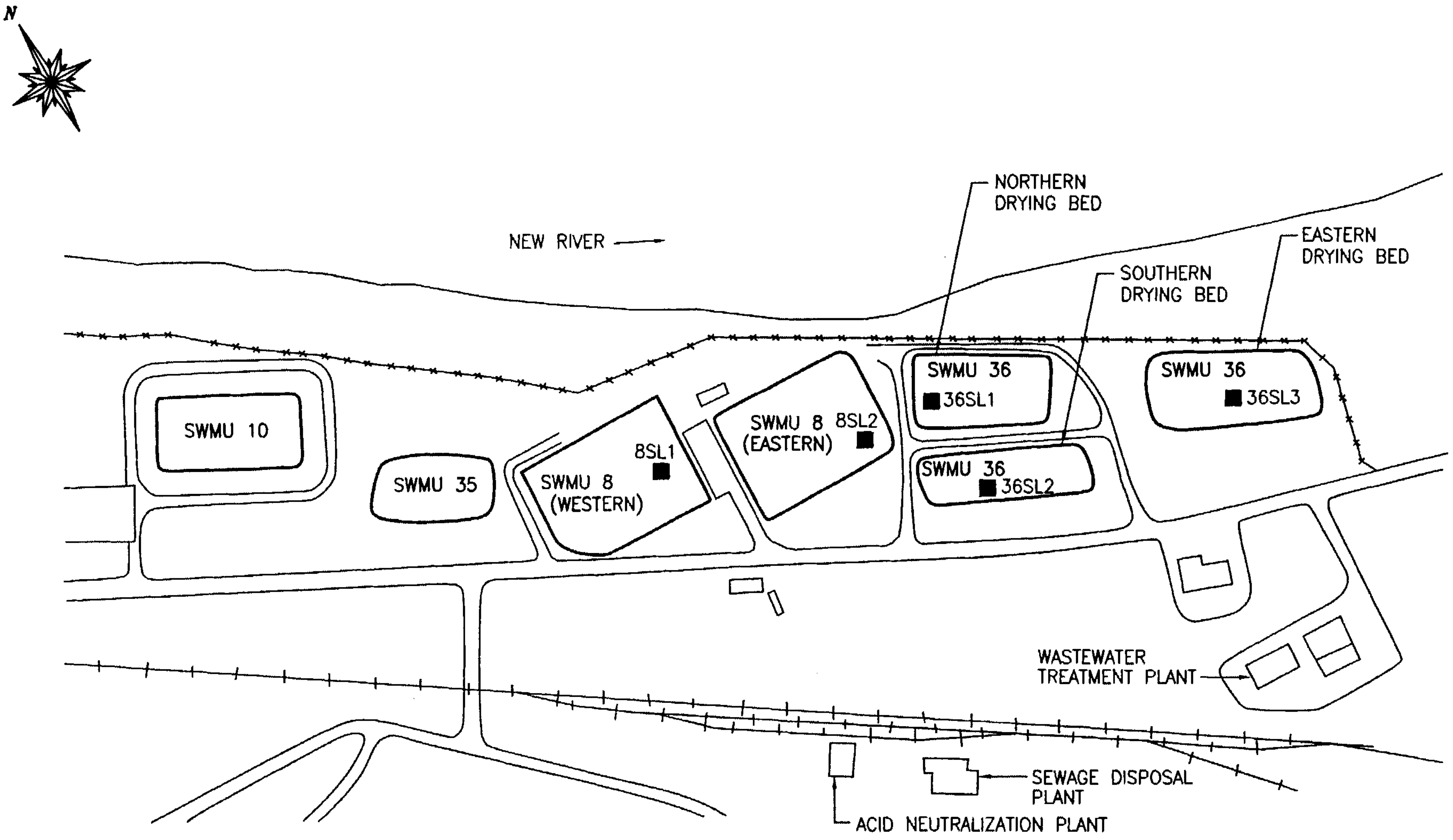
Prepared By: URS Corp./KDC/BAC

Scale: AS SHOWN

File Name: 09604/Figure 1-2

FIGURE 1-2

SITE TOPOGRAPHY LAYOUT (MODIFIED FROM HERCULES, INC., 1992)



LEGEND

■ Soil Sampling Location

0 200
1 inch = 200 feet

RFAAP

SOIL SAMPLING INVESTIGATION FOR SWMUs 8 AND 36

Date: NOVEMBER 2002

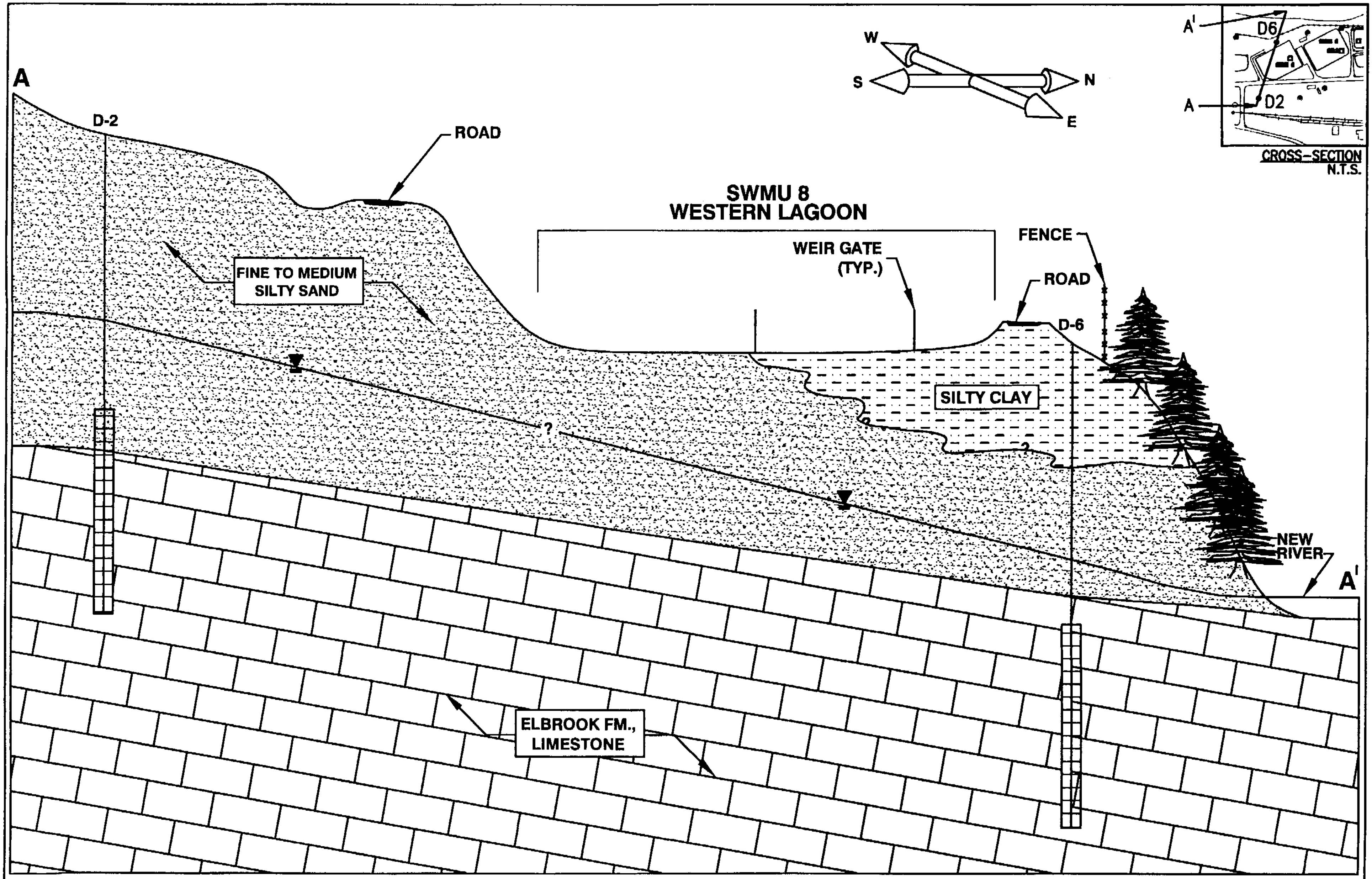
Prepared By: URS Corp./KDC/BAC

Scale: AS SHOWN

File Name: 09604/Figure 1-3

FIGURE 1-3

**SWMU LAYOUT MAP
(FROM
DAMES & MOORE, 1992)**



LEGEND

▯ Well Screen

▼ Static Groundwater Elevation

Horizontal Scale 0 — 50

1 inch = 50 feet

Vertical Scale 0 — 10

1 inch = 10 fe

RFAAP
SOIL SAMPLING INVESTIGATION FOR SWMUs 8 AND 36

Date: NOVEMBER 2002

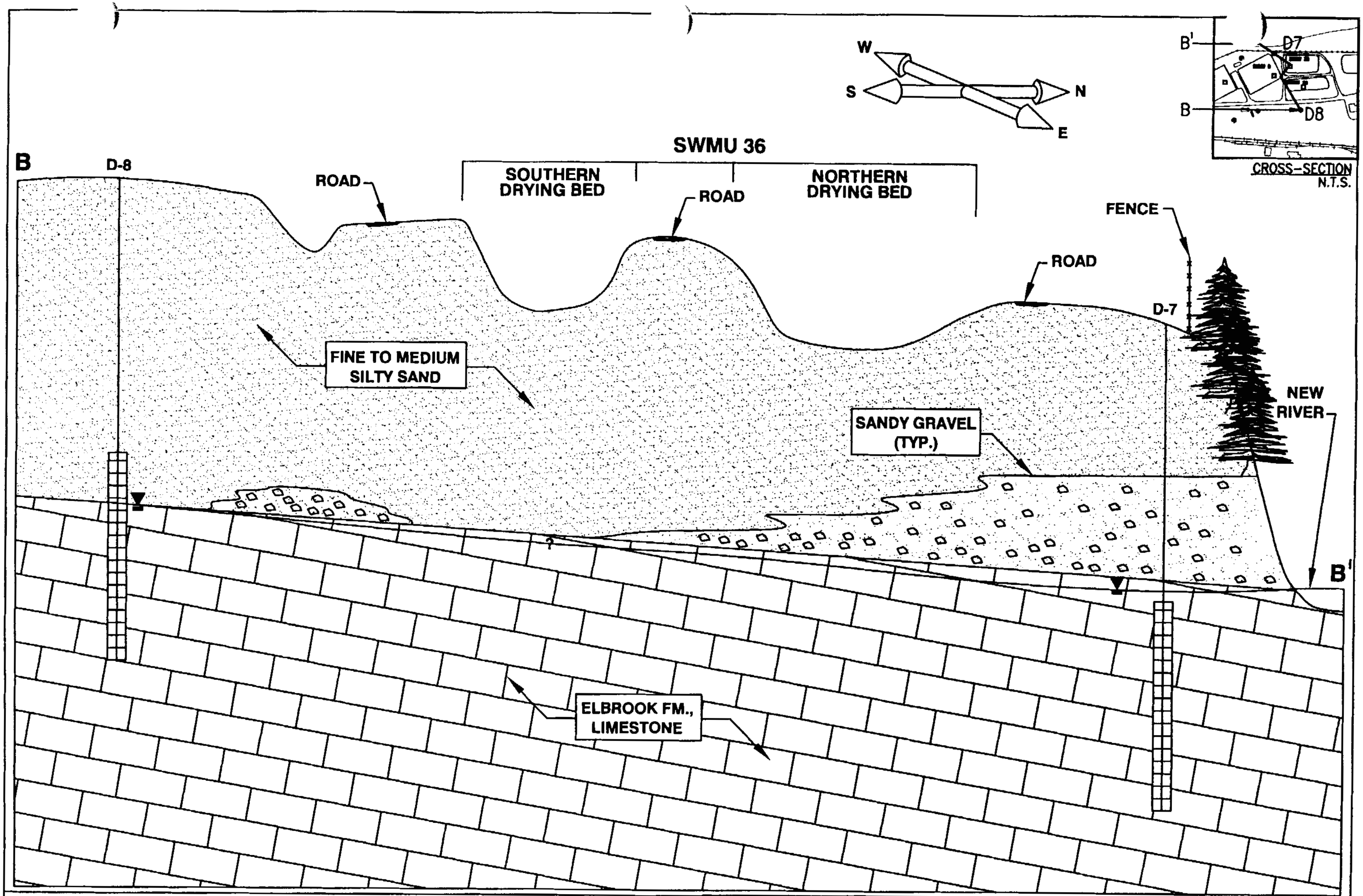
Prepared By: URS Corp./KDC/BAC

Scale: NO SCALE

File Name: 90604/Figure 1-4

FIGURE 1-4

GEOLOGIC CROSS-SECTION FOR SWMU 8



LEGEND

- Well Screen
- ▼ Static Groundwater Elevation

Horizontal Scale 0 50
1 inch = 50 feet

Vertical Scale 0 10
1 inch = 10 feet

RFAAP
SOIL SAMPLING INVESTIGATION FOR SWMUs 8 AND 36

Date: NOVEMBER 2002	Prepared By: URS Corp./KDC/BAC
Scale: NO SCALE	File Name: 90604/Figure 1-5

FIGURE 1-5

GEOLOGIC CROSS-SECTION FOR SWMU 36

sands with varying amounts of concrete, rubber, wood, and wire fragments. Sludge material was encountered in the explored locations and the thickness reportedly ranged from 4 to 7 feet. Alluvial soil was encountered beneath overlying surficial soil, fill material, or sludge at each boring location. Alluvial soil was described as sandy clays, sandy silts, and sands with varying amounts of silt and clay (F&R 2002).

Gray limestone of the Elbrook Formation underlies the soil, fill, and alluvium at the sites. Bedrock is highly weathered and fractured with many calcite filled fractures and vugs present (NUS 1980). Depth to bedrock in the immediate area of these SWMUs ranges from 18 to 28 ft below ground surface (bgs). Figures 1-4 and 1-5 present representative north-south geologic cross-sections and indicate the presence of soil and unconsolidated alluvium overlying the limestone. Based on Figure 4-1 of the Current Conditions Report (IT 2002), bedrock is present in the New River north of SWMUs 8 and 36.

Groundwater – Field and laboratory permeability (hydraulic conductivity) tests were performed during the NUS Hydrogeologic Investigation although the exact methodologies are not described. Media tested can roughly be grouped as sand and silt, gravel, and limestone (based on NUS classifications). Permeabilities in sand and silt reportedly ranged from 3.2×10^{-3} to 1.37×10^{-2} centimeters per second (cm/sec) with an average of 1.79×10^{-3}. Permeabilities in gravel reportedly ranged from 2.17×10^{-3} to 8.33×10^{-3} cm/sec with and average of 4.83×10^{-3} cm/sec. Permeabilities in limestone ranged from 1.73×10^{-4} to 2.08×10^{-2} with and average of 7.42×10^{-3} cm/sec. These values indicate an increase in average permeability values with increasing depth from sand and silt to gravel to limestone.

Groundwater monitoring well data from SWMU 8 indicate that the water is present from approximately 13 to 25 ft bgs. Well data indicate that groundwater flow is north toward the New River with a component of flow east of SWMU 36 toward Stroubles Creek (NUS 1980).

Tanks and Structures – SWMU 35, $CaSO_4$ Drying Bed, is located immediately to the west and adjacent to SWMU 8, and SWMU 10, Bioplant Basin, is located adjacent and to the west of SWMU 35. Other tanks and structures near SWMU 8 and SWMU 36 include the new concrete settling tank located at SWMU 8 (Eastern Lagoon) and an underground water line leading to the New River.

1.2.2 Site Background – History

SWMUs 8 and 36 are units used for the settling (SWMU 8) and drying (SWMU 36) of $CaSO_4$ sludge (USEPA 1987). Historically, the SWMU 8 lagoons have received treated wastewater from the A-B Line Acidic Wastewater Treatment Plants (ATK 2003). The A-B Line Acidic Wastewater Treatment Plant has received acidic wastewater from the acid sewer collection system in the acid area and B-Line nitrocellulose production area. The acid area produced concentrated nitric acid and sulfuric acid for production of nitrocellulose and nitroglycerin. Until the mid nineties, the wastewater from C Line nitrocellulose manufacturing went to C Line Acidic Wastewater Treatment and on to SWMU 9. In the mid nineties, the wastewater from C Line was directed to A-B Line Acidic Wastewater Treatment and on to SWMU 8. The neutralization process at the Acidic Wastewater Treatment Plants uses hydrated lime ($Ca(OH)_2$) and soda ash (Na_2CO_3) and results in calcium sulfate and water.

The treated wastewater received by SWMU 8 was directed through a series of weir gates in the lagoons, allowing the $CaSO_4$ to precipitate and settle to the bottom of the lagoons as sludge (Dames and Moore 1992). The supernatant was discharged to the New River via Virginia Pollutant Discharge Elimination System (VPDES) Outfall 007 adjacent to the unit. The SWMU 8 lagoons were operated on an alternating basis to accommodate maintenance and sludge removal. The $CaSO_4$ sludge was dredged from the SWMU 8 lagoons on a periodic basis and placed into adjacent drying beds at SWMU 36 (Dames and Moore 1992). Between 1982 and 1991, dried sludge removed from the beds was disposed of in Fly Ash

Landfill No. 2 (SWMU 29). On December 14, 1998, the Closure Report for the Eastern Lagoon of SWMU 8 was submitted to EPA. In October 1999, the lagoon was replaced with a concrete tank. Each drying bed of SWMU 36 no longer received sludge after October 1999. No sludge has been removed from the drying beds since 1991.

1.2.3 Previous Investigations

The following section reviews previous site investigations, emphasizing the usability of collected data and the screening of historical data with respect to current criteria (i.e., current RBCs and BTAGs).

1.2.3.1 Hydrogeologic Investigation – 1980

In 1980, as part of a hydrogeologic investigation, NUS Corporation advanced eight monitoring well borings near SWMU 8 to study subsurface conditions at the site. Analyses of selected physical properties were conducted (i.e., soil permeability and cation-exchange capacity). Samples tested were identified as fine sand or silt and exhibited a cation-exchange capacity between 2.9 and 11.4 milliequivalents per gram (meg)/100 gram (gm) of soil (NUS 1980). Boring logs presented by NUS were used to generate geologic cross-sections presented as Figures 1-4 and 1-5.

1.2.3.2 RCRA Facility Assessment (RFA) – 1987

In 1987, USEPA conducted a RFA of RFAAP which was designed to "evaluate releases of hazardous waste or hazardous constituents and to implement corrective actions, as necessary, under the broad authorities of the 1984 Hazardous and Solid Waste Amendments (HSWA) (USEPA 1987)." SWMU 8 was identified as managing neutralized acidic wastewater from the Acidic Wastewater Treatment Plant (USEPA 1987).

USEPA noted during the 1987 site visit, "each of these units contained what appeared to be calcium sulfate sludge" and received 1000 tons of sludge." In 1982, the sludge from SWMU 8 was analyzed for reactivity. The data indicate that the sludge was not a reactive waste (USEPA 1987). No visible signs of release were noted during the April 1987 site visit (USEPA 1987).

1.2.3.3 Verification Investigation – 1992

In 1992, as part of a Verification Investigation (VI), Dames and Moore collected and analyzed sludge samples from SWMUs 8 and 36 to "evaluate whether hazardous constituent concentrations exceed[ed] the [then current] health based numbers (HBNs) in the [Facility] permit." One sample was collected from the top one foot of sludge from each of the two lagoons at SWMU 8 (8SL1 and 8SL2). The two sludge samples were analyzed for Volatile Organic Compounds (VOCs), Semivolatile Organic Compounds (SVOCs), and Toxicity Characteristic Leaching Procedure (TCLP) Metals.

A composite sludge sample was collected from each of the three drying beds (36SL1, 36SL2, and 36SL3). A five-foot hand auger boring was advanced near the center of each bed and a sample was composited from multiple depth intervals in each five-foot boring to provide a representative sample of numerous sludge-drying episodes (Dames and Moore 1992). The samples were analyzed for VOCs, SVOCs, and TCLP Metals.

Tables 1-2 and 1-3 present a summary of the detected constituents as part of the waste characterization investigation at SWMUs 8 and 36. A review of the data indicates that detected concentrations of constituents do not exceed the October 2002 RBCs or TCLP Regulatory Limits.

Table 1-2
Summary of Analytical Data for Sediment/Sludge Samples Collected, SWMUs 8 and 36
Modified from Dames and Moore VI Investigation Report
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

SITE ID		36SL1	36SL2	36SL3	8SL1	8SL2			
FIELD ID		RVFS*31	RVFS*32	RVFS*33	RVFS*17	RVFS*18			
SAMPLE DATE		15-Jan-92	15-Jan-92	15-Jan-92	15-Jan-92	15-Jan-92	Soil	Soil	
DEPTH (ft bgs)		5.0	5.0	5.0	1.0	1.0	Industrial	Residential	BTAG
MATRIX	PQLs	CSE	CSE	CSE	CSE	CSE	RBC	RBC	
UNITS	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Volatiles									
1,1,1-Trichloroethane	0.005	<0.004	0.011	<0.004	<0.004	0.025	57,000	2,200	0.3
Acetone	0.1	0.229	<0.017	<0.017	<0.017	<0.017	20,000	780	NA
Chloroform	0.005	<0.001	<0.001	<0.001	0.016	<0.001	2,000	78	0.3
Semivolatiles									
Di-N-Butyl Phthalate	0.3	4.4	1.11	<0.305	<0.305	<0.305	20,000	780	NA
Fluoranthene	0.3	**4.77**	<0.34	<0.34	<0.34	<0.34	8,200	310	0.1
N-Nitrosodiphenylamine	0.3	24.3	12.3	12.2	<0.95	<0.95	1,200	130	NA
Phenanthrene(1)	0.5	**2.12**	**0.43**	<0.165	<0.165	<0.165	6,100	230	0.1

Notes:

CSE = Chemical sediment

NA = Not available

PQL = Practical quantitation limit; the lowest concentration that can be reliably detected at a defined level of precision for a given analytical method

RBC = USEPA Region III Risk-based Concentration, October 9, 2002; Non-carcinogenic constituents have been adjusted to reflect an HQ of 0.1

BTAG = USEPA Region III Biological Technical Assistance Group Screening Levels

USEPA = United States Environmental Protection Agency

< = Concentration is reported as less than the certified reporting limit

mg/kg = milligrams per kilogram

ft bgs = feet below ground surface

▨ = Concentration exceeds BTAG Screening Level

(1) = The RBC for pyrene was substituted for this compound

Table 1-3
Summary of Analytical TCLP Data for Sediment/Sludge Samples Collected, SWMUs 8 and 36
Modified from Dames and Moore VI Investigation Report
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

SITE ID FIELD ID SAMPLE DATE DEPTH (ft bgs) MATRIX UNITS	PQLs ug/L	36SL1 RVFS*31 15-Jan-92 5.0 CSE ug/L	36SL2 RVFS*32 15-Jan-92 5.0 CSE ug/L	36SL3 RVFS*33 15-Jan-92 5.0 CSE ug/L	8SL1 RVFS*17 15-Jan-92 1.0 CSE ug/L	8SL2 RVFS*18 15-Jan-92 1.0 CSE ug/L	TCLP Regulatory Limit ug/L
TCLP Metals							
Barium	20	284	209	371	341	231	100,000
Chromium	10	36.2	30.4	<6.02	15.4	40.6	5,000
Silver	2	7.84	6.21	12.5	5.49	5.29	5,000

Notes:

CSE = Chemical sediment

NA = Not available

PQL = Practical quantitation limit, the lowest concentration that can be reliably detected at a defined level of precision for a given analytical method

TCLP = Toxicity Characteristic Leaching Procedure

< = Concentration is reported as less than the certified reporting limit

ug/L = micrograms per liter

ft bgs = feet below ground surface

1.2.3.4 Installation Assessment (Air Photo Interpretation) – 1992

The Environmental Photographic Interpretation Center (EPIC), under direction of the USEPA, performed an assessment of multiple SWMUs at RFAAP using selected aerial photographs from 1937 to 1986. The objective was to "concentrate upon tracking 42 known SWMUs located at the RFAAP and to identify other features which may represent potential groundwater or surface water contamination sources (USEPA 1992)." Two lagoons at SWMU 8, first visible in the 1953 photograph and visible again in the 1962 photograph, appear to be empty in both photographs (USEPA 1992). USEPA noted that both lagoons remained unchanged through the 1971 photograph. In the 1986 photograph, the Western Lagoon "appears to contain low vegetation."

One lagoon at SWMU 36 was first noted on the 1962 photograph as "containing liquid." USEPA reported, "Between 1962 and 1966, two lagoons were constructed where one lagoon was visible in the 1962 photography" and "the eastern most lagoon in this site was constructed between 1966 and 1970." The 1962 photograph reportedly depicts the eastern-most lagoon contains "medium-toned liquid," while those to the west contain "medium- and dark-toned material." Reportedly, the 1986 photograph depicts each lagoon at SWMU 36 "appear to be dry at this time." This photograph depicts the eastern lagoon as "partially vegetated with light- and dark-toned material present and the northern lagoon appears to be completely re-vegetated, while the southern lagoon appears to contain a light-toned material."

1.2.3.5 New River and Tributaries Study – 1997

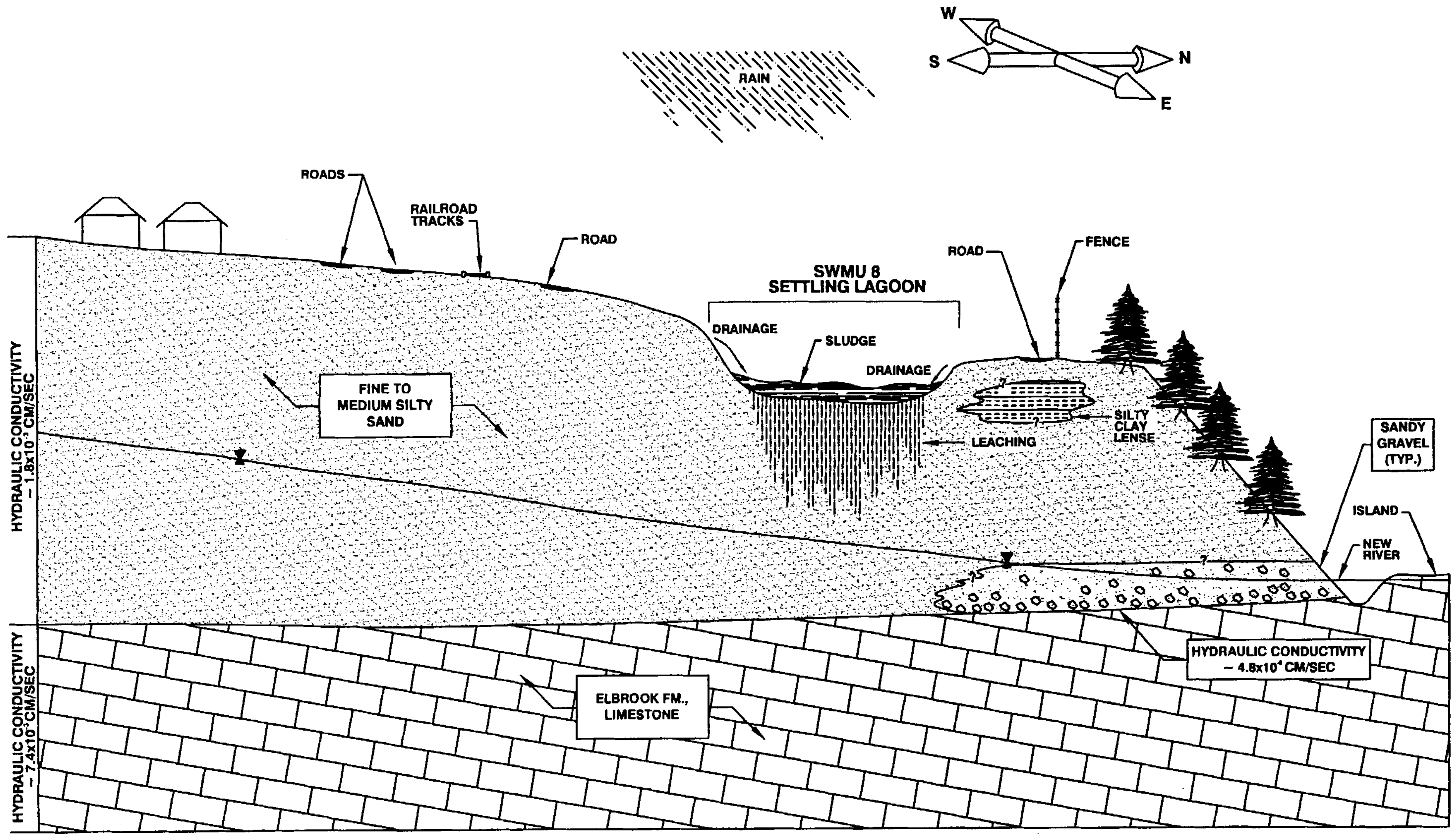
The objective of this study was to provide data for migration pathways along the river and tributaries to assess adverse impacts to human health and the environment (Parsons 1997). One sediment sample (NRSE11) was collected from the New River downstream of SWMUs 8 and 36 to assess potential impacts from these SWMUs. The sample was analyzed for VOCs, SVOCs, Pesticides/Polychlorinated Biphenyls (PCBs), and Target Analyte List (TAL) Metals. Sample results indicate that two metals, cadmium and chromium, were reported above the current BTAG Screening Level Criteria.

1.2.4 Conceptual Site Model

A site-specific CSM has been developed for SWMUs 8 and 36 to assess potential contaminant sources, exposure pathways, and human and ecological receptors (Figure 1-6 and 1-7). Potentially affected media include surface and subsurface soil. The SWMUs are represented as being located within gently sloping topography adjacent to the steep banks of the New River and Stroubles Creek (SWMU 36). Both SWMUs 8 and 36 are depressed, suggesting that precipitation will infiltrate into the ground rather than migrate overland to a surface water body from the SWMUs.

Subsurface geology is indicated as a fine to medium silty sand stratum with increasing gravel with depth. Gravel rich deposits are represented as discontinuous layers. Silty clay observed in boring D-6 is represented as a possible clay lense downgradient of SWMU 8. The water table surface is represented as sloping moderately to gently toward the New River. Limited data regarding depth to groundwater indicates a variable water table surface within soil and alluvium as well as bedrock. A possible pathway may exist to groundwater via infiltration of water that may collect in the lagoons. Site groundwater discharge may be hydraulically connected to the New River.

Although current and future land-use scenarios are limited to industrial operations, both industrial and residential scenarios will be considered. SWMUs 8 and 36 are enclosed by the site perimeter fence; therefore, site workers, future construction workers, and terrestrial biota are considered receptors. Figures 1-8 and 1-9 present the potential exposure pathways for each receptor at each SWMU. Based on current data available for the sites, leaching of constituents into subsurface soil is a potential migration



CONCEPTUAL DRAWING - NO SCALE IMPLIED

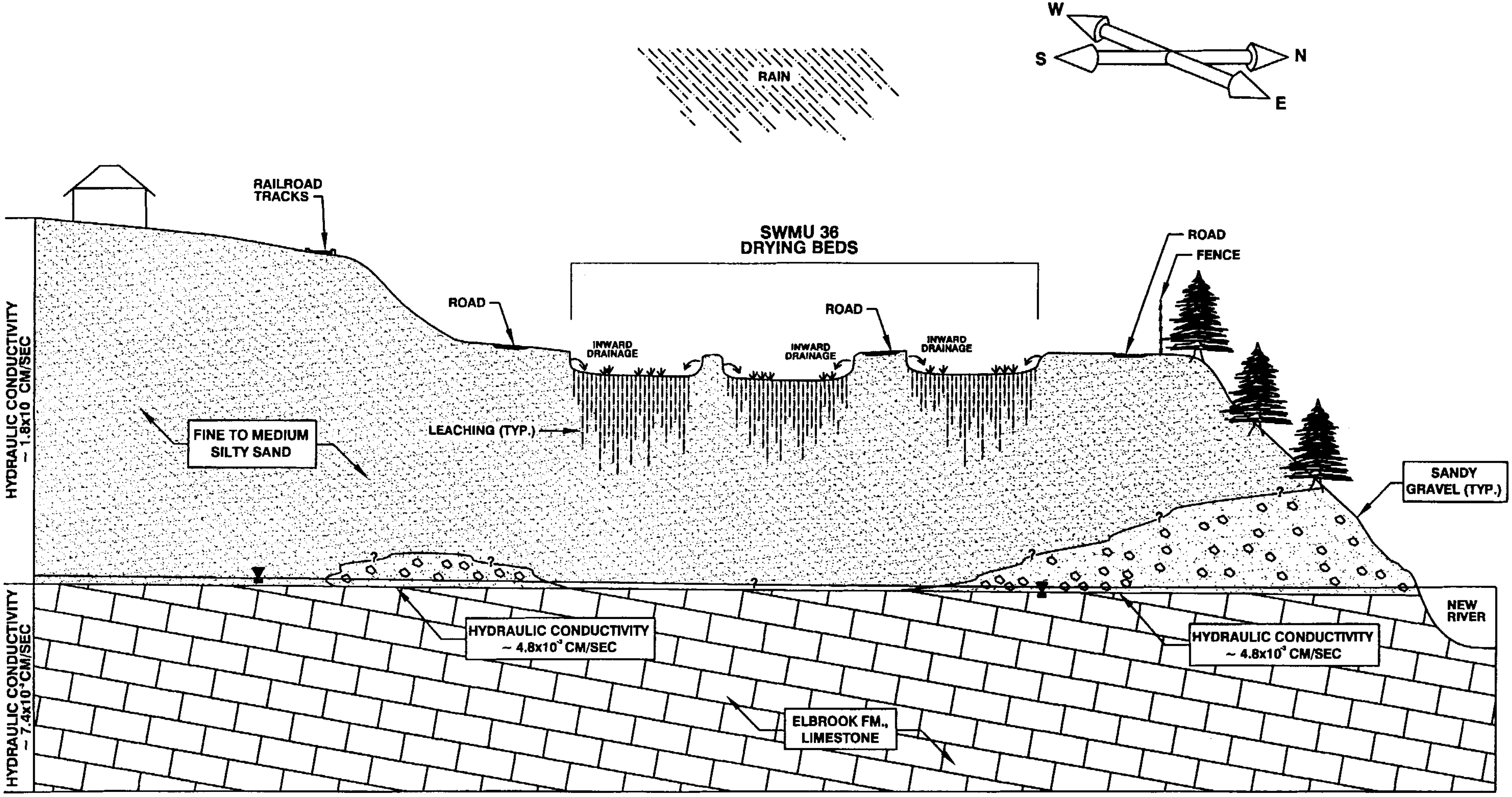
RFAAP

SOIL SAMPLING INVESTIGATION FOR SWMUs 8 AND 36

Date: *NOVEMBER 2002*	**Prepared By:** *URS Corp./KDC/BAC*
Scale: *NO SCALE*	**File Name:** *90604/Figure 1-6*

FIGURE 1-6

CONCEPTUAL SITE MODEL FIGURE FOR SWMU 8



CONCEPTUAL DRAWING - NO SCALE IMPLIED

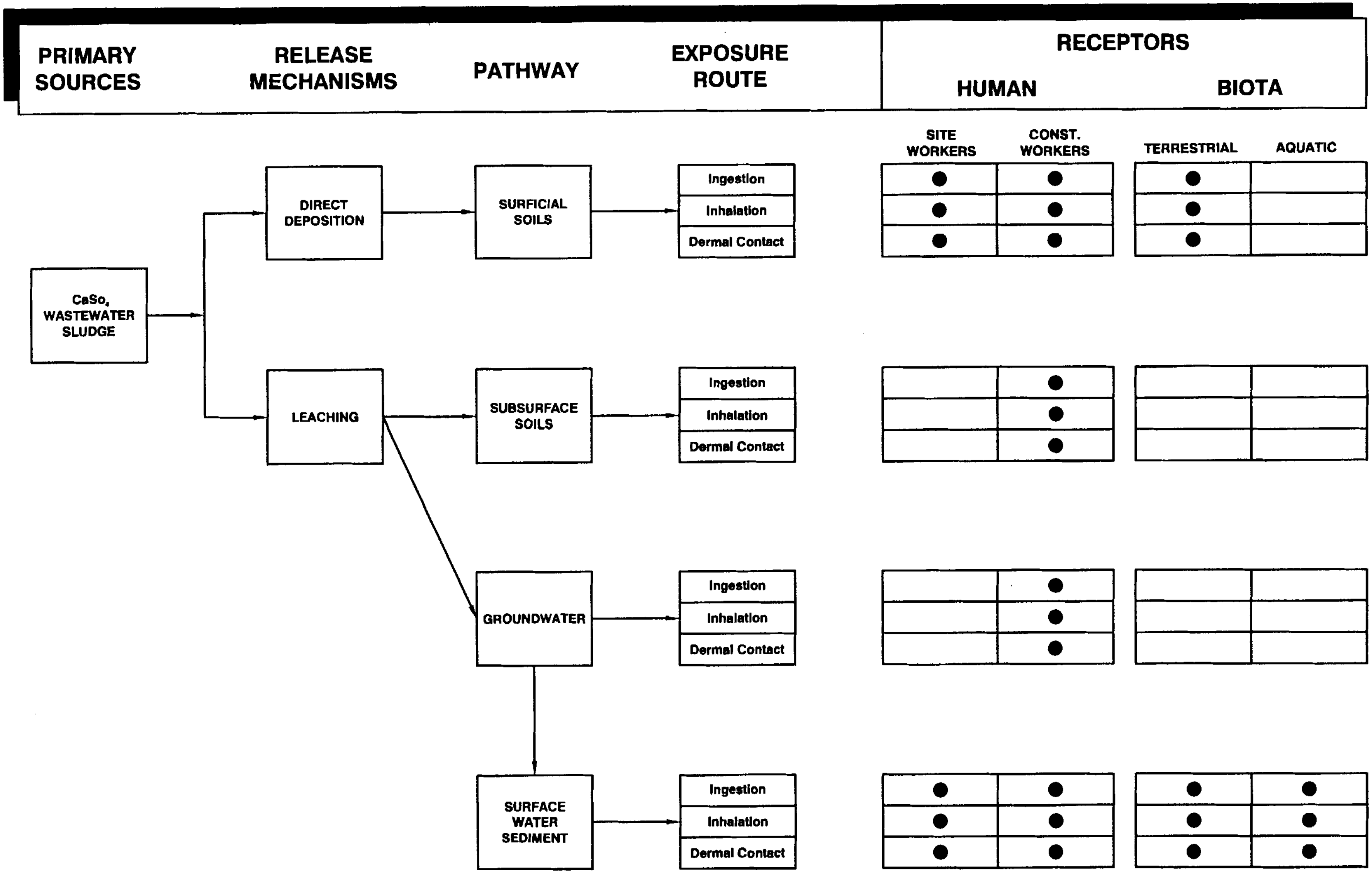
RFAAP

SOIL SAMPLING INVESTIGATION FOR SWMUs 8 AND 36

Date: *NOVEMBER 2002*	**Prepared By:** *URS Corp./KDC/BAC*
Scale: *NO SCALE*	**File Name:** *90604/Figure 1-7*

FIGURE 1-7

CONCEPTUAL SITE MODEL FIGURE FOR SWMU 36



Pathway	Exposure Route	Human: Site Workers	Human: Const. Workers	Biota: Terrestrial	Biota: Aquatic
SURFICIAL SOILS	Ingestion	●	●	●	
	Inhalation	●	●	●	
	Dermal Contact	●	●	●	
SUBSURFACE SOILS	Ingestion		●		
	Inhalation		●		
	Dermal Contact		●		
GROUNDWATER	Ingestion		●		
	Inhalation		●		
	Dermal Contact		●		
SURFACE WATER SEDIMENT	Ingestion	●	●	●	●
	Inhalation	●	●	●	●
	Dermal Contact	●	●	●	●

RFAAP

SOIL SAMPLING INVESTIGATION FOR SWMUs 8 AND 36

Date: *NOVEMBER 2002*

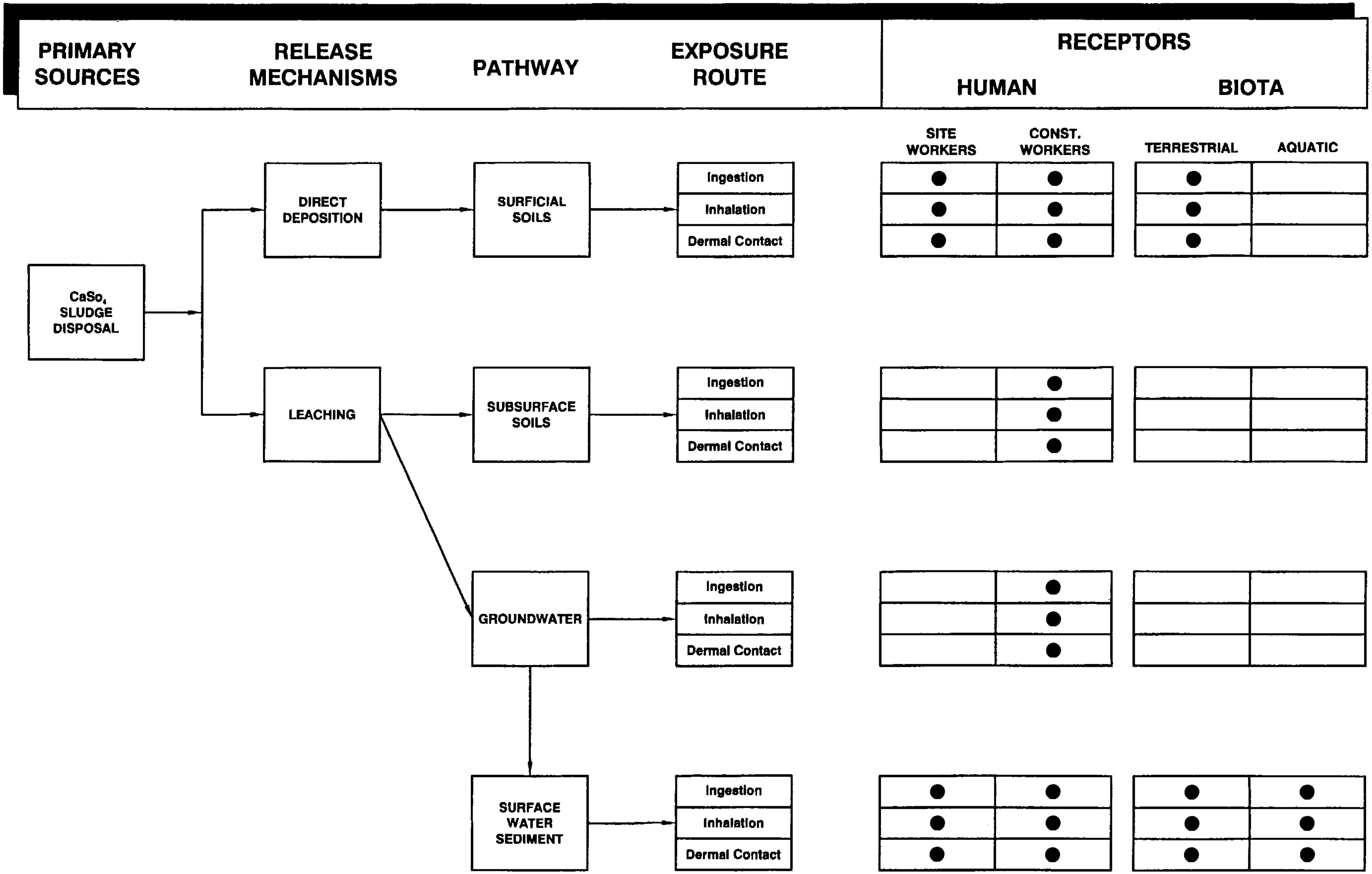
Prepared By: *URS Corp./KDC/BAC*

Scale: *NO SCALE*

File Name: *09604/Figure 1-8*

FIGURE 1-8

CONCEPTUAL SITE MODEL DIAGRAM FOR SWMU 8



Pathway	Exposure Route	Human: Site Workers	Human: Const. Workers	Biota: Terrestrial	Biota: Aquatic
SURFICIAL SOILS	Ingestion	●	●	●	
	Inhalation	●	●	●	
	Dermal Contact	●	●	●	
SUBSURFACE SOILS	Ingestion		●		
	Inhalation		●		
	Dermal Contact		●		
GROUNDWATER	Ingestion		●		
	Inhalation		●		
	Dermal Contact		●		
SURFACE WATER SEDIMENT	Ingestion	●	●	●	●
	Inhalation	●	●	●	●
	Dermal Contact	●	●	●	●

RFAAP

SOIL SAMPLING INVESTIGATION FOR SWMUs 8 AND 36

Date: NOVEMBER 2002

Prepared By: URS Corp./KDC/BAC

Scale: NO SCALE

File Name: 09604/Figure 1-8

FIGURE 1-9

CONCEPTUAL SITE MODEL DIAGRAM FOR SWMU 36

pathway at both SWMU 8 and SWMU 36. Direct deposition of wastewater (SWMU 8) and sludge (SWMU 36) is considered a release mechanism to surface soil at these sites. Site workers, construction workers, and terrestrial biota could contact surface soil via incidental ingestion of soil, inhalation of fugitive dust, and dermal absorption through direct contact with soil.

Leaching of constituents through site soil is considered a potential release mechanism to subsurface soil and groundwater at the site. In turn, subsurface soil and groundwater may be received by potential future construction workers via incidental ingestion of soil or groundwater, inhalation of dust or groundwater, and dermal absorption through direct contact with soil or groundwater.

1.2.5 Data Gap Analysis

Limited sampling has occurred at SWMU 8 and SWMU 36. Sludge samples were collected from each SWMU; however, data regarding deeper soil and perimeter soil have not been collected.

<u>TCL VOCs</u> – Sludge samples, collected as part of the 1992 VI, were analyzed for Target Compound List (TCL) VOCs. A review of the data indicates that TCL VOCs were detected but are not identified as COPCs. Subsurface soil or perimeter surface soil samples were not collected during previous investigations. Therefore, TCL VOCs represent a data gap for surface and subsurface soil and will be analyzed in surface and subsurface samples.

<u>TCL SVOCs/PAHs</u> – TCL SVOC analysis was performed on sludge during the VI investigation with SVOC detections reported. Subsurface samples were not collected and Polynuclear Aromatic Hydrocarbons (PAHs) analysis was not conducted during the previous investigations. Therefore, in order to meet the objectives of this Soil Sampling Investigation, TCL SVOCs and PAHs will be analyzed in surface and subsurface samples.

<u>TCL Pesticides</u> – TCL Pesticides analysis has not been performed during previous investigations. Therefore, TCL Pesticides represent a data gap and will be analyzed in surface samples.

<u>TCL PCBs</u> – TCL PCBs analysis has not been performed during previous investigations. Therefore, TCL PCBs represent a data gap and will be analyzed in surface samples.

<u>Explosives (including nitroglycerin)</u> – Samples were not analyzed for explosive constituents during the previous investigations. Therefore, explosives represent a data gap and will be analyzed in surface and subsurface samples.

<u>TAL Metals (including mercury)</u> – Samples were not analyzed for TAL Metals during previous investigations. Therefore, TAL Metals are considered a data gap and will be analyzed in surface and subsurface samples.

<u>RCRA Waste Characterization</u> – Sludge samples were analyzed for TCLP Metals during the 1992 VI. A review of the data indicates that TCLP Metals were not reported above TCLP regulatory limits; however, subsurface soil or perimeter soil samples were not collected during previous investigations. Therefore, a complete RCRA waste characterization, including full TCLP, ignitability, corrosivity, reactivity, and paint filter liquids, will be conducted on sludge and subsurface soil collected from SWMUs 8 and 36.

<u>Other</u> – An analysis of the physical properties of subsurface soil to aid in assessing the nature of possible constituent mobility has not been performed during the previous investigations. Therefore, soil samples from each site will be analyzed for total organic carbon (TOC), grain size, and pH to assess the mobility of constituents in soil.

1.3 PLANNED FIELD ACTIVITIES

The purpose of the Soil Sampling Investigation for SWMUs 8 and 36 is to collect representative discrete and composite samples of the site surface soil, subsurface soil, and sludge to a depth of approximately 15 ft bgs. In selecting the boring locations, consideration was given to the size and shape of SWMUs 8 and 36, as well as, the overall project objectives of screening site soil and residue against relevant criteria established in the RFAAP Site Screening Process and evaluating the soil to properly assess whether potentially removed materials should be managed as a RCRA hazardous waste.

The MWP is referenced where routine activities will be performed in accordance with the MWP specifications. Variances to the specifications and amendments to the procedures will be documented in the WPA.

Components of the investigation will include the following:

- Soil boring and sample collection by direct push technology (e.g. Geoprobe ®);
- Surface and subsurface soil/sludge sampling and collection using hand boring; and
- Composite sample collection and analysis for assessment of hazardous waste characteristics.

Other related components of the investigation will include boring abandonment, stratigraphic logging of soil borings, sample management, portable photoionization detector (PID) screening, documentation, laboratory analysis, quality assurance practices, evaluation of data relative to USEPA Region III RBCs, and performance of a Baseline Risk Screening (see MWP sections 6.0 and 7.0). Investigative activities will be conducted in accordance with the SOPs in the MWP and in accordance with the Master Health and Safety Plan (MHSP). Table 1-1 identifies the SOPs that will be followed as part of the investigation.

1.3.1 Soil Borings

Twenty-four soil borings (eight borings at SWMU 8 and 16 borings at SWMU 36) will be advanced as part of this investigation. Soil borings will be advanced to approximately 15 ft bgs using direct push technology as described in SOP 20.11 in Appendix A. A four-foot Geoprobe Macro-Core® sampling device will be used to continuously collect soil samples from each of the borings. The location of each soil boring will be established to the nearest meter using Geographic Positioning System (GPS) equipment. Stratigraphic logs will be prepared for each boring location in accordance with the procedures outlined in SOP 10.3 in Appendix A.

1.3.1.1 Discrete Sampling

One objective of the sampling investigation is to evaluate residual risk in soil that will remain at SWMUs 8 and 36 at depth and within the surrounding surface soil after possible future construction activities. Data collected from discrete sampling will be used to conduct the residual risk analysis (i.e., Site Screening Process) and to characterize soil that may remain in place after the future construction is completed. Sixteen borings will be advanced at the following locations:

- Borings 8SB2, 8SB4, 36SB3, 36SB6, and 36SB10 are proposed at each SWMU. These locations will be completed to a depth of 10 ft below the sludge-native soil interface (approximately 15 ft bgs). These borings are designed to provide information regarding the chemical nature of *in situ* soil directly underlying the sludge material and at depth. Discrete samples will be collected from below the sludge-native soil interface and from depth (i.e., bottom of boring); and

- Borings 8SB1, 8SB3, 8SB5, 8SB6, 36SB1, 36SB2, 36SB4, 36SB5, 36SB7, 36SB8, and 36SB9 are proposed at each SWMU outside the bermed areas. These borings will be completed to a depth of approximately 15 ft bgs. These borings are designed to provide additional information regarding potential constituent migration from each SWMU in surface and subsurface soil. Discrete samples will be collected at the surface (0 to 6 inches bgs below gravel, vegetative, or organic layers and 6 to 12 inches bgs for VOCs) and from depth (i.e., approximately 15 ft bgs) at each boring.

1.3.1.2 Composite Sampling

A second objective of the sampling investigation at SWMUs 8 and 36 is to evaluate SWMU residue and subsurface soil with respect to hazardous waste characteristics. The RCRA hazardous waste characteristics data will be used to assess appropriate handling method(s) for media excavated during future construction activities. Composite samples will be collected from the following locations:

- Two composite samples (8SC1 and 36SC1) of the *in situ* soil, directly underlying the sludge material, will be collected and composited from multiple locations (8SB2, 8SB4; 36SB3, 36SB6, and 36SB10) at each SWMU; and

- Four composite samples (8SC2, 36SC2, 36SC3, and 36SC4) of sludge material will be collected and composited from multiple locations (8SB7, 8SB8; 36SB11, 36SB12; 36SB13, 36SB14; and 36SB15, and 36SB16) within each SWMU lagoon or bed. The boring locations will be completed to the bottom of the sludge layer approximately 5 ft bgs and samples will be composited to represent multiple layers within the sludge material. These samples are designed to provide information regarding the hazardous waste characteristics of the sludge at each SWMU lagoon and drying bed.

During boring advancement, subsurface soil samples will be screened for the presence of volatile organic compounds using a PID consistent with SOP 90.1 included in Appendix A. Discrete soil samples collected from each boring will be analyzed for TCL VOCs, TCL SVOCs/PAHs, explosives (including nitroglycerin), and TAL Metals (including mercury). In addition to the above, selected surface soil samples will be analyzed for TCL Pesticides and TCL PCBs consistent with the requirements of the Master Quality Assurance Plan (MQAP) and Section 2.0 of this WPA. Composite soil samples from each SWMU will be analyzed for RCRA hazardous waste characteristics (Tables 1-4 and 1-5). Proposed soil boring locations are presented on Figure 1-10 and Tables 1-4 and 1-5 summarize the proposed soil investigative program for SWMUs 8 and 36.

1.3.2 Investigation-derived 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 non-hazardous and hazardous investigation-derived material (IDM). Activities will be performed in accordance with the Installation safety rules, protocols, and MWP SOPs 30.6 and 70.1. Table 1-6 provides the suspected nature (hazardous vs. non-hazardous) of the materials expected during investigative activities.

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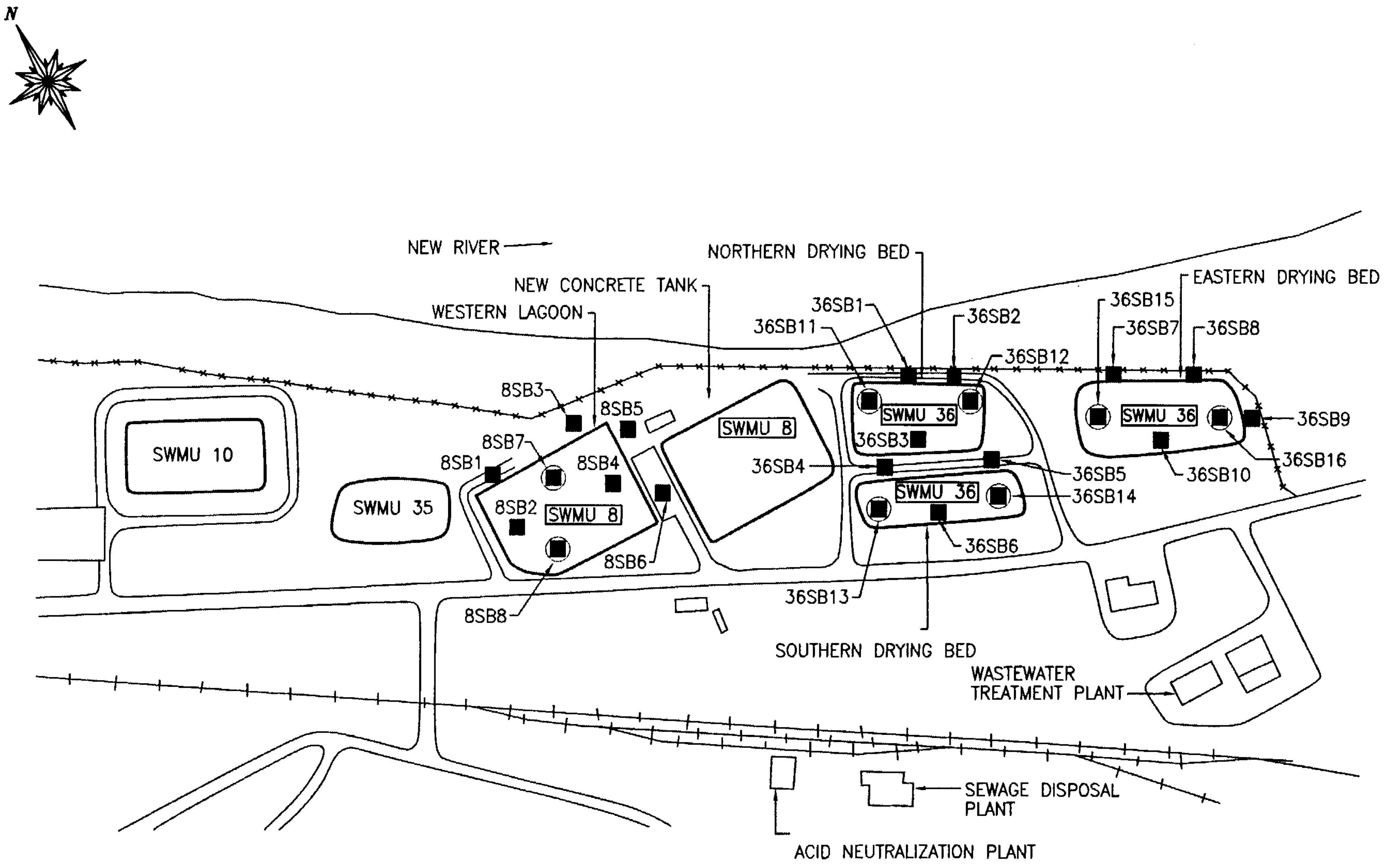

LEGEND

■ Soil Borings

◉ Sludge Composite Sample Borings Only

0 200

1 inch = 200 feet

RFAAP

SOIL SAMPLING INVESTIGATION FOR SWMUs 8 AND 36

Date: NOVEMBER 2002	**Prepared By:** URS Corp./KDC/BAC
Scale: AS SHOWN	**File Name:** 09604/Figure 1-10

FIGURE 1-10

PROPOSED SAMPLING LOCATIONS (MODIFIED FROM DAMES & MOORE, 1992)

Table 1-4
Proposed Sampling Plan for Discrete Sludge/Soil Samples, SWMUs 8 and 36
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

Sample Designation	Discrete Surface Soil[1]	Discrete Soil/Sludge Interface[2]	Discrete Subsurface Soil[3]	Chemical Analytes
8SB1A	x			TCL VOCs, TCL SVOC/PAH, TCL Pest/PCBs[4], Explosives (including nitroglycerin), TAL Metals
8SB1C			x	
8SB2B[4]		x		
8SB2C			x	
8SB3A[4]	x			
8SB3C			x	
8SB4B[4]		x		
8SB4C			x	
8SB5A	x			
8SB5C			x	
8SB6A[4]	x			
8SB6C			x	
36SB1A[4]	x			
36SB1C			x	
36SB2A	x			
36SB2C			x	
36SB3B[4]		x		
36SB3C			x	
36SB4A	x			
36SB4C			x	
36SB5A	x			
36SB5C			x	
36SB6B[4]		x		
36SB6C			x	
36SB7A[4]	x			
36SB7C			x	
36SB8A	x			
36SB8C			x	
36SB9A[4]	x			
36SB9C			x	
36SB10B[4]		x		
36SB10C			x	

Notes:

[1] = Samples will be collected from 0 to 6 inches bgs, except for VOCs which will be collected from 6 to12 inches bgs

[2] = Discrete soil samples will be collected from the sludge/native soil interface

[3] = Soil samples will be collected from approximately 15 ft bgs

[4] = TCL Pesticides and PCBs will be collected from selected surface soil

ft = feet
bgs = below ground surface
TCL = Target Compound List
TAL = Target Analyte List
VOCs = Volatile Organic Compounds

SVOC = Semi-volatile Organic Compound
PAH = Polynuclear Aromatic Hydrocarbon
Pest = Pesticides
PCB = Polychlorinated Biphenyls

Table 1-5
Proposed Sampling Plan for Composite Sludge/Soil Samples, SWMUs 8 and 36
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

Composite Sample Designation	Composite Soil/Sludge Interface[1]	Composite Sludge[2]	Chemical Analytes
8SC1	x		RCRA Hazardous Waste Characteristics[3]
8SC2		x	
36SC1	x		
36SC2		x	
36SC3		x	
36SC4		x	

Notes:

[1] = One composite sample from the soil/sludge interface will be collected from multiple borings at each lagoon at each SWMU

[2] = One composite sludge sample from multiple borings (surface and subsurface intervals) will be collected from each lagoon at each SWMU

[3] = RCRA Hazardous Waste Characteristics include: Full TCLP, Ignitability, Reactivity, Corrosivity, and Paint Filter Liquids

RCRA = Resource Conservation and Recovery Act

TCLP = Toxicity Characteristic Leaching Procedure

Table 1-6
Handling and Disposal of Investigation-derived Materials
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

Area	Material	Description	Quantity	Concern	Action	Expected Nature of Material
SWMUs 8 and 36	Soil cuttings	From 24 borings	Approx. two 55-gallon drums	COPCs	Full TCLP, Ignitability, Corrosivity, Reactivity, and Paint Filter Liquids	Non-hazardous. Concentrations are not expected to exceed TCLP or pH limits.
SWMUs 8 and 36	Decontamination water	Aqueous IDM	Approx. three 55-gallon drums	IDM	Full TCLP, Ignitability, Corrosivity, and Reactivity	Non-hazardous. Concentrations are not expected to exceed TCLP or pH limits.
SWMUs 8 and 36	PPE	Miscellaneous IDM	Approx. three 55-gallon drums	IDM	--	Non-hazardous material. Will be disposed as IDM.

Notes:

SWMU = Solid Waste Management Unit

Approx. = Approximately

COPC = Constituent of Potential Concern

IDM = Investigation-derived Material

TCLP = Toxicity Characteristics Leaching Procedure

PPE = Personal Protective Equipment

gal = Gallon

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2.0 QUALITY ASSURANCE PLAN ADDENDUM

2.1 INTRODUCTION

This QAPA establishes function-specific responsibilities and authorities to ensure data quality for investigative activities at RFAAP. The project objectives will be met through the execution of the SOPs included in the MWP and appended to this document. The applicable SOPs are referenced below. Specific QC requirements include development of Data Quality Objectives (DQOs), performance of internal QC checks, and execution of appropriate analytical procedures during investigative activities. This QAPA is designed to be used in conjunction with the 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 MQAP
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

Quality Assurance Measure	Section in MQAP	SOP No. (MWP Appendix A and Appendix A of WPA No. 15)
Project Organization and Responsibilities	2.0	--
Lines of Authority	2.2	--
Chemical Data Measurements	3.2	--
Levels of Concern	3.3	--
Site Investigation	4.0/5.0	20.11, 30.1, 30.6, 30.7, 30.9, 50.1, 50.2, 70.1, 80.1
Documentation Requirements	5.6	10.1, 10.2, 10.3, 50.1
Chain-of-custody Requirements	5.7	10.4, 50.2
Calibration Procedures	7.0	90.1
Data Reduction, Validation, Reporting, and Management	9.0	--
Corrective Action	10.0	--
Quality Assessments	11.0	--

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The distribution list for submittals associated with the Soil Sampling Investigation is defined in the Facility Permit (USEPA, 2000b). At least six copies of draft documents and three copies of the final plans, reports, notifications, or other documents submitted as part of the Soil Sampling Investigation for SWMUs 8 and 36 are to be submitted to the USEPA Regional Administrator, and shall be sent Certified Mail, Return Receipt Requested, overnight mail, or hand-carried to:

USEPA Region III
Federal Facilities Branch (3HS13)
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

In addition, one copy each such submission shall be sent to:

Commonwealth of Virginia
Department of Environmental Quality
Waste Division
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Moreover, one or more copies of each such submission shall be sent to:

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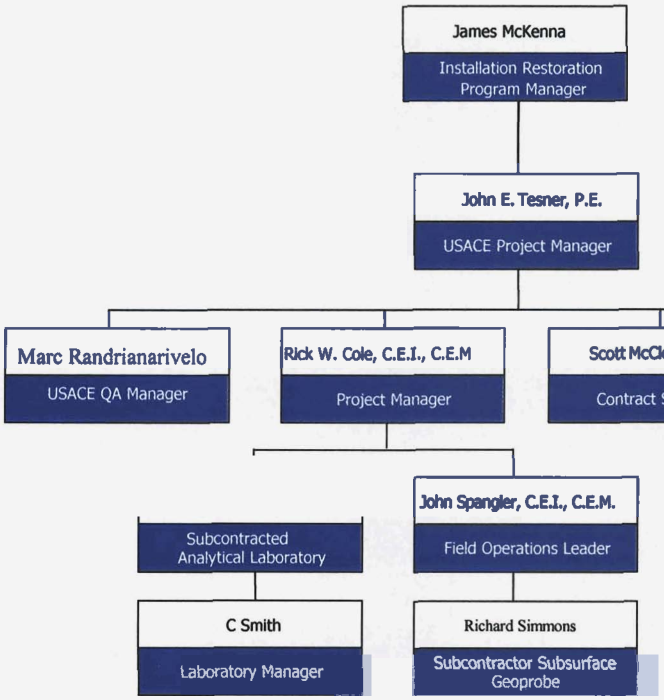
2.2 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.2.1 Contractor and Subcontractor Responsibilities

Contractor and subcontractor personnel requirements 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 project management personnel.

Figure 2-1
Project Organizational Chart
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia



2.2.2 Key Points of Contact

Table 2-2 provides the names and points of contact for URS personnel and subcontractors.

The Project Manager (PM) is responsible for ensuring that activities are conducted in accordance with contractual specifications, the Statement of Work (SOW), and approved work plans. The PM will also provide technical coordination with the Installation's designated counterpart. The PM is responsible for management of operations conducted for this project. In addition, the PM will ensure that personnel assigned the project, including subcontractors, will review the technical plans prior to initiation of each task associated with the project. The PM will monitor the project budget and schedule and will ensure availability of necessary personnel, equipment, subcontractors, and services. The PM will participate in the development of the field program, evaluation of data, reporting, and the development of conclusions and recommendations.

Table 2-2
Contractor and Subcontractor Key Points of Contact
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

Contractor	Key Point of Contact
Project Manager, Rick Cole e-mail: rick_cole@urscorp.com	URS Group, Inc. 5540 Falmouth Street, Suite 201 Richmond, Virginia 23230 Tel: 804.474.5417; Fax: 804.965.9764
Health and Safety Manager, Phillip Jones e-mail: phillip_l_jones@urscorp.com	URS Group, Inc. 1400 Union Meeting Road, Suite 202 Blue Bell, Pennsylvania 19422-1972 Tel: 215.619.4160; Fax: 215.542.3888
Quality Assurance Manager, John Kearns e-mail: john_kearns@urscorp.com	URS Group, Inc. 849 International Drive, Suite 320 Linthicum, Maryland 21090 Tel: 410.859.5049; Fax: 410.859.5049
Field Operations Leader and Site Health and Safety Officer, John Spangler e-mail: john_spangler@urscorp.com	URS Group, Inc. 5540 Falmouth Street, Suite 201 Richmond, Virginia 23230 Tel: 804.474.5419; Fax: 804.965.9764
Subcontractor	**Key Point of Contact**
Analytical Laboratory Services CompuChem Laboratories, Inc. e-mail: csmith@compuchemlabs.com	Chuck Smith Cary, North Carolina Tel: 919.679.4024; Fax: 919.379.4050
Subsurface (Geoprobe®) Richard Simmons Drilling	Richard Simmons Tel: 540.254-2289; Fax 540.254-1268

The Field Operations Leader will provide management of the field activities during the fieldwork. The Field Operations Leader is responsible for ensuring that technical matters pertaining to the field-sampling program are addressed. They will participate extensively in data interpretation, report writing, and preparation of deliverables, and will ensure that work is being conducted as specified in the technical plans. In addition, the Field Operations Leader is responsible for field QA/QC procedures and for safety-related issues. Prior to initiation of field activities, the Field Operations Leader will conduct a field staff orientation and briefing to acquaint project personnel with the sites and assign field responsibilities.

The Health and Safety Manager will review and internally approve the HSPA that will be tailored to the specific needs of the project in the task specific addendum. In consultation with the PM, the Health and Safety Manager will ensure that an adequate level of personal protection exists for anticipated potential hazards for field personnel. On-site health and safety will be the responsibility of the SHSO who will work in coordination with the PM and the project Health and Safety Manager.

The QA Manager is responsible for ensuring that the QA procedures and objectives in the project-specific work plans are met, reviewing field and analytical data to ensure adherence to Quality Assurance/Quality Control (QA/QC) procedures, and approving the quality of data prior to inclusion in associated reports. This may include the performance of field and laboratory audits during the investigation. In addition, the QA Manager will be responsible for the review, evaluation, and validation of analytical data for the project and will participate in interpreting and presenting analytical data. QC coordination is under the technical guidance of the QA Manager to direct the task leaders on a day-to-day or as-needed basis to ensure the application of QA/QC procedures.

The Data Validator, Ms. Andrea Sansom of URS-Linthicum, is responsible for analytical data evaluation and review to provide information on analytical data limitations based on specific quality control criteria. Responsibilities of the Data Validator include establishing if data meet the project technical, quality control criteria, assessing the usability and extent of bias of data not meeting the specific technical, and quality criteria. The reviewer will establish a dialogue with the data users prior to and after review to answer questions, assist with interpretation, and to provide the validation reports.

The Contract Specialist is responsible for tracking funds for labor and materials procurement and oversight of the financial status of the project. Responsibilities include:

- Preparation of monthly cost reports and invoices;
- Administration of equipment rental, material purchases, and inventory of supplies;
- Administration and negotiation of subcontracts and interaction with the Administrative Contracting Officer and Procurement Contracting Officer on contract and subcontract issues; and
- Preparation of project manpower estimates and administration of contract documents.

2.3 QUALITY ASSURANCE OBJECTIVES

QA is defined as the overall system of activities for assuring the reliability of data produced. Section 2.1, of this WPA references investigative, chemical, and regulatory measures associated with the Quality Assurance Objectives of this project. Conformance with appended SOPs will ensure attainment of QA objectives. 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 Data Quality Objective (DQO) process is a strategic planning approach to ensure environmental data is of the appropriate type, quantity, and quality for decision-making. Project-specific DQOs are included in Table 2-3 for investigative activities. The overall QA objective is to develop and implement procedures for sample and data collection, shipment, 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 decision-making process and specify the data required to support corrective actions. DQOs specify the level of uncertainty that will be accepted in results derived from environmental data. *Guidance for the Data Quality Objectives Process* (USEPA 1994), and *Data Quality Objective Process for Hazardous Waste Sites* (USEPA 2000a) formed the basis for the DQO process and development of RFAAP data quality criteria and performance specifications.

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Table 2-3
Summary of Project Data Quality Objectives
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

DQO Element	Project DQO Summary
Problem Statement	• The nature and extent of potential contamination of the SWMUs is currently unknown. • Possible risks to human health and the environment are currently unknown.
Identify Decision/Study Question	• Collect samples representative of each SWMU
Decision Inputs	• Field investigation data: soil borings and samples. • Chemical analyses: submit media samples to USACE-approved off-site analytical laboratory for analyses.
Study Boundaries	• Physical horizontal boundary of each SWMU will be defined within the WPA and by combining previous information.
Decision Rule	• Comparison to USEPA Region III RBCs, (USEPA October 2002 or most recent) as modified for risk screening; and • Comparison to USEPA Region III BTAG Screening Levels (surface soil).
Tolerable Limits on Decision Errors	• SW-846 Test Methods reporting limits, USEPA Contract Laboratory Program-like raw data package suitable for validation (level M3 for Organic, level IM2 for inorganic).
Optimize the Design for Obtaining Data	• Soil borings and soil sampling locations have been selected to provide crucial information.

The DQO process consists of the seven steps specified below.

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 and the primary decision-maker, (2) the statement of the problem, and (3) the identification of available resources, constraints, and deadlines.

    1) The planning team consists of the RFAAP, USACE, USEPA, Virginia Department of Environmental Quality (VDEQ), the RFAAP operating contractor, and URS; Relative to the implementation of this Work Plan Addendum, the primary decision-maker is RFAAP, in consultation with USACE, USEPA, VDEQ, the RFAAP operating contractor, and URS;

    2) RFAAP seeks to assess whether concentrations of hazardous constituents remain at SWMUs 8 and 36 exceeding USEPA Region III RBCs and/or BTAGs and to assess whether material removed from SWMUs 8 and 36 would be a RCRA Hazardous Waste; and

    3) The Soil Sampling Investigation project budget has been established, the project team has been identified, and a project schedule has been developed.

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(s) and (2) definition of resultant alternative actions.

   1) Principal study questions include:

      i. Do concentrations of hazardous constituents remain at SWMUs 8 and 36 in excess of relevant screening criteria identified in the USEPA Site Screening Process and do the site conditions pose an unacceptable risk to human health or the environment?

      ii. Will material removed from SWMUs 8 and 36 during planned construction activities be a RCRA Hazardous Waste?

   2) The resultant alternative actions include:

      i. If concentrations of hazardous constituents remain at SWMUs 8 and 36 in excess of relevant screening criteria, the team plans additional risk assessment activities and possibly additional investigation of the site; and

      ii. If material removed from SWMUs 8 and 36 during planned construction activities will be a hazardous waste under RCRA, removed material will be managed in accordance with the applicable regulations.

3. **Identify Inputs to the Decision**: Identify information inputs required for resolving the decision statement and determining which inputs require environmental measures. This step of the process includes identification of the data that will be required to make the decision, identification of the information sources, identification of data required for establishment of study action levels, and confirmation of appropriate field sampling and analytical methods. The kinds of information that is needed to resolve the decision statement and the sources of this information include the following:

   1) RBCs in the most recent version of the USEPA Region III Risk-based Concentration Table for soil ingestion using the residential and industrial scenarios;

   2) RBCs in the most recent version of the USEPA Region III Risk-based Concentration Table for tap water and federal and State of Virginia Maximum Contaminant Levels;

   3) USEPA RCRA Hazardous Waste Characteristics threshold levels;

   4) Method Detection Limits and Reporting Limits for the full suite of Contract Laboratory Procedure (CLP) constituents and other constituents based on the findings of the desktop audit;

   5) Results of an examination of site use, operational history, environmental setting, groundwater and surface water use and characteristics, and soil exposure characteristics;

   6) Details of a visual inspection of each SWMU; and

   7) Validated results of analyses performed on soil and waste samples.

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

   1) The physical horizontal boundary of each SWMU will encompass the berms surrounding each treatment/disposal area and drying bed and the areas contained within the berms;

   2) The media that will be investigated include surface soil, subsurface soil, and treatment residue within and beneath the SWMUs; and

   3) Practical constraints that could interfere with sampling include property access, weather, and undetected site appurtenances.

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

   1) Parameters of interest include:

      - TAL Metals (including mercury), TCL SVOCs, PAHs, TCL VOCs, TCL Pesticides, TCL PCBs, and explosives (including nitroglycerin); and

      - RCRA Characteristics: complete TCLP list, Ignitability, Corrosivity, Reactivity.

   2) Action levels include:

      - Action levels for risk screening include USEPA Region III RBCs, USEPA Region III BTAGs (surface soil), as well as the background soil inorganic constituent concentrations within the as reported in the Facility-wide Background Study Report; and

      - Method Detection Limits (MDLs) and Reporting Limits (RLs), as defined herein, will ensure that data quality is sufficient for intended data use. Selected laboratory is within the CLP network and it is assumed that sources of analytical errors are small and known.

   3) Decision rules include:

      - Constituents of potential concern will be identified by comparing maximum detected concentrations (or a 95% Upper Confidence Limit if appropriate) to established action levels in order to decide the need for further evaluation, investigation, or response action;

      - Analytical laboratory decision rules are presented in the laboratory QAP. These include specific action levels and decision rules based on accuracy and precision;

      - If boring refusal is encountered at less than the expected depth for each SWMU, then the boring will be offset five feet and advanced to the depth of previous refusal prior to collection of additional samples; and

      - Results of site activities will be used to refine the site conceptual model and will be used in remedial alternative decisions.

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

   1) Method Detection Limits (MDLs) and Reporting Limits (RLs) are established for each analyte within the suite of parameters sought. MDLs and RLs below the action levels will ensure the data meets the DQOs. The contract laboratory will provide a CLP-like raw data package (Level IV). Data validation will be conducted based on the MQAP, the USACE Shell Document, and USEPA Region III guidance.

   2) The main baseline condition decision error is to decide that the true mean concentration of a site-related contaminant does not exceed the action level for further study when in fact the mean concentration exceeds the action level and further action is needed (Type I, false rejection). Conversely, consequences of incorrectly deciding that the true mean concentration of a site-related contaminant is above the action level when in fact the mean concentration is below the action level include spending un-necessary resources to study further or remediate a site with insignificant risk (Type II, false acceptance).

   3) Information from previous studies and physical features of the areas surrounding each SWMU were used to develop a field-sampling plan design and measurements that allow for a low probability of decision error.

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, and (3) documentation of operational details and theoretical assumptions.

   1) DQO outputs will be reviewed based on the data collection activities; the validity of the data could be verified if necessary based on the review;

   2) Data collection is based upon site-specific characteristics and the end use of the data; and

   3) This addendum contains the proposed sampling design program based on the DQOs. Project documentation will be implemented in accordance with the MWP.

2.4 SAMPLE MANAGEMENT

Sample management objectives will be met through adherence to the sample identification procedures (identification convention), documentation requirements, and chain-of-custody procedures in the MWP.

2.4.1 Number and Type

Table 1-4 includes the number and types of environmental samples proposed during this investigation.

2.4.2 Sample Containers, Preservation, and Holding Times

Table 2-4 identifies the analytical parameters, containers, preservation requirements, and the sample holding times.

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Table 2-4
Sample Container, Sample Preservation, and Holding Times
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

PARAMETER	SAMPLE CONTAINER		PRESERVATION METHODS	HOLDING TIMES
	Quantity	Type		
SOLID SAMPLES				
Volatile Organic Compounds	3	5-g EnCore samplers, zero headspace	Cool to 4 ± 2°C	48 hours (must be analyzed within 48 hours or transferred to soil vial within 48 hours)
Volatile Organic Compounds – Sodium Bisulfate Preservation (Low Level)	3	60-mL glass vial, septum sealed for screening and dry weight determination; 2, 40-mL screw cap, PTFE lined, septum-sealed for analysis.	Cool to 4 ± 2°C, methanol pH <2 (except dry weight aliquot)	–
Volatile Organic Compounds – Methanol Preservation (High Level)	3	60-mL glass vial, septum sealed for screening and dry weight determination; 2, 40-mL screw cap, PTFE lined, septum-sealed for analysis.	Cool to 4 ± 2°C	14 days
Semivolatile Organic Compounds	1	250-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2°C	Extraction: 7 days Analysis: 40 days
Pesticides/Aroclors	2	250-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2°C	Extraction: 7 days Analysis: 40 days
Explosives	1	250-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2°C	Extraction: 7 days Analysis: 40 days
Metals*	1	200-g polyethylene or glass container, Teflon®-lined cap	Cool to 4 ± 2°C	6 months
Mercury*	1	500-mL polyethylene or glass container, Teflon®-lined cap	Cool to 4 ± 2°C	28 days
Reactivity (percent explosive material)	1	250-mL wide-mouth glass container, Teflon®-lined cap	–	–
SOLID WASTE CHARACTERIZATION				
TCLP VOCs	1	250-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2°C	Leaching: 14 days Analysis: 14 days
TCLP SVOCs	1	250-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2°C	Leaching: 14 days Extraction: 7 days Analysis: 40 days
TCLP Pesticides	1	250-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2°C	Leaching: 14 days Extraction: 7 days Analysis: 40 days

Table 2-4 (Continued)
Sample Container, Sample Preservation, and Holding Times
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

PARAMETER	SAMPLE CONTAINER		PRESERVATION METHODS	HOLDING TIMES
	Quantity	Type		
SOLID WASTE CHARACTERIZATION (continued)				
TCLP Herbicides	1	250-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2°C	Leaching: 14 days Extraction: 7 days Analysis: 40 days
TCLP Metals	1	250-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2°C	Leaching: 14 days Analysis: 6 months Mercury analysis: 28 days
Corrosivity, Paint Filter	1	250-mL wide-mouth glass container, Teflon®-lined cap	Cool to 4 ± 2°C	Corrosivity: 7 days Reactivity: 7 days
Reactivity (percent explosive material)	1	250-mL wide-mouth glass container, Teflon®-lined cap	--	--
AQUEOUS SAMPLES				
Volatile Organic Compounds	2	40-mL glass vials, Teflon®-lined septum cap	HCl to pH<2, Cool to 4 ± 2°C	14 days
Semivolatile Organic Compounds	2	1-liter narrow-mouth amber glass, Teflon®-lined cap	Cool to 4 ± 2°C	Extraction: 7 days Analysis: 40 days
Pesticides/Aroclors	4	1-liter narrow-mouth amber glass, Teflon®-lined cap	Cool to 4 ± 2°C	Extraction: 7 days Analysis: 40 days
Explosives	1	1-liter narrow-mouth amber glass, Teflon®-lined cap	Cool to 4 ± 2°C	Extraction: 7 days Analysis: 40 days
Metals	1	1-liter polyethylene container	HNO_3 to pH<2, Cool to 4 ± 2°C	6 months
Mercury	1	1-liter polyethylene container	HNO_3 to pH<2, Cool to 4 ± 2°C	28 days

Notes:

* = Metals and mercury sample for soil will be combined into one 500-mL bottle
VOC = Volatile Organic Compound
SVOC = Semivolatile Organic Compound
PTFE = Poly Teflon
TCLP = Toxicity Characteristic Leaching Procedure
mL = milliliter
°C = Celsius
g = gram
HCL = Hydrochloric Acid
HNO_3 = Nitric Acid
® = Registered Trademark

2.4.3 Sample Identification

The sample identification number will conform to past nomenclature at RFAAP. The identification will consist of an alphanumeric designation related to the sampling location, media type, and sequential order according to the sampling event. The identification number will not exceed thirty-two characters for entry into Environmental Restoration Information System (ERIS). Samples will be coded in the following order to ensure a unique identification.

Site Location Code: The first two characters will be the SWMU number (i.e., 36 for SWMU 36).

- **Sample/Media Type:** The next two characters will be the sample/media types. In this case, the characters will be SB for soil boring and SS for surface soil.

- **Sampling Location Number**: The next one or two characters will be the number of the sampling location (e.g., 3, 4, 5).

- **Sample Depth:** The sampling unit representing zero to six inches bgs (6 to 12 inches for VOCs) will be designated with an "A" after the boring number. The sample collected from intermediate depths of the boring or from below the sludge/native soil interface will be designated with a "B" following the boring number. Samples representative of sludge will be designated with an "S." Samples collected from above bedrock, at the base of the boring will be designated with a "C."

- **Duplicate:** Duplicate samples will be identified with a "D" designation followed by a numeric designation corresponding to the sequence of duplicates collected (e.g., D-1). A record of the sample that corresponds to the duplicate will be kept in the field logbook. In this manner, duplicates will be submitted as blind duplicates, eliminating the potential for laboratory bias in analysis.

Sample Identification Examples:

1) A subsurface soil sample collected above the terminational depth of boring location four at SWMU 36 would be identified as sample 36SB4C (for SWMU 36, soil boring four, and "C" which stands for the soil above bedrock at that location).

2) Quality Control Samples: QC samples will be identified by date (month, day, year), followed by QC sample type, and sequential order number at one digit. The QC sample types include Matrix Spike (MS), Matrix Spike Duplicate (MSD), Rinse Blank (R), and Trip Blank (T).

2.4.4 Documentation

SOPs 10.1 through 10.4 in Appendix A and Section 9.8 of the MQAP specify documentation protocols.

2.4.5 Sample Management

SOPs 50.1 and 50.2 in Appendix A and Section 9.8 on the MQAP specify sample management protocols for sample labels and sample packaging.

2.5 ANALYTICAL PROCEDURES

CompuChem Laboratory, Inc. will perform off-site analytical activities. Analytical methods to be used and associated MDLs and RLs are identified in Table 2-5 through 2-11. Laboratory analyses will be in accordance with the current USEPA SW-846 Test Methods for the analysis of the following:

Table 2-5
Summary of Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for TCL VOCs (SW 8260B), Soil and Water Samples
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

Compound	CAS Number	Laboratory-Specific Method Detection and Reporting Limits				USEPA Region III Risk-Based Concentrations					USEPA Region III BTAG Screening Levels	
		Soil		Water								
		MDL mg/kg	Reporting Limit mg/kg	MDL µg/L	Reporting Limit µg/L	C/N	Soil RBC (Industrial) mg/kg	Adjusted Soil RBC (Industrial) mg/kg	Soil RBC (Residential) mg/kg	Adjusted Soil RBC (Residential) mg/kg	Water µg/L	Soil mg/kg
1,1,1-Trichloroethane	71-55-6	4.9E-04	5.0E-03	0.60	5	N	5.7E+05	5.7E+04	2.2E+04	2.2E+03	9400	0.3
1,1,2,2-Tetrachloroethane	79-34-5	7.3E-04	5.0E-03	1.3	5	C	2.9E+01	2.9E+01	3.2E+00	3.2E+00	2400	0.3
1,1,2-Trichloroethane	79-00-5	5.5E-04	5.0E-03	1.6	5	C	1.0E+02	1.0E+02	1.1E+01	1.1E+01	9400	0.3
1,1-Dichloroethane	75-34-3	4.4E-04	5.0E-03	0.67	5	N	2.0E+05	2.0E+04	7.8E+03	7.8E+02	160000	0.3
1,1-Dichloroethene	75-35-4	8.3E-04	5.0E-03	0.44	5	N	1.0E+05	1.0E+04	3.9E+03	3.9E+02	11600	–
1,2-Dichloroethane	107-06-2	1.6E-04	5.0E-03	0.92	5	C	6.3E+01	6.3E+01	7.0E+00	7.0E+00	20000	870
1,2-Dichloroethene (total)	540-59-0	9.1E-04	2.0E-02	1.7	10	N	1.8E+04	1.8E+03	7.0E+02	7.0E+01	11600	0.3
1,2-Dichloropropane	78-87-5	3.0E-04	5.0E-03	0.84	5	C	8.4E+01	8.4E+01	9.4E+00	9.4E+00	--	–
2-Butanone	78-93-3	7.2E-04	1.3E-02	2.1	13	N	1.2E+06	1.2E+05	4.7E+04	4.7E+03	3220000	–
2-Hexanone	591-78-6	7.7E-04	1.3E-02	2.0	13	N	8.2E+04	8.2E+03	3.1E+03	3.1E+02	428000	–
4-Methyl-2-pentanone	108-10-1	4.0E-04	1.3E-02	2.7	13	N	1.6E+05	1.6E+04	6.3E+03	6.3E+02	460000	100
Acetone	67-64-1	9.2E-04	1.3E-02	2.7	13	N	2.0E+05	2.0E+04	7.8E+03	7.8E+02	9000000	–
Benzene	71-43-2	1.1E-04	5.0E-03	0.68	5	C	1.0E+02	1.0E+02	1.2E+01	1.2E+01	5300	0.1
Bromodichloromethane	75-27-4	3.1E-04	5.0E-03	0.94	5	C	9.2E+01	9.2E+01	1.0E+01	1.0E+01	11000	450
Bromoform	75-25-2	6.0E-04	5.0E-03	1.5	5	C	7.2E+02	7.2E+02	8.1E+01	8.1E+01	--	–
Bromomethane	74-83-9	6.1E-04	5.0E-03	0.98	5	N	2.9E+03	2.9E+02	1.1E+02	1.1E+01	–	--
Carbon disulfide	75-15-0	3.2E-04	5.0E-03	0.76	5	N	2.0E+05	2.0E+04	7.8E+03	7.8E+02	2	–
Carbon tetrachloride	56-23-5	6.5E-04	5.0E-03	0.78	5	C	4.4E+01	4.4E+01	4.9E+00	4.9E+00	35200	0.3
Chlorobenzene	108-90-7	5.0E-04	5.0E-03	0.88	5	N	4.1E+04	4.1E+03	1.6E+03	1.6E+02	50	0.1
Chloroethane	75-00-3	6.8E-04	5.0E-03	0.46	5	C	2.0E+03	2.0E+03	2.2E+02	2.2E+02	–	–
Chloroform	67-66-3	3.2E-04	5.0E-03	0.95	5	N	2.0E+04	2.0E+03	7.8E+02	7.8E+01	1240	0.3
Chloromethane	74-87-3	7.6E-04	5.0E-03	0.64	5	C	4.4E+02	4.4E+02	4.9E+01	4.9E+01	–	--
cis-1,3-Dichloropropene[1]	10061-01-5	3.1E-04	5.0E-03	0.68	5	C	5.7E+01	5.7E+01	6.4E+00	6.4E+00	244	0.3
trans-1,3-Dichloropropene[1]	10061-02-6	3.2E-04	5.0E-03	1.5	5	C	5.7E+01	5.7E+01	6.4E+00	6.4E+00	244	0.3
Dibromochloromethane	124-48-1	4.8E-04	5.0E-03	1.5	5	C	6.8E+01	6.8E+01	7.6E+00	7.6E+00	--	–
Ethylbenzene	100-41-4	7.5E-04	5.0E-03	1.1	5	N	2.0E+05	2.0E+04	7.8E+03	7.8E+02	32000	0.1
Methylene chloride	75-09-2	1.6E-03	5.0E-03	1.7	5	C	7.6E+02	7.6E+02	8.5E+01	8.5E+01	11000	0.3
Styrene	100-42-5	5.5E-04	5.0E-03	0.72	5	N	4.1E+05	4.1E+04	1.6E+04	1.6E+03	–	0.1
Tetrachloroethene	127-18-4	6.4E-04	5.0E-03	1.1	5	C	1.1E+02	1.1E+02	1.2E+01	1.2E+01	840	0.3
Toluene	108-88-3	5.0E-04	5.0E-03	1.1	5	N	4.1E+05	4.1E+04	1.6E+04	1.6E+03	17000	0.1
Trichloroethene	79-01-6	5.3E-04	5.0E-03	0.97	5	C	1.4E+01	1.4E+01	1.6E+00	1.6E+00	21900	0.3
Vinyl Chloride[2]	75-01-4	8.7E-04	5.0E-03	0.52	5	C	7.9E+00	7.9E+00	9.0E-02	9.0E-02	11600	0.3
Xylenes	1330-20-7	1.3E-03	1.0E-02	2.9	10	N	4.1E+06	4.1E+05	1.6E+05	1.6E+04	6000	0.1

Notes:

CAS = Chemical Abstract Service
MDL = Method Detection Limit
Method Detection and Reporting Limits provided by CompuChem
mg/kg = Milligram per kilogram
µg/L = Microgram per liter
RBC = Risk-based Concentration
USEPA Region III Risk-Based Concentration (RBC) values from the October 9, 2002 RBC Table
C/N = Carcinogenic or Non-carcinogenic status

C = Carcinogenic
Ct = Carcinogen with a hazard quotient of 0.1; see USEPA Region III guidance
N = Non-carcinogenic
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
(1) = RBC value is for 1,3-Dichloropropene
(2) = RBCs presented are for early-life, except industrial soil RBC, which is for adult
TCL = Target Compound List
VOC = Volatile Organic Compound

Table 2-6
Summary by Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for TCL SVOCs (SW8270C), Soil and Water Samples
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

Compound	CAS Number	Laboratory-Specific Method Detection and Reporting Limits				USEPA MCLs	USEPA Region III Risk-based Concentrations							USEPA Region III BTAG Screening Levels	
		Soil		Water											
		MDL mg/kg	Reporting Limit mg/kg	MDL µg/L	Reporting Limit µg/L	µg/L	C/N	Tap water RBC µg/L	Adjusted Tap Water RBC µg/L	Soil RBC (Industrial) mg/kg	Adjusted Soil RBC (Industrial) mg/kg	Soil RBC (Residential) mg/kg	Adjusted Soil RBC (Residential) mg/kg	Water µg/L	Soil mg/kg
1,2,4-Trichlorobenzene	120-82-1	4.2E-02	3.3E-01	1.2	10	7.0E+01	N	7.2E+00	7.2E-01	2.0E+04	2.0E+03	7.8E+02	7.8E+01	50	0.1
1,2-Dichlorobenzene	95-50-1	3.3E-02	3.3E-01	0.96	10	--	N	2.7E+02	2.7E+01	1.8E+05	1.8E+04	7.0E+03	7.0E+02	763	0.3
1,3-Dichlorobenzene	541-73-1	3.4E-02	3.3E-01	1.1	10	--	N	1.8E+02	1.8E+01	6.1E+04	6.1E+03	2.3E+03	2.3E+02	763	--
1,4-Dichlorobenzene	106-46-7	2.9E-02	3.3E-01	0.95	10	--	C	4.7E-01	4.7E-01	2.4E+02	2.4E+02	2.7E+01	2.7E+01	763	0.1
2,2'-oxybis(1-Chloropropane)	108-60-1	4.0E-02	3.3E-01	0.93	10	--	C	2.6E-01	2.6E-01	8.2E+01	8.2E+01	9.1E+00	9.1E+00	--	--
2,4,5-Trichlorophenol	95-95-4	5.0E-02	3.3E-01	1.5	10	--	N	3.7E+03	3.7E+02	2.0E+05	2.0E+04	7.8E+03	7.8E+02	63	0.1
2,4,6-Trichlorophenol	88-06-2	6.5E-02	3.3E-01	1.9	10	--	C	6.1E+00	6.1E+00	5.2E+02	5.2E+02	5.8E+01	5.8E+01	970	0.1
2,4-Dichlorophenol	120-83-2	2.2E-02	3.3E-01	0.70	10	--	N	1.1E+02	1.1E+01	6.1E+03	6.1E+02	2.3E+02	2.3E+01	365	0.1
2,4-Dimethylphenol	105-67-9	3.0E-02	3.3E-01	1.5	10	--	N	7.3E+02	7.3E+01	4.1E+04	4.1E+03	1.6E+03	1.6E+02	--	0.1
2,4-Dinitrophenol	51-28-5	1.6E-01	1.7E+00	3.5	50	--	N	7.3E+01	7.3E+00	4.1E+03	4.1E+02	1.6E+02	1.6E+01	150	0.1
2,4-Dinitrotoluene	121-14-2	1.3E-02	3.3E-01	0.43	10	--	N	7.3E+01	7.3E+00	4.1E+03	4.1E+02	1.6E+02	1.6E+01	230	--
2,6-Dinitrotoluene	606-20-2	2.4E-02	3.3E-01	0.73	10	--	N	3.7E+01	3.7E+00	2.0E+03	2.0E+02	7.8E+01	7.8E+00	230	--
2-Chloronaphthalene	91-58-7	3.3E-02	3.3E-01	0.74	10	--	N	4.9E+02	4.9E+01	1.6E+05	1.6E+04	6.3E+03	6.3E+02	--	--
2-Chlorophenol	95-57-8	3.6E-02	3.3E-01	1.0	10	--	N	3.0E+01	3.0E+00	1.0E+04	1.0E+03	3.9E+02	3.9E+01	970	0.1
2-Methylnaphthalene	91-57-6	3.8E-02	3.3E-01	0.93	10	--	N	1.2E+02	1.2E+01	4.1E+04	4.1E+03	1.6E+03	1.6E+02	--	--
2-Methylphenol	95-48-7	2.9E-02	3.3E-01	0.92	10	--	N	1.8E+03	1.8E+02	1.0E+05	1.0E+04	3.9E+03	3.9E+02	--	0.1
2-Nitroaniline	88-74-4	2.5E-02	6.7E-01	0.46	20	--	--	--	--	--	--	--	--	--	--
2-Nitrophenol	88-75-5	3.0E-02	3.3E-01	0.77	10	--	--	--	--	--	--	--	--	150	0.1
3,3'-Dichlorobenzidine	91-94-1	1.6E-02	6.7E-01	1.2	10	--	C	1.5E-01	1.5E-01	1.3E+01	1.3E+01	1.4E+00	1.4E+00	--	--
3-Nitroaniline	99-09-2	2.5E-02	6.7E-01	1.1	20	--	C!/N	3.3E+00	3.3E+00	2.9E+02	2.9E+02	2.3E+01	2.3E+00	--	--
4,6-Dinitro-2-methylphenol	534-52-1	3.4E-02	6.7E-01	0.86	20	--	N	3.7E+00	3.7E-01	2.0E+02	2.0E+01	7.8E+00	7.8E-01	--	--
4-Bromophenyl-phenylether	101-55-3	2.7E-02	3.3E-01	0.84	10	--	--	--	--	--	--	--	--	--	--
4-Chloro-3-Methylphenol	59-50-7	3.1E-02	3.3E-01	0.51	10	--	--	--	--	--	--	--	--	--	--
4-Chloroaniline	106-47-8	9.5E-03	3.3E-01	1.6	10	--	N	1.5E+02	1.5E+01	6.2E+03	8.2E+02	3.1E+02	3.1E+01	--	--
4-Chlorophenyl-phenylether	7005-72-3	2.3E-02	3.3E-01	0.61	10	--	--	--	--	--	--	--	--	--	--
4-Methylphenol	106-44-5	2.8E-02	3.3E-01	0.90	5	--	N	1.8E+02	1.8E+01	1.0E+04	1.0E+03	3.9E+02	3.9E+01	--	0.1
4-Nitroaniline	100-01-6	1.9E-02	6.7E-01	0.76	20	--	C/C!	3.3E+00	3.3E+00	2.9E+02	2.9E+02	3.2E+01	3.2E+01	--	--
4-Nitrophenol	100-02-7	5.1E-02	6.7E-01	2.7	20	--	N	2.9E+02	2.9E+01	1.6E+04	1.6E+03	6.3E+02	6.3E+01	150	0.1
Acenaphthene	83-32-9	2.2E-02	3.3E-01	0.55	10	--	N	3.7E+02	3.7E+01	1.2E+05	1.2E+04	4.7E+03	4.7E+02	520	0.1
Acenaphthylene (1)	208-96-8	2.6E-02	3.3E-01	0.72	10	--	N	1.8E+02	1.8E+01	6.1E+04	6.1E+03	2.3E+03	2.3E+02	--	0.1
Anthracene	120-12-7	2.5E-02	3.3E-01	0.61	10	--	N	1.8E+03	1.8E+02	6.1E+05	6.1E+04	2.3E+04	2.3E+03	0.1	0.1
Benzo(a)anthracene	56-55-3	2.4E-02	3.3E-01	0.46	10	--	C	9.2E-02	9.2E-02	7.8E+00	7.8E+00	8.7E-01	8.7E-01	6.3	0.1
Benzo(a)pyrene	50-32-8	2.6E-02	3.3E-01	0.58	10	2.0E-01	C	9.2E-03	9.2E-03	7.8E-01	7.8E-01	8.7E-02	8.7E-02	--	0.1
Benzo(b)fluoranthene	205-99-2	2.4E-02	3.3E-01	0.51	10	--	C	9.2E-02	9.2E-02	7.8E+00	7.8E+00	8.7E-01	8.7E-01	--	0.1
Benzo(g,h,i)perylene (1)	191-24-2	3.3E-02	3.3E-01	0.85	10	--	N	1.8E+02	1.8E+01	6.1E+04	6.1E+03	2.3E+03	2.3E+02	--	0.1
Benzo(k)fluoranthene	207-08-9	3.6E-02	3.3E-01	0.74	10	--	C	9.2E-01	9.2E-01	7.8E+01	7.8E+01	8.7E+00	8.7E+00	--	0.1
Bis(2-chloroethoxy)methane	111-91-1	3.6E-02	3.3E-01	0.79	10	--	--	--	--	--	--	--	--	11000	--
Bis(2-chloroethyl)ether	111-44-4	3.0E-02	3.3E-01	0.93	10	--	C	9.6E-03	9.6E-03	5.2E+00	5.2E+00	5.8E-01	5.8E-01	--	--

Table 2-6 (Continued)
Summary by Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for TCL SVOCs (SW8270C), Soil and Water Samples
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

Compound	CAS Number	Laboratory-Specific Method Detection and Reporting Limits				USEPA MCLs	USEPA Region III Risk-based Concentrations							Region III BTAG Screening Levels	
		Soil		Water											
		MDL mg/kg	Reporting Limit mg/kg	MDL µg/L	Reporting Limit µg/L	µg/L	C/N	Tap water RBC µg/L	Adjusted Tap Water RBC µg/L	Soil RBC (Industrial) mg/kg	Adjusted Soil RBC (Industrial) mg/kg	Soil RBC (Residential) mg/kg	Adjusted Soil RBC (Residential) mg/kg	Water µg/L	Soil mg/kg
Bis(2-ethylhexyl)phthalate	117-81-7	3.9E-02	3.3E-01	0.65	10	–	C	4.8E+00	4.8E+00	4.1E+02	4.1E+02	4.6E+01	4.6E+01	30	–
Butylbenzylphthalate	85-68-7	2.1E-02	3.3E-01	0.52	10	–	N	7.3E+03	7.3E+02	4.1E+05	4.1E+04	1.6E+04	1.6E+03	3	–
Carbazole	86-74-8	2.5E-02	3.3E-01	0.78	10	–	C	3.3E+00	3.3E+00	2.9E+02	2.9E+02	3.2E+01	3.2E+01	–	–
Chrysene	218-01-9	2.8E-02	3.3E-01	0.65	10	–	C	9.2E+00	9.2E+00	7.8E+02	7.8E+02	8.7E+01	8.7E+01	–	0.1
Dibenz(a,h)anthracene	53-70-3	2.9E-02	3.3E-01	0.80	10	–	C	9.2E-03	9.2E-03	7.8E-01	7.8E-01	8.7E-02	8.7E-02	–	0.1
Dibenzofuran	132-64-9	2.9E-02	3.3E-01	0.66	10	–	N	2.4E+01	2.4E+00	8.2E+03	8.2E+02	3.1E+02	3.1E+01	–	–
Diethylphthalate	84-66-2	1.5E-02	3.3E-01	0.58	10	–	N	2.9E+04	2.9E+03	1.6E+06	1.6E+05	6.3E+04	6.3E+03	3	–
Dimethylphthalate	131-11-3	2.2E-02	3.3E-01	0.56	10	–	N	3.7E+05	3.7E+04	2.0E+07	2.0E+06	7.8E+05	7.8E+04	3	–
Di-n-butylphthalate	84-74-2	2.0E-02	3.3E-01	0.80	10	–	N	3.7E+03	3.7E+02	2.0E+05	2.0E+04	7.8E+03	7.8E+02	0.3	–
Di-n-octylphthalate	117-84-0	1.9E-02	3.3E-01	0.68	10	–	N	7.3E+02	7.3E+01	4.1E+04	4.1E+03	1.6E+03	1.6E+02	0.3	–
Fluoranthene	206-44-0	1.6E-02	3.3E-01	0.70	10	–	N	1.5E+03	1.5E+02	8.2E+04	8.2E+03	3.1E+03	3.1E+02	3980	0.1
Fluorene	86-73-7	1.7E-02	3.3E-01	0.56	10	–	N	2.4E+02	2.4E+01	8.2E+04	8.2E+03	3.1E+03	3.1E+02	430	0.1
Hexachlorobenzene	118-74-1	2.9E-02	3.3E-01	0.75	10	1.0E+00	C	4.2E-02	4.2E-02	3.6E+00	3.6E+00	4.0E-01	4.0E-01	3.68	–
Hexachlorobutadiene	87-68-3	3.3E-02	3.3E-01	1.1	10	–	C!	8.6E-01	8.6E-01	7.3E+01	7.3E+01	8.2E+00	8.2E+00	9.3	–
Hexachlorocyclopentadiene	77-47-4	6.7E-02	3.3E-01	1.0	10	–	N	2.2E+02	2.2E+01	1.2E+04	1.2E+03	4.7E+02	4.7E+01	5.2	–
Hexachloroethane	67-72-1	3.7E-02	3.3E-01	1.4	10	–	C!	4.8E+00	4.8E+00	4.1E+02	4.1E+02	4.6E+01	4.6E+01	540	–
Indeno(1,2,3-cd)pyrene	193-39-5	3.0E-02	3.3E-01	0.85	10	–	C	9.2E-02	9.2E-02	7.8E+00	7.8E+00	8.7E-01	8.7E-01	–	0.1
Isophorone	78-59-1	3.0E-02	3.3E-01	0.67	10	–	C	7.0E+01	7.0E+01	6.0E+03	6.0E+03	6.7E+02	6.7E+02	11700	–
Naphthalene	91-20-3	3.5E-02	3.3E-01	0.90	10	–	N	6.5E+00	6.5E-01	4.1E+04	4.1E+03	1.6E+03	1.6E+02	100	0.1
Nitrobenzene	98-95-3	4.3E-02	3.3E-01	1.0	10	–	N	3.5E+00	3.5E-01	1.0E+03	1.0E+02	3.9E+01	3.9E+00	27000	–
N-Nitrosodi-n-propylamine	621-64-7	3.3E-02	3.3E-01	0.77	10	–	C	9.6E-03	9.6E-03	8.2E-01	8.2E-01	9.1E-02	9.1E-02	–	–
N-Nitrosodiphenylamine	86-30-6	3.2E-02	3.3E-01	0.71	10	–	C	1.4E+01	1.4E+01	1.2E+03	1.2E+03	1.3E+02	1.3E+02	5850	–
Pentachlorophenol	87-86-5	4.6E-02	6.7E-01	1.2	20	1.0E+00	C	5.6E-01	5.6E-01	4.8E+01	4.8E+01	5.3E+00	5.3E+00	13	0.1
Phenanthrene (1)	85-01-8	2.4E-02	3.3E-01	0.67	10	–	N	1.8E+02	1.8E+01	6.1E+04	6.1E+03	2.3E+03	2.3E+02	6.3	0.1
Phenol	108-95-2	3.5E-02	3.3E-01	1.2	10	–	N	1.1E+04	1.1E+03	6.1E+05	6.1E+04	2.3E+04	2.3E+03	79	0.1
Pyrene	129-00-0	2.7E-02	3.3E-01	0.59	10	–	N	1.8E+02	1.8E+01	6.1E+04	6.1E+03	2.3E+03	2.3E+02	–	0.1

Notes:

CAS = Chemical Abstract Service
Method Detection and Reporting Limits provided by CompuChem Laboratories
MDL = Method Detection Limit
mg/kg = milligram per kilogram
µg/L = microgram per liter
RBC = Risk-based Concentration
USEPA = United States Environmental Protection Agency
USEPA Region III Risk-based Concentration (RBC) values from the October 9, 2002 RBC Table
– = No RBC available
SVOC = Semivolatile Organic Compound

TCL SVOCs = Target Compound List Semivolatile Organic Compounds
C/N = Carcinogenic or Non-carcinogenic status
C = Carcinogenic
C! = Carcinogen with a hazard quotient of 0.1; see USEPA Region III guidance
N = Non-carcinogenic
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
MCL = Maximum Contaminent Level
(1) = the RBC for pyrene was substituted for these compounds
BTAG = USEPA Region III Biological Technical Assistance Group

Table 2-7
Summary of Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for PAHs (SW8310), Soil and Water Samples
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, VA

Compound	CAS Number	Laboratory-Specific Method Detection and Reporting Limits				USEPA MCLs	USEPA Region III Risk-Based Concentrations							USEPA Region III BTAG Screening Levels	
		Soil		Water											
		MDL mg/kg	Reporting Limit mg/kg	MDL µg/L	Reporting Limit µg/L	µg/L	C/N	Tap water RBC µg/L	Adjusted Tap Water RBC µg/L	Soil RBC (Industrial) mg/kg	Adjusted Soil RBC (Industrial) mg/kg	Soil RBC (Residential) mg/kg	Adjusted Soil RBC (Residential) mg/kg	Water µg/L	Soil mg/kg
Acenaphthene	83329	2.2E-02	4.2E-02	0.31	1.25	–	N	3.7E+02	3.7E+01	1.2E+05	1.2E+04	4.7E+03	4.7E+02	520	0.1
Acenaphthylene (1)	208968	6.9E-03	4.2E-02	0.41	1.25	–	N	1.8E+02	1.8E+01	6.1E+04	6.1E+03	2.3E+03	2.3E+02	–	0.1
Anthracene	120127	5.9E-03	4.2E-02	0.14	1.25	–	N	1.8E+03	1.8E+02	6.1E+05	6.1E+04	2.3E+04	2.3E+03	0.1	0.1
Benzo(a)anthracene	56553	2.0E-03	8.3E-03	0.02	0.25	–	C	9.2E-02	9.2E-02	7.8E+00	7.8E+00	8.7E-01	8.7E-01	6.3	0.1
Benzo(a)pyrene	50328	2.7E-03	8.3E-03	0.03	0.25	2.0E-01	C	9.2E-03	9.2E-03	7.8E-01	7.8E-01	8.7E-02	8.7E-02	–	0.1
Benzo(b)fluoranthene	205992	4.0E-03	8.3E-03	0.03	0.25	–	C	9.2E-02	9.2E-02	7.8E+00	7.8E+00	8.7E-01	8.7E-01	–	0.1
Benzo(ghi)perylene (1)	191242	1.7E-03	8.3E-03	0.01	0.25	–	N	1.8E+02	1.8E+01	6.1E+04	6.1E+03	2.3E+03	2.3E+02	–	0.1
Benzo(k)fluoranthene	205992	1.8E-03	8.3E-03	0.023	0.25	–	C	9.2E-01	9.2E-01	7.8E+01	7.8E+01	8.7E+00	8.7E+00	–	0.1
Chrysene	218019	3.1E-03	8.3E-03	0.23	0.25	–	C	9.2E+00	9.2E+00	7.8E+02	7.8E+02	8.7E+01	8.7E+01	–	0.1
Dibenzo(a,h)anthracene	53703	4.5E-03	8.3E-03	0.05	0.25	–	C	9.2E-03	9.2E-03	7.8E-01	7.8E-01	8.7E-02	8.7E-02	–	0.1
Fluoranthene	206440	6.3E-03	1.7E-02	0.22	0.50	–	N	1.5E+03	1.5E+02	8.2E+04	8.2E+03	3.1E+03	3.1E+02	3980	0.1
Fluorene	86737	1.4E-02	4.2E-02	0.97	1.25	–	N	2.4E+02	2.4E+01	8.2E+04	8.2E+03	3.1E+03	3.1E+02	430	0.1
Indeno(1,2,3-c,d)pyrene	193395	1.1E-03	8.3E-03	0.089	0.25	–	C	9.2E-02	9.2E-02	7.8E+00	7.8E+00	8.7E-01	8.7E-01	–	0.1
Naphthalene	91203	1.1E-02	4.2E-02	0.60	1.25	–	N	6.5E+00	6.5E-01	4.1E+04	4.1E+03	1.6E+03	1.6E+02	100	0.1
Phenanthrene (1)	85018	5.5E-03	4.2E-02	0.12	0.50	–	N	1.8E+02	1.8E+01	6.1E+04	6.1E+03	2.3E+03	2.3E+02	6.3	0.1
Pyrene	129000	8.3E-03	1.7E-02	0.08	0.50	–	N	1.8E+02	1.8E+01	6.1E+04	6.1E+03	2.3E+03	2.3E+02	–	0.1

Notes:

CAS = Chemical Abstract Service
Method Detection and Reporting Limits provided by CompuChem Laboratories
MDL = Method Detection Limit
mg/kg = milligram per kilogram
µg/L = microgram per liter
RBC = Risk-based Concentration
USEPA = United States Environmental Protection Agency
USEPA Region III Risk-based Concentration (RBC) values from the October 9, 2002 RBC Table
C/N: Carcinogenic or Non-carcinogenic status

C = Carcinogenic
CI = Carcinogen with a hazard quotient of 0.1; see USEPA Region III guidance
N = Non-carcinogenic
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
– = No Criteria available
MCL = Maximum Contaminant Level
PAH = Polynuclear aromatic hydrocarbon
(1) = the RBC for pyrene was substituted for these compounds

Table 2-8
Summary of Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for TCL Pesticides (SW8081A), Soil and Water Samples
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammuniton Plant, Radford, Virginia

Compound	CAS Number	Laboratory-Specific Method Detection and Reporting Limits				USEPA Region III Risk-based Concentrations					USEPA Region III BTAG Screening Levels	
		Soil		Water								
		MDL mg/kg	Reporting Limit mg/kg	MDL µg/L	Reporting Limit µg/L	C/N	Soil RBC (Industrial) mg/kg	Adjusted Soil RBC (Industrial) mg/kg	Soil RBC (Residential) mg/kg	Adjusted Soil RBC (Residential) mg/kg	Water µg/L	Soil mg/kg
4,4'-DDD	72-54-8	1.2E-03	3.3E-03	0.025	0.10	C	2.4E+01	2.4E+01	2.7E+00	2.7E+00		
4,4'-DDE	72-55-9	7.8E-04	1.7E-03	0.014	0.050	C	1.7E+01	1.7E+01	1.9E+00	1.9E+00		
4,4'-DDT	50-29-3	1.1E-03	5.0E-03	0.017	0.15	C	1.7E+01	1.7E+01	1.9E+00	1.9E+00		
Aldrin	309-00-2	3.9E-04	8.3E-04	0.016	0.025	C	3.4E-01	3.4E-01	3.8E-02	3.8E-02		
alpha-BHC	319-84-6	5.9E-04	8.3E-04	0.015	0.025	C	9.1E-01	9.1E-01	1.0E-01	1.0E-01		
alpha-Chlordane[1]	5103-71-9	5.4E-04	8.3E-04	0.010	0.050	C	1.6E+01	1.6E+01	1.8E+00	1.8E+00		
gamma-Chlordane[1]	5103-74-2	3.7E-04	8.3E-04	0.0069	0.025	C	1.6E+01	1.6E+01	1.8E+00	1.8E+00		
beta-BHC	319-85-7	1.4E-03	1.7E-03	0.027	0.050	C	3.2E+00	3.2E+00	3.5E-01	3.5E-01		
delta-BHC	319-86-8	7.8E-04	8.3E-04	0.015	0.025	--	--	--	--	--		
Dieldrin	60-57-1	7.3E-04	1.7E-03	0.019	0.050	C	3.6E-01	3.6E-01	4.0E-02	4.0E-02		
Endosulfan I	959-98-8	3.1E-04	1.7E-03	0.013	0.050	N	1.2E+04	1.2E+03	4.7E+02	4.7E+01		
Endosulfan II	33213-65-9	9.4E-04	3.3E-03	0.020	0.10	--	--	--	--	--		
Endosulfan sulfate	1031-07-8	1.1E-03	3.3E-03	0.020	0.10	--	--	--	--	--		
Endrin	72-20-8	7.4E-04	3.3E-03	0.018	0.10	N	6.1E+02	6.1E+01	2.3E+01	2.3E+00		
Endrin aldehyde	7421-93-4	1.6E-03	3.3E-03	0.028	0.10	--	--	--	--	--		
Endrin ketone	53494-70-5	9.7E-04	8.3E-03	0.023	0.25	--	--	--	--	--		
gamma-BHC (Lindane)	58-59-9	6.3E-04	8.3E-04	0.018	0.025	C	4.4E+00	4.4E+00	4.9E-01	4.9E-01		
Heptachlor	76-44-8	4.8E-04	8.3E-04	0.018	0.025	C	1.3E+00	1.3E+00	1.4E-01	1.4E-01		
Heptachlor epoxide	1024-57-3	4.4E-04	8.3E-04	0.0067	0.025	C	6.3E-01	6.3E-01	7.0E-02	7.0E-02		
Methoxychlor	72-43-5	2.7E-03	8.3E-03	0.078	0.25	N	1.0E+04	1.0E+03	3.9E+02	3.9E+01		
Toxaphene	8001-35-2	2.7E-02	1.7E-01	0.70	5.0	C	5.2E+00	5.2E+00	5.8E-01	5.8E-01		

Notes:

CAS = Chemical Abstract Service
Method Detection and Reporting Limits provided by CompuChem Laboratories
MDL = Method Detection Limit
mg/kg = milligram per kilogram
µg/L = microgram per liter
-- = RBC not available
RBC = Risk-based Concentration
USEPA = United States Environmental Protection Agency
USEPA Region III Risk-based Concentration (RBC) values from the October 9, 2002 RBC Table

C/N = Carcinogenic or Non-carcinogenic status
C = Carcinogenic
C! = Carcinogen with a hazard quotient of 0.1; see USEPA Region III guidance
N = Non-carcinogenic
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
(1) = Chlordane value is for sum of isomers
TCL = Target Compound List

Table 2-9
Summary of Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for TCL PCBs (SW8082)
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammuniton Plant, Radford, Virginia

Compound	CAS Number	Laboratory-specific Method Detection and Reporting Limits				USEPA Region III Risk-based Concentrations						USEPA Region III BTAG Screening Levels	
		Soil		Water									
		MDL mg/kg	Reporting Limit mg/kg	MDL µg/L	Reporting Limit µg/L	C/N	Soil RBC (Industrial) mg/kg	Adjusted Soil RBC (Industrial) mg/kg	C/N	Soil RBC (Residential) mg/kg	Adjusted Soil RBC (Residential) mg/kg	Water µg/L	Soil mg/kg
Aroclor 1016	12674-11-2	1.4E-02	6.3E-02	0.510	2.0	C!	8.2E+01	8.2E+01	N	5.5E+00	5.5E-01	0.0014	0.0001
Aroclor 1221	11104-28-2	1.9E-02	8.3E-02	0.940	3.0	C	2.9E+00	2.9E+00	C	3.2E-01	3.2E-01	0.0014	0.0001
Aroclor 1232	11141-16-5	1.3E-02	6.3E-02	0.270	2.0	C	2.9E+00	2.9E+00	C	3.2E-01	3.2E-01	0.0014	0.0001
Aroclor 1242	53469-21-9	1.5E-02	4.2E-02	0.420	2.0	C	2.9E+00	2.9E+00	C	3.2E-01	3.2E-01	0.0014	0.0001
Aroclor 1248	12672-29-6	1.4E-02	4.2E-02	0.380	2.0	C	2.9E+00	2.9E+00	C	3.2E-01	3.2E-01	0.0014	0.0001
Aroclor 1254	11097-69-1	8.3E-03	4.2E-02	0.180	2.0	C	2.9E+00	2.9E+00	C!	3.2E-01	3.2E-01	0.0014	0.0001
Aroclor 1260	11096-82-5	6.8E-03	6.3E-02	0.5200	2.0	C	2.9E+00	2.9E+00	C	3.2E-01	3.2E-01	0.0014	0.0001

Notes:

CAS = Chemical Abstract Service

Method Detection and Reporting Limits provided by CompuChem Laboratories

MDL = Method Detection Limit

mg/kg = milligram per kilogram

µg/L = microgram per liter

RBC = Risk-based Concentration

USEPA = United States Environmental Protection Agency

USEPA Region III Risk-based Concentration (RBC) values from the October 9, 2002 RBC Table

C/N = Carcinogenic or Non-carcinogenic status

C = Carcinogenic

N = Non-carcinogenic

C! = Carcinogen with RBC at hazard index of 0.1 < RBC$_C$; see USEPA Region III guidance

Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens

n/a = Not applicable

PCB = Polychlorinated Biphenyl

Table 2-10
Summary of Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for Explosives (SW8330 and SW8332), Soil and Water Samples
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

Compounds by Method 8330	CAS Number	Laboratory-specific Method Detection and Reporting Limits				USEPA MCLs	USEPA Region III Risk-based Concentrations							USEPA Region III BTAG Screening Levels	
		Soil		Water											
		MDL mg/kg	Reporting Limit mg/kg	MDL µg/L	Reporting Limit µg/L	µg/L	C/N	Tap water RBC µg/L	Adjusted Tap Water RBC µg/L	Soil RBC (Industrial) mg/kg	Adjusted Soil RBC (Industrial) mg/kg	Soil RBC (Residential) mg/kg	Adjusted Soil RBC (Residential) mg/kg	Water µg/L	Soil mg/kg
1,3,5-Trinitrobenzene	99-35-4	0.18	1.0	1.03	3.0	–	N	1.1E+03	1.1E+02	6.1E+04	6.1E+03	2.3E+03	2.3E+02	–	–
1,3-Dinitrobenzene	99-65-0	0.13	1.0	1.04	3.0	–	N	3.7E+00	3.7E-01	2.0E+02	2.0E+01	7.8E+00	7.8E-01	1200	–
2,4,6-Trinitrotoluene	118-96-7	0.31	1.0	0.61	3.0	–	C!	2.2E+00	2.2E+00	1.9E+02	1.9E+02	2.1E+01	2.1E+01	–	–
2,4-Dinitrotoluene	121-14-2	0.30	1.0	0.47	3.0	–	N	7.3E+01	7.3E+00	4.1E+03	4.1E+02	1.6E+02	1.6E+01	230	–
2,6-Dinitrotoluene	606-20-2	0.27	1.5	0.59	4.0	–	N	3.7E+01	3.7E+00	2.0E+03	2.0E+02	7.8E+01	7.8E+00	230	–
2-Amino-4, 6-dinitrotoluene	355-72-78-2	0.23	1.5	0.86	4.0	–	N	2.2E+00	2.2E-01	1.2E+02	1.2E+01	4.7E+00	4.7E-01	–	–
2-Nitrotoluene	88-72-2	0.53	1.5	1.16	3.0	–	N	6.1E+01	6.1E+00	2.0E+04	2.0E+03	7.8E+02	7.8E+01	–	–
3-Nitrotoluene	99-08-1	0.53	1.5	0.96	3.0	–	N	1.2E+02	1.2E+01	4.1E+04	4.1E+03	1.6E+03	1.6E+02	–	–
4-Amino-2,6-dinitrotoluene	1946-51-0	0.42	1.5	0.78	4.0	–	N	2.2E+00	2.2E-01	1.2E+02	1.2E+01	4.7E+00	4.7E-01	–	–
4-Nitrotoluene	99-99-0	0.70	1.5	1.31	3.0	–	N	6.1E+01	6.1E+00	2.0E+04	2.0E+03	7.8E+02	7.8E+01	–	–
HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)	2691-41-0	0.20	1.5	1.07	4.0	–	N	1.8E+03	1.8E+02	1.0E+05	1.0E+04	3.9E+03	3.9E+02	–	–
Nitrobenzene	98-95-3	0.20	1.0	0.36	3.0	–	N	3.5E+00	3.5E-01	1.0E+03	1.0E+02	3.9E+01	3.9E+00	27000	–
RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)	121-82-4	0.34	1.0	0.88	3.0	–	C	6.1E-01	6.1E-01	5.2E+01	5.2E+01	5.8E+00	5.8E+00	–	–
Tetryl (Methyl-2,4,6-trinitrophenylnitramine)	479-45-8	0.55	1.5	0.91	4.0	–	N	3.7E+02	3.7E+01	2.0E+04	2.0E+03	7.8E+02	7.8E+01	–	–
Compound by Method 8332															
Nitroglycerin	55-63-0	1.99	10	20.0	60	–	C	4.8E+00	4.8E+00	4.1E+02	4.1E+02	4.6E+01	4.6E+01	–	–

Notes:

CAS = Chemical Abstract Service

Method Detection and Reporting Limits provided by CompuChem Laboratories

MDL = Method Detection Limit

mg/kg = milligram per kilogram

µg/L = microgram per liter

RBC = Risk-based Concentration

USEPA = United States Environmental Protection Agency

USEPA Region III Risk-based Concentration (RBC) values from the October 9, 2002 RBC Table

C = Carcinogenic

C! = Carcinogen with a hazard quotient of 0.1; see USEPA Region III guidance

N = Non-carcinogenic

C/N = Carcinogenic or Non-carcinogenic status

Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens

– = No RBC available

MCL = Maximum Contaminant Level

Table 2-11

Summary of Analyte Method Detection Limits, Reporting Limits, and Risk Screening Criteria for TAL Metals (SW6010 and SW7000 Series), Soil and Water Samples

Soil Sampling Investigation for SWMUs 8 and 36

Radford Army Ammunition Plant, Radford, Virginia

Compound	CAS Number	Laboratory-specific Method Detection and Reporting Limits				USEPA MCLs	USEPA Region III Risk Based Concentrations							USEPA Region III BTAG Screening Levels	
		Soil		Water											
		MDL mg/kg	Reporting Limit mg/kg	MDL µg/L	Reporting Limit µg/L	µg/L	C/N	Tap water RBC µg/L	Adjusted Tap Water RBC µg/L	Soil RBC (Industrial) mg/kg	Adjusted Soil RBC (Industrial) mg/kg	Soil RBC (Residential) mg/kg	Adjusted Soil RBC (Residential) mg/kg	Water µg/L	Soil mg/kg
Aluminum	7429-90-5	8.9E-01	1.0E+01	1.7E+01	1.0E+02		N	3.7E+04	3.7E+03	2.0E+06	2.0E+05	7.8E+04	7.8E+03	25	1
Antimony	7440-36-0	8.9E-02	1.0E+00	1.3E+00	1.0E+01	6.0E+00	N	1.5E+01	1.5E+00	8.2E+02	8.2E+01	3.1E+01	3.1E+00	30	0.48
Arsenic	7440-38-2	2.7E-01	1.0E+00	3.5E+00	1.0E+01	1.0E+01	C	4.5E-02	4.5E-02	3.8E+00	3.8E+00	4.3E-01	4.3E-01	48	328
Barium	7440-39-3	3.2E-02	1.0E+00	2.8E-01	1.0E+01	2.0E+03	N	2.6E+03	2.6E+02	1.4E+05	1.4E+04	5.5E+03	5.5E+02	10000	440
Beryllium	7440-41-7	3.9E-02	5.0E-01	1.1E-01	5.0E+00	4.0E+00	N	7.3E+01	7.3E+00	4.1E+03	4.1E+02	1.6E+02	1.6E+01	5.3	0.02
Cadmium	7440-43-9	2.0E-02	5.0E-01	2.3E-01	5.0E+00	5.0E+00	N	1.8E+01	1.8E+00	2.0E+03	2.0E+02	7.8E+01	7.8E+00	0.53	3
Calcium	7440-70-2	3.1E+00	1.0E+02	2.8E+01	1.0E+03	--	--	--	--	--	--	--	--	--	--
Chromium (VI)^1	7440-47-3	4.5E-02	5.0E-01	6.5E-01	5.0E+00	1.0E+02	N	1.1E+02	1.1E+01	6.1E+03	6.1E+02	2.3E+02	2.3E+01	2	0.02
Cobalt	7440-48-4	3.6E-02	5.0E-01	2.8E-01	5.0E+00	--	N	7.3E+02	7.3E+01	4.1E+04	4.1E+03	1.6E+03	1.6E+02	35000	0.1
Copper	7440-50-8	5.0E-02	5.0E-01	3.1E-01	5.0E+00	1.3E+03	N	1.5E+03	1.5E+02	8.2E+04	8.2E+03	3.1E+03	3.1E+02	6.5	15
Iron	7439-89-6	3.6E+00	1.0E+01	1.0E+01	1.0E+02	--	N	1.1E+04	1.1E+03	6.1E+05	6.1E+04	2.3E+04	2.3E+03	320	3260
Lead^2	7439-92-1	1.1E-01	3.0E-01	1.2E+00	3.0E+00	1.5E+01	--	--	--	1.0E+03	1.0E+03	4.0E+02	4.0E+02	3.2	2
Magnesium	7439-95-4	6.4E-01	1.0E+02	3.6E+00	1.0E+03	--	--	--	--	--	--	--	--	--	0.00044
Manganese (non-food)	7439-96-5	3.7E-02	1.0E+00	2.7E-01	1.0E+01	--	N	7.3E+02	7.3E+01	4.1E+04	4.1E+03	1.6E+03	1.6E+02	14500	330
Mercury^3	7439-97-6	1.1E-01	2.0E-01	3.3E-03	2.0E-02	2.0E+00	N	1.1E+01	1.1E+00	6.1E+02	6.1E+01	2.3E+01	2.3E+00	0.012	0.058
Nickel	7440-02-0	7.8E-02	5.0E-01	6.3E-01	5.0E+00	--	N	7.3E+02	7.3E+01	4.1E+04	4.1E+03	1.6E+03	1.6E+02	160	2
Potassium	7440-09-7	4.7E+00	1.0E+02	1.8E+01	1.0E+03	--	--	--	--	--	--	--	--	--	--
Selenium	7782-49-2	1.7E-01	5.0E-01	3.5E+00	5.0E+00	5.0E+01	N	1.8E+02	1.8E+01	1.0E+04	1.0E+03	3.9E+02	3.9E+01	5	2
Silver	7440-22-4	8.2E-02	5.0E-01	5.7E-01	5.0E+00	--	N	1.8E+02	1.8E+01	1.0E+04	1.0E+03	3.9E+02	3.9E+01	0.0001	0.0000098
Sodium	7440-23-5	1.8E+01	2.0E+02	1.6E+02	2.0E+03	--	--	--	--	--	--	--	--	--	--
Thallium	7440-28-0	4.2E-01	1.0E+00	2.1E+00	1.0E+01	2.0E+00	N	2.6E+00	2.6E-01	1.4E+02	1.4E+01	5.5E+00	5.5E-01	40	0.001
Vanadium	7440-62-2	2.8E-02	2.0E+00	2.5E-01	2.0E+01	--	N	2.6E+02	2.6E+01	1.4E+04	1.4E+03	5.5E+02	5.5E+01	10000	0.5
Zinc	7440-66-6	3.9E-01	2.0E+00	4.9E+00	2.0E+01	--	N	1.1E+04	1.1E+03	6.1E+05	6.1E+04	2.3E+04	2.3E+03	30	10

Notes:

CAS = Chemical Abstract Service
Method Detection and Reporting Limits provided by CompuChem Laboratories
MDL = Method Detection Limit
mg/kg = milligram per kilogram
µg/L = microgram per liter
RBC = Risk-based Concentration
USEPA = United States Environmental Protection Agency
USEPA Region III Risk-based Concentration (RBC) values from the October 9, 2002 RBC Table
MCL = Maximum Contaminant Level

C = Carcinogenic
C! = Carcinogen with a hazard quotient of 0.1; see USEPA Region III guidance
N = Non-carcinogenic
C/N = Carcinogenic or Non-carcinogenic status
Adjusted RBCs = a Hazard Quotient (HQ) of 0.1 applied to non-carcinogens
TAL = Target Analyte List
(1) = Chromium MCL is for total
(2) = Lead criteria are Action Levels; see USEPA Region III guidance
(3) = Mercuric chloride soil RBC value used

- TAL Metals (including mercury);
- TCL VOCs;
- TCL SVOCs;
- PAHs;
- TCL Pesticides;
- TCL PCBs; and
- Explosives (including nitroglycerin).

Samples of IDM (decontamination water and soil) will be characterized for disposal purposes by analyzing for the following:

- Ignitability;
- TCLP, complete list;
- Reactivity (percent explosives);
- Corrosivity;
- Paint Filter Liquids (solids); and
- Chemical Oxygen Demand (aqueous).

2.5.1 Organics

The following techniques will be used for determination of organic constituents. Chemical analyses to identify and quantify VOCs and SVOCs are 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. Qualitative 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. Quantification of these TICs is performed against internal standards. TIC results that can be qualitatively identified and that meet the above minimum response requirement 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. The top 10 VOC and/or 20 SVOC 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 may 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 VOC and/or 20 SVOC TICs are to be reported for all GC/MS analyses.

2.5.1.1 VOCs by SW 8260B

The aqueous samples are prepared for analysis by purge-and-trap Method 5030 and the solid samples are prepared by purge-and-trap Method 5035. The volatile compounds are introduced into the gas chromatograph by the purge-and-trap method or by other methods (see Section 1.2 of Method SW8260B). The analytes are introduced directly to a wide-bore capillary column or cryo-focused on a capillary pre-column before being flash evaporated to a narrow-bore capillary for analysis. The column is temperature-programmed to separate the analytes, which are then detected with a mass spectrometer (MS) interfaced to the gas chromatograph (GC). Analytes eluted from the capillary column are introduced into the mass spectrometer via a jet separator or a direct connection. (Wide-bore capillary columns normally require a jet separator, whereas narrow-bore capillary columns may be directly interfaced to the ion source.) Identification of target analytes is accomplished by comparing their mass spectra with the electron impact (or electron impact-like) spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitation) ion relative to an internal standard using a five-point calibration curve.

2.5.1.2 SVOCs by SW 8270C

The samples are prepared for analysis by gas chromatography/mass spectrometry (GC/MS) using SW-846 Test Method 3520C for aqueous media and Test Method 3540C for solid media, or other appropriate methods. If necessary, sample cleanup procedures will be used (refer to Test Method 3600 series). The semivolatile compounds are introduced into the GC/MS by injecting the sample extract into a gas chromatograph with a narrow-bore fused-silica capillary column.

The GC column is temperature-programmed to separate the analytes, which are then identified with a mass spectrometer, connected to the gas chromatograph. Analytes eluted from the capillary column are introduced into the mass spectrometer via a jet separator or a direct connection. Identification of target analytes is accomplished by comparing their mass spectra with the electron impact (or electron impact-like) spectra of authentic standards. Quantitation is accomplished by comparing the response of a major (quantitation) ion relative to an internal standard using a five-point calibration curve.

2.5.1.3 Pesticides by SW 8081A

A measured volume or weight of sample (approximately one liter for liquids, two grams to 30 grams for solids) is extracted using the appropriate matrix-specific sample extraction technique. Liquid samples are extracted at neutral pH with methylene chloride using Method 3520C (continuous liquid-liquid extractor), or other appropriate technique. Solid samples are using Method 3540C (Soxhlet) or other appropriate technique. A variety of cleanup steps may be applied to the extract, depending on the nature of the matrix interferences and the target analytes. Suggested cleanups include alumina (Method 3610), Florisil (Method 3620), silica gel (Method 3630), gel permeation chromatography (Method 3640), and sulfur (Method 3660). After cleanup, the extract is analyzed by injecting a one µL sample into a gas chromatograph with a narrow- or wide-bore fused silica capillary column and electron capture detector (GC/ECD) or an electrolytic conductivity detector (GC/ELCD).

2.5.1.4 PCBs by SW 8082

A measured volume or weight of sample (approximately one liter for liquids, two grams to 30 grams for solids) is extracted using the appropriate matrix-specific sample extraction technique. Aqueous samples are extracted at neutral pH Method 3520C (continuous liquid-liquid extractor), or other appropriate technique. Solid samples are extracted Method 3540C (Soxhlet) or other appropriate technique. Extracts for PCB analysis may be subjected to a sulfuric acid/potassium permanganate cleanup (Method 3665) designed specifically for these analytes. This cleanup technique will remove (destroy) many single component organochlorine or organophosphate pesticides. Therefore, Method 8082 is not applicable to the analysis of those compounds. Instead, use Method 8081. After cleanup, the extract is analyzed by injecting a two µL aliquot into a gas chromatograph with a narrow- or wide-bore fused silica capillary column and ECD. The chromatographic data may be used to identify the seven Aroclors in Table 2.9, individual PCB congeners, or total PCBs.

2.5.1.5 PAHs by SW 8310

Method 8310 provides high performance liquid chromatographic (HPLC) conditions for the detection of part per billion (ppb) levels of certain polynuclear aromatic hydrocarbons (PAHs) in water, soil and sediment matrix. Aqueous samples are extracted at neutral pH with methylene chloride using Method 3520C (continuous liquid-liquid extractor), or other appropriate method. Solid samples are extracted using Method 3540C (Soxhlet), or other appropriate technique. Prior to HPLC analysis, the extraction solvent must be exchanged to acetonitrile. To achieve maximum sensitivity with this method, the extract must be concentrated to one milliliter. If interferences prevent proper detection of the analytes of interest, the method may also be performed on extracts that have undergone cleanup using silica gel column cleanup (Method 3630). A five to 25-µL aliquot of the extract is injected into an HPLC, and compounds in the effluent are detected by ultraviolet (UV) and fluorescence detectors.

2.5.1.6 Explosives by SW 8330 and SW 8332

Method 8330 and 8332 provide HPLC conditions for the detection of ppb levels of certain explosives residues in water, soil and sediment matrix. Prior to use of these methods, appropriate sample preparation techniques must be used. Two sample preparation techniques are available.

1) Low-Level, Salting-out Method with No Evaporation: 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 un-dissolved 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 using a Pasteur pipette. The concentrated extract is diluted 1:1 with reagent grade water. An aliquot is separated on a C-18 reverse phase column, identified at 254 nanometer (nm), and confirmed on a CN reverse phase column.

2) High-level Direct Injection Method: Aqueous samples of higher concentration can be diluted 1/1 (v/v) with methanol or acetonitrile, filtered, separated on a C-18 reverse phase column, identified at 254 nm, and confirmed on a CN reverse phase column. If HMX is an important target analyte, methanol is preferred. Soil and sediment samples are extracted using acetonitrile in an ultrasonic bath, filtered and-chromatographed as described above.

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2.5.2 Inorganics

The following techniques will be used for determination of inorganic constituents.

2.5.2.1 Target Analyte List Metals by ICP by SW 6010/7000 Series

Prior to analysis, samples are prepared by Method 3010A for aqueous media and Method 3050B for solid media, or other appropriate methods. When analyzing groundwater samples for dissolved constituents, acid digestion is not necessary if the samples are filtered and acid preserved before analysis. This method describes multi-elemental determinations by Inductively Coupled Plasma (ICP) - Atomic Emission Spectroscopy (AES) using sequential or simultaneous optical systems and axial or radial viewing of the plasma. The instrument measures characteristic emission spectra by optical spectrometry. Samples are nebulized and the resulting aerosol is transported to the plasma torch. Element-specific emission spectra are produced by radio frequency inductively coupled plasma. The spectra are dispersed by a grating spectrometer, and the intensities of the emission lines are monitored by photosensitive devices.

Background correction is required for trace element determination. Background must be measured adjacent to analyte lines on samples during analysis. The position selected for the background-intensity measurement, on either or both sides of the analytical line, will be defined by the complexity of the spectrum adjacent to the analyte line. In one mode of analysis, the position used should be as free as possible from spectral interference and should reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result. The possibility of additional interferences named in Section 3.0 of Method 3050B should also be recognized and appropriate corrections made; tests for their presence are described in Section 8.5 of Method 3035B. Alternatively, users may choose multivariate calibration methods. In this case, point selections for background correction are superfluous since entire spectral regions are processed.

2.5.2.2 Mercury by SW 7470 (aqueous samples) and SW 7471 (soil/solid samples)

Prior to analysis, the liquid, solid, or semi-solid samples must be prepared according to the procedure discussed in the method. Methods 7470 and 7471, cold-vapor atomic absorption techniques are based on the absorption of radiation at 253.7 nm by mercury vapor. The mercury is reduced to the elemental state and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an atomic absorption spectrophotometer. Absorbance (peak height) is measured as a function of mercury concentration.

2.5.3 Waste Samples

2.5.3.1 TCLP Extraction

For liquid wastes (i.e., those containing less than 0.5% dry solid material), the waste, after filtration through a 0.6 to 0.8-micrometer (μm) glass fiber filter, is defined as the TCLP extract. For wastes containing greater than or equal to 0.5% solids, the liquid, if present, is separated from the solid phase and stored for later analysis; the particle size of the solid phase is reduced, if necessary. The solid phase is extracted with an amount of extraction fluid equal to 20 times the weight of the solid phase. The extraction fluid employed is a function of the alkalinity of the solid phase of the waste. A special extractor vessel is used when testing for volatile analytes. Following extraction, the liquid extract is separated from the solid phase by filtration through a 0.6 to 0.8-μm-glass fiber filter. If compatible (i.e., multiple phases will not form on combination), the initial liquid phase of the waste is added to the liquid extract, and these are analyzed together. If incompatible, the liquids are analyzed separately and the results are mathematically combined to yield a volume-weighted average concentration. Extracts are analyzed using the analytical methods described above.

2.5.3.2 Ignitability by SW 1010 (Aqueous) and SW 1030 (Solid)

For liquid wastes, the sample is heated at a slow, constant rate with continual stirring. A small flame is directed into the cup at regular intervals with simultaneous interruption of stirring. The flash point is the lowest temperature at which application of the test flame ignites the vapor above the sample. For solid wastes, in a preliminary test, the test material is formed into an unbroken strip or powder train 250 millimeters (mm) in length. An ignition source is applied to one end of the test material to learn whether combustion will propagate along 200 mm of the strip within a specified time. Materials that propagate burning along a 200-mm strip within the specified time are then subjected to a burning rate test. Materials that do not ignite or propagate combustion as described above do not require further testing. In the burning rate test, the burning time is measured over a distance of 100 mm and the rate of burning is calculated. The test method described here is based on the test procedure adopted by the U.S. Department of Transportation from the United Nations regulations for the international transportation of dangerous goods and is contained in Appendix E to Part 173 of Title 49 of the Code of Federal Regulations (CFR).

2.5.3.3 Corrosivity by SW 9040B (Aqueous) and 9045C (Solid)

The corrosivity of a sample will be based on its pH. The pH of a liquid sample is either analyzed electrometrically using a glass electrode in combination with a reference potential or a combination electrode. The measuring device is calibrated using a series of standard solutions of known pH. For soil/solid waste samples, the sample is mixed with reagent water, and the pH of the resulting aqueous solution is measured. The same procedure is used for pH determination of water and soil samples.

2.5.3.3 Chemical Oxygen Demand by USEPA Method 410.4 (Aqueous)

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.

2.5.4 Physical/Geotechnical Analysis

As discussed in the Planned Field Activities Sections, soil samples will be collected for analysis of physical/geotechnical parameters. Analysis will be conducted by a USACE-approved laboratory. Analyses will be conducted for the following:

- Grain-size analysis (ASTM D 422-98);
- Total organic carbon (ASTM D 2974-00); and
- pH (ASTM D 4972-01).

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2.6 INTERNAL QUALITY CONTROL CHECK

Internal QC components that will be used by URS during operations at RFAAP are presented below and in Section 8.0 of the MQAP. The internal quality components include the field QC samples and the laboratory QC elements to be followed.

Rinse blanks, trip blanks, and field duplicates will be collected during the acquisition of environmental samples at RFAAP. Table 2-12 presents guidelines for the collection of QC samples that will be taken in conjunction with environmental sampling. Field QC acceptance criteria are summarized in Table 2-13.

Table 2-12
Field Quality Control Samples

Control	Purpose of Sample	Collection Frequency
Field Duplicate	Ensure precision in sample homogeneity during collection and analysis	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 per 20 samples per matrix per sample technique
Temperature Blank	Verify sample cooler temperature during transport	1 temperature blank per cooler
Trip Blank	Assess if cross contamination occurs during shipment or storage with aqueous VOC samples	1 trip blank per cooler containing aqueous VOC samples

Table 2-13
Field Quality Control Elements Acceptance Criteria

Item	DQO	Parameter	Frequency of Association	Criteria Goal
Field Duplicate	P	Inorganics	1 per 10 samples	RPD ≤ 20% Aqueous; difference ± RL* RPD ≤ 35% Solid; difference ± 2xRL*
		Organics	1 per 10 samples	RPD ≤ 40% Aqueous; difference ± RL* RPD ≤ 60% Solid; difference ± 2xRL*
Trip Blank	A,R	VOCs in water	1 per cooler with aqueous VOCs	No target analytes detected greater than the RL
Rinse Blank	A,R	Entire	1 per 20 samples per matrix per equipment type	No target analytes detected greater than the RL
Chain of Custody Forms	R	Entire	Every sample	Filled out correctly to include signatures; no missing or incorrect information.
Representative Sampling Forms	R	Entire	Every sample	Filled out correctly to include signatures; no missing or incorrect information.
Field Logbook	R	Entire	Every sample	Filled out correctly to include analytical parameters; map file data; and applicable coding information.
Field Instrument Calibration Logs	A	Entire	Every measurement	Measurements must have associated calibration reference

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

* The difference will be evaluated when either of the field duplicate results is less than the reporting limit.

2.6.1 Laboratory Quality Control Elements

The laboratory QC elements are summarized in Table 2-14. Specific laboratory analytical QC criteria and corrective actions are summarized in Tables 2-15 through 2-21 for the parameters specified in Section 2.5.

Table 2-14
Analytical Quality Control Elements of a Quality Assurance Program

Item	DQO	Parameter	Frequency of Association	Criteria Requirement
Analytical Method	C	Entire	Each analysis	Method analyses based on USEPA methods as defined in Section 2.5
Chemical Data Packages	C	Entire	Each lot/batch	Pass peer review and formal QA/QC check.
Laboratory Chain of Custody	R	Entire	Each lot/batch	Custody of sample within laboratory fully accounted for and documented
Laboratory System Controls	A,C,P, R	Entire	During laboratory operations	No deficiencies
Holding Time	A,C,P, R	Entire	Each analysis	No deficiencies (USEPA Region III Modifications)
Method Blanks	A,R	Entire	Each lot/batch	No target analytes detected in the method blanks greater than RL
Laboratory Control Spike	A	Entire	Each lot/batch	Must meet criteria as defined in Tables 2-15 through 2-21
Matrix Spikes and Duplicates	A,P	Entire	Each lot/batch	Must meet criteria as defined in Tables 2-15 through 2-21
Surrogates	A	Entire	Organic fractions, including QC samples	Must meet criteria as defined in Tables 2-15 through 2-21
Serial dilution	A	Metals	Inorganic Fractions, Each lot/batch	Must meet criteria as defined in Table 2-19

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

Table 2-15
Quality Control Method Criteria for Volatile Organic Compounds by USEPA SW-846 8260B

Procedure	Frequency	Acceptance Criteria		Corrective Action
Initial Calibration 5-pt curve (linear) 6-pt curve (2° order)	Set-up, major maintenance, or for drift correction	RRF > 0.10/0.30 for SPCCs RSD ≤ 30% for CCCs response factors RSD for all analytes ≤ 15% or r>0.995 (linear) or r>0.99 (2° order)		Sample analysis cannot begin until this criterion is met. Data reviewer should review and judge each target compound against the acceptance criteria.
Initial Calibration Verification	Immediately following every initial calibration	A second source full compliment target list with a percent recovery = 80-120%		Sample analysis cannot begin until this criterion is met.
Continuing Calibration Check	Every 12 hours	RRF > 0.10/0.30 for SPCCs %Difference for RF of CCCs ±30% from initial calibration. Mean for all analytes ≤ 20% as no individual target exceeds 40%D		Sample analysis cannot begin until this criterion is met. Data reviewer should review and judge each target compound against the acceptance criteria.
Method Blank	Every day/batch.	No target analytes greater than the RL		Document source of contamination. Re-analysis is required for all positive results associated with blank contamination.
Tuning BFB	Prior to calibration and every 12 hours	Must meet tuning criteria		Re-tune, re-calibrate, and re-analyze affected sample analyses.
Laboratory Control Spike	Every batch	<u>Standards</u> Full compliment target list	Laboratory generated control limits not to exceed recovery limits of 50-150% or RPD of 50%	Recoveries indicating a low bias require a re-extraction/reanalysis. Recoveries indicating a high bias require a re-extraction/re-analysis for associated positive field samples. Qualify associated data biased high or biased low as appropriate.
Internal Standards	Every sample	<u>Recommended Standards</u> fluorobenzene chlorobenzene-d_5 1,4-dichlorobenzene-d_4	Retention time ±30 seconds of mid point of initial calibration Area changes within a factor of two (-50% to +100%)	Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples associated with standards outside criteria. A third analytical run may be required at a dilution.
Surrogate	Every sample	<u>Recommended Standards</u> toluene-d_8 4-bromofluorobenzene 1,2-dichloroethane-d_4 dibromofluoromethane	Laboratory generated control limits not to exceed 50-150%	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.
Matrix Spike and Duplicate	1 per 20 per matrix	<u>Standards</u> Full compliment target list	Laboratory generated control limits not to exceed recovery limits of 50-150% or RPD of 50%	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.

Table 2-16
Quality Control Method Criteria for Semivolatile Organic Compounds by USEPA SW-846 8270C

Procedure	Frequency	Acceptance Criteria		Corrective Action
Initial calibration 5-pt curve (linear) 6-pt curve (2° order)	Set-up, major maintenance, or for drift correction	RRF > 0.05 for SPCCs RSD ≤30% for CCC compounds RSD for all target analytes ≤ 15% or r>0.995 (linear) or r>0.99 (2° order)		Sample analysis cannot begin until this criterion is met. Data reviewer should review and judge each target compound against the acceptance criteria.
Initial Calibration Verification	Immediately following every initial calibration	A second source full compliment target list with a percent recovery = 70-130%		Sample analysis cannot begin until this criterion is met.
Continuing Calibration Check	12 hours	RRF > 0.05 for SPCCs %Difference for RF of CCCs ±30% from initial calibration Mean for all analytes ≤ 20% as no individual target exceeds 40%D		Sample analysis cannot begin until this criterion is met. Data reviewer should review and judge each target compound against the acceptance criteria.
Internal standards	Every sample	Retention time ±30 seconds from mid point of initial calibration Area changes by a factor of two (-50% to +100%)		Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples with internal standards outside criteria.
Tuning DFTPP	12 hours	Must meet tuning criteria.		Re-tune, re-calibrate, and re-analyze affected sample analyses.
Method Blank	Per extraction batch	No target analytes greater than the RL		Document source of contamination. Re-extraction/re-analysis is required for all positive results associated with blank contamination.
Laboratory Control Spike	Every batch	Standards Full compliment target list	Laboratory generated control limits not to exceed recovery limits of 10-150%or RPD of 50%	Recoveries indicating a low bias require a re-extraction/reanalysis. Recoveries indicating a high bias require a re-extraction/re-analysis for associated positive field samples. Qualify associated data biased high or biased low as appropriate.
Internal Standards	Every sample	Recommended Standards phenanthrene-d10 chrysene-d12 perylene-d12 1,4-dichlorobenzene-d4 naphthalene-d8 acenaphthalene-d10	Retention time ±30 seconds of mid point of initial calibration Area changes within a factor of two (-50% to +100%)	Inspect for malfunction. Demonstrate that system is functioning properly. Reanalyze samples associated with standards outside criteria. A third analytical run may be required at a dilution.
Surrogate Spikes	Every sample	Recommended Standards nitrobenzene-d_5 2-fluorobiphenyl p-terphenyl-d14 phenol-d5 2,4,6-tribromophenol 2-fluorophenol	Laboratory generated control limits not to exceed 10-150%	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-extraction and re-analysis to confirm that the non-compliance is due to sample matrix effects rather than laboratory deficiencies.
Matrix Spike and Duplicate	1 per 20 samples per matrix	Standards Full compliment target list	Laboratory generated control limits not to exceed recovery limits of 10-150%or RPD of 60%	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.

Table 2-17
Quality Control Method Criteria for Polynuclear Aromatic Hydrocarbons by USEPA SW-846 8310

Procedure	Frequency of QC Procedure	Acceptance Criteria		Corrective Action
Initial calibration 5-pt curve (linear) 6-pt curve (2° order)	Set-up, major maintenance, or for drift correction for each column used during analysis	%RSD<20% or r>0.995 (linear) or r>0.99 (2° order)		Sample analysis cannot begin until this criterion is met.
Initial Calibration Verification	Immediately following every initial calibration	A second source full compliment of target list with a percent recovery = 85-115%		Sample analysis cannot begin until this criterion is met.
Continuing Calibration Check	Every ten samples or twelve hours	%D ± 15% of the response factor from the initial curve. The mean may be used as long as no individual target exceeds 30%D		Sample analysis cannot begin until this criterion is met. If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, initial calibration must be repeated. Data reviewer should review and judge each target compound against the acceptance criteria.
Method Blank	1 per batch	No target analytes detected greater than the reporting limit		Document source of contamination. Re-extraction/re-analysis is required for all positive results associated with blank contamination.
Laboratory Control Spike	1 per batch	<u>Standards</u> Full compliment target list	Laboratory generated control limits not to exceed recovery limits of 40-150% or RPD of 60%	Recoveries indicating a low bias require a re-extraction/reanalysis. Recoveries indicating a high bias require a re-extraction/re-analysis for associated positive field samples. Qualify associated data biased high or biased low as appropriate.
Surrogate Spikes	Every sample	<u>Standards</u> A similar compound that is not expected to be found at the site	Laboratory generated control limits not to exceed 30-150%	If surrogate compounds do not meet criteria, there should be a re-extraction and re-analysis to confirm that the non-compliance is due to the sample matrix effects rather than laboratory deficiencies.
Matrix Spike and Duplicate	1 per 20 samples per matrix	<u>Standards</u> Full compliment target list	Laboratory generated control limits not to exceed recovery limits of 40-150% or RPD of 60%	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.
Target Analyte Confirmation	Every positive detection	RPD ≤ 40%		Report the higher of the two concentrations unless a positive bias is apparent and qualify.

Table 2-18
Quality Control Method Criteria for Explosives by USEPA SW-846 8330 and 8332

Procedure	Frequency of QC Procedure	Acceptance Criteria		Corrective Action
Initial Calibration Curve 5-pt curve (linear) 6-pt curve (2° order)	Set-up, major maintenance, or for drift correction for each column used for analysis	%RSD<20% or r>0.995 (linear) or r>0.99 (2° order)		Sample analysis cannot begin until this criterion is met.
Initial Calibration Verification	Immediately following every initial calibration	A second source full compliment of target list with a percent recovery = 85-115%		Sample analysis cannot begin until this criterion is met.
Continuing Calibration Check	Every ten samples or twelve hours	%D ± 15% of the response factor from the initial curve. The mean may be used as long as no individual target exceeds 30%D		Sample analysis cannot begin until this criterion is met. If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, initial calibration must be repeated. Data reviewer should review and judge each target compound against the acceptance criteria.
Method Blank	1 per batch	No target analytes detected greater than the reporting limit		Document source of contamination. Re-extraction/re-analysis is required for all positive results associated with blank contamination.
Laboratory Control Spike	1 per batch	<u>Standards</u> Full compliment target list	Laboratory generated control limits not to exceed recovery limits of 40-150%or RPD of 60%	Recoveries indicating a low bias require a re-extraction/reanalysis. Recoveries indicating a high bias require a re-extraction/re-analysis for associated positive field samples. Qualify associated data biased high or biased low as appropriate.
Surrogate Spikes	Every sample	<u>Standards</u> A similar compound that is not expected to be found at the site	Laboratory generated control limits not to exceed 30-150%	If surrogate compounds do not meet criteria, there should be a re-extraction and re-analysis to confirm that the non-compliance is due to the sample matrix effects rather than laboratory deficiencies.
Matrix Spike and Duplicate	1 per 20 samples per matrix	<u>Standards</u> Full compliment target list	Laboratory generated control limits not to exceed recovery limits of 40-150%or RPD of 60%	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.
Target Analyte Confirmation	Every positive detection	RPD ≤ 40%		Report the higher of the two concentrations unless a positive bias is apparent and qualify.

Table 2-19
Quality Control Method Criteria for Metals by USEPA SW-846 6010B / 7470A

Procedure	Frequency of QC Procedure	Acceptance Criteria		Corrective Action
Initial Calibration Curve (ICP & Hg)	Daily, major maintenance, or to correct drift.	ICP Option 1 - 1-standard and a blank with a low level standard at RL.	Low level check standard ± 20%.	The standards for that element must be re-prepared and re-analyzed again.
		ICP Option 2 - 3-standards and a blank	r > 0.99 for each element	
		Hg - 5-standards and a blank	r > 0.99 for each element	
Initial Calibration Verification (ICP & Hg)	Immediately following every initial calibration	A second source full compliment of target list with a percent recovery = 90-110%		Sample analysis cannot begin until this criterion is met.
Initial Calibration Blank (ICP & Hg)	Immediately following every initial calibration verification.	No target analytes detected at concentration above the RL.		Sample analysis cannot proceed until this criterion is met.
Interference check (ICP)	Beginning of each sample analytical run.	Recovery ±20% of true value.		Terminate the analysis, correct the problem, re-calibrate, re-verify the calibration, and reanalyze the samples.
Continuing Calibration Check (ICP & Hg)	Every 10 samples and end of analytical run.	ICP - Recovery ±10%.		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.
		Hg - Recovery ±20%.		
Continuing Calibration Blank (ICP & Hg)	Every 10 samples and end of analytical run.	No target analytes detected at concentration above the RL.		Sample sequence should not continue until this criterion is met. Demonstrate "clean". Affected samples will be reanalyzed.
Preparation Blank (ICP & Hg)	1 per batch per matrix	No target analytes detected at concentration above the RL.		Document source of contamination. Re-digestion/re-analysis is required for all positive results associated with blank contamination, unless DQOs are still met.
Laboratory Control Sample (ICP & Hg)	1 per batch per matrix	<u>Standards</u> Full compliment target list.	80-120% recovery Soil use generated limits	Recoveries indicating a low bias require a re-digestion/reanalysis. Recoveries indicating a high bias require a re-digestion/re-analysis for associated positive field samples. Qualify associated data biased high or biased low as appropriate.
Matrix Spike and Duplicate or Sample Duplicate (ICP & Hg)	1 per 20 samples per matrix	<u>Standards</u> Full compliment target list.	75-125% recovery; RPD≤25 Soil use generated limits	Qualify associated data biased high or biased low as appropriate.
Post Digestion Spike (PDS) (ICP)	1 per 20 samples per matrix	<u>Standards</u> Full compliment target list.	75-125% recovery	
Serial Dilution (ICP)	1 per 20 samples per matrix	Used to assess new matrices	For sample results >5x RL %D between diluted and undiluted sample result ≤10%.	Chemical or physical interference indicated. Investigate to identify cause.

Table 2-20
Quality Control Method Criteria for Pesticides and PCBs by USEPA SW-846 8081A & 8082

Procedure	Frequency of QC Procedure	Acceptance Criteria		Corrective Action
Initial calibration curve 5-pt curve (linear) 6-pt curve (2° order)	Set-up, major maintenance	%RSD<20% or r>0.995 (linear) or r>0.99 (2° order)		Sample analysis cannot begin until this criterion is met.
Initial Calibration Verification	Immediately following every initial calibration	A second source full compliment of target list with a percent recovery = 85-115%		Sample analysis cannot begin until this criterion is met.
Continuing Calibration Check	Bracketing samples	%D recovery ± 15% of the response factor from the initial curve or mean with no individual peak >30%		Sample analysis cannot begin until this criterion is met. If criteria are not met, reanalyze the daily standard. If the daily standard fails a second time, initial calibration must be repeated. Data reviewer should review and judge each target compound against the acceptance criteria.
Endrin/4,4-DDT Breakdown	Bracketing samples	endrin degradation ≤15%. 4,4-DDT degradation ≤15%.		If criterion is not met, system must be deactivated and the affected samples reanalyzed.
Instrument Blank	After continuing calibration and highly contaminated samples.	No target analytes detected greater than the RL.		Demonstrate "clean". Affected samples will be reanalyzed.
Method Blank	Per extraction batch	No target analytes detected greater than the RL.		Document source of contamination. Re-extraction/re-analysis is required for all positive results associated with blank contamination.
Laboratory Control Spike	Per extraction batch	Standards Full compliment target list	Laboratory generated control limits not to exceed recovery limits of 30-150% or RPD of 60%	Recoveries indicating a low bias require a re-extraction/reanalysis. Recoveries indicating a high bias require a re-extraction/re-analysis for associated positive field samples. Qualify associated data biased high or biased low as appropriate.
Surrogate Spikes	Every sample	Standards TCMX and DCB	Laboratory generated control limits not to exceed 30-150%	Investigate to determine cause, correct the problem, and document actions taken; re-extract and re-analyze sample. Specific method cleanups may be used to eliminate or minimize sample matrix effects. If still out, qualify.
Matrix Spike and Duplicate	1 per 20 samples per matrix	Standards Full compliment target list	Laboratory generated control limits not to exceed recovery limits of 30-150% or RPD of 60%	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. Specific method cleanups may be used to eliminate or minimize sample matrix effects.
Target Analyte Confirmation	Every positive detection	RPD ≤ 40%		Report the higher of the two concentrations unless a positive bias is apparent and qualify.

Table 2-21

Quality Control Method Criteria for Chemical Oxygen Demand by USEPA Method of Chemical Analysis for 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	$r>0.995$ (linear) or $r>0.99$ (2° order)	Sample analysis cannot begin until this criterion is met.
Initial Calibration Verification	Immediately following every initial calibration	Recovery ±10% of true value	Sample analysis cannot begin until this criterion is met. If criteria are not met, reanalyze the daily standards. If the ICV fails a second time, initial calibration must be repeated.
Continuing Calibration Check	Every 10 samples, end of analytical run	Recovery ±10% of true value	Sample analysis cannot proceed until this criterion is met. Reanalyze CCC. If the CCC 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	Every 10 samples, end of analytical run	No target analytes detected greater than the RL.	If not within criteria, terminate the analysis, correct the problem, re-calibrate, and reanalyze each sample analyzed since the last acceptable CCB.
Method Blank	1 per 20 samples or batch per matrix	No target analytes detected greater than the RL.	Document source of contamination. Re-extraction/re-analysis is required for all positive results associated with blank contamination.
Laboratory Control Sample	1 per 20 samples per matrix	Laboratory generated control limits not to exceed recovery limits of 60-140% or RPD of 30%	Recoveries indicating a low bias require a re-extraction/reanalysis. Recoveries indicating a high bias require a re-extraction/re-analysis for associated positive field samples. Qualify associated data biased high or biased low as appropriate.
Matrix Spike and Duplicate	1 per 20 samples per batch, per matrix	Laboratory generated control limits not to exceed recovery limits of 60-140% or RPD of 30%	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.

2.7 DATA COLLECTION AND VALIDATION

Non-CLP SW-846 Test Methods are proposed for analytical work for these WPA and analyses will be conducted by a USACE-validated analytical laboratory. Level IV CLP-like raw data will be provided along with the Form 1. Additional discussion as to the laboratory deliverables may be found in Section 9.8.3 of the MQAP. Data will be made available to the USEPA upon request and presented in the Soil Sampling Investigation Report.

Data validation will be conducted on 100% of the data and documented based on the MQAP Section 9.5, USEPA SW-846 Test Method criteria, the USACE Shell Document - Appendix I to the Engineer Manual 200-1-3 (USACE 1994), and USEPA Region III guidance. Data qualifiers will follow the USEPA Region III Modifications to the USEPA National Functional Guidelines for Evaluating Inorganic Analysis and USEPA Region III Modifications to the USEPA National Functional Guidelines for Organic Data Review Multi-media, Multi-concentration (OLM01.0-OLM01.9). Verification for organic data will be performed at level M3 and the verification for inorganic data will be performed at level IM2.

Manual data validation will be conducted by an independent, third party data validator not directly associated with the field-sampling program. Mr. John Kearns, Quality Assurance Manager, in the URS Linthicum, Maryland, Office will oversee the performance of data validation functions. Data validation will be performed by knowledgeable and experienced individuals who can best perform evaluations within the necessary validation components. The data validator's qualifications will include experience with each of the elements required for the data verification and validation including ensuring that the measuring system meets the user's needs, assigning qualifiers to individual data values, assessing the relevancy of performance criteria, and concluding that data can proceed to quality assessment and reporting.

URS will direct the overall data management. Data management activities for the sampling program will be divided between URS and CompuChem Laboratories. Each firm has the equipment needed to perform the required data management functions. The laboratory will perform data entry and manipulation operations associated with the analysis of raw analytical data and provisions of chemical analysis results by sampling location. These data will be transmitted to URS for evaluation and interpretation. In addition, URS will review boring logs and sample location maps.

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3.0 HEALTH AND SAFETY PLAN ADDENDUM

3.1 INTRODUCTION

This site-specific HSPA was developed to provide the requirements for protection of site personnel, including government employees, URS personnel, regulators, subcontractors, and visitors, that are expected to be involved with field investigation work at SWMUs 8 and 36.

This HSPA addresses project-specific hazards, which include physical hazards, biological hazards, and chemical hazards, as identified in Section 3.2.2, below.

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 Master Health and Safety Plan (MHSP), as shown in Table 3-1.

Table 3-1
Health and Safety Issues Discussed in the MHSP
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

Health and Safety Issue	Section in MHSP
Site Safety and Health Documentation	1.4
Safety Statement	1.5
Health and Safety Personnel and Responsibilities	2.1
Hazard Assessment and Hazard Control	3.0
Training Plan	4.0
Medical Surveillance Plan	5.0
Site Safety and Control	6.0
PPE	7.0
Personnel and Equipment Decontamination	8.0
Monitoring Plan	9.0
Emergency Response and Contingency Plan	10.0

URS, subcontractor personnel, and site visitors will read this HSPA and will be required to follow its protocols as minimum standards. A copy of this HSPA will be available at each work site.

The contractor will provide a safe work environment for personnel involved in RFAAP investigative activities. The contractor will emphasize the importance of personnel injury and illness prevention at the work site.

3.2 TRAINING PLAN

Training will be used to review important topics outlined in this addendum and to inform URS personnel and subcontractor personnel of the hazards and control techniques associated with facility-wide conditions.

Site personnel will be informed of the specific PPE that will be worn during field activities. This includes, at a minimum, steel-toed boots, safety glasses with side shields, gloves, and hardhat. Each field person will also have a respirator on the site, in the event that an emergency occurs and a respirator is necessary for site evacuation, or if the use of a respirator is necessary based on air monitoring results. Prior to initiation of fieldwork, the staff will be required to review the manual *Safety, Security and Environmental Rules for Contractors and Subcontractors* (ATK 2000). Additional training, which will be conducted during daily safety "tailgate" meetings, will include emergency and evacuation procedures, general safety rules, and use of automobiles. Written documentation of safety briefings will be kept on the site.

3.2.1 Hazard Information Training

Hazard information training will be presented to URS and subcontractor personnel to provide a description of the Hazardous, Toxic, and Radioactive Waste (HTRW) with the potential to be found at SWMUs 8 and 36. Training will also be provided on the potential biological, chemical, and physical hazards to be found at the Installation. The URS SHSO will conduct this training based on information provided by the operating contractor.

3.2.2 Project-specific Hazard Analysis

The following hazards must be recognized and controlled during applicable investigative activities:

(1) Physical Hazards

- Cold stress – refer to Section 3.2.2 of the MHSP;
- Falls, open excavation, confined-space entry;
- Noise from heavy equipment;
- Cuts, abrasions, and lacerations;
- Manual lifting – refer to Section 3.2.4 of the MHSP;
- Slips, trips and falls associated with walking through heavily vegetated areas – refer to Section 6.1.1 of the MHSP;
- Heavy equipment – refer to Section 6.1.2.1 of the MHSP; and
- Main Manufacturing Area – overhead power lines.

(2) Biological Hazards (refer to Section 3.3 of the MHSP)

- Insect bites and stings;
- Tick bites;
- Snake, rodent, or other animal bites; and
- Dangerous plants.

(3) Chemical Hazards

- Potential exposure to toxic chemicals; and

- Potential exposure to dangerous fumes in case of a nearby release or spill of acids resulting in the creation of a fume cloud.

3.2.3 Hazard Communication Training

In order to comply with the requirements of the OSHA Hazard Communication (HAZCOM) Standard, 29 CFR 1910.1200, URS will have a written HAZCOM Program in place. The written hazard communication program addresses training (including potential safety and health effects from exposure), labeling, hazardous chemicals on the 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 the URS HAZCOM Program will be maintained on the site 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 entered during this investigation.

3.3 PERSONAL PROTECTIVE EQUIPMENT AND CLOTHING

The minimum and initial level of PPE for these activities will be Level D. 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 appropriate will be made by the SHSO.

In accordance with 29 CFR 1910.134, URS personnel working on the site will be required to participate in the written URS respiratory protection program. 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.

3.4 MONITORING PLAN

During sampling activities, the SHSO will monitor the site initially and periodically for potentially hazardous airborne constituents or physical hazards. The SHSO will use a PID equipped with an 11.7 eV lamp to detect volatile organic vapors. SOP 90.1 in appendix A describes the calibration of the PID that the SHSO will conduct daily. The action levels for volatile organic compounds at sustained concentrations in the breathing zone are as follows:

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PID Readings	Action
Background plus 5 ppm	Investigate
Five ppm to 25 ppm	Upgrade to Level C (full face air-purifying respirator with organic vapor/acid gas cartridges) and investigate
Greater than 25 ppm	Suspend work, depart area, and investigate
ppm = Parts Per Million	

3.5 EMERGENCY RESPONSE PLAN

Emergency response will follow the protocols set fort in MHSP, Section 10.0. Table 3-2 presents the current emergency telephone numbers applicable to activities performed at RFAAP.

Table 3-2
Emergency Telephone Numbers
Soil Sampling Investigation for SWMUs 8 and 36
Radford Army Ammunition Plant, Radford, Virginia

Contact	Telephone Number
Emergency Response Services	
Installation Fire Department**	16 (on post)
Installation Security Police**	7325 (on post) (540) 639-7325 (off post)
Installation Safety Department**	7294 (on post) (540) 639-7294 (off post)
Installation Spill Response**	7323, 7324 or 7325 (on post) (540) 639-7323, 7324, or 7325 (off post)
Installation Medical Facility** (RFAAP Hospital)	7323 or 7325 (on post) (540) 639-7323 or 7325 (off post)
Local Police Department	911
New River Valley Medical Center	(540) 731-2000 - General Telephone Number
National Poison Control Center	(800) 222-1222
National Response Center	(800) 424-8802
Regional USEPA Emergency Response	(215) 814-9016
Chemical Manufacturers Association Chemical Referral Center	(800) 262-8200

Directions from the Main Gate:

New River Valley Medical Center
2900 Lamb Circle
Christiansburg, VA 24073

Take Route 114 toward Radford to first traffic light. Take US Route 11 South and go across the bridge over the New River. Turn left after crossing the bridge, go to Virginia Route 177 South, and turn right. Proceed on VA 177 South and cross over Interstate 81. New River Valley Medical Center is on the left.

** These telephone numbers are referenced from *Safety, Security, and Environmental Rules for Contractors and Subcontractors* (ATK 2000).

4.0 REFERENCES

Alliant TechSystems (ATK). 2000. *Safety, Security, and Environmental Rules for Contractors and Subcontractors.*

Dames & Moore. 1992. *Draft VI Report for the Radford Army Ammunition Plant, Virginia.* Prepared for the U.S. Army Toxic and Hazardous Materials Agency.

Froehling & Robertson, Inc. (F&R). 2002. *Report of Subsurface Exploration and Geotechnical Engineering Evaluation, Proposed East Sludge Drying Beds*, Radford Army Ammunition Plant, Radford, Virginia.

IT Corporation (IT). 2002a. *Current Conditions Report Horseshoe Area.* Prepared for U.S. Army Corps of Engineers Baltimore District.

IT Corporation (IT). 2002b. *Facility-wide Background Study.* Prepared for U.S. Army Corps of Engineers Baltimore District.

NUS Corporation (NUS). 1981. Hydrogeologic Evaluation at RAAP.

Parsons Engineering Science, Inc. (Parsons). 1997. *New River and Tributaries Study. Radford Army Ammunition Plant, Virginia.* Prepared for U.S. Army Environmental Center.

Radford Army Ammunition Plant. 2003. *2003 Installation Action Plan. Radford Army Ammunition Plant, Virginia.*

URS Corporation (URS). *2002. Master Work Plan, Quality Assurance Plan, Health and Safety Plan, Radford Army Ammunitions Plant, Radford, Virginia.* Prepared for U.S. Army Corps of Engineers, Baltimore District.

U.S. Army Toxic and Hazardous Materials Agency (USATHAMA). 1976. *Installation Assessment of Radford Army Ammunition Plant.* Records Evaluation Report No. 103.

U.S. Environmental Protection Agency (USEPA). 1987. RCRA Facility Assessment for Radford Army Ammunition Plant, Radford, Virginia. VAD-21-002-0730.

U.S. Environmental Protection Agency (USEPA). 1989. *Draft Permit for Corrective Action and Incinerator Operation, Radford Army Ammunition Plant, Radford, Virginia, VAD-21-002-0730.*

U.S. Environmental Protection Agency (USEPA). 1992. *Installation Assessment, Radford Army Ammunition Plant, Radford, Virginia.* Environmental Photographic Interpretation Center (EPIC).

U.S. Environmental Protection Agency (USEPA). 1994. *Guidance for the Data Quality Objectives Process.* EPA/600/R-96/055. September.

U.S. Environmental Protection Agency (USEPA). 1997. *Test Methods for Evaluating Solid Waste Physical/Chemical Methods.* Third Edition, Update III, July.

U.S. Environmental Protection Agency (USEPA). *2000. Permit for Corrective Action and Waste Minimization; Pursuant to the Resource Conservation and Recovery Act as Amended by the Hazardous and Solid Waste Amendments of 1984, Radford Army Ammunition Plant, Radford, Virginia, VA1210020730.*

U.S. Environmental Protection Agency (USEPA). 2002. *USEPA Region III Risk-based Concentration Table.* October 09, 2002.

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Standard Operating Procedures

SOP SERIES	TITLE
10.0	**DOCUMENTATION**
10.1	Field Logbook
10.2	Surface Water, Groundwater, and Soil/Sediment Field Logbooks
10.3	Boring Logs
10.4	Chain-of-Custody Forms
20.0	**SUBSURFACE INVESTIGATION**
20.3	Well and Boring Abandonment
20.11	Drilling Methods and Procedures
30.0	**SAMPLING**
30.1	Soil Sampling
30.6	Containerized Material
30.7	Sampling Strategies
30.9	Collection of Soil Samples By USEPA SW-846 Method 5035 Using Disposable Samplers
50.0	**SAMPLE MANAGEMENT**
50.1	Sample Labels
50.2	Sample Packaging
70.0	**INVESTIGATION-DERIVED MATERIAL**
70.1	Investigation-Derived Material
80.0	**DECONTAMINATION**
80.1	Decontamination
90.0	**AIR MONITORING EQUIPMENT**
90.1	Photoionization Detector (HNu Model PI-101 and HW-101)

STANDARD OPERATING PROCEDURE 10.1
FIELD LOGBOOK

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for recording daily site investigation activities.

Records should contain sufficient information so that anyone can reconstruct the sampling activity without relying on the collector's memory.

2.0 MATERIALS

- Field Logbook;
- Indelible ink pen; and
- Clear tape.

3.0 PROCEDURE

Information pertinent to site investigations will be recorded in a bound logbook. Each page/form will be consecutively numbered, dated, and signed. All entries will be made in indelible ink, and all corrections will consist of line out deletions that are initialed and dated. If only part of a page is used, the remainder of the page should have an "X" drawn across it. At a minimum, entries in the logbook will include but not be limited to the following:

- Project name (cover);
- Name and affiliation of personnel on site;
- Weather conditions;
- General description of the field activity;
- Sample location;
- Sample identification number;
- Time and date of sample collection;
- Specific sample attributes (e.g., sample collection depth flow conditions or matrix);
- Sampling methodology (grab or composite sample);
- Sample preservation, as applicable;
- Analytical request/methods;

- Associated quality assurance/quality control (QA/QC) samples;
- Field measurements/observations, as applicable; and
- Signature and date of personnel responsible for documentation.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

None.

6.0 REFERENCES

USEPA. 1990. *Sampler's Guide to the Contract Laboratory Program.* EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, DC.

USEPA. 1991. *User's Guide to the Contract Laboratory Program.* EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response, January.

USEPA. 1998. *EPA Requirements for Quality Assurance Project Plans.* EPA/600/R-98/018, QA/R5, Final, Office of Research and Development, Washington, D.C.

STANDARD OPERATING PROCEDURE 10.2
SURFACE WATER, GROUNDWATER, AND SOIL/SEDIMENT FIELD LOGBOOKS

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for recording surface water, groundwater, and soil/sediment sampling information, as well as instrument calibration data in field logbooks.

2.0 MATERIAL

- Applicable field logbook (see attached forms); and
- Indelible ink pen.

3.0 PROCEDURE

All information pertinent to surface water, groundwater, or soil/sediment sampling will be recorded in the appropriate logbook. Each page/form of the logbook will be consecutively numbered. All entries will be made with an indelible ink pen. All corrections will consist of line out deletions that are initialed and dated.

3.1 SOIL/SEDIMENT

3.1.1 Field Parameters/Logbook (Form 10.2-a)

1. HIGH CONCENTRATION EXPECTED?: Answer "Yes" or "No.";
2. HIGH HAZARD?: Answer "Yes" or "No.";
3. INSTALLATION/SITE: Record the complete name of the installation or site;
4. AREA: Record the area designation of the sample site;
5. INST. NAME: Record the two-letter installation name for Radford Army Ammunition Plant – "RD";
6. SAMPLE MATRIX CODE: Record the appropriate sample matrix code. Common codes are "SD" for solid - sediment, "SI" for soil - gas, "SL for solid sludge, "SO" for surface other, "SS" for solid – soil, "SW" for surface wipe, "WD" for water – potable, "WG" for water – ground, "WS" water – surface, "WT" – water treated and "WW" water -waste;
7. SITE ID: Record a code up to 20 characters or numbers that is unique to the site;
8. ENV. FIELD SAMPLE IDENTIFIER: Record a code up to 20 characters specific for the sample;
9. DATE: Enter the date the sample was taken;
10. TIME: Enter the time (12-hour or 24-hour clock acceptable as long as internally consistent) the sample was taken;

11. AM PM: Circle "AM" or "PM" to designate morning or afternoon (12-hour clock);
12. SAMPLE PROG: Record "RFI" (RCRA Facility Investigation) or other appropriate sample program;
13. DEPTH (TOP): Record the total depth sampled;
14. DEPTH INTERVAL: Record the intervals at which the plug will be sampled;
15. UNITS: Record the units of depth (feet, meters);
16. SAMPLE MEASUREMENTS: Check the appropriate sampling method;
17. CHK: Check off each container released to a laboratory;
18. ANALYSIS: Record the type of analysis to be performed on each sample container;
19. SAMPLE CONTAINER: Record the sample container type and size;
20. NO.: Record the number of containers;
21. REMARKS: Record any remarks about the sample;
22. TOTAL NUMBER OF CONTAINERS FOR SAMPLE: Record the total number of containers;
23. SITE DESCRIPTION: Describe the location where the sample was collected;
24. SAMPLE FORM: Record the form of the sample (i.e., clay, loam, etc.) using The Unified Soil Classification System (USCS);
25. COLOR: Record the color of the sample as determined from standard Munsell Color Charts;
26. ODOR: Record the odor of the sample or "none";
27. PID: Record the measured PID values or other similar measurement instrument value;
28. UNUSUAL FEATURES: Record anything unusual about the site or sample;
29. WEATHER/TEMPERATURE: Record the weather and temperature; and
30. SAMPLER: Record your name.

3.1.2 Map File Form (refer to form 10.2-c)

1. SITE ID: Record the Site ID from the field parameter form;
2. POINTER: Record the field sample number for the sample being pointed to;
3. DESCRIPTION/MEASUREMENTS: Describe the location where the sample was taken, along with distances to landmarks;
4. SKETCH/DIMENSIONS: Diagram the surroundings and record the distances to landmarks;
5. MAP REFERENCE: Record which U.S.G.S. Quad Map references the site;
6. COORDINATE DEFINITION: Write the compass directions and the X- and Y-coordinates of the map run;
7. COORDINATE SYSTEM: Write "UTM" (Universal Transverse Mercator);
8. SOURCE: Record the 1-digit code representing the Map Reference;
9. ACCURACY: Give units (e.g., write "1-M" for 1 meter);
10. X-COORDINATE: Record the X-coordinate of the sample site location;

11. Y-COORDINATE: Record the Y-coordinate of the sample site location;
12. UNITS: Record the units used to measure the map sections;
13. ELEVATION REFERENCE: Record whether topography was determined from a map or a topographical survey;
14. ELEVATION SOURCE: Record the 1-digit code representing the elevation reference;
15. ACCURACY: Record the accuracy of the map or survey providing the topographical information;
16. ELEVATION: Record the elevation of the sampling site;
17. UNITS: Write the units in which the elevation is recorded; and
18. SAMPLER: Write your name.

3.2 SURFACE WATER

3.2.1 Field Parameter Logbook (Forms 10.2-b and 10.2-c)

1. CAL REF: Record the calibration reference for the pH meter;
2. pH: Record the pH of the sample;
3. TEMP: Record the temperature of the sample in degrees Celsius;
4. COND: Record the conductivity of the water;
5. Description of site and sample conditions (refer to 10.2-b);
6. Map File Form (refer to Section 3.1.2).

3.3 GROUNDWATER (FORMS 10.2- D)

3.3.1 Field Parameter Logbook (Form 10.2.b)

Refer to Section 3.2.1.

3.3.2 Map File and Purging Forms

1. WELL NO. OR ID: Record the abbreviation appropriate for where the sample was taken. Correct abbreviations can be found on pages 18-21 of the IRDMIS User's Guide for chemical data entry;
2. SAMPLE NO.: Record the reference number of the sample;
3. WELL/SITE DESCRIPTION: Describe the location where the sample was taken, along with distances to landmarks;
4. X-COORD AND Y-COORD: Record the survey coordinates for the sampling site;
5. ELEV: Record the elevation where the sample was taken;
6. UNITS: Record the units the elevation was recorded in;
7. DATE: Record the date in the form MM/DD/YY;
8. TIME: Record the time, including a designation of AM or PM;
9. AIR TEMP.: Record the air temperature, including a designation of C or F (Celsius or Fahrenheit);
10. WELL DEPTH: Record the depth of the well in feet and inches;

11. CASING HEIGHT: Record the height of the casing in feet and inches;
12. WATER DEPTH: Record the depth (underground) of the water in feet and inches;
13. WELL DIAMETER: Record the diameter of the well in inches;
14. WATER COLUMN HEIGHT: Record the height of the water column in feet and inches;
15. SANDPACK DIAM.: Record the diameter of the sandpack. Generally, this will be the same as the bore diameter;
16. EQUIVALENT VOLUME OF STANDING WATER: Use one of the following equations to determine one equivalent volume (EV);

    1 EV = volume in casing + volume in saturated sandpack. Or:

    $1\ EV = [\pi R_w^2 h_w + 0.30p(R_s^2 - R_w^2)h_s] * (0.0043)$

Where:

R_s = radius of sandpack in inches
R_w = radius of well casing in inches
h_s = height of sandpack in inches
h_w = water depth in inches

$0.0043 = \text{gal/in}^3$
and filter pack porosity is assumed as 30%, or

Volume in casing =
$(0.0043\ \text{gal/in}^3)(p)(12\ \text{in/ft})(R_c^2)(W_h)$

Where:

R_c = radius of casing in inches, and
W_h = water column height in feet

Vol. in sandpack =
(0.0043 gal/in3)(p)(12 in/ft)(Rb2 - Rc2)(Wh)(0.30)

(if Wh is less than the length of the sandpack), or

Vol. in sandpack =
(0.0043 gal/in3)(p)(12 in/ft)(Rb2 - Rc2)(Sh)(0.30)

(if Wh is greater than the length of the sandpack).

where:

Rb = radius of the borehole, and
Sh = length of the sandpack.

Show this calculation in the comments section.

1. PUMP RATE: Record pump rate;
2. TOTAL PUMP TIME: Record total purge time and volume;
3. WELL WENT DRY? Write "YES" or "NO";
4. PUMP TIME: Record pump time that made the well go dry;
5. VOLUME REMOVED: Record the volume of water (gal) removed before the well went dry;
6. RECOVERY TIME: Record the time required for the well to refill;
7. PURGE AGAIN?: Answer "YES" or "NO";
8. TOTAL VOL. REMOVED: Record the total volume of water (in gallons) removed from the well;
9. CAL REF.: Record the calibration reference for the pH meter;
10. TIME: Record time started (INITIAL T(0)), 2 times DURING the sampling and the time sampling ended (FINAL);
11. pH: Record the pH at start of sampling (INITIAL), twice DURING the sampling, and at the end of sampling (FINAL);
12. TEMP: Record the water temperature (Celsius) at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL);
13. COND: Record the conductivity of the water at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL);
14. D.O.: Record the dissolved oxygen level in the water at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL);
15. TURBIDITY: Record the readings from the turbidity meter (nephelometer) and units at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL);
16. ORD: Record the oxidation/reduction (RedOx) potential of the water sample at the start of sampling, twice DURING the sampling, and at the end of sampling (FINAL);
17. HEAD SPACE: Record any positive readings from organic vapor meter reading taken in well headspace before sampling;
18. NAPL: Record the presence and thickness of any non-aqueous phase liquids (LNAPL and DNAPL)
19. COMMENTS: Record any pertinent information not already covered in the form; and
20. SIGNATURE: Sign the form.

3.4 FIELD CALIBRATION FORMS (REFER TO FORM 10.2-E)

1. Record time and date of calibration;
2. Record calibration standard reference number;
3. Record meter ID number;
4. Record initial instrument reading, recalibration reading (if necessary), and final calibration reading on appropriate line;
5. Record value of reference standard (as required);
6. COMMENTS: Record any pertinent information not already covered on form; and

7. SIGNATURE: Sign form.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

None.

6.0 REFERENCE

USEPA. 1991. *User's Guide to the Contract Laboratory Program.* EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response, January.

FIELD PARAMETER/LOGBOOK FORM 10.2-a
SOIL AND SEDIMENT SAMPLES

HIGH CONCENTRATION EXPECTED? ________________ HIGH HAZARD?

INSTALLATION/SITE ____________________________________ AREA ________________

INST NAME _________ FILE NAME ____________________________________

SAMPLE MATRIX CODE ___________ SITE ID ____________
ENV. FIELD SAMPLE IDENTIFIER ________________

DATE (MM/DD/YY) __/__/__ TIME _________ AM PM SAMPLE PROGRAM

DEPTH (TOP) _____ DEPTH INTERVAL ____________ UNIT ___________

SAMPLING METHOD:

SPLIT SPOON __ AUGER __ SHELBY TUBE __ SCOOP __ OTHER

CHK	ANALYSIS	SAMPLE CONTAINER	NO.	REMARKS

TOTAL NUMBER OF CONTAINERS FOR SAMPLE_____

DESCRIPTION OF SITE AND SAMPLE CONDITIONS

SITE DESCRIPTION:____

____

____

SAMPLE FORM __________________ COLOR _____________ ODOR ___________
PID (HNu)__________________ UNUSUAL FEATURES____________________

____

WEATHER/TEMPERATURE

SAMPLER ________________

FIELD PARAMETER/LOGBOOK FORM 10.2-b
GROUNDWATER AND SURFACE WATER SAMPLES

HIGH CONCENTRATION EXPECTED? ________________ HIGH HAZARD?

INSTALLATION/SITE ______________________ AREA

INST CODE __________ FILE NAME ____________________ SITE TYPE

SITE ID ___________________ FIELD SAMPLE NUMBER

DATE (MM/DD/YY) __/__/__ TIME __________ AM PM SAMPLE PROG.

DEPTH (TOP) __________ DEPTH INTERVAL ___________ UNITS

SAMPLING MEASUREMENTS

CAL REF. ____ pH _____ TEMPERATURE °C _____ CONDUCTIVITY _____ REDOX _____

DISSOLVED OXYGEN ____ TURBIDITY _____ OTHER

CHK	ANALYSIS	SAMPLE CONTAINER	NO.	REMARKS

TOTAL NUMBER OF CONTAINERS FOR SAMPLE_____

DESCRIPTION OF SITE AND SAMPLE CONDITIONS

SITE DESCRIPTION____

SAMPLING METHOD_____________________________________

SAMPLE FORM _________________ COLOR ________ ODOR ________

PID (HNu)____

UNUSUAL FEATURES_______________________________

WEATHER/TEMPERATURE____ SAMPLER _______________

EXAMPLE MAP FILE LOGBOOK FORM 10.2-c
SURFACE WATER, SOIL, AND SEDIMENT SAMPLES

SITE ID________________________ POINTER__________________

DESCRIPTION/MEASUREMENTS____

SKETCH/DIMENSIONS :

MAP REFERENCE______________________________________

COORDINATE DEFINITION (X is ______________ Y is ___________)

COORDINATE SYSTEM ______________ SOURCE ______________ ACCURACY________________

X-COORDINATE ___________ Y-COORDINATE ___________ UNITS_________

ELEVATION REFERENCE_______________________________

ELEVATION SOURCE ________________ ACCURACY _____________ELEVATION________________

UNITS______________

SAMPLER_________

EXAMPLE MAP FILE AND PURGING LOGBOOK FORM 10.2-d
GROUNDWATER SAMPLES

WELL COORD. OR ID ____________________ SAMPLE NO.____________

WELL/SITE DESCRIPTION____

X-COORD. ______ Y-COORD. _____________ ELEV. ________ UNITS

DATE ___/___/___ TIME _______________ AIR TEMP.

WELL DEPTH ___________ FT. _____ IN. CASING HT. _____ FT. _____ IN.

WATER DEPTH _____ FT. _____ IN. WELL DIAMETER ________ IN.

WATER COLUMN HEIGHT _______ FT. _____ IN. SANDPACK DIAM. _____ IN.

EQUIVALENT VOLUME OF STANDING WATER ______________ (GAL) (L)

VOLUME OF BAILER _______ (GAL) (L) or PUMP RATE _________ (GPM) (LPM)

TOTAL NO. OF BAILERS (5 EV) ________ or PUMP TIME _______ MIN.

WELL WENT DRY? [Yes] [No] NUM. OF BAILERS _______ or PUMP TIME

VOL. REMOVED _____________ (GAL) (L) RECOVERY TIME

PURGE AGAIN? [Yes] [No] TOTAL VOL. REMOVED __________ (GAL) (L)

DATE & TIME	QUANTITY REMOVED	TIME REQ'D	pH	Cond	Temp	ORD	Turb	DO	Character of water (color / clarity / odor / partic.)
(before)									
(during)									
(during)									
(during									
(after)									

COMMENTS____

SIGNATURE____________________________

EXAMPLE FIELD CALIBRATION FORM 10.2-e
FOR pH, CONDUCTIVITY, TEMPERATURE, TURBIDITY, ORD, AND DISSOLVED OXYGEN METERS

INITIAL CALIBRATION	FINAL CALIBRATION
DATE:	**DATE:**
TIME:	**TIME:**

pH METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO:_______________

METER ID_________________

pH STANDARD	INITIAL READING	RECALIB. READING	FINAL READING
7.0			
10.0			
4.0			

CONDUCTIVITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO:_______________

METER ID_________________

COND. STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

TEMPERATURE METER CALIBRATION

METER ID_________________

TEMP. STANDARD	INITIAL READING	RECALIB. READING	FINAL READING
ICE WATER			
BOILING WATER			
OTHER ________			

EXAMPLE FIELD CALIBRATION FORM 10.2-e
FOR pH, CONDUCTIVITY, TEMPERATURE, TURBIDITY, ORD, AND DISSOLVED OXYGEN METERS

TURBIDITY METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO:________________

METER ID__________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

ORD METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO:________________

METER ID__________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

DISSOLVED OXYGEN METER CALIBRATION

CALIBRATION STANDARD REFERENCE NO:________________

METER ID__________________

STANDARD	INITIAL READING	RECALIB. READING	FINAL READING

COMMENTS____

SIGNATURE__________________________________

STANDARD OPERATING PROCEDURE 10.3
BORING LOGS

1.0 INTRODUCTION

The purpose of this standard operating procedure (SOP) is to describe the methods to be followed for classifying soil and rock, as well as preparing borehole logs and other types of soil reports.

2.0 MATERIALS

The following equipment is required for borehole logging:

- HTRW ENG Form 5056-R and 5056A-R boring log forms;
- Daily inspection report forms;
- Chain-of-custody forms;
- Request for analysis forms;
- ASTM D 2488 classification flow chart;
- Soil and/or Rock color chart (i.e., Munsell®);
- Grain size and roundness chart;
- Graph paper;
- Engineer's scale;
- Previous reports and boring logs;
- Pocketknife or putty knife;
- Hand lens;
- Dilute hydrochloric acid (10% volume);
- Gloves;
- Personal protective clothing and equipment, as described in work plan addenda health and safety plan;
- Photoionization detector or other appropriate monitoring equipment per site-specific health and safety plan; and
- Decontamination supplies (SOP 80.1).

3.0 PROCEDURE

Each boring log should fully describe the subsurface environment and the procedures used to obtain this description.

Boring logs should be prepared in the field on USACE Engineer Form 5056-R and 5056-R. Logs should be recorded in the field directly on the boring log form and not transcribed from a field book.

A "site geologist" should conduct borehole logging and soil/rock identification and description or other professional trained in the identification and description of soil/rock.

3.1 BORING LOG INFORMATION

As appropriate, the following information should be recorded on the boring log during the course of drilling and sampling activities:

- Project information including name, location, and project number;
- Each boring and well should be uniquely numbered and located on a sketch map as part of the log;
- Type of exploration;
- Weather conditions including events that could affect subsurface conditions;
- Dates and times for the start and completion of borings, with notations by depth for crew shifts and individual days;
- Depths/heights in feet and in decimal fractions of feet;
- Descriptions of the drilling equipment including rod size, bit type, pump type, rig manufacturer and model, and drilling personnel;
- Drilling sequence and descriptions of casing and method of installation;
- Description and identification of soils in accordance with ASTM Standard D 2488;
- Descriptions of each intact soil sample for the parameters identified in Section 3.2;
- Descriptions and classification of each non-intact sample (e.g., wash samples, cuttings, auger flight samples) to the extent practicable;
- Description and identification of rock;
- Description of rock (core(s)) for the parameters identified in Section 3.7;
- Scaled graphic sketch of the rock core (included or attached to log) according to the requirements identified in Section 3.7;
- Lithologic boundaries, with notations for estimated boundaries;
- Depth of water first encountered in drilling, with the method of first determination (any distinct water level(s) below the first zone will also be noted);
- Interval by depth for each sample taken, classified, and/or retained, with length of sample recovery and sample type and size (diameter and length);
- Blow counts, hammer weight, and length of fall for driven samplers;

- Rate of rock coring and associated rock quality designation (RQD) for intervals cored;
- Drilling fluid pressures, with driller's comments;
- Total depth of drilling and sampling;
- Drilling fluid losses and gains should be recorded;
- Significant color changes in the drilling fluid returned;
- Soil gas or vapor readings with the interval sampled, with information on instrument used and calibration;
- Depth and description of any in-situ test performed; and
- Description of other field tests conducted on soil and rock samples.

3.2 SOIL PARAMETERS FOR LOGGING

In general, the following soil parameters should be included on the boring log when appropriate:

- Identification per ASTM D 2488 with group symbol;
- Secondary components with estimated percentages per ASTM D 2488;
- Color;
- Plasticity per ASTM D 2488;
- Density of non-cohesive soil or consistency of cohesive soil;
- Moisture condition per ASTM D 2488 (dry, moist, or wet);
- Presence of organic material;
- Cementation and HCL reaction testing per ASTM D 2488;
- Coarse-grained particle description per ASTM D 2488 including angularity, shapes, and color;
- Structure per ASTM D 2488 and orientation;
- Odor; and
- Depositional environment and formation, if known.

ASTM D 2488 categorizes soils into 13 basic groups with distinct geologic and engineering properties based on visual-manual identification procedures. The following steps are required to classify a soil sample:

1. Observe basic properties and characteristics of the soil. These include grain size grading and distribution, and influence of moisture on fine-grained soil.
2. Assign the soil an ASTM D 2488 classification and denote it by the standard group name and symbol.
3. Provide a written description to differentiate between soils in the same group if necessary.

Many soils have characteristics that are not clearly associated with a specific soil group. These soils might be near the borderline between groups, based on particle distribution or plasticity characteristics. In such a case, assigning dual group names and symbols (e.g., GW/GC or ML/CL) might be an appropriate method of describing the soil. The two general types of soils, for which classification is performed, coarse- and fine-grained soils, are discussed in the following sections.

3.3 COURSE-GRAINED SOIL IDENTIFICATION

For soils in the coarse-grained soils group, more than half of the material in the soil matrix will be retained by a No. 200 sieve (75-µm).

1. Coarse-grained soils are identified on the basis of the following:
   a) Grain size and distribution;
   b) Quantity of fine-grained material (i.e., silt and clay as a percentage); and
   c) Character of fine-grained material.
2. The following symbols are used for classification:

Basic Symbols	Modifying Symbols
G = gravel	W = well graded
S = sand	P = poorly graded
	M = with silty fines
	C = with clayey fines

3. The following basic facts apply to coarse-grained soil classification.

- The basic symbol G is used if the estimated percentage of gravel is greater than that for sand. In contrast, the symbol S is used when the estimated percentage of sand is greater than the percentage of gravel.
- Gravel ranges in size from 3-inch to 1/4-inch (No. 4 sieve) diameter. Sand ranges in size from the No. 4 sieve to No. 200 sieve. The Grain Size Scale used by Engineers (ASTM Standards D 422-63 and D 643-78) is the appropriate method to further classify grain size as specified by ASTM D 2488.
- Modifying symbol W indicates good representation of all particle sizes.
- Modifying symbol P indicates that there is an excess or absence of particular sizes.
- The symbol W or P is used only when there are less than 15% fines in a sample.
- Modifying symbol M is used if fines have little or no plasticity (silty).
- Modifying symbol C is used if fines have low to high plasticity (clayey).

Figure 10.03a is a flowchart for identifying coarse-grained soils by ASTM D 2488.

3.4 FINED-GRAINED SOIL IDENTIFICATON

If one-half or more of the material will pass a No. 200 sieve (75 µm), the soil is identified as fine-grained.

1. Fine-grained soils are classified based on dry strength, dilatancy, toughness, and plasticity.
2. Classification of fine-grained soils uses the following symbols:

Basic Symbols

M = silt (non plastic)
C = clay (plastic)
O = organic
Pt = peat

Modifying Symbols

L = low liquid limit (lean)
H = high liquid limit (fat)

3. The following basic facts apply to fine-grained soil classification:
   - The basic symbol M is used if the soil is mostly silt, while the symbol C applies if it consists mostly of clay.
4. Use of symbol O (group name OL/OH) indicates that organic matter is present in an amount sufficient to influence soil properties. The symbol Pt indicates soil that consists mostly of organic material.

- Modifying symbols (L and H) are based on the following hand tests conducted on a soil sample:
  - — Dry strength (crushing resistance).
  - — Dilatancy (reaction to shaking).
  - — Toughness (consistency near plastic limit).
- Soil designated ML has little or no plasticity and can be recognized by slight dry strength, quick dilatency, and slight toughness.
- CL indicates soil with slight to medium plasticity, which can be recognized by medium to high dry strength, very slow dilatancy, and medium toughness.

Criteria for describing dry strength per ASTM D 2488 are as follows:

Description	Criteria
None	Dry sample crumbles into powder with pressure of handling
Low	Dry specimen crumbles into powder with some finger pressure
Medium	Dry specimen breaks into pieces or crumbles with considerable finger pressure
High	Dry specimen cannot be broken with finger pressure but will break into pieces between thumb and a hard surface
Very high	Dry specimen cannot be broken between the thumb and a hard surface stiffness

Criteria for describing dilatancy per ASTM D 2488 are as follows:

None	No visible change in the sample
Slow	Water appears slow on the surface of the sample during shaking and does not disappear or disappears slowly upon squeezing
Rapid	Water appears quickly on the surface of the sample during shaking and disappears quickly upon squeezing

Criteria for describing toughness per ASTM D 2488 are as follows:

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit and the thread and lump are weak and soft
Medium	Medium pressure is required to roll the thread to near the plastic limit and the thread and lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit and the thread and lump have very high stiffness

Figure 10.03b is a flowchart for identifying fine-grained soils by ASTM D 2488.

3.5 DENSITY AND CONSISTENCY

Relative density for coarse-grained soils and consistency for fine-grained soils can be estimated using standard penetration test blow count data (ASTM D 1586). The number of blows required for each 6 inches of penetration or fraction thereof is recorded. If the sampler is driven less than 18 inches, the number of blows per each complete 6-inch interval and per partial interval is recorded.

For partial increments, the depth of penetration should be recorded to the nearest 1 inch. If the sampler advances below the bottom of the boring under the weight of rods (static) and/or hammer, then this information should be recorded on the log.

The following are some "rule-of-thumb" guidelines for describing the relative density of coarse-grained soils:

Blow Count	Relative Density for Sand
0–4	Very loose
4–10	Loose
10–30	Medium dense
30–50	Dense
>50	Very Dense

The following are some "rule-of-thumb" guidelines for describing the consistency of fine-grained soils:

Blow Count	Consistency for Clays	Description
0–2	Very Soft	Sample sags or slumps under its own weight
2–4	Soft	Sample can be pinched in two between the thumb and forefinger
4–8	Medium Stiff	Sample can be easily imprinted with fingers
8–16	Stiff	Sample can be imprinted only with considerable pressure of fingers
16–32	Very Stiff	Sample can be imprinted very slightly with fingers
>32	Hard	Sample cannot be imprinted with fingers; can be pierced with pencil

3.6 OTHER DESCRIPTIVE INFORMATION

The approximate percentage of gravel, sand, and fines (use a percentage estimation chart) should be recorded per ASTM D 2488 as follows:

Modifiers	Descriptions
Trace	Less than 5%
Few	5%–10%
Little	15%–25%
Some	30%–45%
Mostly	50%–100%

Color/discoloration should be recorded and described using a soil color chart, such as the Munsell® Soil Color Charts. A narrative and numerical description should be given from the color chart, such as Brown 10 YR, 5/3 (Munsell®). Odor should be described if organic or unusual.

Plasticity should be described as follows:

Description	Criteria
Non-plastic	A 1/8-inch thread cannot be rolled at any water content
Low	Thread can barely be rolled and lump cannot be formed when drier than plastic limit.
Medium	Thread is easy to roll; plastic limit can be reached with little effort and lump crumbles when drier than plastic limit.
High	Considerable time is required to reach the plastic limit and lump can be formed without crumbling when drier than plastic limit

Moisture condition should be recorded as dry (absence of moisture), moist (damp but no visible water) or wet (visible free water).

Cementation should be recorded (carbonates or silicates) along with the results of HCL reaction testing. The reaction with HCL should be described as none (no visible reaction), weak (some reaction with slowly forming bubbles) or strong (violent reaction with bubbles forming immediately).

Particle description information for coarse-grained soil should be recorded where appropriate per ASTM D 2488 including maximum particle size, angularity (angular, subangular, subrounded, or rounded), shape (flat, elongated or flat and elongated), and color.

Structure (along with orientation) should be reported using the following ASTM D 2488 descriptions:

Description	Criteria
Stratified	Alternating layers of varying material or color with layers greater than 6 millimeters thick
Laminated	Alternating layers of varying material or color with layers less than 6 millimeters thick
Fissured	Breaks along definite planes of fracture with little resistance
Slickensided	Fracture planes that appear polished or glossy, can be striated
Blocky	Inclusion of small pockets of different soils
Homogeneous	Same color and appearance throughout

3.7 ROCK CORE PARAMETERS FOR LOGGING

In general, the following parameters should be included on the boring log when rock coring is conducted:

- Rock type;
- Formation;
- Modifier denoting variety;
- Bedding/banding characteristics;
- Color;
- Hardness;
- Degree of cementation;
- Texture;
- Structure and orientation;
- Degree of weathering;
- Solution or void conditions;
- Primary and secondary permeability including estimates and rationale; and
- Lost core interval and reason for loss.

A scaled graphic sketch of the core should provided on or attached to the log, denoting by depth, location, orientation, and nature (natural, coring-induced, or for fitting into core box) of all core breaks. Where fractures are too numerous to be shown individually, their location may be drawn as a zone.

The RQD values for each core interval (run) should be calculated and included on the boring log. The method of calculating the RQD is as follows per ASTM D 6032:

RQD = [Σ length of intact core pieces > 100 mm (4-inches)] x 100%/total core length.

3.8 PROCEDURES FOR ROCK CLASSIFICATION

For rock classification record mineralogy, texture, and structural features (e.g., biotite and quartz fine grains, foliated parallel to relict bedding oriented 15 to 20 degrees to core axis, joints coated with iron oxide). Describe the physical characteristics of the rock that are important for engineering considerations such as fracturing (including minimum, maximum, and most common and degree of spacing), hardness, and weathering.

1. The following is to be used as a guide for assessing fracturing:

AEG Fracturing	Spacing
Crushed	up to 0.1 foot
Intense	0.1–0.5 foot
Moderate	0.5 foot–10 feet
Slight	1.0 foot–3.0 feet
Massive	>3.0 feet

2. Record hardness using the following guidelines:

Hardness	Criteria
Soft	Reserved for plastic material
Friable	Easily crumbled by finger pressure
Low	Deeply gouged or carved with pocketknife
Moderate	Readily scratched with knife; scratch leaves heavy trace of dust
Hard	Difficult to scratch with knife; scratch produces little powder and is often faintly visible
Very Hard	Cannot be scratched with knife

3. Describe weathering using the following guidelines:

Weathering	**Decomposition**	**Discoloration**	**Fracture Condition**
Deep	Moderate to complete alteration of minerals feldspars altered to clay, etc.	Deep and thorough	All fractures extensively coated with oxides, carbonates, or clay
Moderate	Slight alteration of minerals, cleavage surface lusterless and stained	Moderate or localized and intense	Thin coatings or stains
Weak	No megascopic alteration of minerals	Slight and intermittent and localized	Few strains on fracture surfaces
Fresh	Unaltered, cleavage, surface glistening		

3.9 PROCEDURE FOR LOGGING REFUSE

The following procedure applies to the logging of subsurface samples composed of various materials in addition to soil as may be collected from a landfill or other waste disposal site.

1. Observe refuse as it is brought up by the hollow stem auger, bucket auger, or backhoe.

2. If necessary, place the refuse in a plastic bag to examine the sample.

3. Record observations according to the following criteria:

   - Composition (by relative volume), e.g., paper, wood, plastic, cloth, cement, or construction debris. Use such terms as "mostly" or "at least half." Do not use percentages;
   - Moisture condition: dry, moist, or wet;
   - State of decomposition: highly decomposed, moderately decomposed, slightly decomposed, etc.;
   - Color: obvious mottling and/or degree of mottling;
   - Texture: spongy, plastic (cohesive), friable;
   - Odor;

- Combustible gas readings (measure down hole and at surface); and
- Miscellaneous: dates of periodicals and newspapers, ability to read printed materials, degree of drilling effort (easy, difficult, and very difficult).

3.10 SUBMITTAL REQUIREMENTS

Each original boring log should be submitted to the Contracting Officer Representative (CRO) after completion of the boring. When a monitoring well will be installed in a boring, the boring log and well installation diagram should be submitted together.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

Not applicable.

6.0 REFERENCES

ASTM Standard D 1586–84 (1992). 1992. *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.*

ASTM Standard D 2488-93. 1993. *Standard Practice for Description and Identification of Soils Visual-Manual Procedure).*

ASTM Standard D 5434-93. 1993. *Guide for Field Logging of Subsurface Explorations of Soil and Rock.*

ASTM Standard D 6032-96. 1996. *Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core.*

Compton, R. R. 1962. *Manual of Field Geology.* John Wiley & Sons, Inc., New York.

USACE. 1998. *Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites.* EM 1110-1-4000, 1, November.

U.S. Department of the Interior. 1989. *Earth Manual.* Water and Power Resources Service, Washington, DC.

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STANDARD OPERATING PROCEDURE 10.4
CHAIN-OF-CUSTODY FORM

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for use of the chain-of-custody form. An example is provided as part of this SOP. Other formats with similar levels of detail are acceptable.

2.0 MATERIALS

- Chain-of-custody form; and
- Indelible ink pen.

3.0 PROCEDURE

1. Record the project name and number.
2. Record the project contact's name and phone number.
3. Print sampler's names in "Samplers" block.
4. Enter the Field Sample No.
5. Record the sampling dates for all samples.
6. List the sampling times (military format) for all samples.
7. Indicate, "grab" or "composite" sample with an "X."
8. Record matrix (e.g., aqueous, soil).
9. List the analyses/container volume across top.
10. Enter the total number of containers per Field Sample No. in the "Subtotal" column.
11. Enter total number of containers submitted per analysis requested.
12. State the carrier service and airbill number, analytical laboratory, and custody seal numbers.
13. List any comments or special requests in the "Remarks" section.
14. Sign, date, and time the "Relinquished By" section when the cooler is relinquished to the next party.
15. Upon completion of the form, retain the shipper copy and place the forms and the other copies in a zip seal bag to protect from moisture. Affix the zip seal bag to the inside lid of the sample cooler to be sent to the designated laboratory.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

None.

6.0 REFERENCES

USEPA. 1990. *Sampler's Guide to the Contract Laboratory Program.* EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, DC, December 1990.

USEPA. 1991. *User's Guide to the Contract Laboratory Program..* EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response, January 1991.

USEPA. 1998. *EPA Requirements for Quality Assurance Project Plans.* EPA/600/R-98/018, QA/R5, Final, Office of Research and Development, Washington, D.C.

FIGURE 10.4-a
EXAMPLE CHAIN-OF-CUSTODY FORM

<table>
<tr><td>Project Number</td><td colspan="4">Project Name</td><td rowspan="4">Matrix</td><td colspan="8">ANALYSES</td><td rowspan="4">Subtotal</td><td>LAB :</td></tr>
<tr><td colspan="5">Project Contact (Name and Phone Number)</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td>AIRBILL No:</td></tr>
<tr><td colspan="5">Samplers:</td><td>Courier:</td></tr>
<tr><td>Field Sample No.</td><td>Date (MM-DD-YY)</td><td>Time</td><td>Comp</td><td>Grab</td><td>REMARKS</td></tr>
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STANDARD OPERATING PROCEDURE 20.3
WELL AND BORING ABANDONMENT

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to establish the protocols by which all borings and wells will be abandoned. The primary objective of boring or well abandonment activities is to permanently abandon the boring or well so that the natural migration of groundwater or soil vapor is not significantly influenced.

2.0 MATERIALS

- Well abandonment equipment including appropriate grout mixing/placement equipment, and heavy equipment as appropriate (drill rig, crane, backhoe, etc.);
- Pure sodium bentonite powder with no additives (bentonite);
- Bentonite pellets (seal);
- Cement (Portland Type II); and
- Approved source water.

3.0 PROCEDURE

The volume of grout required for borehole or well abandonment should be calculated prior to proceeding with abandonment. These calculations should consider loss of material to the formation, changes in borehole diameter, potential zones of washout, and shrinkage of material. Calculations should be recorded on an abandonment record (see Section 3.1.4).

In general, cement grout should be used for boring and well abandonment per the specifications in Section 3.1 and procedures identified in the following sections. Specialized narrow diameter soil borings (3-inches or less) associated with direct push methods or hand augers may be abandoned using bentonite pellets or chips (see Section 3.5).

Any replacement borings or wells associated with the abandonment should be offset at least 20 feet from any abandoned site in a presumed up- or cross-gradient direction.

3.1 GROUT

Grout used in construction will be composed by weight of the following:

- Type II Portland cement (Type IV Portland Cement if sulfate concentrations are greater than 1,500 ppm);
- Bentonite (2 to 5% dry bentonite per 94-lb sack of dry cement); and

- A maximum of 6 to 7 gallons of approved water per 94-lb sack of cement.

Neither additives nor borehole cuttings will be mixed with the grout. Bentonite will be added after the required amount of cement is mixed with the water.

All grout material will be combined in an aboveground container and mechanically blended to produce a thick, lump-free mixture. The mixed grout will be recirculated through the grout pump before placement.

Grout placement will be performed using a commercially available grout pump and a rigid tremie pipe. Removal and grouting will be accomplished in stages, aquifer by aquifer, sealing the boring from the bottom to ground surface. This will be accomplished by placing a grout pipe to the bottom and pumping grout through the pipe until undiluted grout reaches the bottom of the next higher section of casing or, for the top-most section, until grout flows from the boring at ground surface.

After 24 hours, the abandoned drilling site will be checked for grout settlement. Any settlement will be filled with grout and rechecked 24 hours later. This process will be repeated until firm grout remains at the ground surface.

3.2 BORINGS

The term "borings" as used in this SOP applies to any drilled hole made that is not completed as a well. This includes soil test borings, soil sampling borings, and deep stratigraphic borings. Whether completed to the planned depth or aborted for any reason before reaching that depth, borings will be grouted and will be normally closed within 12 hours.

To achieve an effective seal, the borehole to be abandoned should be free of debris and foreign matter that may restrict the adhesion of the grout to the borehole wall. Borehole flushing with a tremie pipe may be required to remove such materials prior to grouting.

Each boring to be abandoned should be sealed by grouting from the bottom of the boring to the ground surface. This will be accomplished by placing a tremie pipe to the bottom of the borehole and pumping grout through the pipe at a steady rate. The grouting should be completed slowly and continuously to prevent channeling of material. The tremie pipe should be raised when pumping pressure increases significantly or when undiluted grout reaches the surface.

After 24 hours of completing the abandonment, the abandoned boring or well should be checked for any grout settlement. The settlement depression should be filled with grout and rechecked 24 hours later. Grout should be placed with a tremie pipe if the open hole is 15 feet or deeper or if the hole is not dry. Otherwise, the grout may be poured from the surface.

3.3 NARROW BORINGS

Narrow borings, those with diameter less than 3 inches, advanced by hand auger or direct push methods, may be sealed using bentonite pellets or chips rather than a grout mixture. Often times a grout pump is not available to mix the grout when these methods have been used. Bentonite pellets or chips will be poured into the boring from the ground surface. Then bentonite will hydrate by absorbing moisture from the ground; unapproved water should not be added to the boring. After 24 hours, the abandoned boring will be checked, and any grout settlement will be topped off with more bentonite. The process will be repeated until bentonite remains at ground surface unless site condition indicates otherwise.

3.4 WELLS

The following procedure applies to wells aborted before completion and existing wells determined to be ineffective or otherwise in need of closure.

General Considerations

A number of techniques are available for abandoning monitoring wells and other monitoring devices including:

- Abandonment in place by grouting the well screen and casing in place;
- Removal of the well by pulling; and
- Overdrilling.

The particular method used for abandonment should be specified in the work plan addenda developed for a site-specific investigation. Several factors must be considered when selecting the appropriate abandonment technique including well construction, well condition, and subsurface conditions.
In general the preferred method for abandonment of wells is to remove all existing well materials to:

- Reduce the potential for the formation of a vertical conduit to occur at the contact between the casing and annular seal;
- Reduce the potential for well materials interfering with the abandonment procedures; and
- Decrease the potential for reaction between the well materials and grout used for abandonment.

In general, all well materials will be removed during abandonment (including screen and casing) by either pulling out the casing, screen, and associated materials or by overdrilling using a rotary or hollow stem auger drilling procedure.

Abandonment with Well Materials In Place

In the event that it is not possible to remove the casing and screen, the casing and screen will be perforated using a suitable tool. A minimum of four rows of perforations several inches long and a minimum of five perforations per linear foot of casing or screen is recommended.

After the screen and casing have been appropriately perforated, the well should be abandoned by grouting from the bottom of the well to the ground surface using a tremie pipe as described in Section 3.2. The tremie pipe should be raised when pumping pressure increases significantly or when undiluted grout reaches the surface.

After 24 hours of completing the abandonment, the abandoned well should be checked for any grout settlement. The settlement depression should be filled with grout and rechecked 24 hours later. Grout should be placed with a tremie pipe if the open hole is 15 feet or deeper or if the hole is not dry. Otherwise, the grout may be poured from the surface.

Abandonment by Removal

Site conditions permitting, relatively shallow monitoring wells may be successfully abandoned by removal providing that the well is generally good condition and sections of casing (including screen) can be successfully removed with materials intact.

This method of abandonment is generally accomplished by removing (pulling) sections of casing and screen out of the subsurface using a drill rig, backhoe, crane, etc. of sufficient capacity. Materials with lower tensile strength such as polyvinyl chloride (PVC) generally cannot be removed by pulling if they have been appropriately cemented in place.

Once the well materials have been removed from the borehole, the borehole should be abandoned by grouting in the same manner discussed for borings in Section 3.2. If the borehole collapses after removal of well materials, then the borehole should be over drilled to remove all material and then grouted to the surface.

Overdrilling

With this method of abandonment, the well materials are removed by overdrilling (overreaming) the well location. Overdrilling using rotary techniques may be accomplished using an overreaming tool. This tool consists of a pilot bit that is approximately the same size as the inner diameter of well casing and a reaming bit that is slightly larger than the diameter of the borehole. As drilling proceeds, all well materials are destroyed and returned to the surface. After completion of the overdrilling, the borehole should be immediately grouted with a tremie pipe as described in Section 3.2.

In the case of overburden wells, a hollow stem auger may be used for overdrilling providing that this method of drilling appropriate for the subsurface conditions. The hollow stem auger should be equipped with outward facing carbide-cutting teeth with a diameter 2 to 4 inches larger than the well casing. With this method, the casing guides the cutting head and remains inside the auger. When the auger reaches the bottom of the well boring and the well materials have been removed, the borehole may be grouted with a tremie pipe (Section 3.2) through the augers as the augers are gradually withdrawn.

Considerations for Fractured Bedrock and Karst Wells

Multi-cased wells completed into bedrock as screened wells, open wells, or open-lined wells may be abandoned with the outer casing left in place providing that the integrity of this casing and associated annular seal is good. A cement bond log (acoustic amplitude boring geophysical log) may be used to evaluate the integrity of the casing and annular seal, if the outer casing is to be left in place.

Borings or wells completed in karst zones may be difficult to abandon because of the potential presence of large conduits, which may make it difficult to grout. Where large conduits exist or difficulties are encountered when abandoning a boring or well, fill the portion of the borehole penetrating the solution cavity with inert gravel (quartz, claystone, etc.). Packers can be used to isolate critical intervals for filling with grout above and below these zones.

3.5 RESTORATION

All work areas around the borings or wells abandoned should be restored to a condition essentially equivalent to that before the borings and wells were installed.

3.6 INVESTIGATION-DERIVED MATERIAL

Investigation-derived material should be managed in accordance with the requirements of SOP 70.1 and the work plan addenda associated with the site investigation

3.7 DOCUMENTATION

For each abandoned boring or well, a record should be prepared to include the following as appropriate:

- Project and boring/well designation;
- Location with respect to replacement boring well (if any);
- Open depth of well/annulus/boring prior to grouting;
- Casing or items left in hole by depth, description, composition, and size;
- Copy of the boring log;
- Copy of construction diagram for abandoned well;
- Reason for abandonment;
- Description and total quantity of grout used initially;
- Description and daily quantities of grout used to compensate for settlement;
- Disposition of investigation-derived material;
- Water or mud level prior to grouting and date measured; and
- Remaining casing above ground surface, height above ground surface, size, and disposition of each.

Daily investigation activities at the site related to boring and well abandonment should be recorded in field logbooks as described in SOPs 10.1 and 10.2.

4.0 PRECAUTIONS

Refer to the health and safety plan associated with the Work Plan Addenda and the Master Health and Safety Plan.

5.0 REFERENCES

ASTM Standard D 5299-92. 1992. *Standard Guide for Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities.*

USACE. 1998. *Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites.* EM 1110-1-4000, 1 November.

STANDARD OPERATING PROCEDURE 20.11
DRILLING METHODS AND PROCEDURES

1.0 SCOPE AND APPLICATION

The use of an appropriate drilling procedure is contingent upon the existing conditions at the project site. The purpose of this standard operating procedure (SOP) is to outline procedures for the various methods of soil and rock drilling identified in the Master Work Plan. In addition it provides procedures for using sampling devices commonly used during soil and rock drilling such as split-barrel sampling, thin walled tube sampling, direct push samplers, and rock coring. For a particular site investigation, the associated work plan addendum will identify the appropriate drilling method and method of sampling, along with proposed sampling depths and intervals and any special procedures or methods.

2.0 MATERIALS

The following types of materials are generally appropriate for drilling:

2.1 SPLIT-BARREL SAMPLING

- Split barrel sampler;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.2 THIN WALLED TUBE SAMPLING

- Thin walled tubes;
- Sealing materials for sample such as sealing wax, metal disks, wood disks, tape, cheesecloth, caps, etc;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.3 DIRECT PUSH SAMPLING

- Direct push unit with hydraulic ram, hammer, etc;
- Sample collection devices, associated equipment and expendable supplies such as sample liners, sample retainers, appropriate lubricants, etc;
- Hollow extension rods;
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;

- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.4 HOLLOW-STEM AUGER DRILLING

- Drill rig and associated equipment;
- Hollow stem auger assemblies for drilling to appropriate depth including auger heads, drive assembly, pilot assembly, and hollow-stem auger sections;
- Auxiliary devices such as wrenches, auger forks, hoisting hooks, swivels, and adaptors;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.5 DIRECT AIR ROTARY DRILLING

- Drill rig with rotary table and Kelly or top-head drive unit;
- Drill rods, bits, and core barrels (as appropriate);
- Casing;
- Sampling devices and equipment, as appropriate;
- Air compressor and filters, pressure lines, discharge hose, swivel, dust collector, and air-cleaning device (cyclone separator);
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.6 DRILL-THROUGH CASING DRIVER

- Drill rig equipped with a mast-mounted, percussion driver;
- Casing, drill rods, and drill bits or hammers;
- Air compressor and filters, pressure lines, discharge hose, swivel, dust collector, and air-cleaning device (cyclone separator);
- Sampling devices and equipment, as appropriate;
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;
- Welding equipment and materials for installation of casing;

- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.7 DIRECT WATER-BASED ROTARY DRILLING

- Drill rig with derrick, rotary table and Kelly or top-head drive unit;
- Drill rods, bits, and core barrels (as appropriate);
- Casing;
- Water based drilling fluid, with approved additives as appropriate;
- Mud tub, suction hose, cyclone de-sander(s), drilling fluid circulation pump, pressure hose, and swivel;
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1.
- Decontamination supplies and equipment per SOP 80.1.

2.8 DIRECT ROTARY WIRELINE-CASING ADVANCEMENT DRILLING

- Drill rig with either hollow spindle or top-head drive;
- Drill rods, coring or casing bits, overshot assembly, pilot bit, and core barrel;
- Water based drilling fluid, with approved additives as appropriate;
- Mud tub, suction hose, drilling fluid circulation pump, pressure hose, and swivel;
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;
- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

2.9 DIAMOND CORE DRILLING

- Direct rotary drill rig and associated equipment (see Sections 2.4, 2.5 or 2.6);
- Core barrels and core bits;
- Core lifters;
- Core boxes, engineers scale, permanent marking pen, and camera for photographing cores;
- Auxiliary tools for handling, assembling, and disassembling tools and samplers;
- Borehole logging materials per SOP 10.3 and sampling equipment and materials, as appropriate per SOP 30.1;

- Containers to manage investigation-derived material per SOP 70.1; and
- Decontamination supplies and equipment per SOP 80.1.

3.0 PROCEDURES

3.1 PENETRATION TEST AND SPLIT-BARREL SAMPLING OF SOILS

The following general procedure may be followed as outlined in ASTM Standard Test Method D 1586-84.

1. Advance the boring to the desired sampling depth using an appropriate drilling method (see sections below) and remove excessive cuttings from the borehole.
2. Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.
3. Position the hammer above and attach the anvil to the top of the drilling rods.
4. Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the borehole, remove the sampler and rods from borehole and remove the cuttings.
5. Mark the drill rods in three successive 6-inch increments so that the advance of the sampler can be observed.
6. Drive the sampler with blow from the 140 pound hammer and count the number of blows applied in each 6-inch increment until:
    a. Fifty (50) blows have been applied during one of the three 6-inch increments.
    b. A total of 100 blows have been applied.
    c. There is no observed advance of the sampler during the application of 10 successive blows of the hammer.
7. The sampler is advanced the complete 18-inches without the limiting blow counts occurring as described above.
8. Record the number of blows that is required to achieve each 6-inch increment of penetration or fraction of this increment on the boring.
    a. The first 6 inches is considered the seating driver.
    b. The sum of the second and third 6-inch penetration intervals is termed the "standard penetration resistance" or "N-value."
    c. If the sampler is driven less than 18 inches as discussed in No. 6, then the number of blow for each partial increment will be recorded.
    d. For partial increments, the depth of penetration should be recorded to the nearest 1-inch on the boring log.
    e. If the sampler advances below the bottom of the boring under the weight of rods (static) and/or hammer, then this information will be recorded on the boring log.
9. The raising and dropping of the 140 pound hammer may be accomplished by:
    a. Using a trip, automatic, or semi-automatic hammer drop system that lifts the hammer and allows it to drop 30± 1 inches.

   b. Using a cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 inches. The cathead should be operated at a minimum speed of rotation of 100 revolutions per minute. No more than 2-1/4 rope turns on the cathead may be used when conducting the penetration test.

10. For each hammer blow, a 30-inch lift and drop shall be used.
11. After completing the penetration test, retrieve the sampler and open. Record the percent recovery or the length of sample recovered. Following the procedures outlined in SOP 30.1 when collecting environmental soil samples.
12. Borehole logging should be completed per SOP 10.3.
13. Split-barrel samples must be decontaminated before and after each use per the requirements of SOP 80.1.

3.2 THIN WALLED TUBE SAMPLING

The following general procedure may be followed for collection of relatively undisturbed, thin walled tube samples (e.g., Shelby tube) as outlined in ASTM Standard Practice D 1587-94.

1. Clean out the borehole to targeted sampling depth using most appropriate method, which avoids disturbing the material to be sampled. If groundwater is encountered, maintain the liquid level in the borehole at or above the groundwater level during sampling.
2. Place the sample tub so that its bottom rests on the bottom of the borehole.
3. Advance the sampler without rotation by a continuous relatively rapid motion.
4. Determine the length of the advance by the resistance and condition of the formation, the length of the advance should never exceed 5 to 10 diameters of the tube in sands and 10 to 15 diameters of the tube in clay.
5. When the formation is too hard for push type of sampling, the tube may be driven or the practice used for ring-lined barrel sampling may be used per ASTM Standard D 3550-84 (1995). When a sample is driven, the weight and fall of the hammer must be recorded along with the penetration achieved.
6. The maximum length of sample advance will be no longer than the sample-tube length minus an allowance for the sample head and a minimum of 3-inches for sludge-end cuttings.
7. Upon removal of the tube, measure the length of the sample in the tube. Remove the disturbed material in the upper end of the tube and re-measure the sample length.
8. Remove at least one-inch of material from the lower end of the tube for soil description and identification per SOP 10.3. Measure the overall sample length. Seal the lower end of the tube. If directed, the material from the end of the tube will not be removed for soil identification and description; in this case the tube will be sealed promptly.
9. Prepare sample labels and affix (or markings) on the tube.

3.3 DIRECT PUSH SOIL BORING

The following general procedures outlined in this section may be followed as described in ASTM Standard Test Method D 6282-98.

General considerations for this method include the following:

- A variety of direct push drive systems may be used to advance soil borings based on the intended sampling depths and subsurface conditions and include the following:

  Shallower Depths and Less Difficult Conditions

  - Percussive driving systems – use hydraulically operated hammers and mechanically operated hammers.
  - Static push drive systems – use hydraulic rams to apply pressure and exert static pull (e.g., cone penetrometer systems).
  - Vibratory/sonic systems – use a vibratory device, which is attached to the top of the sampler extension rods.

  Greater Depths and More Difficult Conditions

  - Sonic or resonance drilling systems – use a high power vibratory system to advance larger diameter single or dual tube systems.
  - Rotary drilling equipment – use hydraulic system of drill rig for direct push.
- The equipment used for direct push must be capable of apply sufficient static force, or dynamic force, or both, to advance the sampler to the required depth of collection. Additionally, this equipment must have adequate retraction force to remove the sampler and extension/drive rods once the sample has been collected.
- Avoid using excessive down pressure when advancing the drilling tools/sampler. Excessive pressure may cause the direct push unit to offset from the boring location and may damage drilling tools and samplers.
- Sample liners should be compatible with the material being sampled and the type of analysis to be conducted on the sample. Sealing of liners for submittal to the laboratory for physical testing should be accomplished according to ASTM Standard D 4220-95 (Standard Practice for Preserving and Transporting Soil Samples).
- The general procedure for completing direct push soil borings is the following:

1. Stabilize direct push unit and raise mast at desired location.
2. Attach the hammer assembly to the drill head if not permanently attached. Attach the anvil assembly in the prescribed manner, slide the direct push unit the position over the borehole, and ready the tools for insertion.
3. Inspect the direct push tools before and after use. Decontaminate all down hole tools before and after use per SOP 80.1.
4. Inspect drive shoes for damaged cutting edges, dents or thread failures and these conditions could cause loss of sample recovery and slow the rate of advancement.
5. Assemble samplers and install where required, install sample retainers where needed, and install and secure sampler pistons to ensure proper operation where needed (see Steps 14 through 20 for the various sampler assembly procedures, etc.).
6. After sampler has been appropriately installed (see Steps 14 through 20 for installation procedures, etc.) advance the boring to the target sampling depth using an appropriate direct push technique, as identified above under general considerations.
7. Collect the soil sample from the target sampling depth using one of the methods identified in Steps 14 through 20.

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8. Retrieve the sampler and appropriately process the soil sample as identified in Steps 14 through 20 below and in SOP 30.1.
9. Log the borehole per the requirements of SOP 10.3.
10. If collecting another soil sample, decontaminate the sampler for reuse per the requirements of SOP 80.1 or use another decontaminated sampler.
11. Appropriately manage investigation-derived material (discarded samples, decontamination fluids, etc.) per SOP 70.1.
12. Upon completion of the boring and collection of the desired soil samples, abandon the boring per the requirements of SOP 20.2.
13. The following single tube sampling systems (generally piston rod) may be used to collect soil samples (see Steps 14 through 16 below):
    a. Open Solid Barrel Sampler;
    b. Closed Solid Barrel Sampler (e.g. Geoprobe Macro-Core® Piston Rod Sampler); and
    c. Standard Split Barrel Sampler (see Section 3.1).
14. The following two tube sampling systems may be used to collect soil samples (see Steps 17 through 20 below):
    a. Split Barrel Sampler;
    b. Thin Wall Tubes;
    c. Thin Wall Tube Piston Sampler; and
    d. Open Solid Barrel Samplers.
15. Sampling with the single tube, open solid barrel sampler:
    a. Attach the required liner to the cutting shoe by insertion into the machined receptacle are or by sliding over the machined tube.
    b. Insert the liner and shoe into the solid barrel and attach the shoe.
    c. Attach the sampler head to the sampler barrel.
    d. Attach the sampler assembly to the drive rod and the drive head to the drive rod.
    e. Position the sampler assembly under the hammer anvil and advance the sampler assembly into the soil at a steady rate slow enough to allow the soil to be cut by the shoe and move up into the sample barrel.
    f. At the completion of the sampling interval, removal the sampler from the borehole. Remove the filled sampler liner from the barrel by unscrewing the shoe. Cap the liner for laboratory testing or split open for field processing (see SOP 30.1).
    g. Log the borehole per the requirements of SOP 10.3.
16. Sampling with the closed, solid barrel sampler (e.g., Macro-Core® sampler).
    a. Insert or attach the sample liner to the shoe and insert the assembly into the solid barrel sampler. Install the sample, retaining basket, if desired.
    b. Attach the latch coupling or sampler head to the sampler barrel, and attach the piston assembly with point and "O" rings if free water is present, to the latching mechanism.
    c. Insert the piston or packer into the liner to its proper position so that the point leads the sampler shoe. Set latch, charge packer, or install locking pin, and attach assembled sampler to drive rod.
    d. Add drive head and position under the hammer anvil. Apply down pressure, and hammer if needed, to penetrate the soil strata above the targeted sampling interval.

   e. When the sampling interval is reached, insert the piston latch release and recovery tool, removing the piston, or insert the locking pin removal/extension rods through the drive rods, turn counter clockwise, and remove the piston locking pin so the piston can float on top of the sample, or release any other piston holding device.
   f. Direct push or activate the hammer to advance the sampler the desired interval.
   g. Retrieve the sampler from the borehole by removing the extension/drive rods. Remove the shoe, and withdraw the sample line with sample for processing (see SOP 30.1).
   h. Clean and decontaminate the sampler, reload as described above and repeat the same procedure for collection of addition samples.
   i. Log the borehole per the requirements of SOP 10.3.

17. Sampling with standard split barrel (split spoon) sampler generally consists of the following:
   a. Attach the split barrel sampler to an extension rod or drill rod.
   b. Using a mechanical or hydraulic hammer drive the ampler into the soil the desired interval. The maximum interval that should be driven is equal to the sample chamber length of the split barrel sampler, which is either 18-inches or 24-inches.
   c. Retrieve the sampler from the borehole by removing the extension/drive rods.
   d. Split the sampler open for field processing (see SOP 30.1).
   e. Clean and decontaminate the sampler (SOP 80.1), re-attach and repeat the same procedure for collection of additional samples.
   f. Log the borehole per the requirements of SOP 10.3.

18. Sampling with a two tube, split barrel sampler generally consists of the following:
   a. Assemble the outer casing with the drive shoe on the bottom, attach the drive head to the top of the outer casing, and attach the sampler to the extension rods.
   b. Connect the drive head to the top of the sampler extension rods, and insert the sampler assembly into the outer casing.
   c. The cutting shoe of the sampler should contact the soil ahead of the outer casing to minimize sample disturbance.
   d. The sample barrel should extend a minimum of 0.25 inches ahead of the outer casing.
   e. Mark the outer casing to identify the required drive length, position the outer casing and sampler assembly under the drill head.
   f. Move the drill head downward to apply pressure on the tool string. Advance the casing assembly into the soil at a steady rate, which is slow enough to allow the soil to be cut by the shoe and move up inside the sample barrel.
   g. Occasional hammer action during the push may assist recovery.
   h. If smooth push advancement is not possible because of subsurface conditions, use the hammer to advance the sampler.
   i. Stop the application of pressure or hammering when target interval has been sampled. Move the drill head off the drive head. Attach a pulling device to the extension rods or position the hammer bail and retrieve the sampler from the borehole.
   j. At the surface, remove the sampler from the extension rods and process the sample per Section 3.01 and SOP 30.1.
   k. Log the borehole per the requirements of SOP 10.3.

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19. Sampling with a two tube, thin wall tube sampler generally consists of the following:
    a. Attach the tube to the tube head using removable screws.
    b. Attach the tube assembly to the extension rods and position at the base of the outer casing shoe protruding a minimum of 0.25 inches to contact the soil ahead of the outer casing.
    c. Advance the tube with or without the outer casing at a steady rate.
    d. After completing the sampling interval, let the tube remain stationary for one minute. Rotate the tube slowly two revolutions to shear off the sample.
    e. Remove the tube from the borehole and measure the recovery, and log the borehole per the requirements of SOP 10.3.
    f. For field processing, extrude the sample from the tube sampler and process per SOP 30.1. Alternatively, the tube may be sealed and shipped to the laboratory.
20. Sampling with two tube, thin wall tube, piston sampler generally consists of the following:
    a. Check the fixed piston sampling equipment for proper operation of the cone clamping assembly and the condition of the "O" rings.
    b. Slide the thin wall tube over the piston, and attach it to the tube head. Position the piston at the sharpened end of the thin wall tube just above the sample relief bend.
    c. Attach the tube assembly to the extension rods and lower the sampler into position through the outer casing. Install the actuator rods through the extension rod, and attach to the actuator rod in the sampler assembly.
    d. Attach a holding ring to the to top of the actuator rod string and hook the winch cable or other hook to the holding ring to hold the actuator rods in a fixed position.
    e. Attach the pushing fork to the drill head/probe hammer and slowly apply downward pressure to the extension rods advancing the thin wall tube over the fixed piston into the soil for the length of the sampling interval.
    f. After completing the sampling interval, let the tube remain stationary for one minute. Rotate the tube slowly one revolution to shear off the sample.
    g. Remove the tube sampler from the borehole and measure the recovery, and log the borehole per the requirements of SOP 10.3.
    h. For field processing, extrude the sample from the tube sampler and process per SOP 30.1.
21. Sampling with an two tube, open solid barrel sampler generally consists of the following:
    a. This sampling technique may be used when soil conditions prevent advancement of a split barrel sampler or advancement of an outer casing.
    b. The solid, single, or segmented barrel sampler requires the use of a liner.
    c. Use sampler in advance of outer casing when this casing cannot be advanced.
    d. Follow the procedures outlined for two tube, split barrel sampling.

3.4 HOLLOW-STEM AUGER DRILLING

The following general procedure may be followed as outlined in ASTM Standard Guide D 5784.

1. Stabilize drill rig and raise mast at desired location.
2. Attach an initial assembly of hollow-stem auger components (hollow stem auger, hollow auger head, center rod and pilot assembly, as appropriate) to the rotary drive of the drill rig.
3. Push the auger assembly below the ground surface and initiate rotation at a low velocity.

4. Decontamination of auger head may be necessary after this initial penetration if this surface soil is contaminated.
5. Continue drilling from the surface, usually at a rotary velocity of 50 to 100 rotations per minute to the depth where sampling or in-situ testing is required or until the drive assembly is within approximately 6- to 18 inches of the ground surface.
6. As appropriate, collect a soil sample from the required depth interval. The sample may be conducted by
    a. Removing the pilot assembly, if used, and inserting and driving a sampler through the hollow stem auger of the auger column; or
    b. Using a continuous sampling device within the lead auger section, where the sampler barrel fills with material as the auger is advanced.
7. Additional sections of hollow stems augers may be added to drill to a greater depth. After these auger sections are added, rotation of the hollow-stem auger assembly may be resumed.
8. When drilling through material suspected of being contaminated, the installation of single or multiple (nested) outer casings may be required to isolate zones suspected contamination (see SOP 20.1). Outer casings may be installed in a pre-drilled borehole or using a method in which casing is advanced at the same of drilling.

    Monitoring wells or piezometers may be installed using hollow-stem augers by:
    a. Drilling with or without sampling to the target depth.
    b. Removal of the pilot assembly, if used, and insertion of the monitoring well (or piezometer) assembly.
    c. The hollow stem auger column should be removed incrementally as the monitoring well (or piezometer) completion materials are placed (see SOP 20.1 for grouting).
9. If materials enter the bottom of the auger hollow stem during the removal of the pilot assembly, it should be removed with a drive sampler or other appropriate device.
10. If sampling or *in-situ* testing is not required during completion of the boring, the boring may be advanced with an expendable knock out plate or plug of an appropriate material instead of a pilot assembly.
11. Drill cuttings should be appropriately controlled and contained as IDM per SOP 70.1. It may be necessary to drill through a hole of sheet of plywood or similar material to prevent cuttings from contacting the ground surface.
12. The hollow-auger assembly and sampling devices must be decontaminated before and after each use per the methods specified in SOP 80.1.
13. Borehole logging should be completed per SOP 10.3.
14. Borehole abandonment, when required, should be conducted according to SOP 20.3.

3.5 DIRECT AIR ROTARY DRILLING

The following general procedure may be followed as outlined in ASTM Standard Guide D 5784-95.

1. Stabilize drill rig and raise mast at desired location. Appropriately position the cyclone separator and seal it to the ground surface considering the prevailing wind direction (exhaust).
2. Establish point for borehole measurements.
3. Attach an initial assembly of a bit, down hole hammer, or core barrel with a single section of drill rod, below the rotary table or top-head drive unit, with the bit placed below the top of the dust collector.
4. Activate the air compressor to circulate air through system.

5. Initiate rotation of bit.
6. Continue with air circulation and rotation of the drill-rod column to the depth where sampling or in-situ testing is required or until the length of the drill rod section limits further penetration.
7. Monitor air pressure during drilling operations. Maintain low air pressure at bit to prevent fracturing of surrounding material.
8. Stop rotation and lift the bit slightly off the bottom of the hole to facilitate removal of drill cuttings and continue air circulation until the drill cuttings are removed from the borehole annulus.
9. Open reaching a desired depth of sampling, stop the air circulation and rest bit on bottom of hole to determine the depth. Record the borehole depth and any resultant caving in. If borehole caving is apparent set a decontaminated casing to protect the boring.
10. When sampling, remove the drill rod column from the borehole or leave the drill rod assembly in place if the sampling can be performed through the hollow axis of the drill rods and bit.
11. Compare the sampling depth to clean-out depth by first resting the sampler on the bottom of the hole and compare that measurement with the clean-out depth measurement.
12. If bottom-hole contamination is apparent (indicated by comparison of sample depth to clean-out depth), it is recommended that the minimum depth below the sampler/bit be 18 inches for testing. Record the depth of sampling or in-situ testing and the depth below the sampler/bit.
13. The procedure described in Steps 8 through 12 should be conducted for each sampling or testing interval.
14. Drilling to a greater depth may be accomplished by attaching an additional drill rod section to the top of the previously advanced drill-rod column and resuming drilling operations as described above.
15. When drilling through material suspected of being contaminated, the installation of single or multiple (nested) outer casings may be required to isolate zones suspected contamination (see SOP 20.1 for grouting requirements). Outer casings may be installed in a pre-drilled borehole or using a method in which casing is advanced at the same of drilling.
16. Monitoring wells or piezometers may be installed by:
    a. Drilling with or without sampling to the target depth.
    b. Removal of the drill rod assembly and insertion of the monitoring well (or piezometer) assembly.
    c. Addition of monitoring well (or piezometer) completion materials (see SOP 20.1).
17. Drill cuttings should be appropriately controlled and contained as IDM per SOP 70.1.
18. The drill rod assembly, sampling devices, and other drilling equipment contacting potentially contaminated material must be decontaminated before and after each use per the methods specified in SOP 80.1.
19. Borehole logging should be completed per SOP 10.3.
20. Borehole abandonment, when required, should be conducted according to SOP 20.3

3.6 DRILL-THROUGH CASING DRILLING

The following general procedure may be followed as outlined in ASTM Standard Guide D 5872-95.

1. Stabilize drill rig and raise mast at desired location. Appropriately position the cyclone separator and seal it to the ground surface considering the prevailing wind direction (exhaust).
2. Establish point for borehole measurements.
3. Attach an initial assembly of a bit or down hole hammer with a single section of drill rod and casing to the top-head drive unit.

4. Activate the air compressor to circulate air through system.
5. Drilling may be accomplished by
    a. Method 1- the casing will fall, or can be pushed downward behind the bit.
    b. To drill using Drive the casing first followed by drilling out the plug inside the casing.
    c. Method 2 - Advancing the casing and bit as a unit, with the drill bit or hammer, extending up to 12-inches below the casing.
6. Method 3 - Under reaming method where bit or hammer pens a hole slightly larger than the casing so that Method 1, drive the casing first and drill out the plug in the casing by moving the bit or hammer beyond the casing and then withdrawing it into the casing. Air exiting the bit will remove the cuttings up the hole. Separate cuttings from the return air with a cyclone separator or similar device.
7. To drill using Method 2, advance casing and bit as unit with the bit or hammer extending up to 12-inches beyond the casing depending on the conditions. While drilling, occasionally stop the casing advancement, retract the bit or hammer inside the casing to clear and maintain air circulation to clear cuttings.
8. To drill using Method 3, use a special down hole bit or hammer to open a hole slightly larger than the outside diameter of the casing so that the casing will fall or can be pushed downward immediately behind the bit. After advancing the casing, retract the radial dimension of the drill bit to facilitate removal of the down hole bit or hammer and drill tools inside the casing. Cuttings are removed from the borehole with the air that operates the bit or hammer and can be separated from the air with a cyclone separator or similar device.
9. Monitor air pressure during drilling operations. Maintain low air pressure at bit or hammer to prevent fracturing of surrounding material.
10. Continue air circulation and rotation of the drill rod column until drilling is completed to the target depth (for sampling, in-situ sampling, etc.) or until the length of the drill-rod section limits further penetration.
11. Stop rotation and lift bit or hammer slightly off the bottom of the hole to facilitate removal of drill cuttings and continue air circulation until the drill cuttings are removed from the borehole annulus.
12. After reaching a desired depth of sampling, stop the air circulation and rest the bit on bottom of hole to determine the depth. Record the borehole depth and any resultant caving in. If borehole caving is apparent set a decontaminated casing to protect the boring.
13. When sampling, remove the drill rod column from the borehole. Compare the sampling depth to clean-out depth by first resting the sampler on the bottom of the hole and compare that measurement with the clean-out depth measurement.
14. If bottom-hole contamination is apparent (indicated by comparison of sample depth to clean-out depth), it is recommended that the minimum depth below the sampler/bit be 18 inches for testing. Record the depth of sampling or in-situ testing and the depth below the sampler/bit.
15. The procedure described in Steps 11 through 14 should be conducted for each sampling or testing interval.
16. Drilling to a greater depth may be accomplished by attaching an additional drill rod section and casing section to the top of the previously advanced drill-rod column/casing and resuming drilling operations as described above.
17. Monitoring wells or piezometers may be installed by:
    a. Casing advancement in increments, with or without sampling to the target depth.
    b. Removal of the drill rods and the attached drill bit while the casing is temporarily left in place to support the borehole wall.

   c. Insertion of the monitoring well (or piezometer) assembly.
   d. Addition of monitoring well (or piezometer) completion materials (see SOP 20.1).

18. Drill cuttings should be appropriately controlled and contained as IDM per SOP 70.1.
19. The drill rod assembly, casing, sampling devices, and other drilling equipment contacting potentially contaminated material must be decontaminated before and after each use per the methods specified in SOP 80.1.
20. Borehole logging should be completed per SOP 10.3.
21. Borehole abandonment, when required, should be conducted according to SOP 20.3.

3.7 DIRECT WATER-BASED ROTARY DRILLING

The following general procedure may be followed as outlined in ASTM Standard Guide D 5783-95.

1. Stabilize drill rig and raise mast at desired location. Appropriately position the mud tub and install surface casing and seal at the ground surface.
2. Establish point for borehole measurements.
3. Attach an initial assembly of a bit or core barrel with a single section of drill rod, below the rotary table or top-head drive unit, with the bit placed with the top of the surface casing.
4. Activate the drilling-fluid circulation pump to circulate drill fluid through the system.
5. Initiate rotation of bit and apply axial force to bit.
6. Document drilling conditions and sequence (fluid loss, circulation pressures, depths of lost circulation, etc.) as described in SOP 10.3.
7. Continue with drill fluid circulation as rotation and axial force are applied to the bit until drilling to the depth
   a) Where sampling or in-situ testing is required;
   b) Until the length of the drill rod section limits further penetration; or
   c) Until core specimen has completely entered the core barrel (when coring) or blockage has occurred.
8. Stop rotation and the lift bit slightly off the bottom of the hole to facilitate removal of drill cuttings and continue fluid circulation until the drill cuttings are removed from the borehole annulus.
9. After reaching a desired depth of sampling, stop the fluid circulation and rest the bit on bottom of hole to determine the depth. Record the borehole depth and any resultant caving in. If borehole caving is apparent set a decontaminated casing to protect the boring.
10. When sampling, drill rod removal is not necessary if the sampling can be performed through the hollow axis of the drill rods and bit.
11. Compare the sampling depth to clean-out depth by first resting the sampler on the bottom of the hole and compare that measurement with the clean-out depth measurement.
12. If bottom-hole contamination is apparent (indicated by comparison of sample depth to clean-out depth), it is recommended that the minimum depth below the sampler/bit be 18 inches for testing. Record the depth of sampling or in-situ testing and the depth below the sampler/bit.
13. The procedure described in Steps 8 through 11 should be conducted for each sampling or testing interval.
14. Drilling to a greater depth may be accomplished by attaching an additional drill rod section to the top of the previously advanced drill-rod column and resuming drilling operations as described above.

15. When drilling through material suspected of being contaminated, the installation of single or multiple (nested) outer casings may be required to isolate zones suspected contamination (see SOP 20.1 for grouting requirements). Outer casings may be installed in a pre-drilled borehole or using a method in which casing is advanced at the same of drilling.
16. Monitoring wells or piezometers may be installed using hollow-stem augers by:
    a. Drilling with or without sampling to the target depth.
    b. Removal of the drill rod assembly and insertion of the monitoring well (or piezometer) assembly.
    c. Addition of monitoring well (or piezometer) completion materials (see SOP 20.1).
17. Drill cuttings and fluids should be appropriately controlled and contained as IDM per SOP 70.1.
18. The drill rod assembly, sampling devices, and other drilling equipment contacting potentially contaminated material must be decontaminated before and after each use per the methods specified in SOP 80.1.
19. Borehole logging should be completed per SOP 10.3.
20. Borehole abandonment, when required, should be conducted according to SOP 20.3.

3.8 DIRECT ROTARY WIRELINE CASING ADVANCEMENT DRILLING

The following general procedure may be followed as outlined in ASTM Standard Guide D 5876-95.

1. Stabilize drill rig and raise mast at desired location. Appropriately position the mud tub (for water based rotary) and install surface casing and seal at the ground surface.
2. Record the hole depth by knowing the length of the rod-bit assemblies and comparing its position relative to the established surface datum.
3. Attach an initial assembly of a lead drill rod and a bit or core barrel below the top-head drive unit, with the bit placed with the top of the surface casing.
4. Activate the drilling-fluid circulation pump to circulate drill fluid through the system.
5. Initiate rotation of bit and apply axial force to bit.
6. Document drilling conditions and sequence (fluid loss, circulation pressures, depths of lost circulation, down feed pressures etc.) as described in SOP 10.3.
7. In general, the pilot bit or core barrel can be inserted or removed at any time during the drilling process and the large inside diameter rods can act as a temporary casing for testing or installation of monitoring devices.
8. Continue with drill fluid circulation as rotation and axial force are applied to the bit until drilling to the depth
    a) Where sampling or in-situ testing is required;
    b) Until the length of the drill rod section limits further penetration; or
    c) Until core specimen has completely entered the core barrel (when coring) or blockage has occurred.
9. Stop rotation and lift the bit slightly off the bottom of the hole to facilitate removal of drill cuttings and continue fluid circulation until the drill cuttings are removed from the borehole annulus.
10. After reaching a desired depth of sampling, stop the fluid circulation and rest the bit on bottom of hole to determine the depth. Record the borehole depth and any resultant caving in. If borehole caving is apparent set a decontaminated casing to protect the boring.

11. When sampling, drill rod removal is not necessary if the sampling can be performed through the hollow axis of the drill rods and bit.
12. Compare the sampling depth to clean-out depth by first resting the sampler on the bottom of the hole and compare that measurement with the clean-out depth measurement.
13. If bottom-hole contamination is apparent (indicated by comparison of sample depth to clean-out depth), it may be necessary to further clean the hole by rotary recirculation.
14. Continuous sampling may be conducted with a soil core barrel or rock core barrel (see Section 1.7).
15. The pilot bit or core barrel may need to be removed during drilling such as when core barrels are full or there is evidence of core blocking. Before the drill string is reinserted, the depth of the boring should be rechecked to evaluate hole quality and determine whether casing may be required.
16. Water testing may be performed in consolidated deposits by pulling back on the drill rods and passing inflatable packer(s) with pressure fitting to test the open borehole wall (see ASTM Standards D 4630 and D 4631).
17. Drilling to a greater depth may be accomplished by attaching an additional drill rod section to the top of the previously advanced drill-rod column and resuming drilling operations as described above.
18. When drilling through material suspected of being contaminated, the installation of single or multiple (nested) outer casings might be required to isolate zones suspected contamination (see SOP 20.1 for grouting requirements). Outer casings may be installed in a pre-drilled borehole or using a method in which casing is advanced at the same of drilling.
19. Monitoring wells or piezometers may be installed by:
    a. Drilling with or without sampling to the target depth.
    b. Removal of the pilot bit or core barrel and insertion of the monitoring well (or piezometer) assembly.
    c. Addition of monitoring well (or piezometer) completion materials (see SOP 20.1).
20. Drill cuttings and fluids should be appropriately controlled and contained as IDM per SOP 70.1.
21. The drill rod assembly, sampling devices, and other drilling equipment contacting potentially contaminated material must be decontaminated before and after each use per the methods specified in SOP 80.1.
22. Borehole logging should be completed per SOP 10.3.
23. Borehole abandonment, when required, should be conducted according to SOP 20.3.

3.9 DIAMOND CORE DRILLING

The following general procedure may be followed as outlined in ASTM Standard Practice D 2113-83 (1993).

1. Use core-drilling procedures, such as the water-rotary drilling method outlined in Section 3.6.
2. Seat the casing on bedrock or firm formation to prevent raveling of the borehole and to prevent loss of drilling fluid. Level the formation that the casing will be seated on as needed.
3. Begin core drilling using an N-size double-tube, swivel-type core barrel or other approved size or type. Continue core drilling until core blockage occurs or until the net length of the core has been drilled.
4. Remove the core barrel from the borehole, and dis-assemble the core barrel as necessary to remove the core.
5. Reassemble the core barrel and return it to hole.
6. Continue core drilling.

7. Place the recovered core in the core box with the upper (surface) end of the core at the upper-left corner of the core box. Wrap soft or friable cores, etc. as needed or required. Use spacer blocks or slugs properly marked to indicate any noticeable gap in recovered core that might indicate a change or void in the formation. Fit fracture, bedded, or jointed pieces of core together as they naturally occurred.
8. The core within each completed box should be photographed after core surface has been cleaned or peeled, as appropriate, and wetted. Each photo should be in sharp focus and contain a legible scale in feet and tenths of feet (or metric if appropriate). The core should be oriented so that the top of the core is at the top of the photograph. A color chart should be included in the photograph frame as a check on photographic accuracy. The inside lid of the box should also be shown.
9. The inside of the box lid should be labeled at a minimum with the facility name, project name, boring number, box number, and core interval.
10. A preliminary field log of the core must be completed before the core box has been packed for transport (see SOP 10.3). Detailed logging may be conducted at a later time providing the core is appropriately handled and transported.
11. Four levels of sample protection may be used depending on character of the rock and the intended use of the rock core including:
    a. *Routine care* – for rock cored in 5 to 10 foot runs. Consists of placing in structurally sound boxes. Lay flat tubing may be used prior to placing the core.
    b. *Special care* – for rock samples to be tested that are potentially moisture sensitive, such as shale. This care consists of sealing with a tight fitting wrapping of plastic film and application of wax at the ends of the sample.
    c. *Critical care* – for rock samples that may be sensitive to shock and vibration and/or temperature. Protect by encasing each sample in cushioning material, such as sawdust, rubber, polystyrene, foam, etc. A minimum one-inch thick layer of cushioning material should be used. Thermally insulate samples that are potentially sensitive to changes in temperature.
    d. Soil-Like care – handle per ASTM Standard D 4220-95.
12. Drilling conditions and sequence (fluid loss, circulation pressures, depths of lost circulation, down feed pressures, core blockage etc.) should be documented on the boring log as described in SOP 10.3.
13. Drill cuttings and fluids should be appropriately controlled and contained as investigation-derived material per SOP 70.1.
14. The drill rod assembly, sampling devices, and other drilling equipment contacting potentially contaminated material must be decontaminated before and after each use per the methods specified in SOP 80.1.
15. Borehole logging should be completed per SOP 10.3.
16. Borehole abandonment, when required, should be conducted according to SOP 20.3.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

Refer to site-specific health and safety plan included in work plan addenda.

6.0 REFERENCES

ASTM Standard D 2113-83 (1993). 1993. *Standard Practice for Diamond Core Drilling for Site Investigation.*

ASTM Standard D 1586-84 (1992). 1992. *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.*

ASTM Standard D 1587-94. 1994. *Standard Practice for Thin-Walled Tube Geotechnical Sampling of Soils.*

ASTM Standard D 4220-95. 1995. *Standard Practices for Preserving and Transporting Soil Samples.*

ASTM Standard D 5079-90. 1995. *Standard Practices for Preserving and Transporting Rock Core Samples.*

ASTM Standard D 5782-95. 1995. *Standard Guide for Use of Direct Air-Rotary Drilling for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices.*

ASTM Standard D 5783-95. 1995. *Standard Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices.*

ASTM Standard D 5784-95. 1995. *Standard Guide for Use of Hollow-Stem Augers for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices.*

ASTM Standard D 5872-95. 1995. *Standard Guide for Use of Casing Advancement Drilling Methods for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices.*

ASTM Standard D 5876-95. 1995. *Standard Guide for Use of Direct Rotary Wireline Casing Advancement Drilling Methods for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices.*

ASTM Standard D 6282-98. 1998. *Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations.*

USACE. 1998. *Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites.* EM 1110-1-4000. 1, November.

STANDARD OPERATING PROCEDURE 30.1
SOIL SAMPLING

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for sampling surface and subsurface soils.

2.0 MATERIALS

- Stainless steel scoop, spoon, trowel, knife, spatula, (as needed);
- Split-spoon, Shelby tube, or core barrel sampler;
- Hand auger or push tube sampler;
- Drill rig and associated equipment (subsurface soil);
- Stainless steel bowls;
- Photoionization detector or other appropriate instrument as specified in site-specific health and safety plan;
- Sampling equipment for collection of volatile organic samples;
- Appropriate sample containers;
- Appropriate sample labels and packaging material.;
- Personal protective equipment and clothing (PPE) per site-specific health and safety plan; and
- Decontamination equipment and supplies (SOP 80.1).

3.0 PROCEDURE

3.1 DOCUMENTATION

Soil sampling information should be recorded in the field logbooks as described in SOPs 10.1 and 10.2.

3.2 SURFICIAL SOIL SAMPLES

The targeted depths for surficial soil samples (surface and near surface) will be specified in the work plan addenda developed for site-specific investigations.

1. All monitoring equipment should be appropriately calibrated before beginning sampling according to the requirements of the work plan addenda and SOP 90.1 or 90.2.
2. All sampling equipment should be appropriately decontaminated before and after use according to the requirements of the work plan addendum and SOP 80.1.
3. Use a spade, shovel, or trowel or other equipment (manufactured from material, which is compatible with the soil to be sampled) to remove any overburden material present (including vegetative mat) to the level specified for sampling.
4. Measure and record the depth at which the sample will be collected with an engineers scale or tape.

5. Remove the thin layer that was in contact with the overburden removal equipment using a clean stainless steel scoop or equivalent and discard it.
6. Begin sampling with the acquisition of any discrete sample(s) for analysis of volatile organic compounds (VOCs), with as little disturbance as possible. VOC samples will not be composited or homogenized.
7. When a sample will not be collected with a core type of sampler (push tube, split spoon, etc.), the sample for VOC analysis will be collected from freshly exposed soil. The method of collection will follow the procedures specified in SOP 30.8 (Methanol Preservation Method) or 30.9 (En Core® Method) based on the requirements of the work plan addenda.
8. Field screen the sample with properly calibrated photoionization detector (PID) or other appropriate instrument. Cut a cross-sectional slice from the core or center of the sample and insert the monitoring instrument(s). Based on the screening results, collect the VOC fraction, as applicable.
9. Collect a suitable volume of sample from the targeted depth with a clean stainless steel scoop (or similar equipment), push tube sampler, or bucket auger
10. For core type of samplers, rough trimming of the sampling location surface should be considered if the sampling surface is not fresh or other waste, different soil strata, or vegetation may contaminate it. Surface layers can be removed using a clean stainless steel, spatula, scoop, or knife. Samples collected with a bucket auger or core type of sampler should be logged per the requirements of SOP 10.3.
11. If homogenization or compositing of the sampling location is not appropriate for the remaining parameters, the sample should be directly placed into appropriate sample containers with a stainless steel spoon or equivalent.
12. If homogenization of the sample location is appropriate or compositing of different locations is desired, transfer the sample to a stainless steel bowl for mixing. The sample should be thoroughly mixed with a clean stainless steel spoon, scoop, trowel, or spatula and then placed in appropriate sample containers per the requirements for containers and preservation specified in work plan addenda. Secure the cap of each container tightly.
13. Appropriately, label the samples (SOP 50.1), complete the chain-of-custody (SOP 10.4), and package the samples for shipping (SOP 50.2).
14. Return any remaining unused soil to the original sample location. If necessary, add clean sand to bring the subsampling areas back to original grade. Replace the vegetative mat over the disturbed areas.

3.3 SUBSURFACE SAMPLES

All sampling equipment should be appropriately decontaminated before and after use according to the requirements of the work plan addendum and SOP 80.1.

1. All monitoring equipment should be appropriately calibrated before sampling according to the requirement of the work plan addendum and SOP 90.1 or SOP 90.2.
2. All sampling equipment should be appropriately decontaminated before and after use according to the requirements of the work plan addendum and SOP 80.1.
3. Collect split-spoon; core barrel, Shelby tube, sonic core or other similar samples during drilling.
4. Upon opening sampler or extruding sample, immediately screen soil for VOCs using a PID or appropriate instrument. If sampling for VOCs, determine the area of highest concentration; use a

stainless steel knife, trowel, or lab spatula to cut the sample; and screen for VOCs with monitoring instrument(s).

5. Log the sample on the boring log before extracting from the sampler per the requirements of SOP 10.3.
6. Any required VOC samples will be collected first followed by the other parameters. VOC samples will not be composited or homogenized and will be collected from the area exhibiting the highest screening level. The method of VOC sample collection will follow the procedures specified in SOP 30.8 (Methanol Preservation Method) or 30.9 (En Core® Method) based on the requirements of the work plan addenda.
7. Field screen the sample with properly calibrated photoionization detector (PID) or other appropriate instrument. Cut a cross-sectional slice from the core or center of the sample and insert the monitoring instrument(s). Based on the screening results, collect the VOC fraction, as applicable.
8. Rough trimming of the sampling location surface should be considered if the sampling surface is not fresh or other waste, different soil strata, or vegetation may contaminate it. Surface layers can be removed using a clean stainless steel, spatula, scoop, or knife.
9. If homogenization or compositing of the sampling location is not appropriate for other parameters, the sample should be directly placed into appropriate sample containers with a stainless steel spoon or equivalent.
10. If homogenization of the sample location is appropriate or compositing of different locations is desired, transfer the sample to a stainless steel bowl for mixing. The sample should be thoroughly mixed with a clean stainless steel spoon, scoop, trowel, or spatula and placed in appropriate sample containers per the requirements for containers and preservation specified in work plan addenda. Secure the cap of each container tightly.
15. Appropriately, label the samples (SOP 50.1), complete the chain-of-custody (SOP 10.4), and package the samples for shipping (SOP 50.2).
16. Discard any remaining sample into the drums used for collection of cuttings.
17. Abandon borings according to procedures outlined in SOP 20.2.

3.4 INVESTIGATION-DERIVED MATERIAL

Investigation-derived material will be managed in accordance with procedures defined in the work plan addenda for the site being investigated and SOP 70.1.

NOTES: If sample recoveries are poor, it may be necessary to composite samples before placing them in jars. In this case, the procedure will be the same except that two split-spoon samples (or other types of samples) will be mixed together. The boring log should clearly state that the samples have been composited, which samples were composited, and why the compositing was done. In addition, VOC fraction should be collected from the first sampling device.

When specified, samples taken for geotechnical analysis (e.g., percent moisture, density, porosity, and grain size) will be undisturbed samples, such as those collected using a thin-walled (Shelby tube) sampler, sonic core sampler, etc.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

Refer to the site-specific health and safety plan.

Soil samples will not include vegetative matter, rocks, or pebbles unless the latter are part of the overall soil matrix.

6.0 REFERENCES

ASTM Standard D 1586-84. 1984. *Penetration Test and Split-Barrel Sampling of Soils.*

ASTM Standard D 1587-83. 1983. *Thin Walled Sampling of Soils.*

ASTM Standard D 5633-94. 1994. *Standard Practice for Sampling with a Scoop.*

USACE. 2001. *Requirements for the Preparation of Sampling and Analysis Plans.* EM 200-1-3. 1 February.

STANDARD OPERATING PROCEDURE 30.6
CONTAINERIZED MATERIAL

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for the opening and sampling of containerized liquids of potentially unknown substances.

2.0 MATERIALS

- Work Plans;
- Field logbooks;
- Personal protective equipment and clothing per the site-specific health and safety plan;
- Monitoring instruments per the site-specific health and safety plan;
- Decontamination equipment and supplies (SOP 80.1);
- Tools;
- Historical data, if available;
- Sampling tube; and
- Remote samplers, as required.

3.0 PROCEDURE

Sealed containers with unknown contents represent potential severely hazardous situations for sampling teams. Even when the original identity of the contents is reasonably certain, contents may be under pressure or in a decomposed state and may readily react (sometimes violently) with air or water vapor in the atmosphere.

Only hazardous material specialists that have appropriate training and experience will inspect and sample unidentifiable drums or containers. Specialist team members will use extreme caution and care when opening sealed drums or cans of unknown content for purposes of inspection and sampling.

Efforts will be made to determine the identity of the contents, through markings, history of activities at the site, and similarity and proximity to containers of known contents. The range of possible hazards will dictate which specific procedure will be followed, and specific procedures will be identified in work plan addenda. All predetermined procedures will be strictly followed as designated by the site-specific conditions.

Using this SOP and appropriate health and safety protocols, field personnel will use extreme caution and care in opening sealed drums or cans of unknown contents for purposes of inspection and sampling. Specific activities include the following:

- Determine the identity of the contents through markings, history of activities at the site, and similarity and proximity to containers of known contents. The range of possible hazards will dictate which specific procedure should be followed.
- Handle containers as little as possible; however, if it is necessary to reorient a drum to allow access to a bung or cap, perform this activity using remote-handling forklift equipment with special drum-holding attachments.
- If contents are deemed to be under pressure, highly reactive, or highly toxic (or if these possibilities cannot be disproven), perform initial opening of the container remotely.
- Air monitoring stations will be established as necessary, using the following procedures:
    1. Affix a remote bung opener to the drum.
    2. Evacuate personnel to a safe distance or station them behind a barricade.
    3. Activate the non-sparking motor of the opener.
    4. After the bung is removed, monitor the drum for potential activity of the contents, such as vapor emission, smoking, or audible reaction.
    5. Approach cautiously while monitoring for toxic levels of airborne contaminants.
- If the contents of the drum pose acceptable hazards, accomplish opening (or inspection if previously opened remotely) and sampling with one of three approved devices. The preferred method is to use a clean glass tube, with or without bottom stopper, which can be placed in the drum (breaking it if necessary) after sampling is complete. Alternately (if a bung has been removed), a well sampler such as a Kemmererbailer can be used (but would require removal and cleaning or disposal according to the nature of the waste). By opening either of these devices at a desirable depth, stratified sampling can be performed. Also, the sampling tubes can be made with a plunger rod and O-ring seals at selected intervals, allowing simultaneous collection of multiple samples in a stratified medium.
- Following sampling, the drum will be resealed and/or overpacked to prevent any possibility of leakage while analysis determines the identity of the contents.
- Drums that do not have removable bungs may be opened remotely with a solenoid-activated punch (this requires that the drum be recontainerized or overpacked after sampling is complete).

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

Not applicable.

6.0 REFERENCE

USEPA, 1989. A Compendium of Superfund Field Operation Methods. EPA/540/P-87/001. December.

STANDARD OPERATING PROCEDURE 30.7
SAMPLING STRATEGIES

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate sampling strategies for sampling various media.

2.0 MATERIALS

- Historical site data;
- Site topography;
- Soil types; and
- Sampled media.

3.0 PROCEDURE

The primary goal of any investigation is to collect samples representative of existing site conditions. Statistics are generally used to ensure samples are as representative as possible. Sampling plans may employ more than one approach to ensure project data quality objectives are adequately addressed. A comparison of sampling strategies is presented in Table 1.

3.1 CLASSICAL STATISTICAL SAMPLING

Classical statistical sampling strategies are appropriately applied to either sites where the source of contamination is known or small sites where the entire area is remediated as one unit. Primary limitations of this sampling approach include (1) inability to address media variability; (2) inadequate characterization of heterogenous sites; and (3) inadequate characterization of sites with unknown contamination characteristics.

3.1.1 Simple Random Sampling

Simple random sampling is generally more costly than other approaches because of the number of samples required for site characterization. This approach is generally used when minimal site information is available and visible signs of contamination are not evident and includes the following features:

- Sampling locations are chosen using random chance probabilities.
- This strategy is most effective when the number of sampling points is large.

3.1.2 Stratified Random Sampling

This sampling approach is a modification to simple random sampling. This approach is suited for large site investigations that encompass a variety of soil types, topographic features, and/or land uses. By dividing the site into homogenous sampling strata based on background and historical data, individual random sampling techniques are applied across the site. Data acquired from each stratum can be used to determine the mean or total contaminant levels and provide these advantages:

- Increased sampling precision results due to sample point grouping and application of random sampling approach.

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- Control of variances associated with contamination, location, and topography.

3.1.3 Systematic Grid

The most common statistical sampling strategy is termed either systematic grid or systematic random sampling. This approach is used when a large site must be sampled to characterize the nature and extent of contamination.

Samples are collected at predetermined intervals within a grid pattern according to the following approach:

- Select the first sampling point randomly; remaining sampling points are positioned systematically from the first point.
- Determine the grid design: one or two-dimensional. One-dimensional sample grids may be used for sampling along simple man-made features. Two-dimensional grid systems are ideal for most soil applications.
- Determine the grid type: square or triangular. Sampling is usually performed at each grid-line intersection. Other strategies include sampling within a grid center or obtaining composite samples within a grid.
- Each stratum is sampled based on using the simple random sampling approach but determined using a systematic approach.

3.1.4 Hot-Spot Sampling

Hot spots are small, localized areas of media characterized by high contaminant concentrations. Hot-spot detection is generally performed using a statistical sampling grid. The following factors should be addressed:

- Grid spacing and geometry. The efficiency of hot-spot searches is improved by using a triangular grid. An inverse relationship exists between detection and grid point spacing, e.g., the probability of hot-spot detection is increased as the spacing between grid points is decreased.
- Hot-spot shape/size. The larger the hot spot, the higher the probability of detection. Narrow or semicircular patterns located between grid sampling locations may not be detected.
- False-negative probability. Estimate the false negative (β-error) associated with hot-spot analysis.

3.1.5 Geostatistical Approach

Geostatistics describe regional variability in sampling and analysis by identifying ranges of correlation or zones of influence. The general two-stage approach includes the following:

- Conducting a sampling survey to collect data defining representative sampling areas.
- Defining the shape, size, and orientation of the systematic grid used in the final sampling event.

3.2 NON-STATISTICAL SAMPLING

3.2.1 Biased Sampling

Specific, known sources of site contamination may be evaluated using biased sampling. Locations are chosen based on existing information.

3.2.2 Judgmental Sampling

This sampling approach entails the subjective selection of sampling locations that appear to be representative of average conditions. Because this method is highly biased, it is suggested that a measure of precision be included through the collection of multiple samples.

4.0 MAINTENANCE

Not applicable.

5.0 REFERENCES

USACE. 2001. *Requirements for the Preparation of Sampling and Analysis Plans.* EM200-1-3. 1 February.

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TABLE 1
SAMPLING STRATEGIES

SAMPLING STRATEGY	DESCRIPTION	APPLICATION	LIMITATIONS
Classical 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 are 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 background information or visual signs of contamination do not indicate them. 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.

STANDARD OPERATING PROCEDURE 30.9
COLLECTION OF SOIL SAMPLES BY USEPA SW 846 METHOD 5035 USING DISPOSABLE SAMPLERS

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) outlines the recommended protocol and equipment for collection of representative soil samples to monitor potential volatile organic contamination in soil samples.

This method of sampling is appropriate for surface or subsurface soils contaminated with low to high levels of volatile organic compounds (VOCs). This sampling procedure may be used in conjunction with any appropriate determinative gas chromatographic procedure, including, but not necessarily limited to, SW-846 Method 8015, 8021, and 8260.

2.0 MATERIALS

- Work Plans;
- Field Logbook;
- Photoionization Detector (PID) or other monitoring instrument(s) per site-specific health and safety plan;
- Personal protective equipment and clothing per site-specific health and safety plan;
- Soil sampling equipment, as applicable (SOP 30.1);
- Disposable sampler;
- T-handle and/or Extrusion Tool; and
- Decontamination equipment and supplies (SOP 80.1).

3.0 PROCEDURE

3.1 METHOD SUMMARY

Disposable samplers are sent to the field to be used to collect soil samples. Three samplers must be filled for each soil sampling location, two for the low-level method (sodium bisulfate preservation) and one for the high level method (methanol preservation). After sample collection, disposable samplers are immediately shipped back to the laboratory for preservation (adding soil sample into methanol and sodium bisulfate solution). The ratio of volume of methanol to weight of soil is 1:1 as specified in SW-846 Method 5035 (Section 2.2.2). The amount of preservative in the solution corresponds to approximately 0.2 g of preservative for each 1 g of sample. Enough sodium bisulfate should be present to ensure a sample pH of ≤ 2.

If quality assurance/quality control (QA/QC) samples are needed, seven samplers will be needed for the original, matrix spike, and matrix spike duplicate analysis. Soil samples are collected in the field using the disposable samplers, sealed and returned to the laboratory. A separate aliquot of soil is collected in a 125-mL container for dry weight determination.

3.2 SAMPLE CONTAINERS, PRESERVATION, HANDLING AND STORAGE

After sample collection, the disposable samplers must be cooled to and maintained at 4°C. The contents of the samplers will be analyzed using EPA methods 8015, 8021, and/or 8260. The **disposable** sampler is a single use device. It cannot be cleaned and/or reused.

Disposable samplers have a 48 hour holding time from sample collection to sample preparation in the laboratory. Return the samplers to the laboratory immediately after sampling.

3.3 SAMPLE PROCEDURES

Before sampling, the disposable sampler should be prepared as follows:

1. Unpack the cooler/sampling kit received from the laboratory. Disposable samplers are packed in sealed aluminized bags. These should be over packed in plastic zip lock bags. A T-Handle will also be needed to collect samples with the disposable sampler.
2. Hold coring body and push plunger rod down until small 0-ring rests against tabs. This will assure that plunger moves freely.
3. Depress locking lever on the sampler T-Handle (or other extraction device). Place coring body, plungers end first, into the open end of the T-Handle, aligning the two slots on the coring body with the two locking pins in the T-Handle. Twist the coring body clockwise to lock the pins in the slots. Check to ensure the sampler is locked in place. Sampler is ready for use.

The following procedure should be followed when using a disposable sampler to sample for VOCs in soil:

1. After the soil-sampling device (split spoon, corer, etc.) is opened, the sampling process should be completed in a minimum amount of time with the least amount of disruption.
2. Visual inspection and soil screening should be conducted after the sampler is opened and a fresh surface is exposed to the atmosphere. Soil screening should be conducted with an appropriate instrument (PID or FID).
3. Rough trimming of the sampling location surface should be considered if the sampling surface is not fresh or other waste, different soil strata, or vegetation may contaminate it. Surface layers can be removed using a clean stainless steel, spatula, scoop, or knife.
4. Orient the T-Handle with the T-up and the coring body down. This positions the plunger bottom flush with bottom of coring body (ensure that plunger bottom is in position). Using T-Handle, push sampler into soil until the coring body is completely full taking care not to trap air behind the sampler. When full, the small o-ring will be centered in the T-Handle viewing hole. Remove sampler from soil. Wipe excess soil from coring body exterior with a clean disposable paper towel.
5. Cap coring body while it is still on the T-Handle. ***Push*** cap over flat area of ridge ***and twist*** to lock cap in place. ***Cap must be seated to seal sampler.***
6. Remove the capped sampler by depressing locking lever on T-Handle while twisting and pulling sampler from T-Handle.
7. Lock plunger by rotating extended plunger rod fully counterclockwise until wings rest firmly against tabs.

8. Fill the 125-mL wide mouth jar for the non-preserved portion of the sample to be used for a moisture determination. These may be in a cardboard box. Retain all packaging to return the samples.
9. The disposable sampler should collect approximately 5 grams of soil (not necessary to weigh in the field). After a sample has been collected and capped, tear off the identification tag found at the bottom of the label on the aluminized bag. This tag is added to the sampler on the cap used to seal the sampler.
10. Place the sampler back in the aluminized bag and seal the top (a zip-lock seal). Make sure all the appropriate information is on the label. Record the sampler ID number on the chain-of-custody. Make sure each sampler and 125-mL container is labeled with the same location identification. The sampler should be placed inside the plastic zip-lock bags.
11. Place the 125-mL wide mouth jars in the cooler with the sampler on top. These should be sandwiched between bags of ice to maintain the correct temperature. If sent with the jars and samplers, a temperature bottle (used to evaluate the temperature on receipt) should be placed in the middle of the jars. The sample temperature should be 4°C during shipment.
12. Ship the samples so that they will be received within 24 hours of sampling. The laboratory must receive the sampler within 40 hours of the collection so that they can be correctly preserved.

3.4 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

1. All data must be documented on chain-of-custody forms, field data sheets and in the field logbook.
2. An equipment blank is a QA/QC sample that will determine potential contamination from sampling equipment used to collect and transfer samples from the point of collection to the sample container. An equipment blank is performed by pouring demonstrated analyte free water from one sample container, over a sampler, and into a separate set of identical sample containers. The equipment blank is optional when sampling with the methanol preservation technique. It may be required on a site-specific basis if elevated analytical results are suspected to be due to cross contamination from sampling equipment.
3. A trip blank is a QA/QC sample, which will determine additional sources of contamination that may potentially influence the samples. The sources of the contamination may be from the laboratory, sample containers, or during shipment. The laboratory prepares a trip blank at the same time and in the same manner as the sample containers. The trip blank must accompany the sample containers to the field and back to the laboratory along with the collected samples for analysis. It must remain sealed at all times until it is analyzed at the laboratory. The frequency of collection for the trip blank must be at a rate of one per sample shipment.

3.5 LIMITATIONS IN SAMPLING

This sampling protocol will not be applicable to all solid environmental matrices, such as those that cannot be cored including non-cohesive granular material, gravel, or hard dry clay. In this case, the procedure for collecting VOC samples using Methanol Preservation should be used (see SOP 30.8).

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

None.

6.0 REFERENCES

En Novative Technologies, Inc. 2000. Users Manual for En Core® Sampler. February 2001.

USACE. 2001. *Requirements for the Preparation of Sampling and Analysis Plans.* EM 200-1-3, 1 February. -

USEPA. 1997. *Test Methods for Evaluating Solid Waste, Volume IB: Laboratory Manual Physical/Chemical Methods,* Third Edition, (as updated through update IIIA). Office of Solid Waste and Emergency Response, Washington, DC.

STANDARD OPERATING PROCEDURE 50.1
SAMPLE LABELS

1.0 SCOPE AND APPLICATION

Every sample will have a sample label uniquely identifying the sampling point and analysis parameters. The purpose of this standard operating procedure (SOP) is to delineate protocols for the use of sample labels. An example label is included as Figure 50.1-A. Other formats with similar levels of detail are acceptable.

2.0 MATERIALS

- Sample label; and
- Indelible marker.

3.0 PROCEDURE

The use of preprinted sample labels is encouraged and should be requested from the analytical support laboratory during planning activities.
As each sample is collected, fill out a sample label ensuring the following information has been collected:

- Project name;
- Sample ID: enter the SWMU number and other pertinent information concerning where the sample was taken. This information should be included in site-specific work plan addenda;
- Date of sample collection;
- Time of sample collection;
- Initials of sampler(s);
- Analyses to be performed (NOTE: Due to number of analytes, details of analysis should be arranged with lab *a priori*); and
- Preservatives (water samples only).

Double-check the label information to make sure it is correct. Detach the label, remove the backing and apply the label to the sample container. Cover the label with clear tape, ensuring that the tape completely encircles the container.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

None.

6.0 REFERENCES

USEPA. 1998. *EPA Requirements for Quality Assurance Project Plans.* EPA/600/R-98/018, QA/R5, Final, Office of Research and Development, Washington, D.C.

FIGURE 50.1-A
SAMPLE LABEL

PROJECT NAME ______________________

SAMPLE ID _______________________

DATE: ___/___/___ TIME: ____:____

ANALYTES: VOC SVOC P/P METALS CN

PAH D/F HERBs ANIONS TPH

ALK TSS

PRESERVATIVE: [HCl] [HNO_3] [$NaOH$] [H_2SO_4]

SAMPLER: _________________

STANDARD OPERATING PROCEDURE 50.2
SAMPLE PACKAGING

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for the packing and shipping of samples to the laboratory for analysis.

2.0 MATERIALS

- Waterproof coolers (hard plastic or metal);
- Metal cans with friction-seal lids (e.g., paint cans);
- Chain-of-custody forms;
- Chain-of-custody seals (optional);
- Packing material;
- Sample documentation;
- Ice;
- Plastic garbage bags;
- Clear Tape;
- Zip-top plastic bags; and
- Temperature blanks provided by laboratory for each shipment.

3.0 PROCEDURE

1. Check cap tightness and verify that clear tape covers label and encircles container.
2. Wrap sample container in bubble wrap or closed cell foam sheets. Samples may be enclosed in a secondary container consisting of a clear zip-top plastic bag. Sample containers must be positioned upright and in such a manner that they will not touch during shipment.
3. Place several layers of bubble wrap, or at least 1 in. of vermiculite on the bottom of the cooler. Line cooler with open garbage bag, place all the samples upright inside the garbage bag and tie.
4. Double bag and seal loose ice to prevent melting ice from soaking the packing material. Place the ice outside the garbage bags containing the samples.
5. Pack shipping containers with packing material (closed-cell foam, vermiculite, or bubble wrap). Place this packing material around the sample bottles or metal cans to avoid breakage during shipment.
6. A temperature blank (provided by laboratory) will be included in each shipping container to monitor the internal temperature. Samples should be cooled to 4 degrees C on ice immediately after sampling.

7. Enclose all sample documentation (i.e., Field Parameter Forms, Chain-of-Custody forms) in a waterproof plastic bag and tape the bag to the underside of the cooler lid. If more than one cooler is being used, each cooler will have its own documentation. Add the total number of shipping containers included in each shipment on the chain-of-custody form.
8. Seal the coolers with signed and dated custody seals so that if the cooler were opened, the custody seal would be broken. Place clear tape over the custody seal to prevent damage to the seal.
9. Tape the cooler shut with packing tape over the hinges and place tape over the cooler drain.
10. Ship all samples via overnight delivery on the same day they are collected if possible.

4.0 MAINTENANCE

Not applicable.

5.0 PRECAUTIONS

5.1 PERMISSIBLE PACKAGING MATERIALS

- Non-absorbent
  - Bubble wrap; and
  - Closed cell foam packing sheets.
- Absorbent
  - Vermiculite.

5.2 NON-PERMISSIBLE PACKAGING MATERIALS

- Paper;
- Wood shavings (excelsior); and
- Cornstarch "peanuts".

6.0 REFERENCES

USEPA. 1990. *Sampler's Guide to the Contract Laboratory Program.* EPA/540/P-90/006, Directive 9240.0-06, Office of Emergency and Remedial Response, Washington, D.C., December 1990.

USEPA. 1991. *User's Guide to the Contract Laboratory Program.* EPA/540/O-91/002, Directive 9240.0-01D, Office of Emergency and Remedial Response. January 1991.

USEPA. 1998. *EPA Requirements for Quality Assurance Project Plans.* EPA/600/R-98/018, QA/R5, Final, Office of Research and Development, Washington, D.C

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STANDARD OPERATING PROCEDURE 70.1
INVESTIGATION-DERIVED MATERIAL

1.0 SCOPE AND APPLICATION

Management of investigation-derived material (IDM) minimizes the potential for the spread of waste material onsite or offsite through investigation activities. The purpose of this standard operating procedure (SOP) is to provide general guidelines for appropriate management of potentially contaminated materials derived from the field investigations. Specific procedures related to the transportation and disposal of hazardous waste are beyond the scope of this SOP.

2.0 INTRODUCTION

Investigation derived material (IDM) consists of waste materials that are known or suspected to be contaminated with waste substances through the actions of sample collection or personnel and equipment decontamination. These materials include decontamination solutions, disposable equipment, drill cuttings and fluids, and water from groundwater monitoring well development and purging. To the extent possible, the site manager will attempt to minimize the generation of these materials through careful design of decontamination schemes and groundwater sampling programs. Testing conducted on soil and water investigation-derived material will show if they are also hazardous wastes as defined by RCRA. This will determine the proper handling and ultimate disposal requirements.

The criteria for designating a substance as hazardous waste according to RCRA is provided in 40 CFR 261.3. If IDM meet these criteria, RCRA requirements will be followed for packaging, labeling, transporting, storing, and record keeping as described in 40 CFR 262.34. Those materials that are judged potentially to meet the criteria for a regulated solid or hazardous waste will be placed in DOT-approved 55-gallon steel drums or another type of DOT approved container; based on waste characteristics and volume.
Investigation-derived material will be appropriately placed in containers, labeled, and tested to determine disposal options in accordance with RCRA regulations and Virginia Hazardous Waste Management Regulations.

3.0 INVESTIGATION-DERIVED MATERIAL MANAGEMENT

Procedures that minimize potential for the spread of waste material include minimizing the volume of material generated, material segregation, appropriate storage, and disposal according to RCRA requirements.

3.1 WASTE MINIMIZATION

In the development of work plan addenda, each aspect of the investigation will be reviewed to identify areas where excess waste generation can be eliminated. General procedures that will eliminate waste include avoidance of unnecessary exposure of materials to hazardous material and coordination of sampling schedules to avoid repetitious purging of wells and use of sampling equipment.

3.2 WASTE SEGREGATION

Waste accumulation and management procedures to be used depend upon the type of material generated. For this reason, IDM described below are segregated into separate 55-gallon storage drums or other appropriate DOT containers. Waste materials that are known to be free of potential hazardous waste contamination (such as broken sample bottles or equipment containers and wrappings) must be collected separately for disposal to municipal systems. Large plastic garbage or "lawn and leaf" bags are useful for collecting this trash. Even "clean" sample bottles or Tyvek should be disposed of with care. Although they are not legally a problem, if they are discovered by the public they may cause concern. Therefore, items that are known to be free from contamination but are also known to represent "hazardous or toxic waste" to the public must not be disposed of in any public trash receptacle, such as found at your hotel or park.

3.2.1 Decontamination Solutions

Solutions considered investigation-derived materials range from detergents, organic solvents, and acids used to decontaminate small hand samplers to steam-cleaning rinsate used to wash drill rigs and other large equipment. These solutions are to be placed in 55-gallon drums with bolt-sealed lids or other appropriate DOT approved containers. Residual liquid IDM from decontamination pads will be removed and appropriately placed in container(s) at the end of each field day.

3.2.2 Soil Cuttings and Drilling Muds

Soil cuttings are solid to semi-solid soils generated during trenching activities or drilling for the collection of subsurface soil samples or the installation of monitoring wells. Depending on the type of drilling, drilling fluids known as "muds" may be used to remove soil cuttings. Drilling fluids flushed from the borehole must be directed into a settling section of a mud pit. This allows reuse of the decanted fluids after removal of the settled sediments. Drill cuttings, whether generated with or without drilling fluids, are to be removed with a flat-bottomed shovel and placed in 55-gallon drums with bolt-sealed lids or other appropriate DOT containers, as conditions or volume of IDM dictate.

3.2.3 Well Development and Purge Water

Well development and purge water is removed from monitoring wells to repair damage to the aquifer following well installation, obtain characteristic aquifer groundwater samples, or measure aquifer hydraulic properties. The volume of groundwater to be generated will determine the appropriate container to be used for accumulation of IDM.

For well development and purging, 55-gallon drums are typically an efficient container for accumulation. When larger volumes of water are removed from wells, such as when pumping tests are conducted, the use of large-volume portable tanks such as "Baker Tanks" should be considered for IDM accumulation.

Analytical data for groundwater samples associated with the well development and purge water will be used to assist in characterizing IDM and evaluating disposal options.

3.2.4 Personal Protective Equipment and Disposable Sampling Equipment

Personal protective equipment and clothing (PPE) may include such items as Tyvek coveralls, gloves, booties, and APR cartridges. Disposable sampling equipment may include such items as plastic sheeting, bailers, disposable filters, disposable tubing and paper towels. PPE and disposable sampling equipment that have or may have contacted contaminated media (soil, water, etc.) will be segregated and placed in 55-gallon drums separate from soil and water IDM. Disposition of this type of IDM will be determined by the results of IDM testing of the media in which the PPE and sampling equipment contacted.

3.3 MATERIAL ACCUMULATION

The IDM in containers must be placed in an appropriate designated RCRA container accumulation area at RFAAP, where it is permissible to accumulate such waste. IDM placed into a designated 90-day accumulation area will be properly sealed, labeled and covered. All drums will be placed on pallets.

A secure and controlled waste staging area will be designated by the installation prior the commencement of field sampling activities. Per the facility's requirements as a RCRA large quantity generator, waste accumulation cannot exceed 90 days for materials presumed or shown to be RCRA-designated hazardous wastes; waste which is known not to be RCRA-designated waste should be promptly disposed to municipal waste systems or appropriate facility.

3.3.1 IDM Accumulation Containers

Containers will be DOT-approved (DOT 17H 18/16GA OH unlined) open-head steel drums or other DOT approved container, as appropriate.

Container lids should lift completely off be secured by a bolt ring (for drum). Order enough containers to accumulate all streams of expected IDM including soil, PPE and disposable sampling equipment, decontamination water, purge water, etc.

Solid and liquid waste streams will not be mixed in a container. PPE and expendable sampling equipment will be segregated from other IDM and placed in different containers than soil. Containers inside containers are not permitted. PPE must be placed directly in a drum not in a plastic bag.

Pallets are often required to allow transport of filled drums to the staging area with a forklift. Normal pallets are 3×4 ft and will hold two to three 55-gallon drums depending on the filled weight. If pallets are required for drum transport or storage, field personnel are responsible for ensuring that the empty drums are placed on pallets before they are filled and that the lids are sealed on with the bolt-tighten ring after the drums are filled. Because the weight of one drum can exceed 500 lbs, under no circumstances should personnel attempt to move the drums by hand.

3.3.2 Container Labeling

Each container that is used to accumulate IDM will be appropriately labeled at the time of accumulation and assigned a unique identification number for tracking purposes. The following information will be written in permanent marker on a drum label affixed on the exterior side at a location at least two-thirds of the way up from the bottom of the drum.

- Facility name.
- Accumulation start date and completion date.
- Site identifier information (SWMU, boring, well, etc.).
- Description of IDM.
- Drum ID No.

4.0 MATERIAL CHARACTERIZATION AND DISPOSAL

IDM will be characterized and tested to determine whether it is a hazardous waste as defined by 40 CFR Part 261 and to determine what disposal options exist in accordance with RCRA regulations and the Virginia Hazardous Waste Management Regulations (VHWMR).

In general, IDM will be considered a hazardous waste if it contains a listed hazardous waste or if the IDM exhibits a characteristic of hazardous waste.

Work plan addenda will identify the appropriate characterization and testing program for IDM based on the following:

- Site-specific conditions related to chemicals of concern, etc.
- The nature and quantity of expected IDM to be generated during site-specific investigations.
- Applicable Federal, State, and local regulations, such as RCRA, VHWMR regulations and policies and procedures, and Army Regulation 200-1.
- RFAAP specific requirements and policies for IDM characterization and disposal at the time of the investigation.

In general, appropriate USEPA SW 846 Test Methods for Evaluating Solid Waste will be used for testing IDM and will be specified in work plan addenda. Other appropriate test methods may be specified by RFAAP in addition to SW 846 Methods that are specific to installation operations, the site of interest (percent explosive content, reactivity, etc.), or requirements for disposal at RFAAP water treatment facilities or publicly owned treatment works.

Responsibility for the final disposal of IDM will be determined before field activities are begun and will be described in work plan addenda. Off-site disposal of IDM will be coordinated with RFAAP (generator) to ensure appropriate disposition. The contractor will coordinate IDM transportation and disposal activities for RFAAP (generator).

At the direction of RFAAP, appropriate waste manifests will be prepared by the USACE contractor or Alliant Techsystems subcontractor for transportation and disposal. Alliant Techsystems or other appropriate RFAAP entity will be listed as the generator and an appointed representative from RFAAP will review and sign the manifest for offsite disposal.

RFAAP will make the final decision on the selection of the transporter, storage, and disposal facility (TSDFs) or recycling facility. RFAAP will provide the contractor a listing of previously used TSDFs for priority consideration. Proposed facilities that are not included on the listing are required to provide a copy of the TSDFs most recent state or federal inspection to the installation. Waste characterization and testing results will be submitted to RFAAP (generator) for review and approval before final disposition of the material.

Hazardous waste: Prior to final disposition, a hazardous waste manifest will be furnished by the TSDF to accompany transport to the disposal facility. Following final disposition, a certificate of disposal will be furnished by the disposal facility. Copies of the manifests and certificates of disposal are to be provided to RFAAP and retained on file by the contractor or subcontractor.

4.0 PRECAUTIONS

- Because the weight of one drum can exceed 500 lbs, under no circumstances should personnel attempt to move drums by hand.
- Refer to the site-specific health and safety plan when managing IDM.

5.0 REFERENCES

Safety Rules for Contractors and Subcontractors, 1995. Alliant Techsystems, Incorporated, Radford Army Ammunition Plant.

STANDARD OPERATING PROCEDURE 80.1
DECONTAMINATION

1.0 SCOPE AND APPLICATION

Before leaving the site, all personnel or equipment involved in intrusive sampling or having entered a hazardous waste site during intrusive sampling must be thoroughly decontaminated to prevent adverse health effects and minimize the spread of contamination. Equipment must be decontaminated between sites to preclude cross-contamination. Decontamination water will be free of contaminants as evidenced through either chemical analyses or certificates of analysis. This standard operating procedure (SOP) describes general decontamination requirements for site personnel and sampling equipment. Decontamination procedures for contaminants requiring a more stringent procedure, e.g., dioxins/furans, will be included in site-specific addenda.

2.0 MATERIALS

- Plastic sheeting, buckets or tubs, pressure sprayer, rinse bottles, and brushes;
- U.S. Army Corps of Engineers or installation approved decontamination water source;
- Deionized ultra-filtered, HPLC-grade organic free water (DIUF);
- Non-phosphate laboratory detergent;
- Nitric Acid, 0.1 Normal (N) solution;
- Pesticide-grade solvent, Methanol;
- Aluminum foil;
- Paper towels;
- Plastic garbage bags; and
- Appropriate containers for management of investigation-derived material (IDM).

3.0 PROCEDURE

3.1 SAMPLE BOTTLES

At the completion of each sampling activity the exterior surfaces of the sample bottles must be decontaminated as follows:

- Be sure that the bottle lids are on tight.
- Wipe the outside of the bottle with a paper towel to remove gross contamination.

3.2 PERSONNEL DECONTAMINATION

Review the site-specific health and safety plan for the appropriate decontamination procedures.

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3.3 EQUIPMENT DECONTAMINATION

3.3.1 Drilling Rigs

Drilling rigs and associated equipment, such as augers, drill casing, rods, samplers, tools, recirculation tank, and water tank (inside and out), will be decontaminated before site entry, after over-the-road mobilization and immediately upon departure from a site after drilling a hole. Supplementary cleaning will be performed before site entry. There is a likelihood that contamination has accumulated on tires and as spatter or dust en route from one site to the next.

1. Place contaminated equipment in an enclosure designed to contain all decontamination residues (water, sludge, etc.).
2. Steam-clean equipment until all dirt, mud, grease, asphaltic, bituminous, or other encrusting coating materials (with the exception of manufacturer-applied paint) has been removed.
3. Water used will be taken from an approved source.
4. When cross-contamination from metals is a concern, rinse sampling components such as split spoons, geo-punch stems, and augers with nitric acid, 0.1N.
5. Rinse with DIUF water.
6. When semi-volatile and non-volatile organics may be present, rinse the sampling components with pesticide-grade solvent methanol.
7. Double rinse the sampling components with DIUF water.
8. Decontamination residues and fluids will be appropriately managed as IDM per work plan addenda and SOP 80.1.

3.3.2 Well Casing and Screen

Prior to use, well casing and screen materials will be decontaminated. This activity will be performed in the leak proof, decontamination pad, which will be constructed prior to commencement of the field investigation. The decontamination process will include:

- Steam cleaning with approved source water.
- Rinse with DUIF water.
- Air-dry on plastic sheeting.
- Wrap in plastic sheeting to prevent contamination during storage/transit.

3.3.3 Non Dedicated Submersible Pumps Used for Purging and Sampling

1. Scrub the exterior of the pump to remove gross (visible) contamination using appropriate brushes, approved water, and non-phosphate detergent (steam cleaning may be substituted for detergent scrub).
2. Pump an appropriate amount of laboratory detergent solution (minimum 10 gallons) to purge and clean the interior of the pump.
3. Rinse by pumping no less than 10 gallons of approved water to rinse.
4. Rinse the pump exterior with approved decontamination water.
5. When cross-contamination from metals is a concern, rinse the pump exterior with approved nitric acid 0.1N solution.

6. Rinse the pump exterior with DIUF water.
7. When semi-volatile and non-volatile organics may be present, rinse the pump exterior with pesticide-grade solvent methanol.
8. Double rinse the pump exterior with DIUF water.
9. Air-dry on aluminum foil or clean plastic sheeting.
10. Wrap pump in aluminum foil or clean plastic sheeting, or store in a clean, dedicated PVC or PTFE storage container.
11. Solutions and residuals generated from decontamination activities will be managed appropriately as IDM per work plan addenda and SOP 80.1.

3.3.4 Sample Equipment and Measuring Water Level Devices

1. Scrub the equipment to remove gross (visible) contamination using appropriate brush (es), approved water, and non-phosphate detergent.
2. Rinse with approved source water.
3. When cross-contamination from metals is a concern, rinse the sampling equipment with approved nitric acid 0.1N solution.
4. Rinse equipment with DIUF water.
5. When semi-volatile and non-volatile organics may be present, rinse the sampling equipment with pesticide-grade solvent methanol.
6. Double rinse the sampling equipment with DIUF water.
7. Air-dry on aluminum foil or clean plastic sheeting.
8. Wrap in aluminum foil, clean plastic sheeting, or zip top bag or store in a clean, dedicated PVC or PTFE storage container.
9. Solutions and residuals generated from decontamination activities will be managed appropriately as IDM per work plan addenda and SOP 80.1.

3.3.5 Other Sampling and Measurement Probes

Temperature, pH, conductivity, Redox, and dissolved oxygen probes will be decontaminated according to manufacturer's specifications. If no such specifications exist, remove gross contamination and triple-rinse probe with DIUF water.

4.0 PRECAUTIONS

- Manage IDM appropriately according to the requirements specified in work plan addenda.
- Follow appropriate procedures as specified in the site-specific health and safety plan.

5.0 REFERENCES

USACE. 2001. Requirements for the Preparation of Sampling and Analysis Plans. EM 200-1-3. 1 February.

STANDARD OPERATING PROCEDURE 90.1
PHOTOIONIZATION DETECTOR (HNu Model PI–101 and HW–101)

1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to delineate protocols for field operations with a photoionization detector (HNu Systems Model PI–101 or HW–101). The photoionization detector (PID) detects total ionizables; hence it is used to monitor both organic and inorganic vapors and gases to determine relative concentrations of air contaminants. This information is used to establish level of protection and other control measures such as action levels. The PID cannot effectively detect compounds having ionization potentials above the photon energy level of the lamp used; therefore, methane, which has an ionization potential of 12.98 eV, is undetectable by PIDs because the lamps produce 9.5, 10.2, or 11.7 eV.

Use of brand names in this SOP is in not intended as an endorsement or mandate that a given brand be used. Alternate equivalent brands of detectors, sensors, meters, etc., are acceptable. If alternate equipment is to be used, the contractor shall provide applicable and comparable SOPs for its maintenance and calibration.

2.0 MATERIALS

- HNu Systems Model PI–101 or HW–101 survey probe with 9.5, 10.2, or 11.7 eV lamp;
- Lead-acid gel-cell battery;
- Calibration gas (e.g., isobutylene, 101 ppm) with regulator;
- Tygon tubing;
- Tedlar bag (optional);
- Instrument logbook; and
- Field logbook.

3.0 PROCEDURE

These procedures are to be followed when using the HNu in the field.

3.1 STARTUP

1. Before attaching the probe, check the function switch on the control panel to ensure that it is in the off position. Attach the probe by plugging it into the interface on the top of the readout module.
2. Turn the function switch to the battery check position. The needle on the meter should read within or above the green battery arc on the scale; if not, recharge the battery. If the red indicator light comes on, the battery needs recharging or service may be indicated.
3. Turn the function switch to any range setting. Listen for the hum of the fan motor. Check meter function by holding a solvent-based marker pen near the sample intake. If there is no needle deflection, look briefly into the end of the probe (no more than 1 or 2 sec) to see if the lamp is on; if it is on, it will give a purple glow. Do not stare into the probe any longer than 2 sec. Long-term exposure to UV light can damage the eyes. (See further information in Section 5.)

4. To zero the instrument, turn the function switch to the standby position and rotate the zero adjustment until the meter reads zero. A calibration gas is not needed since this is an electronic zero adjustment. If the span adjustment setting is changed after the zero is set, the zero should be rechecked and adjusted if necessary. Allow the instrument to warm up for 3–5 min to ensure that the zero reading is stable. If necessary, readjust the zero.

3.2 OPERATIONAL CHECK

Follow the startup procedure in Section 3.1.
With the instrument set on the 0–20 range, hold a solvent-based marker near the probe tip. If the meter deflects upscale, the instrument is working.

3.3 FIELD CALIBRATION PROCEDURE

1. Follow the startup procedures in Section 3.1 and the operational check in Section 3.2.
2. Set the function switch to the range setting for the concentration of the calibration gas.
3. Attach a regulator HNu P/N 101-351 or equivalent (flow = 200 to 300 ml/min) to a disposable cylinder of isobutylene (HNu 101-351 or equivalent). Connect the regulator to the probe of the HNu with a piece of clean Tygon tubing. Turn on the valve of the regulator.
4. After 5 sec, adjust the span dial until the meter reading equals the benzene concentration of the calibration gas used, corrected to its equivalence, which should be marked on the canister (Isobutylene ~0.7X benzene).
5. Record in the field log the instrument ID No., serial No., initial and final span settings, date, time, location, concentration and type of calibration gas used, and the signature of the person who calibrated the instrument.
6. If the HNu does not function or calibrate properly, the project equipment manager is to be notified as soon as possible. Under no circumstances is work requiring monitoring with a PI–101 or HW–101 to be done with a malfunctioning instrument.

3.4 CALIBRATION TO A GAS OTHER THAN ISOBUTYLENE

The HNu may be calibrated to any certified calibration gas. However, after calibration, all subsequent instrument readings will be relative to the calibration gas used. General procedures include the following:

1. Calibrate according to procedure 3.3.
2. Partially fill and flush one-to-two times a gas bag (Tedlar recommended) with the certified National Institute of Standards and Technology (NIST) (formerly NBS) traceable calibration gas. Then fill the bag with 1–3 L of the calibration gas. If the gas is toxic, this must be done in a fume hood.
3. Feed the calibration gas into the probe with the range set for the value of the gas. After 5 sec, adjust the span control until the meter reads the value of the calibration gas.
4. Record the results of the calibration on the calibration/maintenance log and attach a new calibration sticker (if available) or correct the existing sticker to reflect the new calibration data. All subsequent readings will be relative to the new calibration gas.

3.5 OPERATION

1. Follow the startup procedure, operational check, and calibration check (refer to Section 3.1).

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2. Set the function switch to the appropriate range. If the concentration of gas vapors is unknown, set the function switch to 0-20 ppm range. Adjust if necessary.
3. Prevent exposing the HNu to excessive moisture, dirt, or contaminant while monitoring the work activity as specified in the Site Health and Safety Plan.
4. When the activity is completed, or at the end of the day, carefully clean the outside of the HNu with a damp disposable towel to remove all visible dirt. Return the HNu to a secure area and place on charge. Charge after each use; the lead acid batteries cannot be ruined by over charging.
5. With the exception of the probe's inlet and exhaust, the HNu can be wrapped in clear plastic to prevent it from becoming contaminated and to prevent water from getting inside in the event of precipitation. If the instrument becomes contaminated, make sure to take necessary steps to decontaminate it. Call the Equipment Administrator if necessary; under no circumstances should an instrument be returned from the field in a contaminated condition.

4.0 MAINTENANCE

Calibration/maintenance logs are to be filled in completely whenever a PI-101 or HW-101 receives servicing. This is true of both contractor-owned and rental instruments.

The equipment manager should be called to arrange for a fresh instrument when necessary. The contractor's equipment facility is responsible for arranging all repairs that cannot be performed by the project equipment manager.

4.1 ROUTINE SERVICE

The PID's performance is affected by a number of factors. These include but are not limited to the decay of the UV lamp output over time and the accumulation of dust and other particulate material and contaminates on the lamp and in the ion chamber. Because of these factors, the PID should not be left in the field for a period of more than 2 weeks before being replaced with a fresh instrument. If a site is going to be inactive for a period of more than a week, all monitoring instruments are to be returned to the project equipment manager or his trained designee for servicing and/or reassignment. The following procedures are to be performed at the designated intervals for routine service.

Procedure	Frequency
Operational check	Before use and at instrument return
Field calibration	Before use and at instrument return
Full calibration	Bi-weekly (return instrument to equipment manager for replacement with a fresh unit)
Clean UV lamp and	Bi-weekly or as needed ion chamber
Replace UV Lamp	As needed

4.1.1 UV Lamp and Ion Chamber Cleaning

During periods of analyzer operation, dust and other foreign materials are drawn into the probe forming deposits on the surface of the UV lamp and in the ion chamber. This condition is indicated by meter readings that are low, erratic, unstable, non-repeatable, or drifting and show apparent moisture sensitivity. These deposits interfere with the ionization process and cause erroneous readings. Check for this condition regularly to ensure that the HNu is functioning properly. If the instrument is malfunctioning, call your equipment manager to arrange to have a fresh replacement.

4.1.2 Lamp eV Change

If different applications for the analyzer would require different eV lamps, separate probes, each with its own eV lamp, must be used. A single readout assembly will serve for any of the probes (9.5, 10.2, and 11.7 eV). A change in probe will require resetting of the zero control and recalibrating the instrument. The 11.7 eV lamp will detect more compounds than either of the two lower eV lamps. However, the 11.7 eV probe needs more frequent calibration; it burns out much faster than the lower eV lamps.

5.0 PRECAUTIONS

- The HNu PI–101 and HW–101 are designed to sample air or vapors only. *Do not allow any liquids or low boiling vapors to get into the probe or meter assembly.*
- High concentrations of any gas can cause erroneous readings. High humidity can also cause the instrument readings to vary significantly from the actual concentration of gases or vapors present. This is true even through the HNu cannot react to water vapor.
- High humidity, dust, and exposure to concentrations of low boiling vapors will contaminate the ion chamber, causing a steady decrease in sensitivity.
- Continued exposure to ultraviolet light generated by the light source can be harmful to eyesight. If a visual check of the UV lamp is performed *do not look at the light source from a distance closer than 6 inches with unprotected eyes.* Use eye protection (UV-blocking sunglasses or safety glasses). Only look briefly—never more than about 2 sec.

Place the instrument on charge after each use; the lead batteries cannot be ruined by over charging.

- If at any time the instrument does not check out or calibrate properly in the field, the equipment manager is to be notified immediately and a replacement obtained for the malfunctioning instrument. Under no circumstances should fieldwork requiring continuous air monitoring for organic vapors and/or gases be done with a malfunctioning Hnu or without a HNu or an approved comparable instrument.

6.0 REFERENCES

Manufacturer's Equipment Manual.

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PHOTO 1: Panoramic view looking southwest to west across SWMU 8, Western Lagoon

PHOTO 2: View looking southeast across SWMU 36, Northeastern Drying Bed

PHOTO 3: View looking east across SWMU 36, Southern Drying Bed. Calcium Sulfate residue is visible in the middle ground

PHOTO 4: Close view of Calcium Sulfate residue in SWMU 36, Southern Drying Bed

PHOTO 5: View looking northeast across SWMU 36, Northwestern Drying Bed. Note the New River in the background

PHOTO 6: View looking west across SWMU 36, Northwestern Drying Bed. Note the steep berms and heavy vegetation

PHOTO 7: View looking south across SWMU 36, Eastern Drying Bed.

PHOTO 8: View looking southeast across SWMU 8.