

Closure Documentation for
Hazardous Waste Management Unit 39
Incinerator Spray Pond
Radford Army Ammunition Plant, Radford, VA
EPA ID# VA1210020730

Volume 1

Rec'd ENV 5-5-99



99-60

C: Jake
Redder
McKean
Olson
ENV file

Lib-Br Cas
Shelf 2
Dennis H. Treacy
Director

Column 2
HW 4039
(804) 698-4000
1-800-592-5482

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Street address: 629 East Main Street, Richmond, Virginia 23219

Mailing address: P.O. Box 10009, Richmond, Virginia 23240

Fax (804) 698-4500 TDD (804) 698-4021

<http://www.deq.state.va.us>

James S. Gilmore, III
Governor

John Paul Woodley, Jr.
Secretary of Natural Resources

May 3, 1999

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

RE: Radford Army Ammunition Plant (RAAP)
EPA ID# VA12100207306
Incinerator Spray Pond
Closure Verification

Dear Ms. Jake:

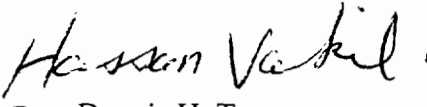
On June 15, 1998, RAAP submitted the required closure certifications and report for its Equalization Basin. The report was revised and submitted on October 26, 1998, in accordance with the Department's comment letter. Additionally, on March 27, 1998, RAAP's Incinerator Spray Pond, SWMU #39, was visited by compliance staff of the Virginia Department of Environmental Quality's (DEQ) West Central Regional Office. The result of the closure verification inspection and the submitted information have been reviewed.

Based on this closure inspection, the closure certifications, and the closure report, clean closure of the unsaturated soils was achieved by background comparison for all constituents, except arsenic, barium, and chromium. Clean closure to a residential risk-based determination was achieved for these three constituents. Therefore, the DEQ concurs that clean closure for the unsaturated soils only has been achieved for RAAP's Incinerator Spray Pond. Please note, however, that the U.S. Environmental Protection Agency retains the authority to address possible corrective action of continuing releases pursuant to the Hazardous and Solid Waste Amendments of 1984. The saturated soils/groundwater underneath the unit is still undergoing closure and may be subject to the post-closure permit process established under Title 9 of the Virginia Administrative Code, Chapter 20-60 (9 VAC 20-60 et seq.), if clean closure cannot be achieved.

Ms. C.A. Jake
April 23, 1999
Page 2

If you have any questions regarding this letter, please contact Debra A. Miller,
Environmental Engineer Senior, of my staff at (804) 698-4206.

Very truly yours,


For Dennis H. Treacy

c: Claire Ballard - DEQ
Melissa Porterfield- DEQ
Glenn VonGonten-DEQ
Aziz Farahmand-DEQ/WCRO
Central Hazardous Waste File

Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

October 14, 1998

98-815-205

Ms. Debra Miller
Virginia Department of Environmental Quality
Office of Permitting Management
629 East Main Street
Richmond, VA 23219

Subject: Risk Assessment and Closure Certification
Incinerator Spray Pond (HWMU 39)
Radford army Ammunition plant
EPA ID# VA1210020730

Dear Ms. Miller:

Enclosed are two copies of the "Amended Risk Assessment and Closure Certification for the Former Incinerator Spray pond at the Radford Army Ammunition Plant". This submittal addresses the comments contained in your May 12, 1998 and July 23, 1998 letters to Ms. C. A. Jake.

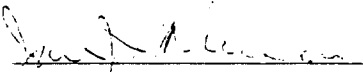
If you have any questions or would like additional information, please coordinate with Arne Olsen (540) 639-8220 (Arne_Olsen@ATK.com) or Jerry Redder (540) 639-7536 (Jerome_Redder@ATK.com).

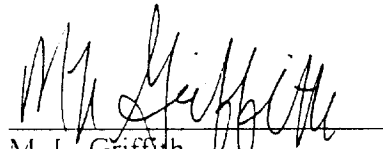
Sincerely,


C. A. Jake, Supervisor
Environmental

AE Olsen.815-205

Coordination:


J. McKenna


M. L. Griffith

Bc: Administrative File
S. J. Barker
C. A. Jake
A. E. Olsen
Env. File

Rec'd ENV 7-28-98 aog

C. Jake
Richardson -
Reiter
Allen
ENV file



98-108

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

James S. Gilmore, III
Governor

John Paul Woodley, Jr.
Secretary of Natural Resources

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Dennis H. Treacy
Director

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

July 23, 1998

C.A. Jake
Alliant Techsystems Inc.
Environmental Manager
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

**RE: Radford Army Ammunition Plant (RAAP)
EPA ID# VA12100207306
Incinerator Spray Pond
Closure Report Risk Assessment Review**

Dear Ms. Jake:

The closure report for the incinerator spray pond, HWMU-39, was received by the Department of Environmental Quality [DEQ] on February 27, 1998. This report was submitted in support of the closure certifications submitted on the same date. The general information and the background closure information was previously reviewed. Review of the risk-based assessment has now been completed.

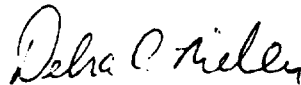
Based on the information provided in support of the risk assessment, the following comments will need to be addressed prior to DEQ verification of the Incinerator Spray Pond closure:

1. Section 3.4.5: Please correct the Chromium concentration listed for Location D3 to 38.5, as is noted in the risk assessment section 4.0.
2. Section 4.2 notes that excavation of 18 to 24 inches of soil underlying the concrete Incinerator Spray Pond was accomplished. Please note, a diagram indicating the lateral and vertical extent of the excavation shall be submitted in order to support both the background and risk-based closure scenarios.

3. Table 1: The chronic inhalation reference dose for arsenic is 1.75 mg/kg/day. This data is based on the default database from the REAMS model. Please correct the calculations for this value and correct the information, as stated in Section 4.5. Additionally, what values were utilized for the dermal absorption factor? Please add these values, as well.
4. Please provide actual example calculations and/or REAMS output for the risk assessments performed in addition to the summary tables [Table 3 and 4] and equation tables of Attachment 4. If the risk analysis was performed using the REAMS model, please provide the electronic data file as well.
5. Table 5: The Site Conceptual Exposure Model [SCEM] is permissible to use; however, additional information will need to be submitted to justify the default values and assumptions made. Please provide the range of default values and the justification for the values used. For instance, the K_d is dependent on soil pH so, for the default values chosen, a discussion should be included that explains the choices made. Justifications for the infiltration rate, soil porosity and bulk density values chosen shall also be submitted. For the default attenuation factor, please provide the justification and reference [it is assumed that the reference is the *Soil Screening User's Guide*, but it is not clearly footnoted].

The closure report format provided is good; however, additional details need to be provided to explain and demonstrate risk-based closure of the incinerator spray pond. Please review these comments and revise the closure report to include the necessary information. If there are any questions, please contact me via my Internet E-mail address at damiller@deq.state.va.us or at (804) 698-4206.

Sincerely,



Debra A. Miller
Environmental Engineer Senior

cc: Claire Ballard, DEQ
Aziz Farahmand, DEQ-RRO
Melissa Porterfield, DEQ

Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

June 8, 1998

98-815-128

Re: 98-76

Debra Miller
Environmental Engineer Senior
Office of Permitting Management
629 East Main Street
Richmond, VA 23219

Subject: Response to Closure Report Review, dated May 12, 1998
Incinerator Spray Pond HWMU 39
Radford Army Ammunition Plant, Radford Virginia,
EPA ID# VA1210020730

Dear Ms. Miller:

Thank you for your review of the closure report for the incinerator spray pond, HWMU-39. The comments to the general information and background closure information are being addressed at this time. Alliant Techsystems feels that a single, final submittal of the closure report for the incinerator spray pond would be the most efficient use of the resources currently available to Alliant. Therefore, Alliant will hold the final submittal of the closure report until the review of the risk-based assessment is completed and the review comments adequately addressed.

The following are preliminary responses to your comments which have been included for clarity:

1. *The narrative of the closure report only briefly mentions the background closure process. As the majority of the hazardous constituents of concern were closed to background standards [i.e., by statistical comparison to background data], additional information is necessary to discuss the background closure. It is noted that the background and upper tolerance level calculations are included in the amendment; however, the statistical comparison of the unit sample data to the background and the results of the comparison need to be presented in the closure report. The closure report shall explain how RAAP determined that each constituent had met or not met the closure requirements for background statistical comparison, and provide the summary data supporting those conclusions.*

Response: The closure report will be revised to include a new section that will adequately address the statistical comparison to background. This section will include: a narrative that discusses the background closure process, information on the statistical development of the background values, an explanation of how RFAAP determined that each constituent had met or not met the closure requirements for background, the statistical comparison of the unit sampled data to the background values and all summary data to support the conclusions derived from this data.

2. *The certification sheet submitted was a copy of the original. Please submit the original to the DEQ and keep a copy for your records.*

Response: The original certification sheet is enclosed. An updated certification will be included with the final submittal of the closure report for the incinerator spray pond.

3. *Attachment 3 of the closure report shows the unit sample data at various depths. Information summarizing the findings (i.e., summary table of pertinent data) and a discussion of the QA/QC findings shall be included in the closure report narrative, as well. For instances, in situations where the PQLs exceeded the approved plan's PQL, appropriate comments and justifications shall be provided in the closure report narrative.*

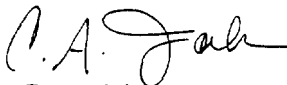
Response: The closure report will be revised to include a new section to discuss the unit sample data including summary tables of pertinent data, and a discussion of the QA/QC findings.

4. *The vertical and lateral extent of the excavation should be shown in diagram form, in addition to the narrative discussion.*

Response: This diagram will be added to the narrative discussion in Section 3.4

If you have any questions or concerns please contact Jerry Redder (540) 639-7536 (Jerome_Redder@ATK.com) or Arne Olsen (540) 639-8220 (Arne_Olsen@ATK.com)

Sincerely



C. A. Jake

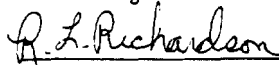
Environmental Manager

Enclosure

c: West Central Regional Office - Roanoke

Coordination:

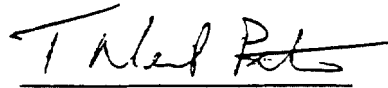

M. L. Griffin


R. L. Richardson

bc: Adm. File
Env. File
D. W. Shead - w/o enclosure
C. A. Jake - w/o enclosure
R. L. Richardson - w/o enclosure
J. J. Redder - w/o enclosure
A. E. Olsen - w/ enclosure

COMPLIANCE CERTIFICATION

Environmental Resources Management certifies that the closure of the incinerator spray pond at the Radford Army Ammunition Plant in Radford, Virginia, was performed and completed in accordance with the Virginia Department of Environmental Quality approved Closure Plan dated 18 August 1995, and amended 9 October 1997.



T. Neil Peters

023736

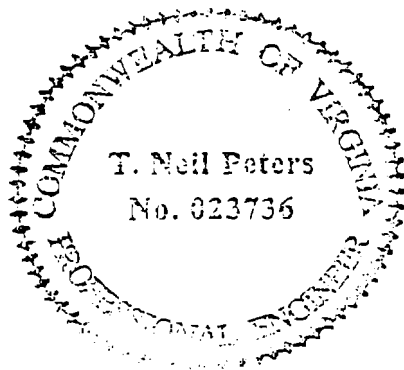
Registration No.

VA

State

1/10/98

Date


for Radford Army Ammunition PlantRESIDENT MANAGER
Title6/11/98
Date

DUP 7819

MEMO SHIPPING ORDER

DATE: 6-12-98

ROUTE TO: 1. TRAFFIC DEPARTMENT

2. FISCAL DEPARTMENT

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SHIP TO: Debra Miller
Environmental Engineer Senior
Office of Permitting Management
629 East Main Street
Richmond, VA 23219

=====
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REQUESTED BY: A. Olsen Dept. 815 CHARGE CODE: 634372-001

APPROVAL:

DEPARTMENT HEAD C. A. Jake

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US ARMY BLDG 220/ALLIANT TECH
RAIDFORD ARMY AMUNITION PLANT
STATE ROUTE 114, P. O. BOX 1
RAIDFORD
VA 241410100

RECIPIENT:
DEBRA MILLER
OFFICE OF PERMITTING MANAGEMENT
629 EAST MAIN STREET
ENVIRONMENTAL ENGINEER SENIOR
RICHMOND
VA 23219

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- **Delivery Location : RICHMOND VA**
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- **Signed For By : S.DREW**
- **Status Exception : Pre-routed meter package**
- **Scan Activity :**
 - **Delivered RICHMOND VA 06/15 10:05**
 - **Package on Van RICHMOND VA 06/15 08:17**
 - **Arrived at Destination RICHMOND VA 06/13 11:31**
 - **Package Left Hub MEMPHIS TN 06/13 01:19**
 - **Package Left Hub MEMPHIS TN 06/13 04:17**
 - **Package Left Hub MEMPHIS TN 06/13 03:32**
 - **Package Left Hub MEMPHIS TN 06/13 00:45**
 - **Package left FedEx Ramp ROANOKE VA 06/12 19:37**
 - **Left Origin Location CHRISTIANSBURG VA 06/12 18:51**
 - **Pickup Exception CHRISTIANSBURG VA 06/12 16:22**

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Rec'd ENV 5-15-98-als



98-76

C: Jake
Redder
Olson
Richardson
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COMMONWEALTH of VIRGINIA

James S. Gilmore, III
Governor

John Paul Woodley, Jr.
Secretary of Natural Resources

DEPARTMENT OF ENVIRONMENTAL QUALITY

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Thomas L. Hopkins
Director

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

May 12, 1998

C.A. Jake
Alliant Techsystems Inc.
Environmental Manager
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

**RE: Radford Army Ammunition Plant (RAAP)
EPA ID# VA12100207306
Incinerator Spray Pond
Closure Report Review**

Dear Ms. Jake:

The closure report for the incinerator spray pond, HWMU-39, was received by the Department of Environmental Quality [DEQ] on February 27, 1998. This report was submitted in support of the closure certifications submitted on the same date. The information has been reviewed; however, please note that this review was limited to the general information and the background closure information provided. Review of the risk-based assessment and associated closure determination will be completed after May 14, 1998.

However, at this time, comments regarding the closure report's general and background closure information will be provided in this letter. Based on the information provided, the following comments will need to be addressed prior to DEQ verification of the Incinerator Spray Pond closure:

1. The narrative of the closure report only briefly mentions the background closure process. As the majority of the hazardous constituents of concern were closed to background standards [i.e., by statistical comparison to background data], additional information is necessary to discuss the background closure. It is noted that the background data and upper tolerance level calculations are included in the amendment;

however, the statistical comparison of the unit sample data to the background and the results of that comparison need to be presented in the closure report. The closure report shall explain how RAAP determined that each constituent had met or not met the closure requirements for background statistical comparison, and provide the summary data supporting those conclusions.

2. The certification sheet submitted was a copy of the original. Please submit the original to the DEQ and keep a copy for your records.
3. Attachment 3 of the closure report shows the unit sample data at various depths. Information summarizing the findings (i.e., summary table of pertinent data) and a discussion of the QA/QC findings shall be included in the closure report narrative, as well. For instances, in situations where the PQLs exceeded the approved plan's PQL, appropriate comments and justifications shall be provided in the closure report narrative.
4. The vertical and lateral extent of the excavation should be shown in diagram form, in addition to the narrative discussion.

The closure report format provided is good; however, additional details need to be provided to explain and demonstrate closure of the incinerator spray pond. Please review these comments and revise the closure report to include the necessary information. If there are any questions regarding these comments, please contact me at (804) 698-4206.

Sincerely,



Debra A. Miller
Environmental Engineer Senior


cc: Claire Ballard, DEQ
- Aziz Farahmand, DEQ-RRO
Melissa Porterfield, DEQ

Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

February 24, 1998

98-815-048

Ms. Debra Miller
Virginia Department of Environmental Quality
Office of Permitting Management
629 East Main Street
Richmond, VA 23219

Subject:: Risk Assessment and Closure Certification
Incinerator Spray Pond (HWMU 39)
Radford Army Ammunition Plant
EPA ID# VA1210020730

Dear Ms. Miller:

Enclosed are two copies of the "*Risk Assessment and Closure Certification for the Former Incinerator Spray Pond*" and the soil sample Quality Assurance package for the incinerator spray pond (HWMU 39) at the Radford Army Ammunition Plant in Radford, Virginia.

Background soil samples were collected in accordance with the approved "*Closure, Contingent Closure and Contingent Post-Closure Plans for Radford Army Ammunition Plant's Incinerator Spray Pond (HWMU 39)*." Upper tolerance limits for each Hazardous Constituent of Concern (HCOC) were calculated based on the background analytical results and were approved by DEQ in a May 22, 1997 letter. These background tolerance limits set the cleanup thresholds for the closure.

Construction activities began July 11, 1997 and were completed October 16, 1997. Mr. Mike Scott and Ms. Kim Batwinas of the Virginia Department of Environmental Quality West Central Regional Office performed a site inspection of the incinerator spray pond on October 22, 1997. Verbal approval to backfill the excavation was provided by Mr. Mike Scott with the understanding that if the risk assessment indicated further soils should be excavated from the unit, the backfilled material would have to be removed. Alliant began backfilling and compaction activities on October 24, 1997 and completed these activities on October 31, 1997.

Three HCOCs exceeded background tolerance limits at the twenty-four (24) inch depth: arsenic, barium, and chromium. A risk assessment was performed for these HCOCs using the REAMS model. As provided in the table below, the results indicate risks below the residential thresholds. Section 4.0 in the attached report provides the details of the REAMS model risk assessment.

<u>Contaminant</u>	<u>Location</u>	<u>Result (ppm)</u>	<u>Threshold (ppm)</u>	<u>Hazard Quotient</u>
Arsenic	D1	6.46	5.43	0.49
Barium	E1	199	125.75	0.05
Chromium	A1	31.3	30.55	0.104*
	A4	32.6	30.55	
	C2	37.5	30.55	
	D1	34.3	30.55	
	D3	38.5	30.55	
	E2	31.5	30.55	
TOTAL				0.644

* Highest concentration of chromium used for hazard quotient calculation. All hazard quotient calculations include both adult and child risks.

If you have any questions or would like additional information, please coordinate with Jerry Redder (540)639-7536 (Jerry_Redder@ATK.com) or Christel Compton (540)639-8211 (Christel_Compton@ATK.com).

Sincerely,

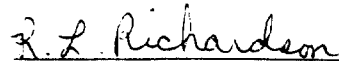

C.A. Jake, Supervisor
Environmental

Enclosures

cc. Mary Beck, USEPA Region III (3)
Rob Thompson, USEPA Region III (2)
Devlin Harris, DEQ West Central Regional Office - Roanoke
Mike Scott, DEQ West Central Regional Office - Roanoke
R.L. Richardson, RFAAP ACO

Coordination:


M.L. Griffin


R.L. Richardson

- bc. Administrative File
 Envir. File, w/ enclosure
 R. Davie, RFAAP ACO - w/ enclosure
 Jim Small, IOC - w/o enclosure
 D.W. Shead - w/o enclosure
 C.A. Jake - w/o enclosure
 J.J. Redder - w/o enclosure
 C.E. Compton - w/o enclosure

Rec'd ENV 10-20-97



97-174

C: Jake.
ENV file
Barker
Olsen
Barker

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

George Allen
Governor

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Thomas L. Hopkins
Director

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

Becky Norton Dunlop
Secretary of Natural Resources

Certified Mail
Return Receipt Requested

October 9, 1997

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

RE: Radford Army Ammunition Plant (RAAP)
EPA ID# VA1210020730
Incinerator Spray Pond Closure Plan Amendment

Dear Ms. Jake:

Your letter requesting an amendment to the approved closure plan for RAAP's incinerator spray pond was submitted to the Department of Environmental Quality (DEQ) on October 3, 1997. The amendment will allow for RAAP to pursue closure to risk-based standards for the referenced hazardous waste management unit.

Based on the information submitted, the amendment requested is approved. An update to the closure plan's pages are attached and will need to be added to the closure plan. Please update your closure plan as needed.

As provided in Rule 2A:2 of the Supreme Court of Virginia, you have 30 days from the date of service of this decision to initiate an appeal by filing a notice of appeal with:

Thomas L. Hopkins, Director
Virginia Department of Environmental Quality
629 East Main Street

P.O. Box 10009
Richmond, Virginia 23240-0009

In the event that this decision is served to you by mail, the date of service will be calculated as three days after the postmark date. Please refer to Part Two A of the Rules of the Supreme Court of Virginia, which describes the required content of the Notice of Appeal, including specifications of the Circuit Court to which the appeal is taken, and additional requirements concerning appeals from decisions of administrative agents.

If you should have any questions, concerning this matter, please contact Debra Miller, Environmental Engineer Senior, of my staff at (804) 698-4206.

Sincerely,

Leslie A. Romanchik

for Thomas L. Hopkins

Attachment

cc: Jerry Redder, Alliant Techsystems-RAAP
Robert Greaves, EPA Region III
Leslie Romanchik, DEQ (w/out Attachment)
Debra Miller, DEQ
Glenn VonGonten, DEQ
Claire Ballard, DEQ (w/out Attachment)
Aziz Farahmand, DEQ/RRO-Compliance
CENTRAL HW FILES

- d. Following resampling, comparison to background¹ along with additional 6-inch soil layer excavation (if required) will be performed in accordance with the protocols previously outlined.

If, upon following these protocols in an attempt to achieve clean closure, the pond surface soils have been removed from the hot spot(s) down to a sufficient level without achievement of clean closure for all closure parameters, Radford Army Ammunition Plant (RAAP) will:

- * Implement the contingent closure and post-closure procedures of this plan; or
- * Continue with removal activities and sampling of soil layers, as detailed above; or
- * Perform closure to risk based standards as detailed in §3.7.6 of this closure plan.

As previously stated, the facility reserves the option, at any point during the incinerator spray pond subsoils assessment, to abandon attempts to demonstrate clean closure to either background or risk based standards, and immediately implement contingent closure and post-closure.

3.7.6 Risk-Based Closure

As an alternative to clean closure to background standards, specified above, or in conjunction with background standards, RAAP may propose to demonstrate that the concentrations of hazardous constituents detected do not pose an unacceptable level of risk to human health and the environment. The facility may present this proposal to the DEQ following the requirements as outlined in this section and as detailed in Appendix A.

In order to estimate the risk for HCOCs, a risk assessment will be conducted according to the DEQ document titled "Guidance for development of health based cleanup goals using decision tree/REAMS program (herein after "Virginia Risk Guidance"), November 1, 1994, prepared by Old Dominion University and the approved closure plan. The risk goals/performance standards will be a hazard index of 1.0 for non-carcinogens and an individual carcinogenic risk of 1×10^{-6} and cumulative carcinogenic risk of 1×10^{-4} . This risk assessment will be conducted assuming a future residential use of the property.

The Department will review the risk assessment report to determine that it conforms to risk assessment requirements for residential risk-based protocols. If acceptable, attainment of the closure standards may then be demonstrated using the residential risk-based assessment in lieu of the clean closure to background standards established under §3.7.1 Background Sampling For Soil Assessment.

If the Incinerator Spray Pond cannot meet the residential risk closure standards, then RAAP may propose to modify this closure plan for industrial risk-based closure. Modification will require notification of the DEQ and the submittal of a closure amendment, in accordance with 9 VAC 20-60-580.C (previously, VHWMR §9.6.C).

¹(Optional) The background critical value described thus far will have been computed from the top layer (0-6 inches) of the background area. It may be necessary to sample background at lower intervals (6-12 inches, 12-24 inches) for comparison at lower intervals to avoid bias. This option should be implemented if, for example, distinctly different soil types are encountered at depth, thereby necessitating re-establishment of background.

Note, for the remaining sections of the closure plan, any discussions of "clean" closure of the incinerator spray ponds' subsoils, will signify either clean closure to background levels and/or closure to risk based closure standards, as described in this section.

3.8 Field Quality Control

To ensure the collection of representative samples, the following field quality control procedures will be utilized during the closure operations.

Equipment blanks will be collected after every 20th sample. If equipment blanks indicate contamination, then resampling will occur only if sample results are above cleanup levels. Samples will be analyzed for the hazardous constituents of concern identified in this document. Laboratory quality control will be according to the methods detailed in SW-846.

Laboratory quality control will be according to the methods detailed in SW-846.

Appendix A
RISK-BASED CLOSURE

1. Introduction

This document discusses the protocol for conducting a risk assessment to implement closure of a hazardous waste management unit (HWMU) in accordance with the Virginia Hazardous Waste Management Regulations (VHWMR) as codified in Title 9 of the Virginia Administrative Code, Agency 20, Chapter 20 (9 VAC 20-60-10 et seq).

2. Risk-Based Evaluation

In order to estimate the risk for hazardous constituents of concern (HCOC) associated with the materials remaining in a HWMU, a risk assessment will be conducted according to the Virginia DEQ document titled "Guidance for Development of Health Based Cleanup Goals Using Decision Tree/REAMS Program (herein after "Virginia Risk Guidance") (November 1, 1994) prepared by Old Dominion University and the approved closure plan. The risk assessment report will contain the following sections:

- site evaluation,
- development of a site conceptual model,
- identification of contaminants of concern,
- identification of media and exposure pathways,
- toxicity assessment,
- estimation of contaminant concentration at the point of exposure, and
- summary of health risk.

The submission instructions contained in Appendix IX of the Virginia Risk Guidance will be reviewed prior to submitting the report to confirm that all necessary risk issues have been addressed. The risk goals associated with the closure performance standards (risk goals) will include:

- i. a hazard index of 1.0 or less for non-carcinogens;
- ii. a risk of 1E-06 or less for individual carcinogens;
- iii. cumulative risk of 1E-04 or less for all carcinogens; and
- iv. the concentrations of HCOC remaining in the HWMU will not result in contamination of other environmental media of concern, including the groundwater underneath the unit.

Compliance with the closure standard shall be verified by comparing the calculated individual and cumulative risk/hazard for all HCOC that failed the background statistical comparison (if such comparison is preformed) to the risk goals.

The risk assessment will be conducted assuming a future residential/industrial use of the property. The methodology and equations for estimating the exposure concentration are presented in subsequent sections.

The initial step in the risk assessment will be to develop a site conceptual exposure model (SCEM) which depicts all potential exposure routes and media for the site and the receptors which may be exposed. Then HCOC for the risk assessment are identified (See Section 3 of this document).

In the next step, the exposure assumptions outlined in the Virginia Risk Guidance will be employed to estimate the risk. Information will also be taken as needed from U.S. EPA documents and databases (e.g., the Risk Assessment Guidance for Superfund (RAGS), and the Integrated Risk Information System (IRIS)). The chemical intake equations and exposure parameter assumptions used to estimate risk (obtained from the Virginia Risk Guidance) are shown in Tables 1 through 4. Additional details on the approach and assumptions used for each potential exposure pathway are provided below.

As a part of the Risk Exposure and Analysis Modeling System (REAMS) evaluation, fate and transport modeling is conducted to demonstrate that the residual soil concentrations of contaminants of concern would not result in contamination of other environmental media of concern including the groundwater underneath the closure unit. For this purpose, representative soil sample(s) will be collected around the unit (subjected to closure) for analysis of the properties listed on page 62 of the REAMS document. In certain situations, groundwater sampling is preferable.

3. Identification of Hazardous Constituents of Concern for Risk Assessment

For the purpose of REAMS evaluation associated with a HWMU, HCOC are those closure constituents present at concentrations statistically exceeding the background levels. If the concentrations of a closure constituent did not statistically exceed the background levels, no further risk-based evaluation for such constituent is required.

4. Exposure Assessment

The exposure assessment will identify transport mechanisms for the contaminants of concern that may potentially impact human receptors. The results of this assessment will be used to document the current and potential exposure posed by the HWMU.

With regard to the soil, a residential exposure will be assumed to document unrestricted closure of the soil. If the risk for potential residential exposure does not exceed the performance standards, unrestricted closure of soil will be accepted. If the site cannot be clean closed for residential use, then the option to pursue restricted closure (commercial/industrial) will be exercised. Closure to commercial/industrial scenario will require the facility to enact a deed restriction that eliminates the possibility of future residential use of the site. The requirements for establishing such a deed restriction are detailed in VDEQ's Guidelines for Developing Health-

Based Cleanup Goals Using Risk Assessment at A Hazardous Waste Site Facility for Restricted Industrial Use, dated June 1995. (A copy of this document is attached.)

Exposure routes will include ingestion, dermal absorption, and inhalation of vapors and dust particles.

With regard to impact to the groundwater underneath the HWMU, REAMS fate and transport modeling² will be required to assess impact from residual soil contamination to the groundwater. If the groundwater does not qualify for clean closure, the scope of future groundwater monitoring will be discussed with VDEQ. The groundwater exposure routes to be evaluated include ingestion, dermal absorption, and inhalation of volatiles emitted from the contaminated groundwater.

The exposure assumptions presented in the following sections are based on residential exposure. These constitute a reasonable maximum exposure scenario (RME), an exposure which is unlikely to occur but is reasonably possible. The exposure pathways for residential exposure include ingestion of soil, dermal contact with soil, inhalation of resuspended soil particulates, and inhalation of volatile organic compounds.

4.1 Ingestion of Soil

The equation for potential chemical intake by soil ingestion on-site is included in Table 1. This scenario also assumes that weather or other conditions (e.g., frozen ground/ snow /other cover) do not affect exposure and that all soil ingested is from contaminated areas of the site. These assumptions are protective of human health and the environment.

4.2 Dermal Contact with Soil

The equation for calculating the potential absorbed chemical dose by dermal contact with contaminated soil is provided in Table 1. This scenario assumes that weather or other conditions (e.g., frozen ground/ snow or other cover) do not affect exposure, that contaminated soil remains on the skin long enough for the HCO₂ to be absorbed and that all soil adhering to the skin is from contaminated areas of the site.

The skin surface areas (SA) used in the dermal pathway have been identified in Virginia Risk Guidance as 4,860 cm² for adults, which is the 50th percentile value for the arms, hands and lower legs (U.S. EPA, 1989b - See Attachment A).

REAMS includes the unsaturated zone fate and transport model SESOIL. The purpose of running the model is two fold: a) determine whether the contaminants will reach the groundwater table in next 30 years. b) calculate the risk associated with the estimated concentration in the groundwater. For constituents with a promulgated MCL, the estimated concentration will be directly compared against the MCL. However, prior to running the SESOIL model the facility should obtain all the information identified on page 62, of the Virginia Risk Guidance. The closure report must include evaluation of model results (concentrations reaching the groundwater) and a copy of SESOIL output file.

A skin-soil adherence factor of 1.45 mg/cm^2 will be used in the dermal intake calculations. The U.S. EPA guidance for dermal exposure assessment (*Dermal Exposure Assessment: Principles and Applications*, EPA/600/8-91/011B) states that a range of values from 0.1 mg/cm^2 to 1.5 mg/cm^2 per event appear possible for dermal adherence factors (AF). In order to estimate the amount of a particular HCOC which may potentially be absorbed through the skin, chemical-specific dermal absorption factors (ABS_{derm}) are used.

4.3 Inhalation of Resuspended Soil

The equation for potential chemical intake by inhalation of resuspended contaminated soil is included in Table 1. An inhalation rate of $0.83 \text{ m}^3/\text{hr}$ will be used as specified in the Virginia Risk Guidance. This scenario assumes that the concentration of HCOC in indoor dust will be equal to that in outdoor soil and that weather or other conditions, (e.g., frozen ground/snow or other cover) do not affect resuspension or exposure.

However, an appropriate model or equations in Table 1 will be used to estimate the potential amount of respirable particulate matter generated by wind erosion. The estimated generation rate for eroded particulate matter will then be used to derive an ambient air particulate concentration. Justification for and documentation of the model(s) used will be submitted to the Department as part of the risk assessment.

4.4 Inhalation of Volatilized HCOC in Soil

Since the HCOC have appreciable vapor pressures, they are expected to volatilize from soil. Inhalation of HCOC as volatilized vapors is considered for this risk assessment. The equations in Table 1 will be considered for estimating the intake for this condition.

5. Toxicity Assessment

The two principle indices of toxicity used in risk assessment are the reference dose (RfD) and the cancer slope factor (SF). An RfD is the intake or dose per unit of body weight (mg/kg-day) that is unlikely to result in toxic (non-carcinogenic) effects to human populations, including sensitive subgroups (e.g., the very young or elderly). The RfD allows for the existence of a threshold dose below which no adverse effects occur.

The SF is used to express the cancer risk attributable to a discrete unit of intake; that is, the cancer risk per milligram ingested per kilogram of bodyweight per day ($[\text{mg/kg-day}]^{-1}$). The SF is an estimate of the upper-bound probability of an individual developing cancer as a result of exposure to a particular carcinogen. Unlike the RfD, the SF assumes that there is no threshold dose below which the probability of developing cancer is zero. Note that SFs are only developed for those chemicals which have been shown to be carcinogens in man or in at least several animal species. A carcinogenic weight of evidence rating is used to describe the strength of the experimental evidence for carcinogenicity. The U.S. EPA has developed SFs for most chemicals

with weight of evidence ratings of "A" (known human carcinogen) or "B" (probable human carcinogen).

RfDs and SFs are derived by the U.S. EPA for the most toxic chemicals generally associated with chemical releases to the environment for which adequate toxicological data are available. If both the carcinogenic and non-carcinogenic effects of a particular compound are significant, both values may be established. However, in most cases only one value is available.

5.1 Inhalation and oral RfDs and SFs

RfDs and SFs pertinent to the oral and inhalation exposure pathways will be obtained from U.S. EPA's IRIS database. The IRIS (Integrated Risk Information System) on-line database was established by the U.S. EPA to provide risk assessors with peer reviewed toxicological data on chemicals commonly encountered at environmental sites of contamination. If data is not available from IRIS, it will be obtained from the Health Effects Assessment Summary Tables (HEAST), a compilation of toxicity values produced by the USEPA on a quarterly basis. The hierarchy presented in Appendix III of Virginia Risk Guidance will be followed for using these sources.

5.2 Dermal RfDs and SFs

Chemical specific oral-route absorption values (ABS_{oral}) are used to adjust the oral RfD or SF, which is computed from an administered dose, for use in the dermal exposure pathway. This correction is necessary due to the differences in absorption between the skin and the gastrointestinal tract. By correcting the administered-dose oral RfD or SF for the fraction expected to be absorbed in the gut, a dermal absorption factor can be used to estimate the correct dose received through the skin.

6. Evaluation of Risk

Using the toxicity criteria and identified exposure pathways discussed above, and the procedures described in the Virginia Risk Guidance, the risk presented by the HCOC will be estimated. The estimated risk will consider the effects from multiple constituents and all routes of exposure. The risk goals will be a total cumulative hazard index of 1.0 for multiple noncarcinogens and a total cumulative carcinogenic risk of $1E-04$ for multiple carcinogens. However, the risk from each individual carcinogen shall not exceed $1E-06$ (i.e., one case of cancer per 1,000,000 population).

6.1 Estimation of exposure concentration

For the contaminants detected at the site, an exposure point concentration (EPC) for each exposure pathway will be calculated for each contaminant by estimating the 95th upper confidence limit (UCL) on the arithmetic mean of the concentrations. If the calculated 95th UCL is greater than the maximum detected concentration, then the

maximum detected concentration will be used as the EPC. The risk for contaminants will be calculated as per the equations and assumptions described in Tables 1 through 4. If for a contaminant both carcinogenic and noncarcinogenic risk-based cleanup goal exists, the lower of the two will be used as a pathway specific to estimate the risk.

6.2. Risk Estimation

Health risk assessments are based on the relationship involving intake, contaminant concentration, risk, and toxicity. Chronic daily intake (CDI), a product of intake and contaminant concentration, are estimated using the exposure equations and assumptions associated with each route of exposure. CDIs are then combined with the RfDs or SFs to determine the resulting risk. For carcinogen(s), cumulative potential risk (RISK_c) can be calculated as follows:

$$\text{RISK}_c = \text{CDI}_{\text{ingestion}} * \text{SF}_{\text{ingestion}} + \text{CDI}_{\text{dermal}} * \text{SF}_{\text{dermal}} + \text{CDI}_{\text{inhalation-VOCs}} * \text{SF}_{\text{inhalation-VOCs}} + \text{CDI}_{\text{inhalation-particles}} * \text{SF}_{\text{inhalation-particles}}$$

For noncarcinogen(s), cumulative hazard index (HI_c) can be calculated as follows:

$$\text{HI}_c = \text{CDI}_{\text{ingestion}} / \text{RfD}_{\text{ingestion}} + \text{CDI}_{\text{dermal}} / \text{RfD}_{\text{dermal}} + \text{CDI}_{\text{inhalation-VOCs}} / \text{RfD}_{\text{inhalation-VOCs}} + \text{CDI}_{\text{inhalation-particles}} / \text{RfD}_{\text{inhalation-particles}}$$

where, taking into account all HCOC and relevant exposure pathways, the excess cancer risk is 10⁻⁶ or the hazard index is 1.0.

Table 1
Risk Assessment Algorithm for Carcinogenic Exposure

Exposure Route	Chronic Daily Intake (CDI), mg/L-day	
	Residential Exposure	Occupational/Industrial Exposure
Ground Water		
Ingestion	$\frac{CW \times IRW_{adj} \times EF}{AT_c}$	$\frac{CW \times IRW_a \times EF_o \times ED_o}{BW_a \times AT_c}$
Inhalation	$\frac{CW \times IRA_{adj} \times EF \times K}{AT_c}$	$\frac{CW \times IRA_a \times EF_o \times ED_o \times K}{BW_a \times AT_c}$
Dermal	$\frac{CW \times SAW_{adj} \times PC \times ET \times EF \times CF}{AT_c}$	$\frac{CW \times SAW_a \times PC \times ET \times EF_o \times ED_o \times CF}{BW_a \times AT_c}$
Soil		
Ingestion	$\frac{CS \times IRS_{adj} \times CF \times FI \times EF}{AT_c}$	$\frac{CS \times IR \times CF \times FI \times EF_o \times ED_o}{BW_a \times AT_c}$
Dermal	$\frac{CS \times CF \times SAS_{adj} \times AF \times ABS \times EF}{AT_c}$	$\frac{CS \times CF \times SAS_a \times AF \times ABS \times EF_o \times ED_o}{BW_a \times AT_c}$
Inhalation of vaporizing VOCs from soil	$\frac{VF \times IRA_{adj} \times ET \times EF}{AT_c}$	$\frac{VF \times IRA_a \times ET \times EF_o \times ED_o}{BW_a \times AT_c}$
Inhalation of emitting particles from soil	$\frac{PEF \times IRA_{adj} \times ET \times EF}{AT_c}$	$\frac{PEF \times IRA_a \times ET \times EF_o \times ED_o}{BW_a \times AT_c}$

Table 2
Risk Assessment Algorithm for Non-carcinogenic Exposure

Exposure Route	Chronic Daily Intake (CDI), mg/L-day	
	Residential Exposure	Occupational/Industrial Exposure
Ground Water		
Ingestion	$\frac{CW \times IRW_c \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{CW \times IRW_a \times EF_o \times ED_o}{BW_a \times AT_n}$
Inhalation	$\frac{CW \times IRA_c \times EF \times ED_c \times K}{BW_c \times AT_n}$	$\frac{CW \times IRA_a \times EF_o \times ED_o \times K}{BW_a \times AT_n}$
Dermal	$\frac{CW \times SAW_c \times PC \times ET \times EF \times ED_c \times CF}{BW_c \times AT_n}$	$\frac{CW \times SAW_a \times PC \times ET \times EF_o \times ED_o \times CF}{BW_a \times AT_n}$
Soil		
Ingestion	$\frac{CS \times IRS_c \times CF \times FI \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{CS \times IRS_a \times CF \times FI \times EF_o \times ED_o}{BW_a \times AT_n}$
Dermal	$\frac{CS \times CF \times SA_c \times AF \times ABS \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{CS \times CF \times SA \times AF \times ABS \times EF_o \times ED_o}{BW_a \times AT_n}$
Inhalation of vaporizing VOCs from soil	$\frac{VF \times IRA_c \times ET \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{VF \times IRA_a \times ET \times EF_o \times ED_o}{BW_a \times AT_n}$
Inhalation of emitting particles from soil	$\frac{PEF \times IRA_c \times ET \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{PEF \times IRA_a \times ET \times EF_o \times ED_o}{BW_a \times AT_n}$

Note: Occupational noncarcinogenic risk assessment is based on adult exposure

Table 3
Age Adjusted Factors

$$IRA_{adj} = \frac{ED_c \times IRA_c}{Bw_c} + \frac{(ED_{tot} - ED_c) \times IRA_a}{BW_a}$$

$$IRW_{adj} = \frac{ED_c \times IRW_c}{Bw_c} + \frac{(ED_{tot} - ED_c) \times IRW_a}{BW_a}$$

$$SAW_{adj} = \frac{ED_c \times SAW_c}{Bw_c} + \frac{(ED_{tot} - ED_c) \times SAW_a}{BW_a}$$

$$IRS_{adj} = \frac{ED_c \times IRS_c}{Bw_c} + \frac{(ED_{tot} - ED_c) \times IRS_a}{BW_a}$$

$$SAS_{adj} = \frac{ED_c \times Sa_c}{Bw_c} + \frac{(ED_{tot} - ED_c) \times Sa_a}{BW_a}$$

Note regarding age adjusted factor:

Because contact rate with tap water, ambient air, and residential soil are different for children and adults, carcinogenic risk during the first 30 years of life were calculated using age adjusted factor. These factors approximate the integrated exposure from birth until age 30 by combining contact rates, body weights, and exposure durations for two age groups - small children and adults.

Table 4
Exposure Variables Included in Tables 1, 2, and 3

Symbol	Term	Unit	Value	Reference
ABS	Absorption factor	-	User specified	
AF	Adherence factor	-	1.45	a, c
AT _c	Averaging time carcinogens	days	25550	
AT _n	Averaging time non-carcinogens	days	ED x 365	
BW _a	Body weight adult	kg	70	c
BW _c	Body weight child	kg	15	c
CF	Conversion factor	-	0.000001	-
CS	Chemical concentration in soil	mg/Kg-day	User specified	
CW	Chemical concentration in water	mg/L	User specified	
ED _c	Exposure duration child	years	6	c
ED _{total} ED	Exposure duration for carcinogen total or Residential	years	30	c
ED _o	Exposure duration occupational	years	25	c
EF	Exposure frequency residential	days	350	c
ET	Exposure Time General/Occupational Groundwater Surface Water - ingestion Surface water - dermal Air -inhalation	hrs/day	8.0 0.2 2.6 2.6 24.0	c, d
FI	Fraction ingested Residential Occupational	-	1.0 0.5	b
IRA _a	Inhalation rate air adult	m ³ /day	20	b
IRA _{adj}	Inhalation rate - air adjusted	-	11.66	
IRA _c	Inhalation rate child	m ³ /day	12	b
IRA _a	Inhalation rate adult	m ³ /day	20	b
IR	Ingestion rate food Fruit/veggies Fish	kg/day	0.28 0.122 0.054	c,d

IRS _a	Ingestion rate soil adult	mg/day	100	b
IRS _c	Ingestion rate soil child	mg/day	200	b
IRS _{adj}	Ingestion - soil adjusted	-	114.29	
IRS _c	Ingestion rate soil child	mg/day	200	b
IRW _a	Ingestion rate water adult	L/day	2	b
IRW _{adj}	Ingestion -water adjusted	L-y/kg-d	1.09	
IRW _c	Ingestion rate water child	L/day	1	b
K	Volatilization factor, water to air	-	0.5	
PC	Permeability constant	cm/hr	User specified	b
PEF	Particulate emission factor	kg/m ³	6.789926E08	f
SAW _c	Surface area child groundwater dermal surface water dermal	cm ²	7500	b,e
SAS _a SAS _c	Surface area soil occupational - adult child	cm ² /event	4500 1875	e
SAS _{adj}	Surface area soil adjusted	cm ² /event	2290	
SAW _a	Surface area for water contact adult	cm ²	820	b
SAW _{adj}	Surface area for water contact	cm ² /event	9200	
VF	Volatilization factor, soil to air	kg/m ³	User specified	-

References:

- Risk Assessment Guidance for Superfund, Volume I, EPA/540/1-89/002, December 1989.
- Region III values
- Exposure Factors handbook, EPA/600/8-89/043, July 1989
- Human health evaluation manual supplemental guidance, OSWER Directive 9285.6-03, March 25, 1991.
- Dermal exposure Assessment, Principles and Applications, Interim Report. EPA/600/8-91/011b, January 1992.
- Technical Background Document for Draft Soil Screening Level Guidance. Office of Solid Waste and Emergency Response. EPA/540/R-94/101. December 1994.

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October 3, 1997

97-815-225

Debra Miller
Office of Permitting Management
629 East Main Street
Richmond, VA 23219

Subject: Risked Based Closure Amendment
Incinerator Spray Pond HWMU 39
Radford Army Ammunition Plant, Radford Virginia,
EPA ID# VA1210020730

Dear Ms. Miller:

Thank-you for talking with Jerry Redder, Bob Richardson (ACO Staff), Arne Olsen, and Christel Compton, October 2, 1997. Enclosed is the amendment to the "Closure, Contingent Closure and Contingent Post-Closure Plans for Radford Army Ammunition Plant's Incinerator Spray Pond (HWMU-39)"; to include Risked Based Closure as an option for site closure. An advance copy was delivered electronically. We are looking forward to your visit October 22, 1997 to inspect the excavation prior to backfilling.

In order to bring you up to speed on our closure activities, the demolition of the Incinerator Spray Pond began in mid-July and was completed in mid August. During the demolition screening level samples were taken which indicated that the first six inch lift was above background for lead. Based on the screening criteria lift was removed. Further screening indicated that the second six inch lift was below background for lead.

It was decided that the first set of confirmation samples would be taken from second lift. The result of this sampling indicated that lead, barium, and chromium were above background and that antimony, beryllium, cadmium, thallium, diethylphthalate, di-n-butylphthalate and resorcinol were below background. The remaining Hazardous Constituents of Concern (HCOC) concentrations were inconclusive due to laboratory error. Additional confirmatory samples were taken from the third and fourth lifts.

Results from the third and fourth lifts are enclosed. These results indicate clean closure to background is impractical. We will remove the third lift. The necessary

risk based closure documentation, in accordance with the enclosed amendment, for the fourth lift is being prepared. If you have any questions or concerns please contact Jerry Redder (540) 639-7536 (Jerome_Redder@ATK.com) or Christel Compton (540)- 639-7536.

Sincerely

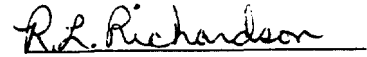


C. A. Jake, Supervisor
Environmental Affairs

Enclosures

c: West Central Regional Office - Roanoke
R. L. Richardson, RFAAP ACO

Coordination:


M. L. Griffith
R. L. Richardson

bc: Adm. File
Env. File, w/ enclosure
R. L. Richardson - w/ enclosure
D. W. Shead - w/o enclosure
C. A. Jake - w/o enclosure
J. J. Redder - w/ enclosure
C. Compton - w/ enclosure

AMENDMENT

3.7.6 Risk Assessment for Closure

As an alternative to the clean closure to background standards specified above or in conjunction with, the owner may propose to demonstrate that the concentrations of hazardous constituents detected do not pose an unacceptable level of risk to human health and the environment. The facility may propose this to the DEQ following the requirements as outlined in this section and as detailed in Appendix A.

In order to estimate the risk for HCOCs, a risk assessment will be conducted according to the DEQ document titled "Guidance for development of health based cleanup goals using decision tree/REAMS program (herein after "Virginia Risk Guidance") (November 1, 1994) prepared by Old Dominion University and the approved closure plan. The risk goals/performance standards will be a hazard index of 1.0 for non-carcinogens and an individual carcinogenic risk of 1×10^{-6} and cumulative carcinogenic risk of 1×10^{-4} . This risk assessment will be conducted assuming a future residential use of the property.

The Department will review the risk assessment report to determine that it conforms to risk assessment requirements for residential risk-based protocols. If acceptable, attainment of the closure standards may then be demonstrated using the residential risk-based assessment in lieu of the clean closure to background standards established under section 3.7.1 Background Sampling For Soil Assessment.

Note, if the Incinerator Spray Pond cannot meet the residential risk closure standards, then Radford Army Ammunition Plant may propose to modify this closure plan for industrial risk-based closure. Modification will require notification of the DEQ and the submittal of a closure amendment.

Appendix D

RISK-BASED CLOSURE

1. **Risk-Based Evaluation** In order to estimate the risk for chemicals of concern (COCs) a risk assessment will be conducted according to the Virginia DEQ document titled "Guidance for development of health based cleanup goals using decision tree/REAMS program (herein after "Virginia Risk Guidance") (November 1, 1994) prepared by Old Dominion University and the approved closure plan. The risk assessment report will contain the following sections:

- site evaluation,
- development of a site conceptual model,
- identification of contaminants of concern,
- identification of media and exposure pathways,
- toxicity assessment,
- estimation of contaminant concentration at the point of exposure, and
- summary of health risks.

The submission instructions contained in Appendix IX of the Virginia Risk Guidance will be reviewed prior to submitting the report to confirm that all necessary risk issues have been addressed. The risk goals/performance standards will be a hazard index of 1.0 for non-carcinogens and an individual carcinogenic risk of $1E-06$ and cumulative carcinogenic risk of $1E-04$.

Compliance with the closure standard will be verified by comparing the calculated individual and cumulative risk/hazard for all the contaminants of concern (COC) that failed background comparison to the risk-based performance standards.

The risk assessment will be conducted assuming a future residential/industrial use of the property. The methodology/equation for estimating the exposure concentration is presented in subsequent sections.

The initial step in the risk assessment will be to develop a site conceptual exposure model (SCEM) which depicts all potential exposure routes and media for the site and the receptors which may be exposed. The procedure for identification of contaminants of concern for health based is presented in section 2.

Once the SCEM is completed, the exposure assumptions outlined in the Virginia Risk Guidance will be employed to estimate the health risks and develop a cleanup criteria. Information will also be taken as needed from U.S. EPA documents and databases (e.g., the Risk Assessment Guidance for Superfund (RAGS), and the Integrated Risk Information System (IRIS)). The chemical intake equations and exposure parameter assumptions used to calculate estimate risks (obtained from Virginia risk assessment guidance/REAMS) are shown in Tables 1 through 4. Additional details on the approach and assumptions used for each potential exposure pathway are provided below.

As a part of the Risk Exposure and Analysis Modeling System (REAMS) evaluation, fate and transport modeling is necessary to demonstrate that the residual soil concentrations of

contaminants of concern would not result in contamination of other environmental media of concern including the groundwater underneath the closure unit. For this purpose, representative soil sample(s) will be collected around the unit (subjected to closure) for analysis of the properties listed on page 62 of the REAMS document. [It is often less expensive to obtain this information from an agriculture lab rather than from an environmental lab]. In certain situations, groundwater sampling may be preferable.

2. Identification of Contaminants of Concern

Contaminants of concern includes those constituents detected during the closure soil and/or groundwater sampling which may be related to past waste management practices and whose concentrations statistically exceeded background levels. Please note that if the concentration of contaminants detected did not exceed the background levels, no further risk-based evaluation will be required. Only those constituents of concern having concentrations that are statistically greater than background concentrations will be subject to REAMS evaluation to estimate the risks.

3. Exposure Assessment

The exposure assessment will identify transport mechanisms for the contaminants of concern that may potentially impact human receptors. The results of this assessment will be used to document the current and future exposure potential posed by the site.

With regard to soil, the following exposure assumptions will apply. Initially, a residential exposure will be assumed for the purpose of attempting to document unrestricted closure of the soil. If the risk for potential residential exposure does not exceed the performance standards, unrestricted closure of soil will be documented/accepted. If the site cannot be clean closed for residential use, then the option to pursue restricted closure (commercial/industrial) will be exercised. Closure to commercial/industrial scenario will require the facility to enact a deed restriction that eliminates the possibility of future residential use of the site. The requirements for establishing such a deed restriction are detailed in DEQ's Guidelines for Developing Health-Based Cleanup Goals Using Risk Assessment at A Hazardous Waste Site Facility for Restricted Industrial Use, dated June 1995. (A copy of this document is attached.)

Exposure routes will include ingestion, dermal absorption, and inhalation of vapors and dust particles.

With regard to groundwater, REAMS fate and transport modeling¹ will be required to assess residual soil contamination impacts to the groundwater. The groundwater exposure routes to be evaluated include ingestion, dermal absorption, and inhalation of volatiles emitted from the contaminated groundwater.

¹ REAMS includes the unsaturated zone fate and transport model SESOIL. The purpose of running the model is two fold: a) determine whether the contaminants will reach the groundwater table in next 30 years. b) calculate the risk associated with the estimated concentration in the groundwater. For constituents with a promulgated MCL, the estimated concentration will be directly compared against the MCL. However, prior to running the SESOIL model the facility should obtain all the information identified on page 62, of the Virginia guidance document. The closure report must include evaluation of model results (concentrations reaching the groundwater) and a copy of SESOIL output file.

The exposure assumptions presented in the following sections are based on residential exposure. These constitute a reasonable maximum exposure scenario (RME), an exposure which is unlikely to occur but is reasonably possible. The exposure pathways for residential exposure include ingestion of soil, dermal contact with soil, inhalation of re-suspended soil particulates, and inhalation of volatile organic compounds.

3.1.1 Ingestion of Soil

The equation for potential chemical intake by soil ingestion for residential scenario on site is included in Table 1. This scenario also assumes that weather or other conditions (e.g., frozen ground/ snow /other cover) do not affect exposure and that all soil ingested is from contaminated areas of the site. These assumptions are protective of human health and the environment.

3.1.2 Dermal Contact with Soil

The equation for calculating the potential absorbed chemical dose by dermal contact with contaminated soil is provided in table 1. This scenario assumes that weather or other conditions (e.g., frozen ground/ snow or other cover) do not affect exposure, that contaminated soil remains on the skin long enough for the COCs to be absorbed and that all soil adhering to the skin is from contaminated areas of the site.

The skin surface areas (SA) used in the dermal pathway have been identified in REAMS guidance as 4,860 cm² for adults, which is the 50th percentile value for the arms, hands and lower legs (U.S. EPA, 1989b - See Attachment A).

A skin-soil adherence factor of 1.45 mg/cm² will be used in the dermal intake calculations. The U.S. EPA guidance for dermal exposure assessment (Dermal Exposure Assessment: Principles and Applications, EPA/600/8-91/011B) states that a range of values from 0.1 mg/cm² to 1.5 mg/cm² per event appear possible for dermal adherence factors (AF).

In order to estimate the amount of a particular COC which may potentially be absorbed through the skin, chemical-specific dermal absorption factors (ABS_{derm}) are used.

3.1.3 Inhalation of Re-suspended Soil

The equation for potential chemical intake by inhalation of re-suspended contaminated soil is included in Table 1. An inhalation rate of 0.83 m³/hr will be used as specified in the Virginia Risk Guidance. This scenario assumes that the concentration of COCs in indoor dust will be equal to that in outdoor soil and that weather or other conditions, (e.g., frozen ground/snow or other cover) do not affect re-suspension or exposure.

However, an appropriate model or equations in table-1, will be used to estimate the potential amount of respirable particulate matter generated by wind erosion. The estimated generation rate for eroded particulate matter will then be used derive an ambient air particulate concentration. Documentation for these models will be presented to the Department.

3.1.4 Inhalation of Volatilized COCs in Soil

Since the COCs have appreciable vapor pressures, they are expected to volatilize from soil.

Inhalation of COCs as volatilized vapors is considered for this risk assessment. The equations in Table-1 will be considered for estimating the intake for this condition.

4. Toxicity Assessment

The two principle indices of toxicity used in risk assessment are the reference dose (RfD) and the cancer slope factor (SF). An RfD is the intake or dose per unit of body weight (mg/kg-day) that is unlikely to result in toxic (non-carcinogenic) effects to human populations, including sensitive subgroups (e.g., the very young or elderly). The RfD allows for the existence of a threshold dose below which no adverse effects occur.

The SF is used to express the cancer risk attributable to a discrete unit of intake; that is, the cancer risk per milligram ingested per kilogram of bodyweight per day ($[\text{mg/kg-day}]^{-1}$). The SF is an estimate of the upper-bound probability of an individual developing cancer as a result of exposure to a particular carcinogen. Unlike the RfD, the SF assumes that there is no threshold dose below which the probability of developing cancer is zero. Note that SFs are only developed for those chemicals which have been shown to be carcinogens in man or in at least several animal species. A carcinogenic weight of evidence rating is used to describe the strength of the experimental evidence for carcinogenicity. The U.S. EPA has developed SFs for most chemicals with weight of evidence ratings of "A" (known human carcinogen) or "B" (probable human carcinogen).

RfDs and SFs are derived by the U.S. EPA for the most toxic chemicals generally associated with chemical releases to the environment for which adequate toxicological data are available. If both the carcinogenic and non-carcinogenic effects of a particular compound are significant, both values may be established. However, in most cases only one value is available.

4.1 Inhalation and Oral RfDs and SFs -

SFs pertinent to the oral and inhalation exposure pathways will be obtained from U.S. EPA's IRIS database. The IRIS (Integrated Risk Information System) on-line database was established by the U.S. EPA to provide risk assessors with peer reviewed toxicological data on chemicals commonly encountered at environmental sites of contamination. If data is not available from IRIS, it will be obtained from the Health Effects Assessment Summary Tables (HEAST), a compilation of toxicity values produced by the USEPA on a quarterly basis. The hierarchy presented in Appendix III of Virginia Risk guidance will be followed for using these sources.

4.2 Dermal RfDs and SFs -

Chemical specific oral-route absorption values (ABS_{oral}) are used to adjust the oral RfD or SF, which is computed from an administered dose, for use in the dermal exposure pathway. This correction is necessary due to the differences in absorption between the skin and the gastrointestinal tract. By correcting the administered-dose oral RfD or SF for the fraction expected to be absorbed in the gut, a dermal absorption factor can be used to estimate the correct dose received through the skin.

5. Evaluation of Risks

Using the toxicity criteria and identified exposure pathways discussed above, and the procedures described in the DEQ guidance document (REAMS, November 1994), the risks presented by the COC will be estimated. The estimated risks will consider the effects from multiple constituents and all routes of exposure. The risk goals will be a total cumulative hazard index of 1.0 for multiple noncarcinogens and a total cumulative carcinogenic risk of $1\text{E-}04$ for multiple carcinogens. However, the risk from each individual carcinogen shall not exceed $1\text{E-}06$ (i.e., one case of cancer per 1,000,000 population).

5.1 Estimation of exposure concentration

For the contaminants detected at the site, an exposure point concentration (EPC) for each exposure pathway will be calculated for each contaminant by estimating the 95th upper confidence limit (UCL) on the arithmetic mean of the concentrations. If the calculated 95th UCL is greater than the maximum detected concentration, then the maximum detected concentration will be used as the EPC. The risks for contaminants will be calculated as per the equations and assumptions described in Table 1 through Table 4. If for a contaminant both carcinogenic and noncarcinogenic risk-based cleanup goal exists, the lower of the two will be used as a pathway specific to estimate the risk.

5.2. Risk Estimation

Health risk assessments are based on the relationship between risk, dose and toxicity:

Since dose is the product of the contaminant concentration multiplied by exposure (the intake), equation (1) becomes:

(Please note that the term CDI in attached tables 1-4, includes intake rate and contaminant conc)

To estimate the intake, the exposure equations and assumptions discussed in Section 1, are used. The intake estimates for each route of exposure are then combined with the RfDs or SFs to determine the resulting risk.

For Carcinogens Risk:

For Noncarcinogens:

where, taking into account all COCs and relevant exposure pathways, the excess cancer risk is 10^{-6} or the hazard index is 1.0.

Using REAMS software a maximum acceptable contaminant concentrations will be calculated

which meets the cumulative risk criteria. This process will be used in this risk assessment to derive the health-based cleanup criteria for the site. If the estimated risks satisfy the risk based performance standards, the soils/groundwater will be considered clean closed.

Table 1
Risk Assessment Algorithm for Carcinogenic Exposure

<u>Exposure Route</u>	<u>Chronic Daily Intake (CDI), mg/L-day</u>	
	<u>Residential Exposure</u>	<u>Occupational/Industrial Exposure</u>
Ground Water		
Ingestion	$\frac{CW \times IRW_{adj} \times EF}{AT_c}$	$\frac{CW \times IRW_o \times EF_o \times ED_o}{BW_o \times AT_c}$
Inhalation	$\frac{CW \times IRA_{adj} \times EF \times K}{AT_c}$	$\frac{CW \times IRA_o \times EF_o \times ED_o \times K}{BW_o \times AT_c}$
Dermal	$\frac{CW \times SAW_{adj} \times PC \times ET \times EF \times CF}{AT_c}$	$\frac{CW \times SAW_o \times PC \times ET \times EF_o \times ED_o \times CF}{BW_o \times AT_c}$
Soil		
Ingestion	$\frac{CS \times IRS_{adj} \times CF \times FI \times EF}{AT_c}$	$\frac{CS \times IR \times CF \times FI \times EF_o \times ED_o}{BW_o \times AT_c}$
Dermal	$\frac{CS \times CF \times SAS_{adj} \times AF \times ABS \times EF}{AT_c}$	$\frac{CS \times CF \times SAS_o \times AF \times ABS \times EF_o \times ED_o}{BW_o \times AT_c}$
Inhalation of	$VF \times IRA_{adj} \times ET \times EF$	$VF \times IRA_o \times ET \times EF_o \times ED_o$

<u>Exposure Route</u>	<u>Chronic Daily Intake (CDI), mg/L-day</u>	
	<u>Residential Exposure</u>	<u>Occupational/Industrial Exposure</u>
vaporizing VOCs from soil	----- At_c	----- $BW_a \times AT_c$
Inhalation of emitting particles from soil	$PEF \times IRA_{adj} \times ET \times EF$ ----- AT_c	$PEF \times IRA_a \times ET \times EF_o \times ED_o$ ----- $BW_a \times AT_c$

Table 2
Risk Assessment Algorithm for Non-carcinogenic Exposure

<u>Exposure Route</u>	<u>Chronic Daily Intake (CDI), mg/L-day</u>	
	<u>Residential Exposure</u>	<u>Occupational/Industrial Exposure</u>
Ground Water		
Ingestion	$\frac{CW \times IRW_c \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{CW \times IRW_o \times EF_o \times ED_o}{BW_o \times AT_n}$
Inhalation	$\frac{CW \times IRA_c \times EF \times ED_c \times K}{BW_c \times AT_n}$	$\frac{CW \times IRA_o \times EF_o \times ED_o \times K}{BW_o \times AT_n}$
Dermal	$\frac{CW \times SAW_c \times PC \times ET \times EF \times ED_c \times CF}{BW_c \times AT_n}$	$\frac{CW \times SAW_o \times PC \times ET \times EF_o \times ED_o \times CF}{BW_o \times AT_n}$
Soil		
Ingestion	$\frac{CS \times IRS_c \times CF \times FI \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{CS \times IRS_o \times CF \times FI \times EF_o \times ED_o}{BW_o \times AT_n}$
Dermal	$\frac{CS \times CF \times SA_c \times AF \times ABS \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{CS \times CF \times SA_o \times AF \times ABS \times EF_o \times ED_o}{BW_o \times AT_n}$

<u>Exposure Route</u>	<u>Chronic Daily Intake (CDI), mg/L-day</u>	
	<u>Residential Exposure</u>	<u>Occupational/Industrial Exposure</u>
Inhalation of vaporizing VOCs from soil	$\frac{VF \times IRA_c \times ET \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{VF \times IRA_o \times ET \times EF_o \times ED_o}{BW_o \times AT_n}$
Inhalation of emitting particles from soil	$\frac{PEF \times IRA_c \times ET \times EF \times ED_c}{BW_c \times AT_n}$	$\frac{PEF \times IRA_o \times ET \times EF_o \times ED_o}{BW_o \times AT_n}$

Note: Occupational noncarcinogenic risk assessment is based on adult exposure

Table 3
Age Adjusted Factors

$$IRA_{adj} = \frac{ED_c \times IRA_c}{BW_c} + \frac{(ED_{tot} - ED_c) \times IRA_a}{BW_a}$$

$$IRW_{adj} = \frac{ED_c \times IRW_c}{BW_c} + \frac{(ED_{tot} - ED_c) \times IRW_a}{BW_a}$$

$$SAW_{adj} = \frac{ED_c \times SAW_c}{BW_c} + \frac{(ED_{tot} - ED_c) \times SAW_a}{BW_a}$$

$$IRS_{adj} = \frac{ED_c \times IRS_c}{BW_c} + \frac{(ED_{tot} - ED_c) \times IRS_a}{BW_a}$$

$$SAS_{adj} = \frac{ED_c \times Sa_c}{BW_c} + \frac{(ED_{tot} - ED_c) \times Sa_a}{BW_a}$$

Note regarding age adjusted factor:

Because contact rate with tap water, ambient air, and residential soil are different for children and adults, carcinogenic risks during the first 30 years of life were calculated using age adjusted factor. These factors approximate the integrated exposure from birth until age 30 by combining contact rates, body weights, and exposure durations for two age groups - small children and adults.

Table 4
Exposure Variables Included in Tables 1, 2, and 3

Symbol	Term	Unit	Value	Reference
ABS	Absorption factor	-	User specified	
AF	Adherence factor	-	1.45	a, c
AT _c	Averaging time carcinogens	days	25550	
AT _n	Averaging time non-carcinogens	days	ED x 365	
BW _a	Body weight adult	kg	70	c
BW _c	Body weight child	kg	15	c
CF	Conversion factor	-	0.000001	-
CS	Chemical concentration in soil	mg/Kg-day	User specified	
CW	Chemical concentration in water	mg/L	User specified	
ED _c	Exposure duration child	years	6	c
ED _{total} ED	Exposure duration for carcinogen total or Residential	years	30	c
ED _o	Exposure duration occupational	years	25	c
EF	Exposure frequency residential	days	350	c
ET	Exposure Time General/Occupational Groundwater Surface Water - ingestion Surface water - dermal Air -inhalation	hrs/day	8.0 0.2 2.6 2.6 24.0	c, d

Symbol	Term	Unit	Value	Reference
FI	Fraction ingested Residential Occupational	-	1.0 0.5	b
IRA _a	Inhalation rate air adult	m ³ /day	20	b
IRA _{adj}	Inhalation rate - air adjusted	-	11.66	
IRA _c	Inhalation rate child	m ³ /day	12	b
IRA _a	Inhalation rate adult	m ³ /day	20	b
IR	Ingestion rate food Fruit/veggies Fish	kg/day	0.28 0.122 0.054	c,d
IRS _a	Ingestion rate soil adult	mg/day	100	b
IRS _c	Ingestion rate soil child	mg/day	200	b
IRS _{adj}	Ingestion - soil adjusted	-	114.29	
IRS _c	Ingestion rate soil child	mg/day	200	b
IRW _a	Ingestion rate water adult	L/day	2	b
IRW _{adj}	Ingestion -water adjusted	L-y/kg-d	1.09	
IRW _c	Ingestion rate water child	L/day	1	b
K	Volatilization factor, water to air	-	0.5	
PC	Permeability constant	cm/hr	User specified	b
PEF	Particulate	kg/m ³	6.789926E08	f

Symbol	Term	Unit	Value	Reference
	emission factor			
SAW _c	Surface area child groundwater dermal surface water dermal	cm ²	7500	b,e
SAS _a SAS _c	Surface area soil occupational - adult child	cm ² /event	4500 1875	e
SAS _{adj}	Surface area soil adjusted	cm ² /event	2290	
SAW _a	Surface area for water contact adult	cm ²	820	b
SAW _{adj}	Surface area for water contact	cm ² /event	9200	
VF	Volatilization factor, soil to air	kg/m ³	User specified	-

References:

- a. Risk Assessment Guidance for Superfund, Volume I, EPA/540/1-89/002, December 1989.
- b. Region III values
- c. Exposure Factors handbook, EPA/600/8-89/043, July 1989
- d. Human health evaluation manual supplemental guidance, OSWER Directive 9285.6-03. March 25, 1991.
- e. Dermal exposure Assessment, Principles and Applications, Interim Report. EPA/600/8-91/011b. January 1992.
- f. Technical Background Document for Draft Soil Screening Level Guidance. Office of Solid Waste and Emergency Response. EPA/540/R-94/101. December 1994.

THIRD LIFT

**ALLIANT TECHSYSTEMS INC.
P O BOX 1
RADFORD VIRGINIA 24141**

**REIC JOB #: 0997-54714
SITE ID: RAAP - VA
PROJECT ID: INCIN. SPRAY POND CLOSURE
CUSTODY NO.: 53420 AND 53421**

**Prepared By:
REI Consultants, Inc.
P O Box 286
Beaver WV 25813**

**Phone: 304-256-2500
800-999-0106
Fax: 304-256-2572**

ALLIANT SAMPLE #: A1 18"
REIC SAMPLE #: 54714-1

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 20%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	80

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	30
2-fluorobiphenyl	38
p-terphenyl-d14	43

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	3100	ug/kg	7060A	200	09-23-97/TJ
barium	94800	ug/kg	6010A	1000	09-16-97/MS
beryllium	800	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	25700	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	13700	ug/kg	6010A	7500	09-18-97/MS
silver	48	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: A1 24"
REIC SAMPLE #: 54714-2

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 19%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	88

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	33
2-fluorobiphenyl	40
p-terphenyl-d14	47

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2560	ug/kg	7060A	200	09-23-97/TJ
barium	116000	ug/kg	6010A	1000	09-16-97/MS
beryllium	800	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	31300	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	20100	ug/kg	6010A	7500	09-18-97/MS
silver	30	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: A4 18"
REIC SAMPLE #: 54714-3

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 17%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	104

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	26
2-fluorobiphenyl	34
p-terphenyl-d14	40

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2990	ug/kg	7060A	200	09-23-97/TJ
barium	101000	ug/kg	6010A	1000	09-16-97/MS
beryllium	780	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	36400	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	20700	ug/kg	6010A	7500	09-18-97/MS
silver	50	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: A4 24"
REIC SAMPLE #: 54714-4

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 19%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	94

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	26
2-fluorobiphenyl	34
p-terphenyl-d14	39

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2400	ug/kg	7060A	200	09-23-97/TJ
barium	101000	ug/kg	6010A	1000	09-16-97/MS
beryllium	720	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	32600	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	17600	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: B2 18"
REIC SAMPLE #: 54714-5

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 18%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	88

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	29
2-fluorobiphenyl	37
p-terphenyl-d14	42

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2610	ug/kg	7060A	200	09-23-97/TJ
barium	89600	ug/kg	6010A	1000	09-16-97/MS
beryllium	750	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	34300	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	16800	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: B2 24"
REIC SAMPLE #: 54714-6

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 19%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	100

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	26
2-fluorobiphenyl	32
p-terphenyl-d14	38

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2450	ug/kg	7060A	200	09-23-97/TJ
barium	88100	ug/kg	6010A	1000	09-16-97/MS
beryllium	820	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	29700	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	17400	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: C2 18"
REIC SAMPLE #: 54714-7

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 23%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	94

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	27
2-fluorobiphenyl	32
p-terphenyl-d14	41

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	4580	ug/kg	7060A	200	09-23-97/TJ
barium	123000	ug/kg	6010A	1000	09-16-97/MS
beryllium	880	ug/kg	6010A	100	09-18-97/MS
cadmium	50	ug/kg	7131A	50	09-17-97/TJ
chromium	37900	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	20800	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: C2 24"
REIC SAMPLE #: 54714-8

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 20%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	89

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	29
2-fluorobiphenyl	30
p-terphenyl-d14	41

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	3410	ug/kg	7060A	200	09-23-97/TJ
barium	102000	ug/kg	6010A	1000	09-16-97/MS
beryllium	800	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	37500	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	19400	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: D1 18"
REIC SAMPLE #: 54714-9

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 20%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	96

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	25
2-fluorobiphenyl	32
p-terphenyl-d14	38

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2330	ug/kg	7060A	200	09-23-97/TJ
barium	103000	ug/kg	6010A	1000	09-16-97/MS
beryllium	650	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	31200	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	11600	ug/kg	6010A	7500	09-18-97/MS
silver	40	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: D1 24"
REIC SAMPLE #: 54714-10

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 25%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	86

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-21-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-21-97/WP
resorcinol	ND	ug/kg	8270B	330	09-21-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	50
2-fluorobiphenyl	38
p-terphenyl-d14	61

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	6460	ug/kg	7060A	200	09-23-97/TJ
barium	98200	ug/kg	6010A	1000	09-16-97/MS
beryllium	1280	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	34300	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	11600	ug/kg	6010A	7500	09-18-97/MS
silver	25	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: D3 18"
REIC SAMPLE #: 54714-11

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 21%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	84

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	27
2-fluorobiphenyl	31
p-terphenyl-d14	53

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	3050	ug/kg	7060A	200	09-23-97/TJ
barium	126000	ug/kg	6010A	1000	09-16-97/MS
beryllium	900	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	39000	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	19100	ug/kg	6010A	7500	09-18-97/MS
silver	45	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: D3 24"
REIC SAMPLE #: 54714-12

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 21%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	90

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	24
2-fluorobiphenyl	33
p-terphenyl-d14	56

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	3500	ug/kg	7060A	200	09-23-97/TJ
barium	112000	ug/kg	6010A	1000	09-16-97/MS
beryllium	1000	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	38500	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	16700	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: E1 18"
REIC SAMPLE #: 54714-13

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 19%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

Surrogate	% Recovery
tetrachloro-m-xylene	114

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

Surrogates	% Recovery
nitrobenzene-d5	27
2-fluorobiphenyl	34
p-terphenyl-d14	52

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	1740	ug/kg	7060A	200	09-23-97/TJ
barium	211000	ug/kg	6010A	1000	09-16-97/MS
beryllium	1000	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	29800	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	17500	ug/kg	6010A	7500	09-18-97/MS
silver	68	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: E1 24"
REIC SAMPLE #: 54714-14

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 22%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	100

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	26
2-fluorobiphenyl	32
p-terphenyl-d14	49

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	1680	ug/kg	7060A	200	09-23-97/TJ
barium	199000	ug/kg	6010A	1000	09-16-97/MS
beryllium	1020	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	25100	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	15.3	ug/kg	6010A	7500	09-18-97/MS
silver	25	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: E1 18" DUP.
REIC SAMPLE #: 54714-15

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 20%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	100

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	28
2-fluorobiphenyl	39
p-terphenyl-d14	57

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	1860	ug/kg	7060A	200	09-23-97/TJ
barium	113000	ug/kg	6010A	1000	09-16-97/MS
beryllium	1520	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	26100	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	12700	ug/kg	6010A	7500	09-18-97/MS
silver	30	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: E1 24" DUP.
REIC SAMPLE #: 54714-16

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 21%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	114

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	27
2-fluorobiphenyl	34
p-terphenyl-d14	56

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2940	ug/kg	7060A	200	09-23-97/TJ
barium	110000	ug/kg	6010A	1000	09-16-97/MS
beryllium	650	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	28300	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	12800	ug/kg	6010A	7500	09-18-97/MS
silver	30	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: E2 18"
REIC SAMPLE #: 54714-17

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 19%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	86

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-21-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-21-97/WP
resorcinol	ND	ug/kg	8270B	330	09-21-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	25
2-fluorobiphenyl	41
p-terphenyl-d14	53

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	3690	ug/kg	7060A	200	09-23-97/TJ
barium	100000	ug/kg	6010A	1000	09-16-97/MS
beryllium	820	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	36200	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	20600	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: E2 24"
REIC SAMPLE #: 54714-18

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 20%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	88

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-21-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-21-97/WP
resorcinol	ND	ug/kg	8270B	330	09-21-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	35
2-fluorobiphenyl	30
p-terphenyl-d14	56

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	4390	ug/kg	7060A	200	09-23-97/TJ
barium	85400	ug/kg	6010A	1000	09-16-97/MS
beryllium	820	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	31500	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	16700	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: EQUIP. BLANK
REIC SAMPLE #: 54714-19

DATE SAMPLED: 09-08-97
MATRIX: LIQUID

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/l	8090	25	09-25-97/JA
2,6-dinitrotoluene	ND	ug/l	8090	15	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	78

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/l	8270B	25	09-21-97/WP
di-n-butyl phthalate	ND	ug/l	8270B	25	09-21-97/WP
resorcinol	ND	ug/l	8270B	25	09-21-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	48
2-fluorobiphenyl	64
p-terphenyl-d14	71

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/l	7041	10	09-16-97/TJ
arsenic	ND	ug/l	7060A	10	09-23-97/TJ
barium	ND	ug/l	6010A	100	09-16-97/MS
beryllium	ND	ug/l	6010A	4	09-18-97/MS
cadmium	ND	ug/l	7131A	1	09-17-97/TJ
chromium	ND	ug/l	7191	10	09-25-97/KC
lead	ND	ug/l	7421	10	09-24-97/KC
mercury	ND	ug/l	7470A	1	09-17-97/TJ
nickel	ND	ug/l	6010A	100	09-18-97/MS
silver	ND	ug/l	7761	5	09-17-97/GM
thallium	ND	ug/l	7841	5	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: FIELD BLANK
REIC SAMPLE #: 54714-20

DATE SAMPLED: 09-08-97
MATRIX: LIQUID

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/l	8090	25	09-25-97/JA
2,6-dinitrotoluene	ND	ug/l	8090	15	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	82

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/l	8270B	25	09-21-97/WP
di-n-butyl phthalate	ND	ug/l	8270B	25	09-21-97/WP
resorcinol	ND	ug/l	8270B	25	09-21-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	50
2-fluorobiphenyl	66
p-terphenyl-d14	67

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/l	7041	10	09-16-97/TJ
arsenic	ND	ug/l	7060A	10	09-23-97/TJ
barium	ND	ug/l	6010A	100	09-16-97/MS
beryllium	ND	ug/l	6010A	4	09-18-97/MS
cadmium	ND	ug/l	7131A	1	09-17-97/TJ
chromium	ND	ug/l	7191	10	09-25-97/KC
lead	ND	ug/l	7421	10	09-24-97/KC
mercury	ND	ug/l	7470A	1	09-17-97/TJ
nickel	ND	ug/l	6010A	100	09-18-97/MS
silver	ND	ug/l	7761	5	09-17-97/GM
thallium	ND	ug/l	7841	5	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: TRIP BLANK
REIC SAMPLE #: 54714-21

MATRIX: MUC

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	LAB BY
2,4-dinitrotoluene	ND	ug/l	8090	25	EFJA
2,6-dinitrotoluene	ND	ug/l	8090	15	EFJA

Surrogate % Recovery
tetrachloro-m-xylene 74

PARAMETER	RESULT	UNIT	METHOD	PQL	LAB BY
diethylphthalate	ND	ug/l	8270B	25	EFWF
di-n-butyl phthalate	ND	ug/l	8270B	25	EFWF
resorcinol	ND	ug/l	8270B	25	EFWF

Surrogates % Recovery
nitrobenzene-d5 46
2-fluorobiphenyl 61
p-terphenyl-d14 34

TOTAL METALS

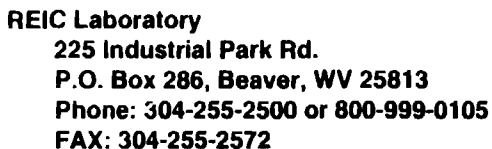
PARAMETER	RESULT	UNIT	METHOD	PQL	LAB BY
antimony	ND	ug/l	7041	10	EFJA
arsenic	ND	ug/l	7060A	10	EFJA
barium	ND	ug/l	6010A	100	EFMS
beryllium	ND	ug/l	6010A	4	EFMS
cadmium	ND	ug/l	7131A	1	EFJA
chromium	ND	ug/l	7191	10	EFKC
lead	ND	ug/l	7421	10	EFKC
mercury	ND	ug/l	7470A	1	EFJA
nickel	ND	ug/l	6010A	100	EFMS
silver	ND	ug/l	7761	5	EFGM
thallium	ND	ug/l	7841	5	EFJA

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

DATE 9-26-97

APPROVED Joseph Robertson
For Janet M. Satterfield

Ivan W. Leef
Ivan W. Leef



NO. 56 10

CLIENT: Alliant Techsystems Inc.
ADDRESS: P.O. Box 2
CITY/STATE/ZIP: Radford, VA 24141
BILL TO: Same
CITY/STATE/ZIP:

CONTACT PERSON: Arne Olsen
TELEPHONE/FAX: 540/631-8220
SITE ID & STATE: RANP - Va.
PROJECT ID: Tric. Spray Pond Closure
SAMPLER: C. Compton, ERM

[illegible]



REIC Laboratory
225 Industrial Park Rd.
P.O. Box 286, Beaver, WV 25813
Phone: 304-255-2500 or 800-999-0105
FAX: 304-255-2572

CHAIN OF CUSTODY RECORD

NO. 53

CLIENT: Alliant Techsystems Inc.
ADDRESS: P.O. Box 1
CITY/STATE/ZIP: Radford, VA 24141
BILL TO: Same
CITY/STATE/ZIP: _____

CONTACT PERSON: Arne Olsen
TELEPHONE/FAX: 540/639-8220
SITE ID & STATE: RAAP - va
PROJECT ID: Incin. Spring Pond Closure
SAMPLER: C. Compton, FRM

SAMPLE LOG AND ANALYSIS REQUEST		TURNAROUND TIME REQUIREMENTS REGULAR: _____ *RUSH: _____ 5-Day _____ 3-Day _____ 2-Day _____ 1-Day *Rush work needs prior Laboratory approval and will include surcharges		PRESERVATIVES		PRESERVATIVE CODES																COMMENTS	
				NOTE PRESERVATIVES →		→																	
				0 No Preservative	1 Hydrochloric Acid	2 Nitric Acid	3 Sulfuric Acid	4 Sodium Thiosulfate	5 Sodium Hydroxide	6 Zinc Acetate	7 EDTA	ANALYSIS REQUESTED & METHOD											
SAMPLE ID	NO. & TYPE OF CONTAINERS	SAMPLING DATE / TIME	MATRIX	SAMPLE COMP / GRAB	24-Dinitrophenol	26-Dinitrophenol	Di-n-butylphthalate	Diethylphthalate	Resorcinol	Antimony	Asenic	Bismuth	Boron	Cadmium	Chromium	Copper	Manganese	Nickel	Silver	Thallium			
A1 18"	2/glass	10:00 10:05	Soil	Grab	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
A1 24"		10:08 10:10			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
A4 18"		10:12 10:15			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
A4 24"		10:20 10:22			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
B2 18"		10:45 10:47			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
B2 24"		10:52 10:55			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
C2 18"		11:15 11:17			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
C2 24"		11:22 11:25			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
D1 18"		12:35 12:37			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
D1 24"		12:43 12:47			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Relinquished by: (Signature)		Date/Time	Received by: (Signature)		Date/Time	Relinquished by: (Signature)		Date/Time	Received by: (Signature)		Date/Time	Relinquished by: (Signature)		Date/Time	Received by: (Signature)		Date/Time	Relinquished by: (Signature)		Date/Time			
Special Requests: <u>Methods per DEA approved plan - A. Olsen</u>					Sample Condition: Good? Y N					Temperature Upon Arrival <u>45°C</u>					9-12-98 2:30 PM								
Shipment	Hand-Del:	Courier:	UPS:	FedEx:	Shipment Date:					FAX Results: Y N													

FOURTH LIFT

**ALLIANT TECHSYSTEMS INC.
P O BOX 1
RADFORD VIRGINIA 24141**

**REIC JOB #: 0997-54714
SITE ID: RAAP - VA
PROJECT ID: INCIN. SPRAY POND CLOSURE
CUSTODY NO.: 53420 AND 53421**

**Prepared By:
REI Consultants, Inc.
P O Box 286
Beaver WV 25813**

**Phone: 304-255-2500
800-999-0105
Fax: 304-255-2572**

ALLIANT SAMPLE #: A1 24"
REIC SAMPLE #: 54714-2

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 19%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	88

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	33
2-fluorobiphenyl	40
p-terphenyl-d14	47

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2560	ug/kg	7060A	200	09-23-97/TJ
barium	116000	ug/kg	6010A	1000	09-16-97/MS
beryllium	800	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	31300	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	20100	ug/kg	6010A	7500	09-18-97/MS
silver	30	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: A4 24"
REIC SAMPLE #: 54714-4

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 19%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	94

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	26
2-fluorobiphenyl	34
p-terphenyl-d14	39

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2400	ug/kg	7060A	200	09-23-97/TJ
barium	101000	ug/kg	6010A	1000	09-16-97/MS
beryllium	720	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	32600	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	17600	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: B2 24"
REIC SAMPLE #: 54714-6

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 19%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	100

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	26
2-fluorobiphenyl	32
p-terphenyl-d14	38

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2450	ug/kg	7060A	200	09-23-97/TJ
barium	88100	ug/kg	6010A	1000	09-16-97/MS
beryllium	820	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	29700	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	17400	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: C2 24"
REIC SAMPLE #: 54714-8

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 20%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	89

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	29
2-fluorobiphenyl	30
p-terphenyl-d14	41

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	3410	ug/kg	7060A	200	09-23-97/TJ
barium	102000	ug/kg	6010A	1000	09-16-97/MS
beryllium	800	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	37500	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	19400	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: D1 24"
REIC SAMPLE #: 54714-10

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 25%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	86

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-21-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-21-97/WP
resorcinol	ND	ug/kg	8270B	330	09-21-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	50
2-fluorobiphenyl	38
p-terphenyl-d14	61

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	6460	ug/kg	7060A	200	09-23-97/TJ
barium	98200	ug/kg	6010A	1000	09-16-97/MS
beryllium	1280	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	34300	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	11600	ug/kg	6010A	7500	09-18-97/MS
silver	25	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: D3 24"
REIC SAMPLE #: 54714-12

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 21%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	90

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	24
2-fluorobiphenyl	33
p-terphenyl-d14	56

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	3500	ug/kg	7060A	200	09-23-97/TJ
barium	112000	ug/kg	6010A	1000	09-16-97/MS
beryllium	1000	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	38500	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	16700	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: E1 24"
REIC SAMPLE #: 54714-14

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 22%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	100

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	26
2-fluorobiphenyl	32
p-terphenyl-d14	49

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	1680	ug/kg	7060A	200	09-23-97/TJ
barium	199000	ug/kg	6010A	1000	09-16-97/MS
beryllium	1020	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	25100	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	15.3	ug/kg	6010A	7500	09-18-97/MS
silver	25	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: E1 24" DUP.
REIC SAMPLE #: 54714-16

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 21%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	114

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	27
2-fluorobiphenyl	34
p-terphenyl-d14	56

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2940	ug/kg	7060A	200	09-23-97/TJ
barium	110000	ug/kg	6010A	1000	09-16-97/MS
beryllium	650	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	28300	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	12800	ug/kg	6010A	7500	09-18-97/MS
silver	30	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: E2 24"
REIC SAMPLE #: 54714-18

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 20%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	88

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-21-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-21-97/WP
resorcinol	ND	ug/kg	8270B	330	09-21-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	35
2-fluorobiphenyl	30
p-terphenyl-d14	56

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	4390	ug/kg	7060A	200	09-23-97/TJ
barium	85400	ug/kg	6010A	1000	09-16-97/MS
beryllium	820	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	31500	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	16700	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: EQUIP. BLANK
REIC SAMPLE #: 54714-19

DATE SAMPLED: 09-08-97
MATRIX: LIQUID

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/l	8090	25	09-25-97/JA
2,6-dinitrotoluene	ND	ug/l	8090	15	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	78

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/l	8270B	25	09-21-97/WP
di-n-butyl phthalate	ND	ug/l	8270B	25	09-21-97/WP
resorcinol	ND	ug/l	8270B	25	09-21-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	48
2-fluorobiphenyl	64
p-terphenyl-d14	71

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/l	7041	10	09-16-97/TJ
arsenic	ND	ug/l	7060A	10	09-23-97/TJ
barium	ND	ug/l	6010A	100	09-16-97/MS
beryllium	ND	ug/l	6010A	4	09-18-97/MS
cadmium	ND	ug/l	7131A	1	09-17-97/TJ
chromium	ND	ug/l	7191	10	09-25-97/KC
lead	ND	ug/l	7421	10	09-24-97/KC
mercury	ND	ug/l	7470A	1	09-17-97/TJ
nickel	ND	ug/l	6010A	100	09-18-97/MS
silver	ND	ug/l	7761	5	09-17-97/GM
thallium	ND	ug/l	7841	5	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: FIELD BLANK
REIC SAMPLE #: 54714-20

DATE SAMPLED: 09-08-97
MATRIX: LIQUID

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/l	8090	25	09-25-97/JA
2,6-dinitrotoluene	ND	ug/l	8090	15	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	82

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/l	8270B	25	09-21-97/WP
di-n-butyl phthalate	ND	ug/l	8270B	25	09-21-97/WP
resorcinol	ND	ug/l	8270B	25	09-21-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	50
2-fluorobiphenyl	66
p-terphenyl-d14	67

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/l	7041	10	09-16-97/TJ
arsenic	ND	ug/l	7060A	10	09-23-97/TJ
barium	ND	ug/l	6010A	100	09-16-97/MS
beryllium	ND	ug/l	6010A	4	09-18-97/MS
cadmium	ND	ug/l	7131A	1	09-17-97/TJ
chromium	ND	ug/l	7191	10	09-25-97/KC
lead	ND	ug/l	7421	10	09-24-97/KC
mercury	ND	ug/l	7470A	1	09-17-97/TJ
nickel	ND	ug/l	6010A	100	09-18-97/MS
silver	ND	ug/l	7761	5	09-17-97/GM
thallium	ND	ug/l	7841	5	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: TRIP BLANK MATRIX: LIQUID
REIC SAMPLE #: 54714-21

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/l	8090	25	09-25-97/JA
2,6-dinitrotoluene	ND	ug/l	8090	15	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	74

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/l	8270B	25	09-21-97/WP
di-n-butyl phthalate	ND	ug/l	8270B	25	09-21-97/WP
resorcinol	ND	ug/l	8270B	25	09-21-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	46
2-fluorobiphenyl	61
p-terphenyl-d14	34

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/l	7041	10	09-16-97/TJ
arsenic	ND	ug/l	7060A	10	09-23-97/TJ
barium	ND	ug/l	6010A	100	09-16-97/MS
beryllium	ND	ug/l	6010A	4	09-18-97/MS
cadmium	ND	ug/l	7131A	1	09-17-97/TJ
chromium	ND	ug/l	7191	10	09-25-97/KC
lead	ND	ug/l	7421	10	09-24-97/KC
mercury	ND	ug/l	7470A	1	09-17-97/TJ
nickel	ND	ug/l	6010A	100	09-18-97/MS
silver	ND	ug/l	7761	5	09-17-97/GM
thallium	ND	ug/l	7841	5	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit



97-171

C: Jake
Redder
Olson
ENV file
Barker-ACO

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

George Allen
Governor

Street address: 629 East Main Street, Richmond, Virginia 23219

Mailing address: P.O. Box 10009, Richmond, Virginia 23240

Fax (804) 698-4500 TDD (804) 698-4021

<http://www.deq.state.va.us>Thomas L. Hopkins
Director(804) 698-4000
1-800-592-5482Becky Norton Dunlop
Secretary of Natural Resources**Certified Mail**
Return Receipt Requested

October 2, 1997

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
Incinerator Spray Pond Closure
EPA ID# VA12100207306
Extension to Closure Schedule**

Dear Ms. Jake:

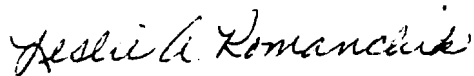
Your letter requesting an extension to the closure schedule for the Incinerator Spray Pond closure activities was received on September 3, 1997. As the closure activities will, of necessity, take longer to complete than the approved closure schedule, the DEQ will approve an extension until March 28, 1998, for completion of closure activities at the RAAP's Incinerator Spray Pond. Please update your approved closure plan with the revised closure schedule submitted with this request. During this extension period, RAAP shall continue to take all steps to prevent threats to human health and the environment from the Incinerator Spray Pond that is no longer operating, but has not undergone formal closure.

If there are any additional questions, please contact Debra Miller, Environmental Engineer Senior, of my staff at (804) 698-4206. Please note, any further requests for an extension to the closure period should be submitted with detailed justification at least 30 days prior to the

RAAP Closure Extension
Incinerator Spray Pond
Page 2

expiration date, as required by VHWMR 9 VAC 20-60-580.D.3.b. [previously VHWMR §9.6.D.3.b].

Sincerely,

 Thomas L. Hopkins
Director

cc: Leslie Romanchik, DEQ
Lisa Ellis, DEQ
Debra Miller, DEQ
Glenn Von Gonten, DEQ
Claire Ballard, DEQ
Aziz Farahmand, DEQ-RRO



Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

August 26, 1997

97-815-204

Debra Miller
Office of Permitting Management
629 East Main Street
Richmond, VA 23219

Subject: Request for Extension of Closure Schedule
Incinerator Spray Pond HWMU 39
Radford Army ammunition Plant, Radford Virginia,
EPA ID# VA1210020730

Dear Ms. Miller:

Demolition of the Incinerator Spray Pond, HWMU 39, is proceeding. Screening samples have indicated that the soil 12 inches below the bottom of the concrete basin is at background levels of the Hazardous Constituents of Concern. Confirmation samples were taken on August 21, 1997 and sent to REIC laboratories in Beaver, West Virginia. When this analytical work is complete any remaining soil above the 12 inch layer will be removed and disposed of. Alliant Techsystems requests an 180 day extension to the Incinerator Spray Pond Closure Schedule to complete the demolition effort, closure reports and allow for your review of the data.

If you have any questions or concerns please contact Jerry Redder (540) 639-7536 (Jerome_Redder@ATK.com) or Arne Olsen (540) 639-8220 (Arne_Olsen@ATK.com)

Sincerely

A handwritten signature in cursive script that reads "C. A. Jake".

C. A. Jake
Environmental Manager

AE Olsen: V\815-204
Enclosure

c: West Central Regional Office - Roanoke

Coordination:

M. L. Griffith
M. L. Griffith

R. L. Richardson
R. L. Richardson

bc: Adm. File
Env. File
D. W. Shead - w/o enclosure
C. A. Jake - w/o enclosure
R. L. Richardson - w/o enclosure
J. J. Redder - w/o enclosure
A. E. Olsen

TABLE 3-5 CLOSURE SCHEDULE	
Activity	Date
Closure Plan Approved Army Cost estimate, Scope of Work , Legal Review, Receive Funding	8/24/96
Preliminary Background Sampling	11/13/95
Complete Background Sampling	1/3/96
Calculate Background Critical Value/Submit Results to VDEQ for approval of background (VDEQ response 7 days)	1/30/97
Start Removal	1/30/97
Remove and Decontaminate Piping, Pumps, Concrete	7/1/97
Take Soil Samples in Subsoil Assessment	8/21/97
Receive Lab Analysis/ Statically Analysis and Submit ot VDEQ	8/29/97
Remove contaminated soil/ resample/ or contingent close	8/1/97
Receive lab Analyses / Statistical Analysis and submit to VDEQ	9/1/97
Remove contaminated soil/ resample/or contingent close	9/15/97
Equipment Decontamination	9/20/97
Receive lab analyses of Pre- and Post- Rinses	9/25/97
Submit Final Report of QA/QC on Work Performed	10/15/97
Letter submitted for Certification of Closure Submitted or Contingent Closure	10/15/97
Complete Data and Closure Report Review	3/28/98

Rec'd ENV 5-29-97-avg

97-97

C: Jake
Kedder
Olson
Barker-ACO
ENV file



COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Street address: 629 East Main Street, Richmond, Virginia 23219

Mailing address: P.O. Box 10009, Richmond, Virginia 23240

Fax (804) 698-4500 TDD (804) 698-4021

<http://www.deq.state.va.us>

George Allen
Governor

Becky Norton Dunlop
Secretary of Natural Resources

Thomas L. Hopkins
Director

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

May 22, 1997

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 (RAAP), EPA ID# VA12100207306
Incinerator Spray Pond/Background Data Approval**

Dear Ms. Jake:

RAAP's revisions to the background soil sampling report for the Incinerator Spray Pond was received by the Department of Environmental Quality (DEQ) on April 21, 1997. These revisions have been reviewed. Based on the information provided, the report is acceptable. By this letter, the DEQ approves the background data for the hazardous constituents of concern. RAAP should commence with the remaining closure requirements for this unit. If there are any questions regarding these comments or the background data review, please contact me at (804) 698-4206.

Sincerely,

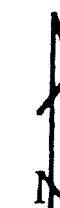
A handwritten signature in cursive script, appearing to read "Debra A. Miller".

Debra A. Miller
Environmental Engineer Senior

cc: Lisa Ellis, DEQ
Claire Ballard, DEQ
Aziz Farahmand, DEQ-RRO

Site Plan/ Background Soil Sample Locations

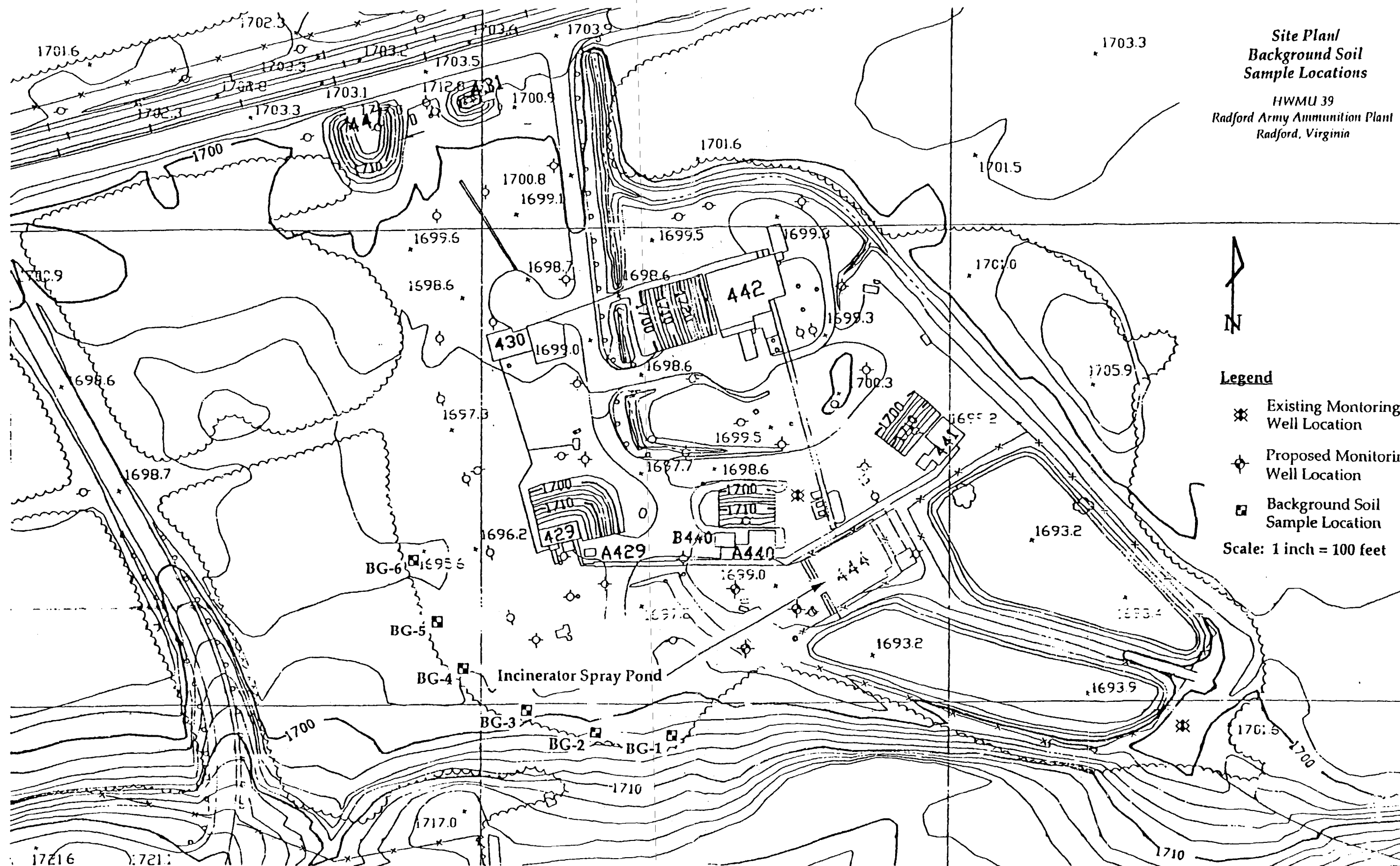
HWMU 39
Radford Army Ammunition Plant
Radford, Virginia



Legend

- ✱ Existing Monitoring Well Location
- ⬢ Proposed Monitoring Well Location
- Background Soil Sample Location

Scale: 1 inch = 100 feet



Source: Reference Drawings, Radford Army Ammunition Plant, Hercules Incorporated.

Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

April 14, 1997

97-815-100

FedEx 4-17-97

Debra Miller
Office of Permitting Management
629 East Main Street
Richmond, VA 23219

Subject: Background Soil Data Revisions
Incinerator Spray Pond HWMU 39
Radford Army ammunition Plant, Radford Virginia,
EPA ID# VA1210020730

Dear Ms. Miller:

Enclosed are the revised background soil sampling results and critical values for the closure of the Incinerator Spray Pond at the Radford Army Ammunition Plant, referenced in your letter of March 28, 1997.

The background soil sampling results have been revised to include the estimated values for all hazardous constituents of concern that were detected below the Practical Quantitation Limit (PQL) but above the Method Detection Limit (MDL). Critical values have been corrected to comply with the approved Closure Plan which requires the use of 95% coverage and 95% confidence level.

In order to meet funding requirements Alliant will proceed with preparing a subcontract to begin remediation of the Incinerator Spray Pond. Alliant realizes that DEQ's approval of the background sampling results is required for closure.

If you have any questions or concerns please contact Jerry Redder (540) 639-7536 (Jerome_Redder@ATK.com) or Arne Olsen (540) 639-8220 (Arne_Olsen@ATK.com)

Debra Miller
Background Soil Data Revisions
April 14, 1997
Page 2

Sincerely,

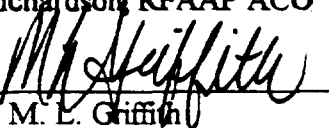


C. A. Jake
Environmental Manager

Enclosures
AEOlsen:V:\815-100

c: West Central Regional Office - Roanoke
R. L. Richardson, RFAAP ACO

Coordination:


M. L. Griffin
R. L. Richardson

bc: Adm. File
Env. File
D. W. Shead - w/o enclosure
C. A. Jake - w/o enclosure
J. J. Redder - w/o enclosure
A. E. Olsen - w/ enclosure

2 April 1997
Reference: L0706.05.01

Mr. Arne Olsen
Alliant Techsystems
P. O. Box 1
Radford, Virginia 24141-0100



Re: Incinerator Spray Pond Closure,
Background Soil Sampling Results

Dear Arne:

The following represents the updated report for background soil sampling results for the Incinerator Spray Pond based on our 26 March 1997 telephone conversation.

Alliant Techsystems, Inc. (Alliant) is submitting background soil sampling results and revised critical values in support of closure of the Incinerator Spray Pond at the Radford Army Ammunition Plant in Radford, Virginia. These changes are being made in response to comments received from the Virginia Department of Environmental Quality (DEQ) on 26 March 1997. Changes include recalculation of the critical values for chromium, lead, mercury, nickel, and thallium using analytical values reported between the method detection limit and practical quantitation limit (PQL). It is noted that because the reported values are less than the laboratory PQL, the values may not be true or accurate values. Basing the critical values on these analytical results may lower cleanup levels. Secondly, the critical values were recalculated using 95% data coverage and 95% confidence level.

The background critical values are based on samples taken on 2 January 1996 and 5 December 1996. In accordance with Section 3.7.1 of the approved closure plan for the Incineratory Spray Pond, Alliant collected and analyzed six background soil samples for the constituents provided in Table 3-2A, "*Hazardous Constituents of Concern*." The following statistical operations were conducted on the data:

- Check for possible data outliers;
- Test assumptions of data normality;

- Check for adequate number of samples collected; and
- Calculation of background critical values.

Table 1 summarizes the analytical results and indicates the hazardous constituents of concern, Practical Quantitation Limit (PQL), units, and results. **Table 2** provides the calculated soil background critical values. Analytical methods, statistical methods, and conclusions are discussed further below.

Data

Background soil sampling results with the Practical Quantitation Limits for the 2 January 1996 sampling events were submitted on 25 March 1996. As indicated in the 28 May 1996 and 28 October 1996 letters from DEQ to Ms. C. A. Jake, Alliant Techsystems, Inc., several analytical methods did not conform to Table 3-2 of the approved closure plan for the Incinerator Spray Pond, dated 24 August 1995. However, because most constituents were detected above the PQL, DEQ accepted the results for all the constituents in Table 3-2 with the exception of arsenic, di-n-butyl phthalate, diethyl phthalate, and resorcinol. Consequently, additional soil samples were collected and analyzed for these constituents on 5 December 1996. The analytical methods used were those identified in the updated Table 3-2A enclosed with DEQ's 28 October 1996 letter.

The analytical methods used for antimony, barium, chromium, lead, mercury, nickel, and thallium were not those identified in the approved closure plan. However, these constituents were detected at levels above the method detection limit for the methods used. Because the constituents were detected, DEQ indicated its approval of the methods in DEQ's 28 October 1996 letter to C.A. Jake, Alliant Techsystems.

Alliant resampled and re-analyzed for arsenic, di-n-butyl phthalate, diethyl phthalate, and resorcinol in December 1996 because of several concerns. First, the analytical method utilized in the first sampling event, SW-846 Method 8061, could not confirm the presence of diethyl phthalate because the ions in the clay soil matrix interfere with the laboratory instrumentation. Second, the recovery of several surrogates was not within acceptable ranges. Finally, the non-detected values for resorcinol and diethyl phthalate were based upon a Mass Spectral Library Search only. Although DEQ later approved the use of Method 8270B for these

**INCINERATOR SPRAY POND BACKGROUND SOIL RESULTS
BASIC RESULTS (CONDENSED)
FOR ALL DATES**

COMPANY: Alliant Techsystems Inc.
SITE: Incin. Spray Pond
PROGRAM: Closure
PROGRAM TYPE: Soil
DATA GROUP:

All Duplicates Used

PARAMETER	UNIT	SAMPLE NUMBER	SAMPLE DATE	RESULT	DETECTION LIMIT	COMMENT CODE
LOCATION ID: Background						
RAAP LIST						
2,4-DINITROTOLUENE	PPB	BG1	01/02/1996	Non-Detec	130.00000	
2,4-DINITROTOLUENE	PPB	BG2	01/02/1996	Non-Detec	130.00000	
2,4-DINITROTOLUENE	PPB	BG3	01/02/1996	Non-Detec	130.00000	
2,4-DINITROTOLUENE	PPB	BG4	01/02/1996	Non-Detec	130.00000	
2,4-DINITROTOLUENE	PPB	BG5	01/02/1996	Non-Detec	130.00000	
2,4-DINITROTOLUENE	PPB	BG6	01/02/1996	Non-Detec	130.00000	
2,6-DINITROTOLUENE	PPB	BG1	01/02/1996	Non-Detec	70.00000	
2,6-DINITROTOLUENE	PPB	BG2	01/02/1996	Non-Detec	70.00000	
2,6-DINITROTOLUENE	PPB	BG3	01/02/1996	Non-Detec	70.00000	
2,6-DINITROTOLUENE	PPB	BG4	01/02/1996	Non-Detec	70.00000	
2,6-DINITROTOLUENE	PPB	BG5	01/02/1996	Non-Detec	70.00000	
2,6-DINITROTOLUENE	PPB	BG6	01/02/1996	Non-Detec	70.00000	
ANTIMONY	PPM	BG1	01/02/1996	3.370	1.50000	
ANTIMONY	PPM	BG2	01/02/1996	3.250	1.50000	
ANTIMONY	PPM	BG3	01/02/1996	3.700	1.50000	
ANTIMONY	PPM	BG4	01/02/1996	5.480	1.50000	
ANTIMONY	PPM	BG5	01/02/1996	2.140	1.50000	
ANTIMONY	PPM	BG6	01/02/1996	4.200	1.50000	
ARSENIC	PPM	BG1	01/02/1996	2.250	1.25000	
ARSENIC	PPM	BG2	01/02/1996	3.880	1.25000	
ARSENIC	PPM	BG3	01/02/1996	2.900	1.25000	
ARSENIC	PPM	BG4	01/02/1996	2.070	1.25000	
ARSENIC	PPM	BG5	01/02/1996	1.910	1.25000	
ARSENIC	PPM	BG6	01/02/1996	1.760	1.25000	
BARIUM	PPM	BG1	01/02/1996	66.100	1.00000	
BARIUM	PPM	BG2	01/02/1996	82.300	1.00000	
BARIUM	PPM	BG3	01/02/1996	63.000	1.00000	

(continues)

**INCINERATOR SPRAY POND BACKGROUND SOIL RESULTS
BASIC RESULTS (CONDENSED)
FOR ALL DATES**

PARAMETER	UNIT	SAMPLE NUMBER	SAMPLE DATE	RESULT	DETECTION LIMIT	COMMENT CODE
BARIUM	PPM	BG4	01/02/1996	93.300	1.00000	
BARIUM	PPM	BG5	01/02/1996	91.500	1.00000	
BARIUM	PPM	BG6	01/02/1996	74.600	1.00000	
BERYLLIUM	PPM	BG1	01/02/1996	0.702	0.10000	
BERYLLIUM	PPM	BG2	01/02/1996	0.538	0.10000	
BERYLLIUM	PPM	BG3	01/02/1996	0.451	0.10000	
BERYLLIUM	PPM	BG4	01/02/1996	0.920	0.10000	
BERYLLIUM	PPM	BG5	01/02/1996	0.895	0.10000	
BERYLLIUM	PPM	BG6	01/02/1996	0.817	0.10000	
CADMIUM	PPM	BG1	01/02/1996	Non-Detec	0.05000	
CADMIUM	PPM	BG2	01/02/1996	Non-Detec	0.05000	
CADMIUM	PPM	BG3	01/02/1996	Non-Detec	0.05000	
CADMIUM	PPM	BG4	01/02/1996	0.058	0.05000	
CADMIUM	PPM	BG5	01/02/1996	0.054	0.05000	
CADMIUM	PPM	BG6	01/02/1996	0.053	0.05000	
CHROMIUM	PPM	BG1	01/02/1996	17.000	25.00000	
CHROMIUM	PPM	BG2	01/02/1996	16.000	25.00000	
CHROMIUM	PPM	BG3	01/02/1996	19.000	25.00000	
CHROMIUM	PPM	BG4	01/02/1996	23.500	25.00000	
CHROMIUM	PPM	BG5	01/02/1996	21.500	25.00000	
CHROMIUM	PPM	BG6	01/02/1996	21.500	25.00000	
DI-N-BUTYL PHTHALATE	PPB	BG1	01/02/1996	Non-Detec	330.00000	
DI-N-BUTYL PHTHALATE	PPB	BG2	01/02/1996	Non-Detec	330.00000	
DI-N-BUTYL PHTHALATE	PPB	BG3	01/02/1996	Non-Detec	330.00000	
DI-N-BUTYL PHTHALATE	PPB	BG4	01/02/1996	Non-Detec	330.00000	
DI-N-BUTYL PHTHALATE	PPB	BG5	01/02/1996	Non-Detec	330.00000	
DI-N-BUTYL PHTHALATE	PPB	BG6	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG1	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG2	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG3	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG4	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG5	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG6	01/02/1996	Non-Detec	330.00000	
LEAD	PPM	BG1	01/02/1996	11.000	50.00000	
LEAD	PPM	BG2	01/02/1996	10.000	50.00000	
LEAD	PPM	BG3	01/02/1996	13.000	50.00000	
LEAD	PPM	BG4	01/02/1996	14.500	50.00000	
LEAD	PPM	BG5	01/02/1996	11.500	50.00000	
LEAD	PPM	BG6	01/02/1996	14.500	50.00000	
MERCURY	PPM	BG1	01/02/1996	0.250	1.00000	
MERCURY	PPM	BG2	01/02/1996	0.250	1.00000	
MERCURY	PPM	BG3	01/02/1996	0.200	1.00000	
MERCURY	PPM	BG4	01/02/1996	0.150	1.00000	
MERCURY	PPM	BG5	01/02/1996	0.100	1.00000	
MERCURY	PPM	BG6	01/02/1996	0.250	1.00000	

(continues)

INCINERATOR SPRAY POND BACKGROUND SOIL RESULTS
BASIC RESULTS (CONDENSED)
FOR ALL DATES

PARAMETER	UNIT	SAMPLE NUMBER	SAMPLE DATE	RESULT	DETECTION LIMIT	COMMENT CODE
NICKEL	PPM	BG1	01/02/1996	5.400	7.50000	
NICKEL	PPM	BG2	01/02/1996	3.500	7.50000	
NICKEL	PPM	BG3	01/02/1996	4.700	7.50000	
NICKEL	PPM	BG4	01/02/1996	10.600	7.50000	
NICKEL	PPM	BG5	01/02/1996	11.500	7.50000	
NICKEL	PPM	BG6	01/02/1996	9.400	7.50000	
RESORCINOL	PPB	BG1	01/02/1996	Non-Detec	330.00000	
RESORCINOL	PPB	BG2	01/02/1996	Non-Detec	330.00000	
RESORCINOL	PPB	BG3	01/02/1996	Non-Detec	330.00000	
RESORCINOL	PPB	BG4	01/02/1996	Non-Detec	330.00000	
RESORCINOL	PPB	BG5	01/02/1996	Non-Detec	330.00000	
RESORCINOL	PPB	BG6	01/02/1996	Non-Detec	330.00000	
SILVER	PPM	BG1	01/02/1996	0.025	0.01000	
SILVER	PPM	BG2	01/02/1996	0.017	0.01000	
SILVER	PPM	BG3	01/02/1996	0.017	0.01000	
SILVER	PPM	BG4	01/02/1996	0.076	0.01000	
SILVER	PPM	BG5	01/02/1996	0.045	0.01000	
SILVER	PPM	BG6	01/02/1996	0.037	0.01000	
THALLIUM	PPM	BG1	01/02/1996	0.160	0.50000	
THALLIUM	PPM	BG2	01/02/1996	0.125	0.50000	
THALLIUM	PPM	BG3	01/02/1996	0.180	0.50000	
THALLIUM	PPM	BG4	01/02/1996	0.280	0.50000	
THALLIUM	PPM	BG5	01/02/1996	0.245	0.50000	
THALLIUM	PPM	BG6	01/02/1996	0.270	0.50000	

----- End of Report -----

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**Table 2: Critical Values
Incinerator Spray Pond Closure**

<u>Parameter</u>	<u>Upper Tolerance Limit (UTL)</u>	<u>Practical Quantitation Limit (PQL)</u>
2,4-Dinitrotoluene	130.0 ppb	130.0 ppb
2,6-Dinitrotoluene	70.0 ppb	70.0 ppb
Antimony	7.8 ppm	1.5 ppm
Arsenic	5.43 ppm	1.25 ppm
Barium	125.75 ppm	1.00 ppm
Beryllium	1.44 ppm	0.1 ppm
Cadmium	0.071 ppm	0.05 ppm
Chromium	30.55 ppm	25.0 ppm
Di-n-butyl phthalate	330.0 ppb	330.0 ppb
Diethyl phthalate	330.0 ppb	330.0 ppb
Lead	19.4 ppm	50.0 ppm
Mercury	0.44 ppm	1.0 ppm
Nickel	20.1 ppm	7.5 ppm
Resorcinol	330.0 ppb	330.0 ppb
Silver	0.12 ppm	0.01 ppm
Thallium	0.45 ppm	0.5 ppm

constituents, Alliant resample and reanalyze for these constituents on 5 December 1996.

SW-846 Method 6020 was utilized for analysis of arsenic. However, the laboratory Minimum Qualifying Limit (MQL) was 1.25 ppm versus 0.2 ppm identified in Table 3-2A. This discrepancy was due to the nature of the sample matrix and the digestion method used. Soils, especially clayey/silty soils, present special interference problems in laboratory analysis. The clay particles contain ionic charges and higher natural levels of metals which tend to interfere with the more sensitive laboratory equipment. Because arsenic was detected above the laboratory MQL, resampling will not be necessary.

Outliers

The data were checked for possible outliers using the Outlier Test, which follows ASTM Standard E178-75. The Monitor System, developed by Entech Systems, Inc., who also developed GRITSTAT, contains the same programs as GRITSTAT. These programs allow users to perform evaluations on more than one constituent at a time. The Outlier Test program is particularly useful for statistically detecting and verifying suspected outliers and locating possible data entry errors. It uses a standard t-test to compare the largest value from a sample set to the remaining values and then designates the possibility of this value being an outlier as "Yes" or "No." If the report indicates "Yes" for any parameter, it then lists the following information about it:

- The value of the possible outlier;
- Sampling location;
- Sample date; and
- Sample number.

No possible outliers were identified for any of the parameters. The test report is included with this letter as **Attachment A**.

Normality

The data were checked for normality using the Shapiro-Wilk Goodness-of-Fit Test. This program systematically designates the underlying distribution as normal, lognormal, or non-normal. If the data fails the test of normality, the program automatically takes the logs of the data and repeats the procedure. The Data Distribution program and report also computes:

- Sample size;
- Percentage of non-detects in each sample set;
- Coefficient of Kurtosis;
- Coefficient of skewness; and

- Coefficient of variation.

The report is included with this letter as **Attachment B**. As expected, the following compounds were not detected in any of the six samples and the data set is, therefore, non-normal:

2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-butyl phthalate
Diethyl phthalate
Resorcinol

The following compounds were detected above the method detection limit, but in some cases below the PQL, in all six samples and normally distributed:

Antimony
Arsenic
Barium
Beryllium
Chromium
Lead
Mercury
Nickel
Silver
Thallium

One compound, cadmium, was detected in 50% of the background samples. A non-normal distribution results when more than 50% of the samples are non-detects. In accordance with DEQ's *Guidance on Statistical Methods for Groundwater Data Analysis at a Solid Waste or Hazardous Waste Site*, Version 2.0 (10 August 1995), Alliant performed the recommended functions for data with more than 15% but less than or equal to 50% non-detected values.

The data set excluding non-detected values was checked for normality. As indicated in **Attachment B**, the detected only data for cadmium were normally distributed.

Appropriate Sample Numbers

A simple check to ensure that an appropriate number of samples were taken for analysis was completed for each parameter which had detected results. An appropriate number of samples could not be calculated for those parameters which had non-detected results.

The method is listed in Chapter 9, *Sampling Plan*, of SW-846, and summarized in **Attachment C** of this letter. Use of this alternate method was approved in a letter to J. J. Redder of Alliant Techsystems from C. L. Parker IV of DEQ dated 15 November 1995.

This method calculates an appropriate number of samples based on the variance as computed by the actual sample results. Then the calculated appropriate number of samples is compared to the actual number of sample measurements taken, which was six for each parameter, to ensure that an adequate number of background samples were taken. The calculated appropriate number of samples should be less than or equal to the actual number of samples taken.

Only barium, for which an appropriate number of 16 samples was calculated, did not pass this test. Alliant believes additional samples for barium are not necessary for the successful closure of this unit. barium is not a constituent of primary concern for closure of this unit; the mean concentration of barium in the samples is 78.5 mg/kg, or 28% of the naturally occurring mean concentration of 280 mg/kg for the eastern United States.

Critical Values

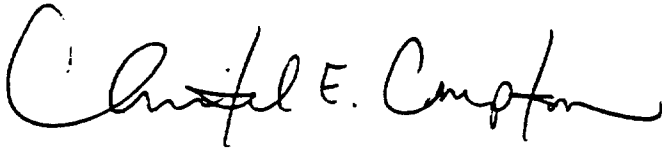
Based on the previous calculations and evaluations, **Table 2** provides the calculated critical soil values for the Incinerator Spray Pond. In accordance with DEQ's guidance, an upper tolerance limit (UTL) was calculated for the data that were detected in all six background samples, using the Tolerance Limits method. A 95% level of coverage and a 95% confidence level were chosen. The calculated UTLs are listed in **Attachment D**.

For cadmium, which had 50% non-detect values and a normal distribution of detected-only values, Cohen's method of adjustment was used to calculate the mean, standard deviation, and UTL. The laboratory

PQL was used as the background value for those constituents with 100% non-detected values.

An electronic copy of this document has been enclosed with this report. If you have any questions regarding this letter or would like any additional information, please call me at (540) 776-3545.

Sincerely,

A handwritten signature in black ink, appearing to read "Christel E. Compton". The signature is fluid and cursive, with the first name "Christel" being the most prominent part.

Christel E. Compton
Branch Manager

CC:db

enclosures: Table 1: Incinerator Spray Pond Analytical Results
Table 2: Critical Values
Attachments A-D

Attachment A
Outlier Test Report

BACKGROUND SOIL SAMPLES
OUTLIER TEST
FOR ALL DATES

COMPANY: Alliant Techsystems Inc.
SITE: Incin. Spray Pond
PROGRAM: Closure
PROGRAM TYPE: Soil
DATA GROUP:

All Duplicates Used
Significance Level (1 - alpha): 95%

Non-Detects = Detection Limit/2

LOCATION	POSSIBLE OUTLIER?	SAMPLE NUMBER	SAMPLE DATE	VALUE	SAMPLE SIZE	MEAN	CALCULATED T	TABULAR T

RAAP LIST

PARAMETER: 2,4-DINITROTOLUENE UNIT: PPB

Background

NO

PARAMETER: 2,6-DINITROTOLUENE UNIT: PPB

Background

NO

PARAMETER: ANTIMONY UNIT: PPM

Background

NO

PARAMETER: ARSENIC UNIT: PPM

Background

NO

PARAMETER: BARIUM UNIT: PPM

Background

NO

(continues)

BACKGROUND SOIL SAMPLES
OUTLIER TEST
FOR ALL DATES

LOCATION	POSSIBLE OUTLIER?	SAMPLE NUMBER	SAMPLE DATE	VALUE	SAMPLE SIZE	MEAN	CALCULATED T	TABULAR T
PARAMETER: BERYLLIUM							UNIT: PPM	
Background	NO							
PARAMETER: CADMIUM							UNIT: PPM	
Background	NO							
PARAMETER: CHROMIUM							UNIT: PPM	
Background	NO							
PARAMETER: DI-N-BUTYL PHTHALATE							UNIT: PPB	
Background	NO							
PARAMETER: DIETHYL PHTHALATE							UNIT: PPB	
Background	NO							
PARAMETER: LEAD							UNIT: PPM	
Background	NO							
PARAMETER: MERCURY							UNIT: PPM	
Background	NO							
PARAMETER: NICKEL							UNIT: PPM	
Background	NO							
PARAMETER: RESORCINOL							UNIT: PPB	
Background	NO							

(continues)

04/02/1997

Alliant Techsystems Inc.

Page: 3

BACKGROUND SOIL SAMPLES
OUTLIER TEST
FOR ALL DATES

LOCATION	POSSIBLE OUTLIER?	SAMPLE NUMBER	SAMPLE DATE	VALUE	SAMPLE SIZE	MEAN	CALCULATED T	TABULAR T

PARAMETER: SILVER UNIT: PPM

Background

NO

PARAMETER: THALLIUM UNIT: PPM

Background

NO

----- End of Report -----

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Attachment B
Normality Test Report and
Descriptive Statistics

**BACKGROUND SOIL SAMPLES
DATA DISTRIBUTION
FOR ALL DATES**

COMPANY: Alliant Techsystems Inc.

SITE: Incin. Spray Pond

PROGRAM: Closure

PROGRAM TYPE: Soil

DATA GROUP:

**All Duplicates Used
Significance Level (1 - alpha): 95%**

Non-Detects - Detection Limit/2

LOCATION ID	SAMPLE SIZE	# N-Ds	SHAPIRO-WILK DISTRIBUTION	CALCULATED W	TABULAR W	SKENNESS	KURTOSIS	COEFFICIENT OF VARIATION

RAAP LIST

PARAMETER: 2,4-DINITROTOLUENE

UNIT: PPB

Background

6	100		Non-Normal	0.0000	0.7880	0.00	0.00	0.00

PARAMETER: 2,6-DINITROTOLUENE

UNIT: PPB

Background

6	100		Non-Normal	0.0000	0.7880	0.00	0.00	0.00

PARAMETER: ANTIMONY

UNIT: PPM

Background

6	0		Normal	0.9687	0.7880	0.25	1.77	0.30

PARAMETER: ARSENIC

UNIT: PPM

Background

6	0		Normal	0.8583	0.7880	0.77	1.81	0.33

PARAMETER: BARIUM

UNIT: PPM

Background

6	0		Normal	0.9173	0.7880	-0.01	1.00	0.16

(continues)

**BACKGROUND SOIL SAMPLES
DATA DISTRIBUTION
FOR ALL DATES**

LOCATION ID	SAMPLE SIZE	% N-Ds	SHAPIRO-WILK DISTRIBUTION	CALCULATED W	TABULAR W	SKENNESS	KURTOSIS	COEFFICIENT OF VARIATION
PARAMETER: BERYLLIUM								UNIT: PPM
Background	6	0	Normal	0.9127	0.7880	-0.27	1.08	0.27
PARAMETER: CADMIUM								UNIT: PPM
Background	6	50	Non-Normal	0.7243	0.7880	0.02	0.73	0.41
PARAMETER: CHROMIUM								UNIT: PPM
Background	6	0	Normal	0.9380	0.7880	-0.07	1.09	0.15
PARAMETER: DI-N-BUTYL PHTHALATE								UNIT: PPB
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00
PARAMETER: DIETHYL PHTHALATE								UNIT: PPB
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00
PARAMETER: LEAD								UNIT: PPM
Background	6	0	Normal	0.9068	0.7880	0.01	1.02	0.15
PARAMETER: MERCURY								UNIT: PPM
Background	6	0	Normal	0.8308	0.7880	-0.49	1.30	0.32
PARAMETER: NICKEL								UNIT: PPM
Background	6	0	Normal	0.8897	0.7880	0.01	0.88	0.45

(continues)

BACKGROUND SOIL SAMPLES
DATA DISTRIBUTION
FOR ALL DATES

LOCATION ID	SAMPLE SIZE	% N-Ds	SHAPIRO-WILK DISTRIBUTION	CALCULATED W	TABULAR W	SKENNESS	KURTOSIS	COEFFICIENT OF VARIATION
PARAMETER: RESORCINOL						UNIT: PPB		
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00
PARAMETER: SILVER						UNIT: PPM		
Background	6	0	Normal	0.8693	0.7880	0.71	1.84	0.56
PARAMETER: THALLIUM						UNIT: PPM		
Background	6	0	Normal	0.9120	0.7880	-0.11	0.98	0.30

----- End of Report -----

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NORMALITY CHECK ON DETECTED VALUES - 50% NON-DETECT
DATA DISTRIBUTION
FOR ALL DATES

COMPANY: Alliant Techsystems Inc.
SITE: Incin. Spray Pond
PROGRAM: Closure
PROGRAM TYPE: Soil
DATA GROUP:

All Duplicates Used
Significance Level (1 - alpha): 95%
Non-Detects Ignored

LOCATION ID	SAMPLE SIZE	% N-Ds	SHAPIRO-WILK DISTRIBUTION	CALCULATED W	TABULAR W	SKENNESS	KURTOSIS	COEFFICIENT OF VARIATION

RAAP LIST

PARAMETER: CADMIUM

UNIT: PPM

Background

3	0	Normal	0.8928	0.7670	0.32	0.67	0.04

----- End of Report -----

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INCINERATOR SPRAY POND BACKGROUND SOIL RESULTS
DESCRIPTIVE STATISTICS
FOR ALL DATES

COMPANY: Alliant Techsystems Inc.

SITE: Incin. Spray Pond

PROGRAM: Closure

PROGRAM TYPE: Soil

DATA GROUP:

All Duplicates Used

Non-Detects = Detection Limit/2

PARAMETER	SAMPLE							
UNIT	SIZE	N-Ds	MEAN	SAMPLE MEDIAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM
LOCATION ID: Background								
RAAP LIST								
ANTIMONY								
PPM	6	0	3.690	3.535	1.110	1.233	2.140	5.480
ARSENIC								
PPM	6	0	2.462	2.160	0.800	0.640	1.760	3.880
BARIUM								
PPM	6	0	78.467	78.450	12.741	162.339	63.000	93.300
BERYLLIUM								
PPM	6	0	0.721	0.760	0.193	0.037	0.451	0.920
CADMIUM								
PPM	6	50	0.040	> 49% N-D's	0.017	0.000	Non-Detect	0.058
CHROMIUM								
PPM	6	0	19.750	20.250	2.911	8.475	16.000	23.500
LEAD								
PPM	6	0	12.417	12.250	1.882	3.542	10.000	14.500
MERCURY								
PPM	6	0	0.200	0.225	0.063	0.004	0.100	0.250
NICKEL								
PPM	6	0	7.517	7.400	3.390	11.494	3.500	11.500
SILVER								
PPM	6	0	0.036	0.031	0.022	0.001	0.017	0.076
THALLIUM								
PPM	6	0	0.210	0.213	0.064	0.004	0.125	0.280

----- End of Report -----

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Attachment C
Appropriate Number of Samples

ALLIANT TECHSYSTEMS, INC.
INCINERATOR SPRAY POND BACKGROUND SOIL SAMPLES
APPROPRIATE NUMBER OF SAMPLES CHECK
SW-846 CHAPTER 9 SAMPLING PLAN

Variance of Sample, s^2

$$s^2 = \frac{\sum X_i^2 - (\sum X_i)^2 / n}{n - 1} \quad \text{where } n = \text{number of sample measurements.}$$

Appropriate Number of Samples, n

$$n = \frac{t^2 s^2}{RT - X}$$

where RT = regulatory threshold,

$\bar{X}$ = sample mean, and

t = value based on the number of degrees of freedom ($n-1$)

The results for the following parameters were non-detect and, therefore, an appropriate number of samples could not be calculated:

2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-butyl phthalate
Diethyl phthalate
Resorcinol

Although many of the results for most of the following parameters were below the PQL, an appropriate number of samples was calculated using the laboratory detection limit.

Antimony =	2.7	Number of Actual Samples = 6
Arsenic =	0.0	
Barium =	16.4	
Beryllium =	0.1	
Cadmium =	0.0	
Chromium =	1.3	
Lead =	1.2	
Mercury =	0.0	
Nickel =	3.3	
Silver =	0.4	
Thallium =	0.0	

Attachment D
Critical Values

UPPER TOLERANCE LIMIT FOR 50% NON-DETECTS
TOLERANCE LIMITS
FOR ALL DATES

COMPANY: Alliant Techsystems Inc.

SITE: Incin. Spray Pond

PROGRAM: Closure

PROGRAM TYPE: Soil

DATA GROUP:

All Duplicates Used
Tolerance Coefficient (Y): 95%

Cohen's Method Used For Non-Detects
Level Of Coverage (P): 95%

LOCATION ID	SAMPLE SIZE	% NON- DETECT	MEAN	REGULATORY LIMIT	UPPER TOLERANCE LIMIT
RAAP LIST					
PARAMETER: CADMIUM UNIT: PPM					
Background	6	50	0.050	0.000	0.071

----- End of Report -----

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UPPER TOLERANCE LIMITS FOR 100% DETECTED
TOLERANCE LIMITS
FOR ALL DATES

COMPANY: Alliant Techsystems Inc.

SITE: Incin. Spray Pond

PROGRAM: Closure

PROGRAM TYPE: Soil

DATA GROUP:

All Duplicates Used
Tolerance Coefficient (Y): 95%

Non-Detects - Detection Limit/2
Level Of Coverage (P): 95%

LOCATION ID	SAMPLE SIZE	% NON- DETECT	MEAN	REGULATORY LIMIT	UPPER TOLERANCE LIMIT

RAAP LIST

PARAMETER: ANTIMONY

UNIT: PPM

Background

6

0

3.690

0.000

7.810

PARAMETER: ARSENIC

UNIT: PPM

Background

6

0

2.462

0.000

5.430

PARAMETER: BARIUM

UNIT: PPM

Background

6

0

78.467

0.000

125.749

PARAMETER: BERYLLIUM

UNIT: PPM

Background

6

0

0.721

0.000

1.436

PARAMETER: CHROMIUM

UNIT: PPM

Background

6

0

19.750

0.000

30.553

(continues)

UPPER TOLERANCE LIMITS FOR 100% DETECTED
TOLERANCE LIMITS
FOR ALL DATES

LOCATION ID	SAMPLE SIZE	% NON- DETECT	MEAN	REGULATORY LIMIT	UPPER TOLERANCE LIMIT
PARAMETER: LEAD					UNIT: PPM
Background	6	0	12.417	0.000	19.401
PARAMETER: MERCURY					UNIT: PPM
Background	6	0	0.200	0.000	0.435
PARAMETER: NICKEL					UNIT: PPM
Background	6	0	7.517	0.000	20.098
PARAMETER: SILVER					UNIT: PPM
Background	6	0	0.036	0.000	0.120
PARAMETER: THALLIUM					UNIT: PPM
Background	6	0	0.210	0.000	0.447

----- End of Report -----

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Becky Norton Dunlop
Secretary of Natural Resources

MAR 28 1997

C.A. Jake
Alliant Techsystems Inc.
Environmental Manager
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

**RE: Radford Army Ammunition Plant (RAAP)
EPA ID# VA12100207306
Incinerator Spray Pond
Closure Plan Amendment/Background Data Review**

Dear Ms. Jake:

Your letter providing the background soil sampling for RAAP's incinerator spray pond was received by the Department of Environmental Quality (DEQ) on February 5, 1997. This submittal has been reviewed.

Based on the information provided, the following comments will need to be addressed prior to DEQ approval of the background values.

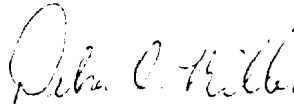
1. Page 5, Critical Values: The upper tolerance limit was calculated for the data using a 99% coverage and 95% confidence level. However, page 48 of the closure plan requires the use of 95% coverage and 95% confidence level. This lower percent coverage will decrease the value of the UTL. Please recalculate the UTL with the 95% coverage.
2. Table 1: It is noted that non-detects are listed for many of the constituents. The data submitted on February 5, 1997, indicated non-detects for chromium, lead, mercury, nickel, and thallium. However, the data submitted with the March 25, 1996, letter to Clifton L. Parker^{IV}, showed values for these constituents. In fact, approval of the methods used for these constituents was qualified by the fact that values were obtained during the analysis. It is noted that this data is likely estimated as the data is less than the PQL, but higher than the detection limit; however, no qualifier is indicated in the analytical results table. As "estimated" values

RAAP Incinerator Spray Pond
Background Data Review
Page 2

are available for chromium, lead, mercury, nickel, and thallium, these values shall be used to calculate the UTL. Please recalculate the UTL for these constituents.

Please review these comments and resubmit the background soil statistical results for the incinerator spray pond (HWMU39). If there are any questions regarding these comments or the background data review, please contact me at (804) 698-4206.

Sincerely,



Debra A. Miller
Environmental Engineer Senior

cc: Lisa Ellis, DEQ *Te*
Claire Slaughter, DEQ
Aziz Farahmand, DEQ-RRO

PM96-0112



97-73

Reader
Olson
Barker
File

Date due 4/6

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

George Allen
Governor

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Thomas L. Hopkins
Director

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Becky Norton Dunlop
Secretary of Natural Resources

Certified Mail
Return Receipt Requested

March 26, 1997

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
Incinerator Spray Pond and Equalization Basin Closure
EPA ID# VA12100207306
Extensions to Closure Schedules**

Dear Ms. Jake:

Your letters requesting extensions to the closure schedules for the Incinerator Spray Pond's and the Equalization Basin's closure activities were received on March 7, 1997. As the closure activities will, of necessity, take longer to complete than the approved closure schedule, the DEQ will approve an extension until May 12, 1997, for completion of closure activities at the RAAP's Equalization Basin and until September 29, 1997, for the Incinerator Spray Pond. Please update the approved closure plans and submit the revised closure schedules to the Department within 30 days. During this extension period, RAAP shall continue to take all steps to prevent threats to human health and the environment from these units that are no longer operating but have not completed formal closure.

If there are any additional questions, please contact Debra Miller, Environmental Engineer Senior, of my staff at (804) 698-4206. Please note, any further requests for an extension to the closure period should be submitted with detailed justification at least 30 days prior to the

expiration date, as required by VHWMR 9 VAC 20-60-580.D.3.b. [previously VHWMR §9.6.D.3.b].

Sincerely,

Leslie A. Romanchuk

for Thomas L. Hopkins
Director

cc: Leslie Romanchik, DEQ
Lisa Ellis, DEQ
Debra Miller, DEQ
Glenn Von Gonten, DEQ
Claire Slaughter, DEQ
Aziz Farahmand, DEQ-RRO

Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

March 10, 1997

97-815-078

Debra Miller
Office of Permitting Management
629 East Main Street
Richmond, VA 23219

Subject: QA/QC Data
Incinerator Spray Pond HWMU 39
Radford Army Ammunition Plant, Radford Virginia,
EPA ID# VA1210020730

Dear Ms. Miller:

Enclosed is a copy of the QA/QC data for background soil samples taken during the Closure of the Incinerator Spray Pond (HWMU 39). Similar data was requested in your March 4, 1997 for the Closure of the Bio-Plant Equalization Basin (HWMU 10).

If you have any questions or concerns, please contact Jerry Redder at (540) 639-7536 (e-mail Jerome_Redder@ATK.com) or Arne Olsen at (540) 639-8220 (e-mail. Arne_Olsen@ATK.com).

Sincerely

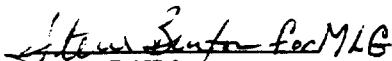


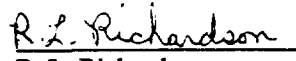
C. A. Jake, Supervisor
Environmental Affairs

Enclosure

c: West Central Regional Office - Roanoke - w/o enclosure
R. L. Richardson, RFAAP ACO - w/o enclosure

Coordination:


M. L. Griffith


R. L. Richardson

bc: Administrative File w/o enclosure
C. A. Jake - w/o enclosure
J. J. Redder - w/o enclosure
A. E. Olsen - w/o enclosure
Env. File

Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

March 4, 1997

97-815-073

Debra A. Miller
Department of Environmental Quality
Office of Permitting Management, Hazardous Waste
629 East Main Street
Richmond, VA 23219

Subject: Incinerator Spray Pond
Extension to Closure Schedule

Dear Ms. Miller:

The Background Soil Analysis was submitted to DEQ January 30, 1997. An extension to the closure schedule was granted October 1, 1996. We cannot proceed with the closure of the Incinerator Spray Pond until the background analysis is accepted by DEQ. Based on comments received for the Equalization Basin Closure Plan we are preparing the laboratory's QA/QC data for submittal as an addendum to the Background Analysis. We intend to complete the closure of the spray pond once the background data and critical values are agreed upon. At this time we are requesting an additional 180 day extension to the closure schedule so that the Background Levels Analysis and the Critical Values can be determined.

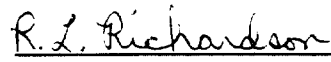
If you have any questions or concerns please contact Jerry Redder at (540) 639-7536.

Sincerely,


C. A. Jake
Environmental Affairs Supervisor

Coordination: 
M. L. Griffith

c: West Central Regional Office- Roanoke
R. L. Richardson, RAAP ACO


R. L. Richardson

bc: Administrative File
Environmental File

C. A. Jake
J. J. Redder

A. E. Olsen
D. W. Shead

Rec'd ENV 2-24-97 -abg

97-45
c: Jake
Redder
Olsen
ENV file



COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

George Allen
Governor

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Thomas L. Hopkins
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Becky Norton Dunlop
Secretary of Natural Resources

February 20, 1997

C.A. Jake
Environmental Manager
Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, Virginia 24141-0100

**RE: Radford Army Ammunition Plant, EPA ID#VA1210020730
Closure Plan for Container Storage Area**

Dear Ms. Jake:

The Department of Environmental Quality (DEQ) received a copy of the "Site Investigation Evaluation, Bioplant Equalization Basin Closure Site Investigation/Evaluation, Radford Army Ammunition Plant" on February 3, 1997, and a copy of the "Background Soil Data, Incinerator Spray Pond HWMU 39, Radford Army Ammunition Plant" on February 5, 1997. The information for closure of the equalization basin is currently under review. Review of the incinerator spray pond background data should commence within the next couple of weeks. If there are any questions regarding either of these reviews, please contact me at (804) 698-4206.

Sincerely,

A handwritten signature in cursive script, reading "Debra A. Miller".

Debra A. Miller
Environmental Engineer Senior
Office of Permitting Management

cc: Lisa Ellis, DEQ-OPM
Mike Scott, DEQ-RRO
Clarie Ballard, DEQ-OTA

Track Nos. PM97-0046 and PM97-0059

Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

January 30, 1997

97-815-046

Debra Miller
Office of Permitting Management
629 East Main Street
Richmond, VA 23219

Subject: Background Soil Data
Incinerator Spray Pond HWMU 39
Radford Army ammunition Plant, Radford Virginia,
EPA ID# VA1210020730

Dear Ms. Miller:

Enclosed is a copy of the "Background Soil Data, Incinerator Spray Pond HWMU 39, Radford Army Ammunition Plant." This document contains the results of the background soil sampling, as well as the statistical analysis of this data. Included are descriptions of the Field QA/QC procedures and the Laboratory QA/QC procedures for both CVLC and REIC Laboratories. QA/QC data in the form of Laboratory logbooks, analysis result sheets and Chain of custody forms will be provided if requested.

Two background efforts were performed for the Closure Plan for Site 39 the Incinerator Spray Pond. Background soil sampling was first performed on January 2, 1996. The results were submitted to the Virginia Department of Environmental Quality (VaDEQ) on March 25, 1996. DEQ requested additional sampling in May 28, 1996 and October 28, 1996 correspondence. Alliant Techsystems resampled the requested background soils. Both sets of data are compiled in the attached documentation.

A map of the location of the background samples is attached. The locations of the first background sampling effort were used in the second sampling effort. Therefore, there is one map for both sampling efforts. The background sampling locations are indicated in the approved Closure Plan.

The results from both sampling efforts and their statistical analysis are enclosed in Section 2. This document contains an in-depth discussion of the correspondences related to the use of two

Debra Miller
Background Soil Data
February 4, 1997
Page 2

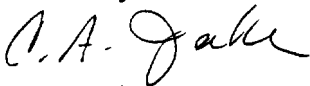
separate sampling efforts, statistical analysis for possible data outliers, data normality, adequate number of samples collected and background critical values.

Field QA/QC procedures are outlined in the approved Closure Plant for Site 39 Incinerator Spray Pond. Field Quality Control is utilized to ensure the collection of representative samples. A copy of these procedures is included in Section 3. They were followed in both of the sampling efforts.

Laboratory QA/QC standard operating procedures from both laboratories are enclosed as Sections 4 and 5, respectively. Both laboratories QA/QC standard operating procedures were developed according to the methods detailed in SW-846.

If you have any questions or concerns please contact Jerry Redder at (540) 639-7536 or Arne Olsen at (540) 639-8220.

Sincerely

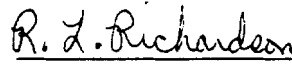


C. A. Jake
Environmental Manager

JJRedder:V:\815-046
Enclosures

c: West Central Regional Office - Roanoke
R. L. Richardson/RFAAP ACO

Coordination:


M. L. Griffith
R. L. Richardson

bc: Adm. File
Env. File
C. A. Jake - w/o enclosure
J. J. Redder - w/o enclosure
A. E. Olsen - w/ enclosure

Background Soil Data
Incinerator Spray Pond HWMU 39

Radford Army Ammunition Plant
Radford, Virginia

February 4, 1997

Index

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Results and Statistical Analysis	Section 2
Field QA/QC Procedures	Section 3
Laboratory QA/QC Procedures (CVLC)	Section 4
Laboratory QA/QC Procedures (REIC)	Section 5

Section 1
Map of the Locations of the Background Samples

Section 2

Results and Statistical Analysis

24 January 1997

Reference: L0706.05.01

Mr. Jerry Redder
Alliant Techsystems
P. O. Box 1
Radford, Virginia 24141-0100

Re: Incinerator Spray Pond Closure,
Background Soil Sampling Results

Dear Jerry:

Alliant Techsystems, Inc. (Alliant) is submitting background soil sampling results in support of closure of the Incinerator Spray Pond at the Radford Army Ammunition Plant in Radford, Virginia. The results include samples taken on 2 January 1996 and 5 December 1996. In accordance with Section 3.7.1 of the approved closure plan for the Incineratory Spray Pond, Alliant collected and analyzed six background soil samples for the constituents provided in Table 3-2A, *"Hazardous Constituents of Concern."* The following statistical operations were conducted on the data:

- Check for possible data outliers;
- Test assumptions of data normality;
- Check for adequate number of samples collected; and
- Calculation of background critical values.

Table 1 summarizes the analytical results and indicates the hazardous constituents of concern, Practical Quantitation Limit (PQL), units, and results.

Table 2 provides the calculated soil background critical values. Analytical methods, statistical methods, and conclusions are discussed further below.

Data

Background soil sampling results with the Practical Quantitation Limits for the 2 January 1996 sampling events were submitted on 25 March 1996. As indicated in the 28 May 1996 and 28 October 1996 letters from DEQ to Ms. C. A. Jake, Alliant Techsystems, Inc., several analytical methods did not conform to Table 3-2 of the approved closure plan for the Incinerator Spray Pond, dated 24 August

1995. However, because most constituents were detected above the PQL, DEQ accepted the results for all the constituents in Table 3-2 with the exception of arsenic, di-n-butyl phthalate, diethyl phthalate, and resorcinol. Consequently, additional soil samples were collected and analyzed for these constituents on 5 December 1996. The analytical methods used were those identified in the updated Table 3-2A enclosed with DEQ's 28 October 1996 letter.

The analytical methods used for antimony, barium, chromium, lead, mercury, nickel, and thallium were not those identified in the approved closure plan. However, these constituents were detected at levels above the method detection limit for the methods used. Because the constituents were detected, DEQ indicated its approval of the methods in DEQ's 28 October 1996 letter to C. A. Jake, Alliant Techsystems.

Alliant resampled and re-analyzed for arsenic, di-n-butyl phthalate, diethyl phthalate, and resorcinol in December 1996 because of several concerns. First, the analytical method utilized in the first sampling event, SW-846 Method 8061, could not confirm the presence of diethyl phthalate because the ions in the clay soil matrix interfere with the laboratory instrumentation. Second, the recovery of several surrogates was not within acceptable ranges. Finally, the non-detected values for resorcinol and diethyl phthalate were based upon a Mass Spectral Library Search only. Although DEQ later approved the use of Method 8270B for these constituents, Alliant agreed to resample and reanalyze for these constituents.

SW-846 Method 6020 was utilized for analysis of arsenic. However, the laboratory Minimum Qualifying Limit (MQL) was 1.25 ppm versus 0.2 ppm identified in Table 3-2A. This discrepancy was due to the nature of the sample matrix and the digestion method used. Soils, especially clayey/silty soils, present special interference problems in laboratory analysis. The clay particles contain ionic charges and higher natural levels of metals which tend to interfere with the more sensitive laboratory equipment. Because arsenic was detected above the laboratory MQL, resampling is not anticipated.

Outliers

The data were checked for possible outliers using the Outlier Test, which follows ASTM Standard E178-75. The Monitor System, developed by Entech Systems, Inc., who also developed GRITSTAT, contains the same programs as GRITSTAT. These programs allow users to perform evaluations on more than one constituent at a time. The Outlier Test program is particularly useful for statistically detecting and verifying suspected outliers and locating possible data entry errors. It uses a standard t-test to compare the largest value from a sample set to the remaining values and then designates the possibility of this value being an outlier as "Yes" or "No." If the report indicates "Yes" for any parameter, it then lists the following information about it:

- The value of the possible outlier;
- Sampling location;
- Sample date; and
- Sample number.

No possible outliers were identified for any of the parameters. The test report is included with this letter as **Attachment A**.

Normality

The data were checked for normality using the Shapiro-Wilk Goodness-of-Fit Test. This program systematically designates the underlying distribution as normal, lognormal, or non-normal. If the data fails the test of normality, the program automatically takes the logs of the data and repeats the procedure. The Data Distribution program and report also computes:

- Sample size;
- Percentage of non-detects in each sample set;
- Coefficient of Kurtosis;
- Coefficient of skewness; and
- Coefficient of variation.

The report is included with this letter as **Attachment B**. As expected, the following compounds were not detected in any of the six samples and the data set is, therefore, non-normal:

2,4-Dinitrotoluene
2,6-Dinitrotoluene
Chromium
Di-n-butyl phthalate
Diethyl phthalate
Lead
Mercury
Resorcinol
Thallium

The following compounds were detected in all six samples and normally distributed:

Antimony
Arsenic
Barium
Beryllium
Silver

Several compounds were detected in 50% of the background samples. A non-normal distribution results when more than 50% of the samples are non-detects. In accordance with DEQ's *Guidance on Statistical Methods for Groundwater Data Analysis at a Solid Waste or Hazardous Waste Site*, Version 2.0 (10 August 1995), Alliant performed the recommended functions for data with more than 15% but less than or equal to 50% non-detected values.

The data set excluding non-detected values was checked for normality. As indicated in **Attachment B**, the detected only data were normally distributed for cadmium and nickel.

Appropriate Sample Numbers

A simple check to ensure that an appropriate number of samples were taken for analysis was completed for each parameter which had detected results. An appropriate number of samples could not be calculated for those parameters which had non-detected results.

The method is listed in Chapter 9, *Sampling Plan*, of SW-846, and summarized in **Attachment C** of this letter. Use of this alternate method was approved in a letter to J. J. Redder of Alliant Techsystems from C. L. Parker IV of DEQ dated 15 November 1995.

This method calculates an appropriate number of samples based on the variance as computed by the actual sample results. Then the calculated appropriate number of samples is compared to the actual number of sample measurements taken, which was six for each parameter, to ensure that an adequate number of background samples were taken. The calculated appropriate number of samples should be less than or equal to the actual number of samples taken.

Only barium, for which an appropriate number of 16 samples was calculated, did not pass this test. Alliant believes additional samples for barium are not necessary for the successful closure of this unit. Barium is not a constituent of primary concern for closure of this unit; the mean concentration of barium in the samples is 78.5 mg/kg, or 28% of the naturally occurring mean concentration of 280 mg/kg for the eastern United States.

Critical Values

Based on the previous calculations and evaluations, Table 2 provides the calculated critical soil values for the Incinerator Spray Pond. In accordance with DEQ's guidance, an upper tolerance limit (UTL) was calculated for the data that were detected in all six background samples, using the Tolerance Limits method. A 99% level of coverage and a 95% confidence level were chosen. The calculated UTLs are listed in **Attachment D**.

For those compounds with more than 50% non-detect values and a normal distribution of detected-only values, Cohen's method of adjustment was used to calculate the mean, standard deviation, and UTL. The laboratory PQL was used as the background value for those constituents with 100% non-detected values.

**BASIC RESULTS (CONDENSED)
FOR ALL DATES**

COMPANY: Radford Army Ammunition Plant
SITE: Incin. Spray Pond
PROGRAM: Closure
PROGRAM TYPE: Soil
DATA GROUP:

All Duplicates Used

PARAMETER	UNIT	SAMPLE NUMBER	SAMPLE DATE	RESULT	DETECTION LIMIT	COMMENT CODE

LOCATION ID: Background

RAAP LIST

2,4-DINITROTOLUENE	PPB	BG1	01/02/1996	Non-Detec	130.00000	
2,4-DINITROTOLUENE	PPB	BG2	01/02/1996	Non-Detec	130.00000	
2,4-DINITROTOLUENE	PPB	BG3	01/02/1996	Non-Detec	130.00000	
2,4-DINITROTOLUENE	PPB	BG4	01/02/1996	Non-Detec	130.00000	
2,4-DINITROTOLUENE	PPB	BG5	01/02/1996	Non-Detec	130.00000	
2,4-DINITROTOLUENE	PPB	BG6	01/02/1996	Non-Detec	130.00000	
2,6-DINITROTOLUENE	PPB	BG1	01/02/1996	Non-Detec	70.00000	
2,6-DINITROTOLUENE	PPB	BG2	01/02/1996	Non-Detec	70.00000	
2,6-DINITROTOLUENE	PPB	BG3	01/02/1996	Non-Detec	70.00000	
2,6-DINITROTOLUENE	PPB	BG4	01/02/1996	Non-Detec	70.00000	
2,6-DINITROTOLUENE	PPB	BG5	01/02/1996	Non-Detec	70.00000	
2,6-DINITROTOLUENE	PPB	BG6	01/02/1996	Non-Detec	70.00000	
ANTIMONY	PPM	BG1	01/02/1996	3.370	1.50000	
ANTIMONY	PPM	BG2	01/02/1996	3.250	1.50000	
ANTIMONY	PPM	BG3	01/02/1996	3.700	1.50000	
ANTIMONY	PPM	BG4	01/02/1996	5.480	1.50000	
ANTIMONY	PPM	BG5	01/02/1996	2.140	1.50000	
ANTIMONY	PPM	BG6	01/02/1996	4.200	1.50000	
ARSENIC	PPM	BG1	01/02/1996	2.250	1.25000	
ARSENIC	PPM	BG2	01/02/1996	3.880	1.25000	
ARSENIC	PPM	BG3	01/02/1996	2.900	1.25000	
ARSENIC	PPM	BG4	01/02/1996	2.070	1.25000	
ARSENIC	PPM	BG5	01/02/1996	1.910	1.25000	
ARSENIC	PPM	BG6	01/02/1996	1.760	1.25000	
BARIUM	PPM	BG1	01/02/1996	66.100	1.00000	
BARIUM	PPM	BG2	01/02/1996	82.300	1.00000	
BARIUM	PPM	BG3	01/02/1996	63.000	1.00000	

(continues)

TABLE 1
INCINERATOR SPRAY POND ANALYTICAL RESULTS
(CONTINUED)

BASIC RESULTS (CONDENSED)
FOR ALL DATES

PARAMETER	UNIT	SAMPLE NUMBER	SAMPLE DATE	RESULT	DETECTION LIMIT	COMMENT CODE
BARIUM	PPM	BG4	01/02/1996	93.300	1.00000	
BARIUM	PPM	BG5	01/02/1996	91.500	1.00000	
BARIUM	PPM	BG6	01/02/1996	74.600	1.00000	
BERYLLIUM	PPM	BG1	01/02/1996	0.702	0.10000	
BERYLLIUM	PPM	BG2	01/02/1996	0.538	0.10000	
BERYLLIUM	PPM	BG3	01/02/1996	0.451	0.10000	
BERYLLIUM	PPM	BG4	01/02/1996	0.920	0.10000	
BERYLLIUM	PPM	BG5	01/02/1996	0.895	0.10000	
BERYLLIUM	PPM	BG6	01/02/1996	0.817	0.10000	
CADMIUM	PPM	BG1	01/02/1996	Non-Detec	0.05000	
CADMIUM	PPM	BG2	01/02/1996	Non-Detec	0.05000	
CADMIUM	PPM	BG3	01/02/1996	Non-Detec	0.05000	
CADMIUM	PPM	BG4	01/02/1996	0.058	0.05000	
CADMIUM	PPM	BG5	01/02/1996	0.054	0.05000	
CADMIUM	PPM	BG6	01/02/1996	0.053	0.05000	
CHROMIUM	PPM	BG1	01/02/1996	Non-Detec	25.00000	
CHROMIUM	PPM	BG2	01/02/1996	Non-Detec	25.00000	
CHROMIUM	PPM	BG3	01/02/1996	Non-Detec	25.00000	
CHROMIUM	PPM	BG4	01/02/1996	Non-Detec	25.00000	
CHROMIUM	PPM	BG5	01/02/1996	Non-Detec	25.00000	
CHROMIUM	PPM	BG6	01/02/1996	Non-Detec	25.00000	
DI-N-BUTYL PHTHALATE	PPB	BG1	01/02/1996	Non-Detec	330.00000	
DI-N-BUTYL PHTHALATE	PPB	BG2	01/02/1996	Non-Detec	330.00000	
DI-N-BUTYL PHTHALATE	PPB	BG3	01/02/1996	Non-Detec	330.00000	
DI-N-BUTYL PHTHALATE	PPB	BG4	01/02/1996	Non-Detec	330.00000	
DI-N-BUTYL PHTHALATE	PPB	BG5	01/02/1996	Non-Detec	330.00000	
DI-N-BUTYL PHTHALATE	PPB	BG6	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG1	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG2	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG3	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG4	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG5	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG6	01/02/1996.	Non-Detec	330.00000	
LEAD	PPM	BG1	01/02/1996	Non-Detec	50.00000	
LEAD	PPM	BG2	01/02/1996	Non-Detec	50.00000	
LEAD	PPM	BG3	01/02/1996	Non-Detec	50.00000	
LEAD	PPM	BG4	01/02/1996	Non-Detec	50.00000	
LEAD	PPM	BG5	01/02/1996	Non-Detec	50.00000	
LEAD	PPM	BG6	01/02/1996	Non-Detec	50.00000	
MERCURY	PPM	BG1	01/02/1996	Non-Detec	1.00000	
MERCURY	PPM	BG2	01/02/1996	Non-Detec	1.00000	
MERCURY	PPM	BG3	01/02/1996	Non-Detec	1.00000	
MERCURY	PPM	BG4	01/02/1996	Non-Detec	1.00000	
MERCURY	PPM	BG5	01/02/1996	Non-Detec	1.00000	
MERCURY	PPM	BG6	01/02/1996	Non-Detec	1.00000	

(continues)

TABLE 1
INCINERATOR SPRAY POND ANALYTICAL RESULTS
(CONTINUED)

BASIC RESULTS (CONDENSED)
FOR ALL DATES

PARAMETER	UNIT	SAMPLE NUMBER	SAMPLE DATE	RESULT	DETECTION LIMIT	COMMENT CODE
NICKEL	PPM	BG1	01/02/1996	Non-Detec	7.50000	
NICKEL	PPM	BG2	01/02/1996	Non-Detec	7.50000	
NICKEL	PPM	BG3	01/02/1996	Non-Detec	7.50000	
NICKEL	PPM	BG4	01/02/1996	10.600	7.50000	
NICKEL	PPM	BG5	01/02/1996	11.500	7.50000	
NICKEL	PPM	BG6	01/02/1996	9.400	7.50000	
RESORCINOL	PPB	BG1	01/02/1996	Non-Detec	330.00000	
RESORCINOL	PPB	BG2	01/02/1996	Non-Detec	330.00000	
RESORCINOL	PPB	BG3	01/02/1996	Non-Detec	330.00000	
RESORCINOL	PPB	BG4	01/02/1996	Non-Detec	330.00000	
RESORCINOL	PPB	BG5	01/02/1996	Non-Detec	330.00000	
RESORCINOL	PPB	BG6	01/02/1996	Non-Detec	330.00000	
SILVER	PPM	BG1	01/02/1996	0.025	0.01000	
SILVER	PPM	BG2	01/02/1996	0.017	0.01000	
SILVER	PPM	BG3	01/02/1996	0.017	0.01000	
SILVER	PPM	BG4	01/02/1996	0.076	0.01000	
SILVER	PPM	BG5	01/02/1996	0.045	0.01000	
SILVER	PPM	BG6	01/02/1996	0.037	0.01000	
THALLIUM	PPM	BG1	01/02/1996	Non-Detec	0.50000	
THALLIUM	PPM	BG2	01/02/1996	Non-Detec	0.50000	
THALLIUM	PPM	BG3	01/02/1996	Non-Detec	0.50000	
THALLIUM	PPM	BG4	01/02/1996	Non-Detec	0.50000	
THALLIUM	PPM	BG5	01/02/1996	Non-Detec	0.50000	
THALLIUM	PPM	BG6	01/02/1996	Non-Detec	0.50000	

----- End of Report -----

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**Table 2: Critical Values
Incinerator Spray Pond Closure**

<u>Parameter</u>	<u>Upper Tolerance Limit (UTL)</u>
2,4-Dinitrotoluene	65.000 ppb
2,6-Dinitrotoluene	35.000 ppb
Antimony	9.313 ppm
Arsenic	6.513 ppm
Barium	143.000 ppm
Beryllium	1.697 ppm
Cadmium	0.078 ppm
Chromium	12.500 ppm
Di-n-butyl phthalate	165.000 ppb
Diethyl phthalate	165.000 ppb
Lead	25.000 ppm
Mercury	0.500 ppm
Nickel	23.070 ppm
Resorcinol	165.000 ppb
Silver	0.15 ppm
Thallium	0.250 ppm

Attachment A
Outlier Test Report

95% ALL PARAMETERS
OUTLIER TEST
FOR ALL DATES

COMPANY: Alliant Techsystems Inc.
SITE: Incin. Spray Pond
PROGRAM: Closure
PROGRAM TYPE: Soil
DATA GROUP:

All Duplicates Used
Significance Level (1 - alpha): 95%

Non-Detects - Detection Limit/2

LOCATION	POSSIBLE OUTLIER?	SAMPLE NUMBER	SAMPLE DATE	VALUE	SAMPLE SIZE	MEAN	CALCULATED T	TABULAR T

RAAP LIST

PARAMETER: 2,4-DINITROTOLUENE

UNIT: PPB

Background

NO

PARAMETER: 2,6-DINITROTOLUENE

UNIT: PPB

Background

NO

PARAMETER: ANTIMONY

UNIT: PPM

Background

NO

PARAMETER: ARSENIC

UNIT: PPM

Background

NO

PARAMETER: BARIUM

UNIT: PPM

Background

NO

(continues)

95% ALL PARAMETERS
OUTLIER TEST
FOR ALL DATES

LOCATION	POSSIBLE OUTLIER?	SAMPLE NUMBER	SAMPLE DATE	VALUE	SAMPLE SIZE	MEAN	CALCULATED T	TABULAR T
PARAMETER: BERYLLIUM							UNIT: PPM	
Background	NO							
PARAMETER: CADMIUM							UNIT: PPM	
Background	NO							
PARAMETER: CHROMIUM							UNIT: PPM	
Background	NO							
PARAMETER: DI-N-BUTYL PHTHALATE							UNIT: PPB	
Background	NO							
PARAMETER: DIETHYL PHTHALATE							UNIT: PPB	
Background	NO							
PARAMETER: LEAD							UNIT: PPM	
Background	NO							
PARAMETER: MERCURY							UNIT: PPM	
Background	NO							
PARAMETER: NICKEL							UNIT: PPM	
Background	NO							
PARAMETER: RESORCINOL							UNIT: PPB	
Background	NO							

(continues)

01/24/1997

Alliant Techsystems Inc.

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95% ALL PARAMETERS
OUTLIER TEST
FOR ALL DATES

LOCATION	POSSIBLE OUTLIER?	SAMPLE NUMBER	SAMPLE DATE	VALUE	SAMPLE SIZE	MEAN	CALCULATED T	TABULAR T

PARAMETER: SILVER UNIT: PPM

Background

NO

PARAMETER: THALLIUM UNIT: PPM

Background

NO

----- End of Report -----

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Attachment B
Normality Test Report

DATA DISTRIBUTION FOR ALL DATES

COMPANY: Alliant Techsystems Inc.
 SITE: Incin. Spray Pond
 PROGRAM: Closure
 PROGRAM TYPE: Soil
 DATA GROUP:

All Duplicates Used
 Significance Level (1 - alpha): 95%

Non-Detects = Detection Limit/2

LOCATION ID	SAMPLE SIZE	% N-Ds	SHAPIRO-WILK DISTRIBUTION	CALCULATED W	TABULAR W	SKENNESS	KURTOSIS	COEFFICIENT OF VARIATION
RAAP LIST								
PARAMETER: 2,4-DINITROTOLUENE				UNIT: PPB				
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00
PARAMETER: 2,6-DINITROTOLUENE				UNIT: PPB				
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00
PARAMETER: ANTIMONY				UNIT: PPM				
Background	6	0	Normal	0.9687	0.7880	0.25	1.77	0.30
PARAMETER: ARSENIC				UNIT: PPM				
Background	6	0	Normal	0.8583	0.7880	0.77	1.81	0.33
PARAMETER: BARIUM				UNIT: PPM				
Background	6	0	Normal	0.9173	0.7880	-0.01	1.00	0.16

(continues)

DATA DISTRIBUTION FOR ALL DATES

LOCATION ID	SAMPLE SIZE	% N-Ds	SHAPIRO-WILK DISTRIBUTION	CALCULATED W	TABULAR W	SKENNESS	KURTOSIS	COEFFICIENT OF VARIATION
PARAMETER: BERYLLIUM								UNIT: PPM
Background	6	0	Normal	0.9127	0.7880	-0.27	1.08	0.27
PARAMETER: CADMIUM								UNIT: PPM
Background	6	50	Non-Normal	0.7243	0.7880	0.02	0.73	0.41
PARAMETER: CHROMIUM								UNIT: PPM
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00
PARAMETER: DI-N-BUTYL PHTHALATE								UNIT: PPB
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00
PARAMETER: DIETHYL PHTHALATE								UNIT: PPB
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00
PARAMETER: LEAD								UNIT: PPM
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00
PARAMETER: MERCURY								UNIT: PPM
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00
PARAMETER: NICKEL								UNIT: PPM
Background	6	50	Non-Normal	0.7460	0.7880	0.07	0.78	0.53

(continues)

DATA DISTRIBUTION
FOR ALL DATES

LOCATION ID	SAMPLE SIZE	% N-Ds	SHAPIRO-WILK DISTRIBUTION	CALCULATED W	TABULAR W	SKENNESS	KURTOSIS	COEFFICIENT OF VARIATION
PARAMETER: RESORCINOL								UNIT: PPB
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00
PARAMETER: SILVER								UNIT: PPM
Background	6	0	Normal	0.8693	0.7880	0.71	1.84	0.56
PARAMETER: THALLIUM								UNIT: PPM
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00

----- End of Report -----

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TEST OF NORMALITY FOR DETECTED DATA - 50% NON-DETECT
DATA DISTRIBUTION
FOR ALL DATES

COMPANY: Alliant Techsystems Inc.

SITE: Incin. Spray Pond

PROGRAM: Closure

PROGRAM TYPE: Soil

DATA GROUP:

All Duplicates Used

Non-Detects Ignored

Significance Level (1 - alpha): 95%

LOCATION ID	SAMPLE SIZE	† N-Ds	SHAPIRO-WILK DISTRIBUTION	CALCULATED W	TABULAR W	SKENNESS	KURTOSIS	COEFFICIENT OF VARIATION

RAAP LIST

PARAMETER: CADMIUM

UNIT: PPM

Background

3	0	Normal	0.8928	0.7670	0.32	0.67	0.04

PARAMETER: NICKEL

UNIT: PPM

Background

3	0	Normal	0.9932	0.7670	-0.09	0.67	0.10

----- End of Report -----

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MEAN AND STANDARD DEVIATION FOR 50% NON-DETECTS
DESCRIPTIVE STATISTICS
FOR ALL DATES

COMPANY: Alliant Techsystems Inc.
SITE: Incin. Spray Pond
PROGRAM: Closure
PROGRAM TYPE: Soil
DATA GROUP:

All Duplicates Used

Cohen's Method Used For Non-Detects

LOCATION ID	SAMPLE SIZE	% N-Ds	MEAN	SAMPLE MEDIAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM

RAAP LIST

PARAMETER: CADMIUM

UNIT: PPM

Background

6	50	0.050	> 49% N-D's	0.005	0.000	Non-Detect	0.058

PARAMETER: NICKEL

UNIT: PPM

Background

6	50	7.867	> 49% N-D's	3.002	9.009	Non-Detect	11.500

----- End of Report -----

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MEAN AND STANDARD DEVIATION FOR 100% DETECTIONS
DESCRIPTIVE STATISTICS
FOR ALL DATES

COMPANY: Alliant Techsystems Inc.
SITE: Incin. Spray Pond
PROGRAM: Closure
PROGRAM TYPE: Soil
DATA GROUP:

All Duplicates Used

Non-Detects - Detection Limit/2

LOCATION ID	SAMPLE SIZE	% N-Ds	MEAN	SAMPLE MEDIAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM

RAAP LIST

PARAMETER: ANTIMONY

UNIT: PPM

Background

6	0		3.690	3.535	1.110	1.233	2.140	5.480

PARAMETER: ARSENIC

UNIT: PPM

Background

6	0		2.462	2.160	0.800	0.640	1.760	3.880

PARAMETER: BARIUM

UNIT: PPM

Background

6	0		78.467	78.450	12.741	162.339	63.000	93.300

PARAMETER: BERYLLIUM

UNIT: PPM

Background

6	0		0.721	0.760	0.193	0.037	0.451	0.920

PARAMETER: SILVER

UNIT: PPM

Background

6	0		0.036	0.031	0.022	0.001	0.017	0.076

----- End of Report -----

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Attachment C
Appropriate Number of Samples

ALLIANT TECHSYSTEMS, INC.
INCINERATOR SPRAY POND BACKGROUND SOIL SAMPLES
APPROPRIATE NUMBER OF SAMPLES CHECK
SW-846 CHAPTER 9 SAMPLING PLAN

Variance of Sample, s^2

$$s^2 = \frac{\sum X_i^2}{n-1} - \frac{(\sum X_i)^2}{n}$$

where n=number of sample measurements.

Appropriate Number of Samples, n

$$n = \frac{t^2 s^2}{RT-X}$$

where RT = regulatory threshold,

X = sample mean, and

t = value based on the number of degrees of freedom (n-1)

The results for the following parameters were non-detect and, therefore, an appropriate number of samples could not be calculated:

2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-butyl phthalate
Diethyl phthalate
Resorcinol

Although many of the results for most of the following parameters were below the PQL, an appropriate number of samples was calculated using the laboratory detection limit.

Antimony =	2.7	Number of Actual Samples = 6
Arsenic =	0.0	
Barium =	16.4	
Beryllium =	0.1	
Cadmium =	0.0	
Chromium =	1.3	
Lead =	1.2	
Mercury =	0.0	
Nickel =	3.3	
Silver =	0.4	
Thallium =	0.0	

TABLE 9-2. TABULATED VALUES OF STUDENT'S "t" FOR EVALUATING
SOLID WASTES

Degrees of freedom (n-1) ^a	Tabulated "t" value ^b
1	3.078
2	1.886
3	1.638
4	1.533
5	1.476
6	1.440
7	1.415
8	1.397
9	1.393
10	1.372
11	1.363
12	1.356
13	1.350
14	1.345
15	1.341
16	1.337
17	1.333
18	1.330
19	1.328
20	1.325
21	1.323
22	1.321
23	1.319
24	1.318
25	1.316
26	1.315
27	1.314
28	1.313
29	1.311
30	1.310
40	1.303
60	1.296
120	1.289
	1.282

^aDegrees of freedom (df) are equal to the number of samples (n) collected from a solid waste less one.

^bTabulated "t" values are for a two-tailed confidence interval and a probability of 0.20 (the same values are applicable to a one-tailed confidence interval and a probability of 0.10).

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Revision 0
Date September 1986

Attachment D
Critical Values

UPPER TOLERANCE LIMITS FOR 100% NON-DETECTS
TOLERANCE LIMITS
FOR ALL DATES

COMPANY: Alliant Techsystems Inc.

SITE: Incin. Spray Pond

PROGRAM: Closure

PROGRAM TYPE: Soil

DATA GROUP:

All Duplicates Used
Tolerance Coefficient (Y): 95%

Non-Detects = Detection Limit/2
Level Of Coverage (P): 99%

LOCATION ID	SAMPLE SIZE	% NON- DETECT	MEAN	REGULATORY LIMIT	UPPER TOLERANCE LIMIT
RAAP LIST					
PARAMETER: 2,4-DINITROTOLUENE					UNIT: PPB
Background	6	100	65.000	0.000	65.001
PARAMETER: 2,6-DINITROTOLUENE					UNIT: PPB
Background	6	100	35.000	0.000	35.001
PARAMETER: CHROMIUM					UNIT: PPM
Background	6	100	12.500	0.000	12.501
PARAMETER: DI-N-BUTYL PHTHALATE					UNIT: PPB
Background	6	100	165.000	0.000	165.001
PARAMETER: DIETHYL PHTHALATE					UNIT: PPB
Background	6	100	165.000	0.000	165.001

(continues)

UPPER TOLERANCE LIMITS FOR 100% NON-DETECTS
TOLERANCE LIMITS
FOR ALL DATES

LOCATION ID	SAMPLE SIZE	% NON- DETECT	MEAN	REGULATORY LIMIT	UPPER TOLERANCE LIMIT
PARAMETER: LEAD					UNIT: PPM
Background	6	100	25.000	0.000	25.001
PARAMETER: MERCURY					UNIT: PPM
Background	6	100	0.500	0.000	0.501
PARAMETER: RESORCINOL					UNIT: PPB
Background	6	100	165.000	0.000	165.001
PARAMETER: THALLIUM					UNIT: PPM
Background	6	100	0.250	0.000	0.251

----- End of Report -----
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UPPER TOLERANCE LIMITS FOR 50% NON-DETECTS
TOLERANCE LIMITS
FOR ALL DATES

COMPANY: Alliant Techsystems Inc.
SITE: Incin. Spray Pond
PROGRAM: Closure
PROGRAM TYPE: Soil
DATA GROUP:

All Duplicates Used
Tolerance Coefficient (Y): 95%

Cohen's Method Used For Non-Detects
Level Of Coverage (P): 99%

LOCATION ID	SAMPLE SIZE	% NON- DETECT	MEAN	REGULATORY LIMIT	UPPER TOLERANCE LIMIT
RAAP LIST					
PARAMETER: CADMIUM					UNIT: PPM
Background	6	50	0.050	0.000	0.078
PARAMETER: NICKEL					UNIT: PPM
Background	6	50	7.867	0.000	23.070

----- End of Report -----
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UPPER TOLERANCE LIMITS FOR 100% DETECTED
TOLERANCE LIMITS
FOR ALL DATES

COMPANY: Alliant Techsystems Inc.
SITE: Incin. Spray Pond
PROGRAM: Closure
PROGRAM TYPE: Soil
DATA GROUP:

All Duplicates Used
Tolerance Coefficient (Y): 95%

Non-Detects - Detection Limit/2
Level Of Coverage (P): 99%

LOCATION ID	SAMPLE SIZE	% NON- DETECT	MEAN	REGULATORY LIMIT	UPPER TOLERANCE LIMIT
RAAP LIST					
PARAMETER: ANTIMONY					UNIT: PPM
Background	6	0	3.690	0.000	9.313
PARAMETER: ARSENIC					UNIT: PPM
Background	6	0	2.462	0.000	6.513
PARAMETER: BARIUM					UNIT: PPM
Background	6	0	78.467	0.000	143.001
PARAMETER: BERYLLIUM					UNIT: PPM
Background	6	0	0.721	0.000	1.697
PARAMETER: SILVER					UNIT: PPM
Background	6	0	0.036	0.000	0.150

----- End of Report -----

Section 3
Field QA/QC Procedures

TABLE 3-4 FIELD QA/QC PROCEDURES FOR SOIL SAMPLES

PROCEDURE	COMMENTS
1. Field Blank	Field blanks are metal-and/or organic free water aliquots that contact sampling equipment under field conditions and are analyzed to detect any contamination from sampling equipment, cross-contamination from previously collected samples, or contamination from conditions during sampling (i.e. airborne contaminants that are not from the waste being sampled). One sample of site tap water will be collected every day in which tap water is used for decontamination purposes.
2. Duplicate Samples	Field duplicates are employed to document precision. The precision in sample duplicates is a function of the variance of waste composition, the variance of the sampling technique, and the variance of the analytical technique. Duplicate samples should be collected in the field by aliquotting a sample into separate containers. One duplicate sample will be collected for every twenty samples. The containers should be labeled as duplicate samples.
3. Trip Blanks	Trip blanks are used to detect any contamination or cross-contamination during handling and transportation. Trip blanks should accompany sample containers to and from the field. The appropriate trip blank containers should be filled with analyte-free water. Preservatives and additives will be added as required for each parameter group. Trip blanks should be sealed and stored in an ice chest where real samples will be stored and transported. A pair of trip blanks will accompany each cooler containing empty or filled volatile sample containers.
4. Equipment Blanks	An equipment blank should be prepared for each parameter group sampled where a particular piece of sampling equipment was employed for sample collection and subsequently decontaminated in the field for use in additional sampling. The equipment blank should be composed in the field by collecting, in the appropriate container for the parameter group, a blank water rinse from the equipment (auger, pump tubing, etc.) after execution of the last step of the proper field decontamination protocol. Preservatives or additives must be added to the equipment blank where appropriate for each parameter group. The type and frequency of these samples are specified within the text discussing the extent of contamination sampling.
NOTES: 1) Reference: SW-846, Chapter Nine, Pages Nine 61-63; Chapter One Page 1-10. 2) Field QA/QC samples should be collected at least once with every analytical batch with a minimum of once per twenty samples.	

3.8.3 Sampling Equipment Decontamination

All non-disposable sampling equipment will be decontaminated between each sample. Those sampling implements which cannot be decontaminated effectively will be containerized and properly disposed of based on sample analytical results.

The decontamination of sampling equipment (hand auger, scoopula, trowel, etc.) will be performed as follows and follows the decontamination procedures for sampling equipment (EPA Region IV, Standard Operating Procedures and Quality Assurance Manual, 1986,):

1. Clean with tap water and a soap solution (A phosphate-free laboratory detergent such as Alconox, Aliquinox, Liquinox will be used for cleaning) using a brush if necessary to remove particulate and surface films.
2. Rinse thoroughly with the Radford's potable water.
3. Rinse thoroughly with deionized water.
4. Rinse thoroughly with organic-free water and allow to air dry as long as possible. If organic-free water is not available, allow equipment to air dry as long as possible. Do not rinse with distilled or deionized water.
5. Wrap with aluminum foil, if appropriate, to prevent contamination if equipment is going to be stored or transported.

All rinsate waters will be contained and analyzed for the constituents of concern prior to discharge. Disposal of rinsate will be performed based on sampling results and in accordance with the VHWMR. All sampling equipment will be decontaminated prior to sampling, between sample depths, and between samples unless new or dedicated (i.e, used only for one sample) equipment is used. Sampling equipment will be disposed of as hazardous waste at the conclusion of the sampling program, where appropriate.

Large equipment used for closure activities will be cleaned prior to its use on site. The decontamination of the larger sampling equipment will occur in a temporary constructed decontamination area. A 20-ft x 30-ft area will be graded with at least a 2% slope towards one corner of the area. The area will be lined with an appropriate plastic liner to prevent infiltration of decontamination water into the soils. The area will drain into a polyethylene container. Rinsate and other wastes generated during decontamination will be placed into 55 gallon drums. This proposed decontamination area has been designed so as not to meet the definition of a surface impoundment (40 CFR Part 260.10). Following closure, the large sampling equipment will be decontaminated using steam cleaning followed by a potable water rinse.

All wastes generated during the decontamination process will be accumulated in 55 gallon drums for less than 90 days storage.

The decontamination area's synthetic liner will be disposed of in accord with the VHWMR and the VSWMR. If analytical results show the liner is a hazardous waste by characteristic, then the liner will be transported via a Virginia permitted hazardous waste transporter and disposed of off-plant at an approved hazardous waste facility. If it is not hazardous, it will be disposed of in a permitted debris or sanitary landfill.

The rinsate collected during the decontamination process will be transferred to 55-gallon drums for storage until test results are received. If the water in the drums tests to be hazardous, it will be accumulated according to VHWMR, § 6.4.E., transported via a Virginia permitted hazardous waste transporter and disposed of off-plant at an approved hazardous waste facility. If it is not hazardous, it will be disposed of in the biological waste water treatment plant with VDEQ approval. Equipment blanks will be collected for decontamination quality control.

3.8.4 Sample Handling

Each sample jar should be clearly labeled with an identifying number, the point of sampling as documented on a diagram of the area, the time and date of sample collection, the name of the individual responsible for sample collection, and the parameters for analysis.

When the sample jars are shipped to the laboratory, a seal will be placed on the shipping container in such a way that the containers cannot be opened in transport without breaking the seal.

A chain-of-custody record will be maintained to document the responsibility for sample possession from the time of collection until the analysis is completed.

A field log book will be maintained. The sample location, the time, date, parameters for analysis, and approximate volume of each sample will be recorded. The appearance of the sample, the conditions at the time of sampling and any other relevant field observations will be recorded.

3.9 Sample Custody

3.9.1 Introduction

Sample identification and chain-of-custody establishes the documentation and control required to identify and trace a sample from collection to completion of analysis. Sample identification and chain-of-custody

will be maintained during all closure activities conducted at Radford Army Ammunition Plant through the following chain-of-custody procedures and documentation:

- Sample labels, which prevent misidentification of samples;
- Custody seals to preserve the integrity of the sample from the time it is collected until it is opened in the laboratory;
- Field logbook and pictures to record information about closure activities and sample collection;
- Chain-of-custody record to establish the documentation necessary to trace sample possession from the time of collection to laboratory analysis; and
- Sample analysis request sheet to inform the laboratory of pertinent information noted in the field logbook.

The purpose of these procedures is to ensure that the quality of the sample is maintained during its collection, transportation, storage and analysis.

3.9.2 Chain-Of-Custody

A sample is in custody if it is (1) in someone's physical possession or view, (2) locked up, or (3) kept in a secure area that is restricted to authorized personnel.

3.9.3 Field Custody Procedures

As few persons as possible should handle samples in the field. The sample collector is personally responsible for the care and custody of samples collected until they are transferred to another person. The site team leader for the closure activities will determine whether proper custody procedures were followed during field work and decide if additional samples are required.

3.9.4 Sample Labels

Identification sample labels are to be attached to the field sample containers. Gummed paper labels or tags should be used. The tags should contain the following information:

1. Name of collector
2. Date and time of sample collection
3. RAAP-#39-XX-YY-ZZ
where: RAAP = Site name (RAAP)
#39 = Unit Number
XX = Grid Location Number
YY = Sample Depth (As depth below datum, i.e., bottom of concrete liner)

ZZ = Special Code as follows:

- 01-Normal Sample
- 02-Duplicate Sample
- 03-Field Blank
- 04-Trip Blank

4. Type of sample with brief description (i.e., grab, composite, background, soil, liquid, concrete, bedding material; random, "hot spot", decontamination test, etc.)

Sample information will be printed on the label in a legible manner using waterproof ink. The identification on the label must be sufficient to enable cross reference with the laboratory logbook.

Sample labels will be affixed to the sample containers prior to or at the time of sampling. The labels will be filled out at the time of collection.

3.9.5 Custody Seals

Custody seals are reprinted adhesive-backed seals with security slots designed to break if the seals are disturbed. Seals are placed over the cap of the individual sample bottle and in as many places as possible on shipping containers. The seals will be affixed to the sample bottles and shipping containers before the samples and containers leave the custody of the sampling personnel. The custody seals will at a minimum contain the following information:

- Sample number (This number must be identical with the number on the sample label)
- Name of collector
- Date and time of sampling
- Place of collection

3.9.6 Field Logbook

Field logbooks are necessary to provide sufficient data to enable field participants to reconstruct events that occurred during the closure activities.

All pertinent sampling and field survey information will be recorded in a logbook. All logs will be kept in a waterproof bound notepad with numbered pages (8-1/2 by 11 inches). All entries will be printed in waterproof ink. No pages will be removed and corrections will be made by drawing a single line through the incorrect data and initializing and dating the correction that was made to the side of the error. Entries in the logbook should contain at a minimum the following information:

- Location of sampling point (and location code XX-YY-ZZ as stated above)

- Name and address of field contact
- Type of waste (i.e. soil, sludge, wastewater)
- Suspected waste composition, including concentrations (i.e, D008)
- Number and volume of samples taken
- Purpose of sampling (i.e. contract number, closure activities)
- Description of sampling point and sampling methodology
- Date and time of collection
- Collector's sample identification number
- Sample distribution and how transported (i.e. name of laboratory, UPS, Federal Express)
- References, such as maps or photographs, of the sampling site
- Field observations
- Any field measurements made (i.e. pH, conductivity)
- Signatures of personnel responsible for observations

3.9.7 Chain of Custody Record

A chain-of-custody record will accompany every sample. The record should contain the following information:

- Sample number
- Signature of collector
- Date and time of collection
- Place and address of collection
- Waste type
- Signature of persons involved in the chain of possession
- Inclusive dates of possession

3.9.8 Photographs

Documentation of a photograph is crucial to its validity as a representation of an existing situation. Therefore, the following information regarding photographs will be recorded in the Field Logbook:

- Date, time, location of photograph
- Photographer
- Weather conditions
- Reasons why photograph was taken
- Sequential number of photograph and the film role number
- Camera lens system used

Once the photographs have been developed, this information will be recorded on the back of the photograph.

Photographs cannot be readily taken without the permission of Radford Army Ammunition Plant's Commanding Officer. Thus, prior to closure activities, a request will be made to the Commanding Officer asking for permission to photograph the closure activities.

3.9.9 Sample Analysis Request Sheet

A sample analysis request sheet will accompany the sample on delivery to the laboratory. The person who collects the sample will complete the field portion of the form. All pertinent information recorded in the field logbook will also be included on the sample analysis request sheet. The laboratory portion of the form will be completed by laboratory personnel. The following minimal information will be recorded:

- Name of person receiving the sample
- Laboratory sample number
- Date and time of sample receipt
- Sample allocation
- Analyses to be performed

All samples will be delivered to the laboratory as soon as practicable (usually within 1 or 2 days after sampling and samples must always be kept at 4°C). The sample will be accompanied by a chain-of-custody record and also by a sample analysis request sheet. The sample will be delivered to the laboratory personnel who is authorized to receive samples.

3.9.10 Sample Designation

Sampling locations at the pond will be marked with stakes and surveyed to determine the coordinate and elevation where possible. Once the stake is marked and in place, the area will be photographed. The stake will be marked with the appropriate station and/or sample number.

Samples collected from each location, other than those collected for on-site field measurements or analyses, will be identified by using a standard label which is attached to the sample container.

3.9.11 Sample Handling, Packaging, and Shipping (VHWMR § 3.1.D.2)

For sampling packing and shipping, Radford Army Ammunition Plant will comply with the U.S. Postal Service Regulations, Department of Transportation Regulations and/or the Virginia Regulations Governing Transportation of Hazardous Materials.

3.10 Data Reporting

During the Incinerator Spray Pond Closure, the following data reporting will be conducted:

- Background soil sampling results along with the QA/QC documentation required by Chapter 1 of SW-846 will be submitted to the VDEQ prior to performing statistical comparisons for approval of background soil sample locations.
- Upon completion of the sub-soil assessment sampling, the data will be tabulated and the required statistical comparisons performed. The results will be submitted to the VDEQ for review. Based on the results, either:
 - Clean closure will be achieved and the corresponding closure certification report will be prepared and submitted to the VDEQ.
 - Additional soil removal efforts will be conducted in an attempt to achieve clean closure.
 - Contingent closure and post closure will be implemented as detailed in this plan.

3.11 Groundwater Closure

Groundwater will be monitored in accordance with the Groundwater Monitoring Plan (as updated) until:

- "Clean" closure for both saturated soils (groundwater) and unsaturated soils (the incinerator spray pond subsoils) have been demonstrated; or,
- A post-closure care permit for cap maintenance and/or groundwater monitoring requirements is obtained.

The specific procedures and criteria for determining "clean" closure with respect to groundwater will be specified in the groundwater monitoring plan. The following procedures are outlined in more detail in the groundwater monitoring plan:

- For all monitoring wells, initial background concentrations of all designated monitoring parameters will be established based on quarterly sampling for 1 year.

Section 4
Laboratory QA/QC Procedures (CVLC)

**CENTRAL VIRGINIA LABORATORIES
&
CONSULTANTS, INC.**

**QUALITY ASSURANCE/
QUALITY CONTROL PROGRAM
GENERAL OVERVIEW**

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Section I - Quality Assurance/Quality Control Program Overview

The CVLC Quality Assurance/Quality Control (QA/QC) Program is designed to monitor laboratory sampling and analysis procedures. The primary objective of the CVLC Quality Assurance/Quality Control is to provide defensible analytical data. This manual addresses the many variables associated in this objective. This Program ensures that the methodologies by which samples are acquired and the laboratory data generated are consistent with the appropriate Environmental Protection Agency's (EPA) protocols.

The Quality Control section of this program covers the "maintenance" requirements and the Quality Assurance section is the "insurance" section. "Maintenance" refers to the physical requirements such as; the use of reagents of the highest quality and the use of clean, Class A glassware. "Insurance" includes as a minimum, the use of calibration checks, spikes, surrogates and duplicates analyses.

A. Analytical Laboratory Personnel Organization

The analytical laboratory personnel are divided into the following groups:

- I. Inorganic Chemistry**
Total Organic Carbon, Total Organic Halide
Wet Chemistry
Ion Chromatography (IC)
- II. Metals**
Atomic Absorption Spectrophotometry
ICP Atomic Emission Spectrometry
- III. Organic Chemistry**
Gas Chromatography (GC)
Gas Chromatography/Mass Spectrometry (GC/MS)
High Performance Liquid Chromatography (HPLC)
- IV. Bioassay/Biological/Bacteriological**
Toxicity Evaluation/Toxicity Identification and Reduction Studies
Biological Oxygen Demand Analyses
Microbiological Evaluation

A separate QA/QC Manual has been developed for this department.

- V. Field Services**
- VI. Safety**
- VII. Receiving**

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Section I - Quality Assurance/Quality Control Program Overview (Continued)

A. Analytical Laboratory Personnel Organization (Continued)

Each Group is headed by a Supervisor who reports directly to the Laboratory Director. A Supervisor shall have a B.S., B.A. or equivalent degree in a closely related science field. Non-degree Supervisors should have a minimum of five years of directly related experience.

B. QA/QC Director

The Quality Assurance/Quality Control Program for this laboratory will be directed by the QA/QC Director who shall not be involved in the actual sampling or analytical work. Each Supervisor will be fully aware of the QA/QC Director's duties and policies. These policies are discussed in this Quality Assurance Manual and in CVLC's Standard Operating Procedures (SOPs). Routine meetings will be conducted upon receipt of updated protocol, receipt of new instrumentation or receipt of independent laboratory audits to further support Supervisor awareness.

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Section II - Chain-of-Custody

A. Receiving

Samples delivered by CVLC personnel, CVLC clients or commercial courier will be subject to the following guidelines. The following required information should be provided on a client or CVLC chain-of-custody document.

The CVLC Sample Administrator will examine the samples to ensure collection in EPA approved containers with appropriate preservatives for the requested analysis; sample collection date and time will also be reviewed to ensure the EPA required sample holding time has not expired; and will ensure samples were transported on ice or under refrigeration to maintain a sample temperature less than ($<$) 4°C.

Any deviations will be reported to the Laboratory Director. Samples can be refused if deviations from established protocol have occurred. Results generated from these samples may be considered invalid. Therefore, the client will be immediately notified. The client will be informed of the deviations, suspected or confirmed. If client clarifications warrant deviations have not occurred, the samples are received and processed in accordance with CVLC protocol established in this section.

For those samples which will be refused, all deviations and follow-up actions will be fully documented utilizing a CVLC RECEIVING CORRECTIVE ACTION FORM. One copy will be immediately sent to the client and one copy will be retained with the client's chain-of-custody document.

The CVLC Sample Administrator will enter sample information into LIMS. LIMS will automatically generate sequential CVLC Identification Numbers (CVLC ID). The sample(s) will be tagged with the CVLC I.D. Number in such a manner as to ensure the label remains legible and intact during laboratory operations.

CVLC work-lists are then generated through LIMS. Each laboratory section requires its own unique work-lists. Upon generation of these forms, they are given to the Laboratory Director for technical review. The Laboratory Director will assign a result due date for each sample on the work-list and main tracking form. The Laboratory Director will then distribute the work-lists.

The pH of each aqueous sample (non-hazardous waste sample) will be recorded in the pH Logbook. In addition, client approved preservative adjustments, required filtration and sample splitting will also occur as required prior to distribution to each laboratory section. Documentation of sample adjustments will be fully documented in the pH Logbook or Filtration Logbook. The samples will then be distributed to the various laboratory sections for storage in accordance with method or matrix specifications until analysis.

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Section II - Chain-of-Custody (Continued)

B. Analysis

1. The Laboratory Director will distribute the work-lists to each laboratory section.
2. During the sample analysis period, the samples will remain in the designated area.
3. Upon completion of each analysis and analyst validation of the results, the Supervisor may review the analytical data to ensure compliance with the QA/QC requirements in Section VII.B. and the method specific requirements. If deviations exist, the necessary corrective action outline in Section VII.B. must be followed.
4. If at any point during the analysis process, the results are considered technically inaccurate, the analysis will be performed again if holding times have not been exceeded. Otherwise the client will be contacted and arrangements for the recollection of the sample will be made.

C. Reporting

1. Upon review of the completed work-list by the Laboratory Director, the analysis results will be reported in the client specified format. Several Data Processing Software Packages are currently utilized.
2. Upon release of the client report by the Laboratory Director, the CVLC copy of the report and the accompanying work-list will be released to the Accounting department for invoicing. Clients reports are typically mailed or delivered by a commercial courier.
3. Upon completion of invoicing, the work-list and CVLC copy of the final analytical report will be filed into the client's file. All work-lists, reports and documentation logs are held for a minimum of five years.

D. Documentation

1. Black, permanent ink shall be used for all analytical documentation.
2. Write legibly, cross out mistakes with a single line, NO SCRIBBLING, and all mistakes shall be initialed by the appropriate person.
3. Each laboratory section has its own Laboratory Logbooks.

Section II - Chain-of-Custody (Continued)

E. Sample Storage and Handling

CVLC QA/QC Document *Temperature Monitoring Program QA/QC-002* contains specific monitoring and maintenance information.

1. Samples will be stored in designated areas in each laboratory section during the analysis period. Samples typically will be stored in refrigerators maintaining a temperature $<4.4^{\circ}\text{C}$.
2. Upon the completion of the analysis, samples are held for two weeks following the release of sample results to the client.
3. Samples are either disposed by CVLC, returned to the client in accordance with Virginia Department of Transportation regulations or shipped to a hazardous waste facility for treatment. Disposal method of each sample is documented. Further detailed discussion is located in the CVLC Chemical Hygiene Plan.

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Section III - Laboratory Equipment and Instrumentation

- A. Quality Control of laboratory apparatus includes servicing and monitoring the operation of such items as ovens, refrigerators, incubators, water supply and hoods. Servicing and monitoring of apparatus will be documented in the maintenance logbook or monitoring logbook.

B. Monitoring Laboratory Equipment

The daily (when the laboratory is in operation), weekly and quarterly monitoring data applicable to each laboratory section is recorded in the CVLC QA/QC Program Daily Calibration/Recording Logbook located in each section. Semi-Annual and annual monitoring is kept in designated files located with other QA/QC information. CVLC QA/QC Documents contain specific monitoring protocol.

1. Balances - CVLC QA/QC Document *Analytical Balance Calibration/Maintenance Program QA/QC-003* contains specific measurement and maintenance information.
2. pH Meter - CVLC SOP Document *pH REC-002* contains specific maintenance information.
3. Reagent Water - CVLC QA/QC Document *Water Monitoring Procedure QA/QC-006* contains specific monitoring and maintenance information.
4. Refrigerators - CVLC QA/QC Document *Temperature Monitoring Program QA/QC-002* contains specific monitoring and maintenance information.
5. Ventilation Hoods - CVLC Document *Chemical Hygiene Plan* contains specific monitoring information.
6. Thermometers - CVLC QA/QC Document *Temperature Monitoring Program QA/QC-002* contains specific monitoring and maintenance information.

C. Instrument Maintenance

1. Routine instrument maintenance is method and/or instrument specific. CVLC SOPs and/or manufacturer's instrument manuals contains specific maintenance schedule.
2. Records of instrument maintenance (routine, minor and major) will be recorded in a maintenance log book designated for each instrument.

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Section IV - Reagents

A. General

All reagents utilized will be method grade and purity specific. This is essential in generating quality data. CVLC SOPs and *Chemical Hygiene Plan* contain specific storage requirements.

1. The purchase of all chemicals, reagents, solvents and gases must be approved by the department supervisor and/or General Manager.
2. An inventory of all chemicals, reagents, solvents and gases is maintained by the Accounting department.
3. All purchased chemical and reagent bottles shall be labeled with the date received, the date opened and the expiration date. For those chemicals and reagents without known expiration dates, an expiration date appropriate for the intended use shall be used.
4. Prepared reagent bottles shall be labeled with the name of reagent, the reagent concentration (if applicable), the date prepared, the applicable expiration date and the initials of the preparer. The expiration date is reagent/method specific. For prepared reagents without known expiration dates, an expiration date appropriate for the intended use shall be used.
5. All reagents and standards must be prepared using Class A volumetric flasks and other Class A glassware, and stored in polyethylene, polypropylene or amber glass bottles with TEFLON lined caps. The specific bottle used is method specific.
6. Prepare reagents from the appropriate type of deionized or distilled water in accordance with the specified method.
7. Store prepared reagents under specific method or manufacturer required conditions.
8. Store chemicals in designated storage cabinets.
9. The grade of compressed gases used will be in accordance with the specific method or instrument requirements.

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Section V - Quality Assurance/Quality Control

A. Quality Assurance Objectives

An assessment of the analytical data generated against a set of established standards is necessary to ensure the data meets the Quality Assurance Objectives established. Specifically these Quality Assurance Objectives are Precision, Accuracy, Representativeness and Completeness.

- a. Precision - "A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed in terms of the standard deviation. Various measures of precision exist depending upon the "prescribed similar conditions"."**

Precision shall be assessed through field and laboratory duplicate analyses. The Relative Percent Difference (RPD) will be used to determine the precision of these field and laboratory duplicates. Field duplicate samples will be collected in the same manner as the actual samples have been collected. The field duplicate sample will travel through the laboratory as an unique sample. The RPD of the field duplicate will monitor field and laboratory precision. While the RPD of the laboratory duplicate will solely monitor laboratory precision.

- b. Accuracy - "The degree of agreement of a measurement (or an average of measurements of the same thing), X, with an accepted reference or true value, T, usually expressed as the difference between the two values, X-T, or the difference as a percentage of the reference or true value, $100(X-T)/T$, and sometimes expressed as a ratio, X/T . Accuracy is a measure of the bias in a system."**

Accuracy shall be assessed through the use of Calibration Verification Standards (CVS) and matrix spike (MS) or matrix spike/matrix spike duplicate (MS/MSD) analyses. Each CVS will be an independent reference standard or from a non-calibration stock with established acceptance criteria. A CVS shall be analyzed after full calibration and with each analytical run. The CVS measures the accuracy of the calibration process.

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Section V - Quality Assurance/Quality Control

A. Quality Assurance Objectives (Continued)

- c. **Representativeness** - "Expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition."

Representativeness will be accomplished by adherence to established USEPA sampling protocol.

- d. **Completeness** - "A measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions." Completeness is project specific.

B. Analytical Quality Assurance/Quality Control

Analytical Quality Assurance/Quality Control in the generation of data will be a priority for all persons generating data. The specific reference methods will be reviewed for complete QC/QA requirements. The requirements and procedures are instrument and method specific. Analytical instruments shall be tuned and aligned in accordance with requirements which are specific to the instrument and reference method employed. Failure to adhere to established protocol may yield invalid data.

All CVLC internal documents shall be written and revised in accordance with CVLC Document QA/QC-001.

General Analytical Quality Control requirements are as follows (refer to each SOP for specific requirements):

1. A minimum of three standards, including the method detection limit, will be used for calibration for each analysis batch unless indicated otherwise by the reference method. Quantitate results between the detection limit and the highest standard. Results in excess of the high standard will either be reanalyzed within a different calibration range or will be diluted and reanalyzed within the calibration range.
2. A method and/or reagent blank will be performed, at a minimum, at the beginning of each analytical batch. The use of either is solely dependent upon the method used. The method blank will consist of the laboratory water used in the analytical procedure. This method blank will be processed in the same manner as the samples. A reagent blank consists of each reagent or solvent used in the analytical procedure. The blank should not have a concentration exceeding the method detection limit.

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Section V - Quality Assurance/Quality Control (Continued)

B. Analytical Quality Assurance/Quality Control (Continued)

3. *Calibration Verification Standard (CVS)* - To verify initial and continuing calibration, an independent Standard should be analyzed per analytical batch. The CVS is either prepared from a stock different from the calibration standards stock or can be a purchased standard. The CVS value obtained should fall within 10% of the true value, unless specified otherwise by the method. Corrective action for CVS failure must be in accordance with the reference method.
4. Ten percent (10%) of the sample batch, unless specified otherwise by the reference method, (excluding blanks and standards) will have duplicate or spike duplicate analyses performed. The relative percent difference between the duplicate and sample will be $\pm$ twenty percent (20 %) of Zero unless specified otherwise by the reference method. This RPD requirement is applicable to those concentrations greater than five (5) to ten (10) times the detection limit, unless specified otherwise by the reference method. For those concentrations less than five (5) to ten (10) times the detection limit, the concentration difference between the sample and the duplicate should not exceed the concentration of the detection limit. Re-analysis of sample and duplicate may be required for those samples which do not fall within this range. The RPD value obtained is not intended to be the sole factor in determining the validity of the analytical data generated. Calibration data, QA data, blank data, sample matrix, reference method as well as RPD determine the precision and accuracy of the generated data.

$$\text{RELATIVE PERCENT DIFFERENCE (RPD)} = \frac{(\text{SAMPLE CONC.} - \text{DUPLICATE CONC.})}{(\text{SAMPLE CONC.} + \text{DUPLICATE CONC.})/2} \times 100\%$$

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Section V - Quality Assurance/Quality Control (Continued)

B. Analytical Quality Assurance/Quality Control (Continued)

5. Ten percent (10%) of the sample batch, unless specified otherwise by the reference method, (excluding blanks and standards) require spike analysis. One hundred $\pm$ twenty percent recovery unless specified otherwise by the reference method is acceptable. Re-analysis of the sample and spike sample may be required for those samples which do not fall within this range. The %REC value obtained is not intended to be the sole factor in determining the validity of the analytical data generated. Calibration data, QA data, blank data, sample matrix, reference method as well as %REC determine the precision and accuracy of the generated data.

$$\begin{array}{l} \text{PERCENT (SPIKED SAMPLE CONC - SAMPLE CONC)} \\ \text{RECOVERY} \frac{\quad}{\text{SPIKE CONCENTRATION}} \times 100\% \\ \text{\% REC. =} \end{array}$$

6. A mid-range standard will be re-analyzed after every ten (10) samples or in accordance with the specific analytical method. If this standard result drifts by more than ten (10) percent (unless specified otherwise by the reference method) from the original result or curve, recalibration may be required. Samples analyzed prior to this standard re-check may require reanalysis following recalibration.
7. A Laboratory Control Sample (LCS) must be processed in the same manner as samples. The mid-range standard should be the spike value, 90 -110 % recovery is acceptable unless specified otherwise by the reference method.
8. The use of surrogates will be a routine part of all organic analyses. Recovery of each surrogate will be within the method or historical data range. Refer to specific organic method for further discussion.
9. A daily check sample will be analyzed for all organic analyses in accordance with method requirements. Recoveries are method specific.
10. All sample reanalyses performed as corrective action for results falling outside of historical data will be analyzed with either a spike or duplicate sample for confirmation of the results.

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Section V - Quality Assurance/Quality Control (Continued)

C. QA/QC Documentation

1. The date, reference method and analyst's initials will be included with all analytical documentation in the corresponding laboratory notebook.
2. Analytical results recorded in the logbooks shall include analyte concentration with corresponding units. Sample weight, percent water or percent solids (when required), final volume of extract and sample dilution factor will be recorded in designated sample preparation logbooks or in analytical logbooks.
3. Calibration curve or coefficient of the linear calibration shall be included along with the concentration/response data (or relative response data) of the calibration standards in the corresponding logbook. The calibration curve will include the initials of the analyst, the date of preparation and name of parameter analyzed.
4. The relative percent difference for duplicates and percent recoveries for spikes and surrogates will also be documented in the corresponding logbook.
5. The reference QA identification, CVLC value, QA true value and QA acceptable range will be documented in the corresponding logbook.
6. The identity and amount of each constituent detected by the method in the blank will be documented. If the concentration of the blank exceeds the method detection limit, the source of the contamination will be determined. Re-analysis of the entire batch may be required if the contamination is evident throughout the entire batch.
7. All chromatograms for the reported results shall be labeled with the CVLC sample identification and the sample volume or amount injected.
8. Any additional sample preparation not part of the documented reference method will be included with an explanation for such action as well as the signature of the supervisor or QA/QC Director. This also includes any corrective action required for the analysis.
10. All raw data will be stored for a minimum of five years in a secure file. Raw data will include strip charts, GC charts, calibration data, blank data, and chain of custody documentation. No primary data will be stored exclusively on magnetic media.

Section V - Quality Assurance/Quality Control (Continued)

E. Internal Control Measures

CVLC's internal control measures are either based upon general EPA protocol or internal development.

1. For inorganic analyses, CVLC utilizes fixed ranges in accordance with general EPA protocol. General Quality Assurance samples/analysis which utilize fixed control measures are:
 - a. Reagent Blank - Value not to exceed MDL.
 - b. Standard Curve - Correlation Coefficient not to exceed 0.995.
 - c. Standard Check - Value not to exceed ten percent (10%) of original curve.
 - d. CVS - 90 - 110% Recovery
 - e. Spike Recovery - 75 - 125% Recovery.
 - f. Duplicate/Replicate Recovery & Dilution Checks - RPD $\pm 20\%$.
 - g. LCS - 90 - 110% Recovery.

These are general ranges, the reference method criteria supersedes these.

Control Charts (CCs) have been developed for calibration standards and LCSs when required. When necessary the Lower Control Limit (LCL) and Upper Control Limit (UCL) are developed using $\pm 2s$, with $\pm 3s$ for Warning Control Limits. Current laboratory certifications held by CVLC do not require the use of inorganic control charts if fixed ranges are used. However, CCs can be made part of CVLC's Standard Operating Procedures as required by state agencies or specific projects.

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Section VI - Data Evaluation

Data Evaluation

Data Evaluation consists of data reduction and validation and shall be performed by the Supervisor, QA/QC Director, Laboratory Director, or other designated person. Special projects, as designated by the Laboratory Director, shall undergo data reduction and validation. Laboratory data shall undergo data reduction by the Group Leader or Supervisor on a daily basis or as deemed necessary by the Supervisor, Laboratory Director or QA/QC Director. Data validation shall be performed by the Supervisor and QA/QC Director and/or Laboratory Director as deemed necessary by the Laboratory Director or QA/QC Director. Data reduction and data validation consists of, but is not limited to, the following:

1. The sample holding time will be reviewed to ensure compliance with EPA established protocol. Sample deviations may be considered invalid, therefore these results generated must be flagged.
2. The raw data generated from each analytical batch will be reviewed to ensure compliance with specific method protocol.
3. The precision and accuracy of the generated data will be determined by the specific method utilized. Calibration data, QA data, blank data, sample matrix, Relative Percent Difference, Percent Spike Recovery and percent surrogate recovery are factors which will be individually reviewed to determine the precision and accuracy of the generated data.
4. Samples may be reanalyzed, provided sample holding time has not been exceeded, if calibration is incorrect or quality assurance measures have failed.
5. Those results of those samples which cannot be reanalyzed shall be reported. However, the deviation associated with the data will also be reported.

Section 5
Laboratory QA/QC Procedures (REIC)

SOP-ORG-005
Revision No. 4
Date 2/20/95
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STANDARD OPERATING PROCEDURES
for
EPA Method 8270B
GC/MS for Semivolatile Organics

I. EPA 8270B - Semivolatile Organic Compounds by GC/MS

II. Scope and Purpose

Method 8270B is used to determine the concentration of semi-volatile organic compounds in extracts prepared from all types of solid waste matrices, soils, and ground water using gas chromatography/mass spectrometry with capillary column.

The compounds determined by this method include polynuclear aromatic hydrocarbons (PAH), phthalate esters, nitrosamines, chlorinated hydrocarbons, nitroaromatic compounds, and phenols.

III. Method Summary

Prior to using this method, the samples should be prepared for chromatography using the appropriate sample preparation and cleanup methods, refer to standard operating procedures for sample preparation.

Sample extract is injected into GC/MS system, separated by GC column, and each component is then identified by MS and quantified by fitting the response into a five-level calibration curve.

Quality control of this method includes a five-level calibration of each of the analytes, mass spectrometer tune check, calibration check, spike recovery check, duplication check, surrogate recovery check, and blank check.

IV. Apparatus and materials

Gas chromatograph: Hewlett-Packard 5890 series II GC with split injection and programmable temperature control from 40 C to 300 C.

Column: J & W Scientific DB-5.625 silicon-coated fused-silica capillary column, 30-m x 0.25-mm I.D., 0.25-micron film thickness.

Mass spectrometer: Hewlett-Packard 5970 series mass selective detector, set to scan from 40 to 450 amu every 1 second. The MS is tuned to meet all the criteria for producing a satisfactory mass spectrum of decafluorotriphenylphosphine (DFTPP). See QC section for details for tuning.

Data system: Hewlett-Packard 9000-300 and 9000-340 UNIX work stations equipped with HP 59940 MS ChemStation software. This system includes CPU, hard discs, data back system, GC/MS controller, color monitor, printer, keyboard, and mouse.

Auto sampler/Auto Injection system: Hewlett Packard 7673A system capable of automatically injecting a sequence of up to 100 samples.

V. Reagents

Standard solutions: concentrated standard mixtures are purchased from EPA certified supplier Supelco, following is the catalog numbers:

Cat.No.	Name	Conc.
4-8904	phenol mix	2000 ug/ml
4-8875	acid surrogates	2000 ug/ml
4-8902	internal standards	2000 ug/ml
4-8906	benzidine mix	2000 ug/ml
4-8925	base/neutral surrogates	1000 ug/ml
4-8905	PAH mix	2000 ug/ml
4-8901	base/neutral mix 1	2000 ug/ml
4-8900	base/neutral mix 2	2000 ug/ml
4-8076	carbazole	2000 ug/ml

5 levels of standards are mixed as follow:

A. mix together

base/neutral mix 1	2000 ug/ml	1.0 ml
base/neutral mix 2	2000 ug/ml	1.0 ml
PAH mix	2000 ug/ml	1.0 ml
methylene chloride		1.0 ml
total		4.0 ml

B. phenol mix	2000 ug/ml
C. acid surrogates	2000 ug/ml
D. base/neutral surrogates	2000 ug/ml
E. internal standards	2000 ug/ml
F. carbazole	2000 ug/ml
G. benzidine mix	2000 ug/ml
H. methylene chloride	

level	A	B	C (all in ul)	D	E	F	G	H	Total
1	10	10	100	100	20	4	2.50	753.5	1000
2	20	25	100	100	20	10	5.00	720.0	1000
3	50	50	100	100	20	20	12.5	647.5	1000
4	100	75	100	100	20	30	25.0	550.0	1000
5	200	100	100	100	20	40	50.0	390.0	1000

Each level has concentration of each components as follow (all in PPM):

Level	Acids Surr	B/N Surr	Acid Std.	B/N	Int. Mix	Carbazol	Benzid
1	20	5	200	100	40	20	5
2	50	10	200	100	40	50	10
3	100	25	200	100	40	100	25
4	150	50	200	100	40	150	50
5	200	100	200	100	40	200	100

All the standard solutions are stored in freezer and are replaced after a year or sooner if determined to have a problem.

V. Reagents

Standard solutions: concentrated standard mixtures are purchased from EPA certified supplier Supelco, following is the catalog numbers:

Cat.No.	Name	Conc.
4-8904	phenol mix	2000 ug/ml
4-8875	acid surrogates	2000 ug/ml
4-8902	internal standards	2000 ug/ml
4-8906	benzidine mix	2000 ug/ml
4-8925	base/neutral surrogates	1000 ug/ml
4-8905	PAH mix	2000 ug/ml
4-8901	base/neutral mix 1	2000 ug/ml
4-8900	base/neutral mix 2	2000 ug/ml
4-8076	carbazole	2000 ug/ml

5 levels of standards are mixed as follow:

A. mix together

base/neutral mix 1	2000 ug/ml	1.0 ml
base/neutral mix 2	2000 ug/ml	1.0 ml
PAH mix	2000 ug/ml	1.0 ml
methylene chloride		1.0 ml
total		4.0 ml

B. phenol mix	2000 ug/ml
C. acid surrogates	2000 ug/ml
D. base/neutral surrogates	2000 ug/ml
E. internal standards	2000 ug/ml
F. carbazole	2000 ug/ml
G. benzidine mix	2000 ug/ml
H. methylene chloride	

level	A	B	C (all in ul)	D	E	F	G	H	Total
1	10	10	100	100	20	4	2.50	753.5	1000
2	20	25	100	100	20	10	5.00	720.0	1000
3	50	50	100	100	20	20	12.5	647.5	1000
4	100	75	100	100	20	30	25.0	550.0	1000
5	200	100	100	100	20	40	50.0	390.0	1000

Each level has concentration of each components as follow (all in PPM):

Level	Acids Surr	B/N Surr	Acid Std.	B/N	Int. Mix	Carbazol	Benzid
1	20	5	200	100	40	20	5
2	50	10	200	100	40	50	10
3	100	25	200	100	40	100	25
4	150	50	200	100	40	150	50
5	200	100	200	100	40	200	100

All the standard solutions are stored in freezer and are replaced after a year or sooner if determined to have a problem.

V. Reagents

Standard solutions: concentrated standard mixtures are purchased from EPA certified supplier Supelco, following is the catalog numbers:

Cat.No.	Name	Conc.
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4-8902	internal standards	2000 ug/ml
4-8906	benzidine mix	2000 ug/ml
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4-8901	base/neutral mix 1	2000 ug/ml
4-8900	base/neutral mix 2	2000 ug/ml
4-8076	carbazole	2000 ug/ml

5 levels of standards are mixed as follow:

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PAH mix	2000 ug/ml	1.0 ml
methylene chloride		1.0 ml
total		4.0 ml

B. phenol mix	2000 ug/ml
C. acid surrogates	2000 ug/ml
D. base/neutral surrogates	2000 ug/ml
E. internal standards	2000 ug/ml
F. carbazole	2000 ug/ml
G. benzidine mix	2000 ug/ml
H. methylene chloride	

level	A	B	C (all in ul)	D	E	F	G	H	Total
1	10	10	100	100	20	4	2.50	753.5	1000
2	20	25	100	100	20	10	5.00	720.0	1000
3	50	50	100	100	20	20	12.5	647.5	1000
4	100	75	100	100	20	30	25.0	550.0	1000
5	200	100	100	100	20	40	50.0	390.0	1000

Each level has concentration of each components as follow (all in PPM):

Level	Acids Surr	B/N Surr	Acid Std.	B/N	Int. Mix	Carbazi	Benzid
1	20	5	200	100	40	20	5
2	50	10	200	100	40	50	10
3	100	25	200	100	40	100	25
4	150	50	200	100	40	150	50
5	200	100	200	100	40	200	100

All the standard solutions are stored in freezer and are replaced after a year or sooner if determined to have a problem.

Internal standard solutions: the internal standard compounds are 1,4-dichlorobenzene-d5, naphthalene-d8, phenanthrene-d10, chrysene-d12, perylene-d5, acenaphthene-d10, the mixture concentrates are purchased from Supelco (cat. no. 4-8902, 2000 ug/ml). 20 ul is used for each 1 ml of sample extract. The internal standard solutions are stored in freezer, and should be replaced after a year or sooner if determined to have a problem.

GC/MS tuning standard: a methylene chloride solution containing 50 ug/ml of decafluorotriphenylphosphine (DFTPP) is prepared by diluting the concentrate purchased from Supelco (cat. no. 4-8082, 2000 ug/ml). The tuning standard solution is stored in freezer, and should be replaced after a year or sooner if determined to have a problem.

Surrogate Standards: the acid surrogate standards are 2-fluorophenol, phenol-d8, 2,4,6-tribromophenol (Supelco cat. no. 4-8875, 2000 ug/ml), and the base/neutral surrogate standards are nitrobenzene-d5, 2-fluorobiphenyl, p-terphenyl-d14 (Supelco cat. no. 4-8925, 1000 ug/ml). Dilute both acid and base/neutral surrogate concentrates 1:10 with methylene chloride and 1 ml of each is injected to weighed sample matrices, spike, and blank to determine recovery.

Spike standards: the acid spike standards are phenol, 2-chlorophenol, 4-chloro-3-methylphenol, 4-nitrophenol, and pentachlorophenol (Supelco cat. no. 4-8878, 2000 ug/ml), and the base/neutral spike standards are 1,4-dichlorobenzene, n-nitrosodi-n-propylamine, 1,2,4-trichlorobenzene, acenaphthene, 2,4-dinitrotoluene, pyrene (Supelco cat. no. 4-8889, 1000 ug/ml). Dilute both acid and base/neutral spike concentrates 1:10 with methylene chloride and 0.5 ml of each is injected to weighed sample matrices, spike, and blank to determine recovery.

VI. Calibration

Initial calibration

GC/MS operating conditions:

Mass range: 40 to 450 amu

Scan time: 1 sec/scan

Initial column temperature and hold time: 40 C and 5 minutes

Column temperature program: 40-280 C @ 10 C/min

Final column temperature hold time: 25 min

Total run time: 64.2 min

Injector temperature: 275 C

Transferline temperature: 250 C

Injection type: split

Injection volume: 1 ul

Mass spectrometer tune: Inject 1 ul of 50 ug/ml DFTPP, the spectrum produced must meet the following criteria:

Mass	Ion Abundance Criteria
51	30-60% of mass 198
68	<2% of mass 69
70	<2% of mass 69
127	40-60% of mass 198
197	<1% of mass 198
198	Base peak, 100% relative abundance
199	5-9% of mass 198
275	10-30% of mass 198
365	>1% of mass 198
441	Present but less than mass 443
442	>40% of mass 198
443	17-23% of mass 442

Initial calibration: inject 1 ul of each of the five levels of standard described in section 3.1.4.4.1, the primary ions of all the analytes are tabulated, and the area responses of all five levels of the analytes are plotted against their concentrations. Each of the internal standards is assigned a group of analytes whose retention times are similar to that of the internal standards. The instrument is tentatively calibrated. To ensure the the calibration is correct, level-3 of the standard is injected and analyzed again, and the area response is fit into the existing calibration curve to obtain the concentrations, the concentrations must be within 30% of the theoretical value, otherwise the initial calibration fails and the above procedures must be repeated.

Daily calibration

Tune check: a DFTPP tuning standard must be analyzed every 12-hr shift and the result must meet the criteria given in initial calibration section.

Calibration check: level-3 or level-4 of the standard is analyzed every 12 hours or every 12 samples, the results must be within +30% of the theoretical value.

If either one of the above checks fails to pass, corrective action must be taken, see corrective action section for details.

VII. Analysis

Sample preparation: soil, water, sludge and oil samples are extracted and cleaned up according to standard operating procedures for sample preparation, refer to SOP's for EPA 3550 and EPA 3510.

GC/MS analysis: inject 1 ul of the sample extract, the GC/MS system operates under the conditions specified in calibration section. If the 1-ml sample extract appears to be very dirty or very oily, it should be diluted before first injection, however, the internal standard level must be maintained at 40 ppm level in all diluted samples.

VIII. Qualitative analysis

An analyte is identified by comparison of the sample mass spectrum with the mass spectrum of a standard of the suspected compound. An analyte must (1) elute at + 0.06 GC relative retention time as the standard component; and (2) match the standard component's mass spectrum to be determined present in the sample.

A library search may be made for components not associated with the standards.

IX. Quantitative analysis and reporting

Integration of the abundance is based on the analyte's primary ion. It must be made sure that the integration is performed on the correct internal standard peak and correct analyte peak. Using the internal standard technique, the software automatically calculates the concentration of each of the identified analytes.

The final report of the analyte concentration is obtained by the following formula:
$$C_e(1\text{-ml}) / W_s \times n = \text{final reported value}$$

where $C_e(1\text{-ml})$ is the concentration of 1-ml sample extract
 W_s is the amount sample used, normally 30-g for solids, and >500-ml for liquids
 n is the dilution factor

Initial calibration: Inject 1 ul of each of the five levels of standard described in section 3.1.4.4.1, the primary ions of all the analytes are tabulated, and the area responses of all five levels of the analytes are plotted against their concentrations. Each of the internal standards is assigned a group of analytes whose retention times are similar to that of the internal standards. The instrument is tentatively calibrated. To ensure the the calibration is correct, level-3 of the standard is injected and analyzed again, and the area response is fit into the existing calibration curve to obtain the concentrations, the concentrations must be within 30% of the theoretical value, otherwise the initial calibration fails and the above procedures must be repeated.

Daily calibration

Tune check: a DFTPP tuning standard must be analyzed every 12-hr shift and the result must meet the criteria given in initial calibration section.

Calibration check: level-3 or level-4 of the standard is analyzed every 12 hours or every 12 samples, the results must be within +30% of the theoretical value.

If either one of the above checks fails to pass, corrective action must be taken, see corrective action section for details.

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GC/MS analysis: Inject 1 ul of the sample extract, the GC/MS system operates under the conditions specified in calibration section. If the 1-ml sample extract appears to be very dirty or very oily, it should be diluted before first injection, however, the internal standard level must be maintained at 40 ppm level in all diluted samples.

VIII. Qualitative analysis

An analyte is identified by comparison of the sample mass spectrum with the mass spectrum of a standard of the suspected compound. An analyte must (1) elute at ± 0.08 GC relative retention time as the standard component; and (2) match the standard component's mass spectrum to be determined present in the sample.

A library search may be made for components not associated with the standards.

IX. Quantitative analysis and reporting

Integration of the abundance is based on the analyte's primary ion. It must be made sure that the integration is performed on the correct internal standard peak and correct analyte peak. Using the internal standard technique, the software automatically calculates the concentration of each of the identified analytes.

The final report of the analyte concentration is obtained by the following formula:
$$C_e(1\text{-ml}) / W_s \times n = \text{final reported value}$$

where $C_e(1\text{-ml})$ is the concentration of 1-ml sample extract
 W_s is the amount sample used, normally 30-g for solids, and >500-ml for liquids
 n is the dilution factor

The final reported value is in mg/kg for solid samples and in mg/l for liquid samples.

MQL and MSR: minimum quantifiable level is determined by substituting Co(1-ml) in the above formula by the lowest level in calibration table.

Normal MQL's are:

for solids: 0.350 for base/neutral extractalbes

0.700 for acid extractalbes

for liquids: 0.020 for base/neutral extractalbes

0.040 for acid extractalbes

Mean surrogate recovery (MSR) is calculated for base/neutral and acid respectively, and reported with analysis results.

X. Quality control

Tune check: DFTPP tune check is performed every day and the criteria in calibration section must be met before any sample is analyzed.

Calibration check: a calibration check is performed for every batch of 20 samples, and all the targeted analytes should be within $\pm 30\%$ of the true value.

Spike check: 50 ppm of base/neutral spike solution and 100 ppm of acid spike solution are add to at least one sample matrix prior to extraction, and the recovery results should be within 15 - 120%.

Lab control spike check: 50 ppm of base/neutral spike solution and 100 ppm of acid spike solution are add to Na₂SO₄ or reagent water prior to extraction, and the recovery results should be within 30 - 110%.

Spike duplicate: for each batch of 20 samples, two matrix spikes must be done on the same sample and each analyte should be within 15% of each other.

Surrogates recovery: follow the EPA guide line for this parameter

Surr. Compound	Water	Soil/sediment
Nitrobenzene-d5	35-114	23-120
2-Fluorobiphenyl	43-116	30-115
p-Terphenyl-d14	33-141	18-137
Phenol-d5	10-94	24-113
2-Fluorophenol	21-100	25-121
2,4,6-Tribromophenol	10-123	18-122

Blank check: for each batch of 20 samples, at least one blank check is done by extracting Na₂SO₄ or reagent water to make sure the system is contamination free.

XII. Corrective action

When one or more QC check fail to pass the requirments, the corresponding corrective action must be conducted as follow:

For tune problems: auto/manul tune the mass spectrometer, and redo tune standard check, if falls again, the mass source is contaminated and must be cleaned up and repeat the tune and tune check procedures until satisfactory result is achieved.

For calibration check problems: if any of the analytes falls out of acceptable range, the 5-level recalibration should be conducted and the calibration check should be done again to show that all the analytes have acceptable result.

For spike/duplicate problems: first check to make sure the instrument is still within good calibration, then reanalyze the spike/spike duplicate, if the results are still not acceptable, the sample must be reextracted and reanalyzed.

For surrogate recovery problems: first check to make sure the instrument is still within good calibration, then reanalyze the sample with problems, if the results are still not acceptable, the sample must be reextracted and reanalyzed.

For blank check problems: locate the contamination source and find out how many samples are affected, eliminate the contamination source and reextract and reanalyze all the samples that are contaminated. New blank check must be performed to show the system is free of contamination.

XIII. References

1. EPA environmental analytical method 8270B
2. Hewlett-Packard MS ChemStation Manual
Date 2/20/95

STANDARD OPERATING PROCEDURE

for

Methods 200.8 and 6020

**Determination of Trace Elements in Waters and Wastes by
Inductively Coupled Plasma-Mass Spectroscopy**

**SOP-MET-26
Revision No. 1
March 1996**

I. Method 200.8 and 6020: Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectroscopy

II. Scope and Purpose:

Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) is used to qualify and quantify trace elements and metals in a wide variety of matrices, which include drinking waters, groundwaters, wastewaters, surface waters, as well as extracts and digests of solid and semi-solid type samples. Method 200.8 specifically applies to drinking, ground and surface waters, whereas Method 6020 applies to waters in general, plus extracts and digests of solid and semi-solid samples. Both methods are essentially equivalent, with only minor differences between them. This SOP is designed to satisfy the requirements for both methods. The specific method quoted for a given analysis will depend only on the sample type.

For most sample types, an appropriate sample prep or dissolution step is necessary before analysis by ICP-MS (see Appendix F). Method 200.8 is applicable to the following elements: Al, Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Mn, Hg, Mo, Ni, Se, Ag, Tl, Th, U, V and Zn. Similarly, Method 6020 applies to the following: Al, Sb, As, Ba, Be, Cd, Cr, Co, Cu, Pb, Mn, Ni, Ag, Tl, and Zn. Additions to these two lists can be made in some cases; in general, the laboratory is required to demonstrate its capability to analyze an analyte not on these lists prior to any actual analysis and reporting of data.

III. Method Summary:

This method involves the multi-element determination of trace elements in a prepared/digested aqueous sample. Elemental analytes in solution are nebulized and the resulting aerosol transported by argon gas into an argon plasma torch. Within the torch, the sample undergoes desolvation, atomization and finally ionization. The analyte ions are extracted from the plasma through a differentially pumped vacuum interface and then separated based on their mass-to-charge ratio by a quadrupole mass spectrometer. The ions transmitted by the quadrupole are detected and quantified by an electron multiplier detector and the resulting ion information processed by a data handling system. The data handling system must also identify and correct for a number of technique related interferences. Actual quantification of unknowns is accomplished by applying processed and corrected signal intensities of each analyte to calibration curves of signal intensity versus concentration.

IV. Apparatus and Materials:

- A. ICP-MS, VG PlasmaQuad XR, computer controlled
- B. Gilson 222 Autosampler, 181 positions

- C. Gilson Model M312 Peristaltic Pump, with 4 channels
- D. Neslab CFT-75 Water Chiller
- E. Argon gas supply, 99.99% or better
- F. 2 Stage pressure regulator
- G. 1.0 and 0.10 mL Eppendorf pipettes
- H. Various volumetric pipettes and flasks
- I. Valved pipetting bulb

V. Reagents:

- A. Type I demineralized, filtered water
- B. Nitric Acid; concentrated, high purity
- C. Appropriate single and multi-element stock solutions
- D. Multi-element calibration solutions; in 2% nitric
- F. Internal Standards Solution, 2000 ppb Li, Sc, Y, Rh, In, Tb, and Bi; with 10,000 ppb Au.
- G. Calibration Blank solution #1: 1% nitric + Internal Standards
#2: 1% nitric + Internal Standards + 100 ppb Au
- H. Rinse Blank solution #1: 2% nitric
#2: 2% nitric + 100 ppb Au
- I. Detector Calibration Solution, 50 ppb Be, Mg, Co, In, Bi, U.
- J. Appropriate spiking solutions
- K. Appropriate Independent Check Samples
- L. Appropriate Interference Check solutions
- M. Tune Solution, 10 ppb Be, Mg, Co, In, Bi and U.

VI. Procedure:

A. Boot up the computer system. Double click on the Fissons/PQVison icon; this loads the instrument operating software. The Login window first appears; enter a User name and then an Experiment from the available lists, and then click on the LOGIN button. For instrument setup and performance checks, etc. login under "Manager/Tests". For running sample analysis procedures, logon under "Ivan/Waters".

B. After login, click on the Instrument window. To startup the instrument, click on the STANDBY button. This action will ignite the plasma and put the instrument into a standby state. When not being used, the instrument is normally kept in PUMPING mode. Prior to putting the instrument into standby mode, ensure that argon and cooling water are being supplied to the instrument. Argon delivery pressure should be 80 psi. The temperature readout on the water chiller unit should read between 5 and 7 °C.

C. Once the plasma has been ignited, allow 15 minutes warmup. After this time lapse, put the instrument into OPERATE mode by clicking on the OPERATE button. Allow another 10-15 minutes for stabilization before proceeding. During the warmup periods, samples to be analyzed can be prepared and loaded into the autosampler.

D. Prepare the instrument for analysis of unknowns....

1. Tune the instrument while aspirating the tune solution (see Appendix C). After tuning, verify acceptable stability by running the "Short Term Stability Procedure" on the tuning solution. %RSD's should be $\leq 5\%$ across the mass range. If any RSD's exceed 5%, additional tuning is required followed by another stability test.

2. Perform a Mass Calibration while aspirating the tune solution. After the calibration, verify it by scanning the tune solution using the "Single Sample Acquisition" facility. All peaks should be located to within 0.1 amu from their theoretical positions. The instrument's resolution should also be checked/verified at this time. Resolution should be < 0.9 amu at 10% peak height. Check the 3 Mg isotopes for proper resolution. Make resolution adjustments only if necessary.

3. Perform a Detector Calibration while aspirating the Detector Calibration solution. This procedure sets up the cross calibration region between pulse counting and analog modes of data acquisition.

Note 1: Tasks D.1, 2 and 3 should all be performed at least once per week, typically on a Monday. Tuning of the instrument should be verified daily by running the 10 minute stability procedure. Mass calibration, detector calibration, resolution and sensitivity should all be monitored and checked throughout the remainder of the work week.

Note 2: During the instrument setup procedure (steps B-D), the analyst should complete that day's instrument log sheet (as shown in Appendix F). All other pertinent information regarding the instrument and associated hardware should be entered into the Plasma-Quad log book.

E. Calibration and Analysis

After the tasks of section D are performed and/or verified, the instrument is ready to be calibrated for running of unknowns/samples.

1. Login under Ivan/Waters, and then acquire the procedure to be run. Choice of procedures will depend on the analyte list and the type of samples.
2. Load the autosampler with a Calibration Blank, a set of Calibration Standards, followed by the samples to be analyzed, plus all required QC solution. Refer to Appendix B for the required QC. The calibration blank, calibration standards and independent check sample should be loaded into the "Rack 5" of the autosampler. Samples are loaded into racks 1-4.
3. The procedure being carried out must then be updated/modified by entering the sample ID's and autosampler addresses. Any dilution factors are also entered at this time.
4. Ensure that the sample introduction system is properly setup.
 - a. Turn on autosampler.
 - b. Prepare peristaltic pump for use. Inspect and install all pump tubing.
 - c. Ensure that the rinse water reservoir is full, that the waste container is empty, and that all fluid carrying lines are properly located and in good condition.
5. Start the analytical run. The instrument will run unattended until the entire analysis is completed. The instrument can also be run in manual mode, but the autosampler will be used most of the time.
6. After the analytical run is completed, process the data and print out a hard copy of the results using the data system. If desired, the software can be configured so that data is calculated and printed out as the analysis progresses.
7. The data and associated QC can then be reviewed and any reruns or additional analytical tasks can be identified.

Appendix A

Misc Procedural Notes

1. Typical vacuum pressures are as follows:

	<u>Operating Mode</u>	<u>Pumping Mode</u>
Gauge 1 (Parani)	$< 1 \times 10^{-4}$ mbar	$< 1 \times 10^{-4}$ mbar
Gauge 2 (Parani)	$< 5 \times 10^0$	atmospheric
Gauge 3 (Penning)	$< 5 \times 10^{-6}$	$< 1 \times 10^{-6}$

2. Typical Forward Power: 1350 W; can go as high as 2000W.

3. Typical Reflected Power: 0 - 5 W Ideal
 5 - 10 OK
 10 - 20 Operable, but indicates a problem.

4. Typical Argon gas flows (L/min):

Auxiliary:	0.5 - 2.5	Typically 1.5
Cool:	12 - 13	Typically 13
Neb:	0.76 - 0.90	Typically 0.84
Neb Press:	20 - 40 psi	Typically 30

5. Most samples should be diluted 5 fold prior to analysis by ICP-MS. Analyte reporting levels should be elevated by the sample's post digestion dilution factor.

6. Analyte reporting levels must be within their respective calibration curves.

7. Samples are to be diluted using 1% nitric acid.

8. When analyzing for mercury, calibration standard concentrations must be kept below 5 ppb. In addition, all calibration standards, calibration blanks, samples and rinse blanks must be made up to contain 100 ppb gold (Au).

9. All solutions (except the rinse blank) must be made up to contain internal standards at 20 ppb. 1 mL of a 2000 ppb mixture of internal standards for every 100 mL of solution will provide an internal standard concentration of 20 ppb.

10. All non-digested samples must be prepared to contain 1% nitric acid (see Appendix F).

11. All calibration standards, independent check samples, ICB's, ICV's, CCB's, CCV's, and nondigested samples should be blank subtracted using the original calibration blank.

F. After all analytical work is performed, allow the system to run and flush out for about 10 minutes before shutting it down. During this time, aspirate 5% nitric acid solution. To shut down the instrument, go to the Instrument window and click on the PUMPING button. The instrument will automatically return to its resting state.

G. Shut off the gas supply and disengage all pump tubing.

H. Properly shut down the computer system by choosing File/Exit. This closes the PQVison software program and leaves you in the OS2 operating system window. Click on the right hand mouse button (with pointer in middle of screen), and then choose SHUTDOWN. After shutdown, the computer may be rebooted or turned off. Note: Never reboot the system without first shutting down the system.

VII. Quality Control:

All quality control measures and associated corrective actions specified in Appendix B shall be followed.

VIII. References:

A. Methods For the Determination of Metals In Environmental Samples, Supplement 1; Method 200.8- Determination of Trace Elements in Water and Wastes by ICP-MS, Revision 5.4, May 1994.

B. Test Methods for Evaluating Solid Waste, SW-846, 3rd Ed., Volume 1A; Method 6020: ICP-MS, Revision 0, Sept 1994.

APPENDICES

- A. Misc Procedural Notes
- B. Quality Control
- C. Tuning Procedures
- D. Maintenance
- E. Operating Log
- F. Sample Preparation

12. All digested samples must be blank subtracted using the method blank.
13. Where possible, multiple isotopes of each analyte should be monitored. This allows the analyst to identify interferences that may otherwise go undetected. Where multiple isotopes of an analyte are monitored, several scenarios can develop:
 - a. All isotopes agree closely with each other. In this case, the reported analyte concentration is obtained by averaging the isotopes. Averaging of isotopes should be performed only when isotopes agree with each other within 90%.
 - b. There exists differences between the isotopes that exceed 10%. In this case, the analyst must determine which of the isotopes represents the best result. The choice of which isotope to report must be backed up, defended and documented. Possible rationale for selecting the best result from a set of isotopes include
 - i. The isotope's performance on various QC samples, such as CCV's, independent check samples, spikes, etc.
 - ii. A result that is significantly higher than the other isotopes (assuming the other isotopes pass all QC) usually indicates a positive interference and can therefore be disregarded. Note: Negative interferences generally do not occur.
 - iii. Investigate the possibilities of interferences on the isotopes. Viewing a mass SCAN can sometimes identify faulty isotopes.
14. Samples of unknown composition should be initially run at a dilution of at least 5:1. Once the approximate composition has been determined, the sample may be rerun at a lower dilution if warranted.
15. Samples that are suspected of having high concentrations of TDS should be screened using ICP-AES. Then, the sample may be appropriately diluted for analysis by ICP-MS.
16. Typically, monitored analyte concentrations should be kept below a concentration of about 5 to 10 ppm. This increases detector lifetime, as well as that of the cones. Instrument drift problems are also minimized by avoiding high concentrations.
17. Samples may be analyzed in one of two modes- scanning or peak jumping. Peak jumping is generally quicker, however scanning allows future manipulation of the raw data and allows visual observations of the sample's mass spectrum.
18. If the possibility exists for a sample to contain measured analyte concentrations of 50 ppb or more, DUAL acquisition mode must be chosen.
19. All standards, test solutions, etc. are to be entered into the ICP-MS standards log for traceability purposes.

Appendix B

Quality Control for Methods 200.8 and 6020

I. BATCH QUALITY CONTROL

A. Method Blanks: One method blank is required for each batch of 20 or less samples. A method blank is an aliquot of Type I water that is carried through the entire digestion and analysis procedure.

Acceptance Criteria: $\leq 10\%$ of measured concentration, or $< 2.2 \times \text{MDL}$, whichever is greater.

Corrective Action: In general, a failing method blank requires the redigestion of the entire affected batch. Exceptions to this rule are where the sample analytes are clearly "ND" (less than 10% of the reporting limit) and where it can be proven that an elevated method blank is consistent and inherent with the method, in which case blank subtraction may be used.

B. Calibration Blank: The calibration blank is to be run prior to the calibration standards, immediately after calibration (ICB), after every 10 samples (CCB), and at the end of the run (FCB).

Acceptance Criteria: Preferably $< 3 \times \text{MDL}$
Absolutely $< \text{Reporting Limit}$

Corrective Action: If the calibration blank exceeds the reporting limit, terminate the analysis and investigate/correct the problem. If the cal blank is between $3 \times \text{MDL}$ and the reporting limit, investigate possible causes.

C. Calibration Verification: The calibration verification is to be run immediately after a calibration (ICV), after every 10 samples (CCV), and at the end of the run (FCV). It can be the middle calibration standard or an independent standard near the midpoint of the calibration curves.

Acceptance Criteria: $\pm 10\%$ of theoretical value

Corrective Action: Recalibrate or reslope and rerun all samples since the last successful calibration verification. Exception: If the recovery on the CCV or FCV is within $\pm 20\%$ of theoretical, AND the sample's analyte concentration is less than half the reporting limit, the sample may be reported as "ND" with no corrective action.

D. Independent Check Sample: An independent check sample is a sample

containing known amounts of all analytes being tested for. It must be prepared from a source independent of the calibration standards. It is to be run immediately after the ICV.

Acceptance Criteria: within the 95% confidence interval, or + 10% of true value.

Corrective Action: Halt the analysis (for failing analytes), investigate, and correct.

E. Control Matrix Spike (Blank spike or LCS- Lab Control Sample): A control matrix spike is a spiked aliquot of Type I water which is carried throughout the entire digestion procedure. It is spiked in exactly the same manner as a sample. One such spike is required for every batch of 20 or less samples.

Acceptance Criteria: 85-115% of theoretical

Corrective Action: Redigest and reanalyze the entire batch for affected analyte. Exceptions: If the recovery on the control matrix spike is within + 30% of theoretical, then those samples with analyte concentrations less than half their reporting limits are exempt from corrective action.

F. Matrix Spikes: A matrix spike is a sample duplicate that is spiked prior to digestion. Samples are spiked on a 10% basis (one spike for every 10 samples).

Acceptance Criteria: 70 - 130% of theoretical

Corrective Action: Dilute the sample (a minimum of 5:1), respire, redigest, and reanalyze. If the spike now passes, elevate the reporting limit by the "post digestion dilution factor". If the spike still fails, elevate the reporting limit and footnote the result as "experiencing matrix interference".

G. Sample Duplicate: A sample duplicate is another exact aliquot of a sample carried through the entire analytical process. One sample duplicate is processed for every 10 samples. In general, duplicates and spikes are performed on the same sample.

Acceptance Criteria: $RPD < 20\%$ $RPD = \frac{\text{abs}(C1 - C2)}{((C1 + C2)/2)}$

Corrective Action: Redigest and reanalyze the affected samples for the affected analytes. Exception: The analyte concentration must be greater than the reporting limit for the acceptance criterion to apply.

H. Post Digestion Spike: A post digestion spike is an aliquot of digested sample that is spiked. Post digestion spikes are prepared and analyzed when it is suspected that a matrix problem or some other interference may exist.

Acceptance Criteria: 75 - 125% of theoretical

Corrective Action: Dilute the sample (at least 5:1) and respire/reanalyze. If the diluted spike passes, raise the reporting limit by the post digestion DF. If the diluted spike fails again, raise the reporting limit and footnote the result as "experiencing matrix

interference".

I. **Dilution Test:** The dilution test consists of diluting an analyzed sample (a minimum of 5:1) and reanalyzing the dilution. To perform this test, the analyte concentration in the undiluted sample must exceed the reporting limit by a factor of 10. This test is performed under any one of two conditions:

1. When the analyst suspects a matrix interference of some type.
2. The undiluted sample yields a result that exceeds the calibration range by a factor of 10.

Acceptance Criteria: The results for the dilution must agree within 10% of that for the undiluted sample.

Corrective Action: Dilute the sample further and reanalyze; continue until 10% agreement is obtained. Exception: The dilution test can only be applied when the analyte concentration exceeds the reporting limit by a factor of 10.

J. **Interference Check Samples:** (for 6020 only) Analysis of interference check solutions A and AB verifies the magnitude and potential interferences and the adequacy of any corrections. These checks are to be run at the beginning of an analytical run or every 12 hours.

II. INSTRUMENT QUALITY CONTROL

A. Internal Standards:

Acceptance Criteria:

1. Method 6020: 30 - 120%
2. Method 200.8: 60 - 125%
3. Internal standard recoveries for the ICB, CCB's and FCB must be within 20% of that for the initial calibration blank.

Corrective Action: Dilute the sample a minimum of 5:1. Reanalyze. Continue the process until the criterion is passed. The reporting limits must be elevated by the final post digestion DF.

B. **Instrument Stability:** Instrument stability must be achieved and verified prior to calibration and running of samples. Frequency is daily.

Acceptance Criteria: $\leq 5\%$ standard deviation for 10 consecutive measurements of the 10 ppb tune solution (10 minute duration).

Corrective Action: Retune the instrument and repeat the stability test.

C. Resolution: Acceptable resolution must be achieved and verified prior to any analysis. Resolution must be verified at least weekly.

Acceptance Criteria: < 0.9 amu, at 10% peak height.

Corrective Action: Adjust resolution until passing.

D. Mass Calibration: All masses must be in calibration prior to any analysis. A mass calibration must be performed at least weekly and verified daily.

Acceptance Criteria: The mass calibration must be within 0.1 amu of theoretical peak position.

Corrective Action: Perform a new mass calibration, then verify its validity by a SCAN.

E. Detector Calibration: The detector must be properly calibrated (cross over range between pulse counting and analog acquisition) prior to any analysis. Calibration must be performed weekly and verified daily.

III. MISC QUALITY CONTROL

A. Calibration Curve Correlation Coefficients: r-values for calibration curves must be ≥ 0.995 . If this criterion is not met, the analysis must be terminated for the affected analytes and the cause identified and corrected.

B. Isotope Comparisons: Questionable data can sometimes be verified by looking at relative peak intensities of alternate isotopes of the analyte in question. Potential interferences can sometimes be identified in this way.

C. Method Cross Checks: Method cross checks are carried out by analyzing the sample using an alternate method. Results should agree within 20%. Alternate methods include GFAA, FAA and ICP-AES.

Appendix C

Tuning Procedures

Tuning the Plasma-Quad ICP-MS is necessary to optimize the performance of the instrument with respect to sensitivity and stability. In most cases, tuning the Plasma-Quad involves adjustment of the ion lenses, argon gas flows, and torch position. The optimum settings of all these variables are those which give the best combination of high sensitivity and high stability. In general, the Plasma-Quad should be tuned on a weekly basis (preferably at the beginning of a work week). Minimal adjustments may be necessary throughout the remainder of the work week, depending on specific requirements. Adequate tuning should be verified by performing a 10 minute stability check across the mass range. Additional tuning is usually not necessary as long as the instrument is producing acceptable sensitivity and stability.

The following steps outline the tuning procedure:

1. Aspirate the 10 ppb tune solution.
2. Set the detector to local pulse counting.
3. Adjust the First Mass control to transmit Indium at mass 115. Adjust the mass controls (First Mass and Fine Mass) controls to gain maximum signal on In-115 (as indicated by the signal screen). Note: In-115 is chosen to tune on because of its proximity to center mass. Any other of the 5 remaining tuning elements (or all 5 at once) can be used; however, optimizing on one central isotope is simpler and generally provides acceptable results.
4. While watching the In-115 signal on the display, begin making small adjustments on the ion lens controls, beginning at the extraction lens and ending with lens L4. Adjust until maximum sensitivity and stability are achieved.
5. Next adjust the torch box position. Three controls are available to adjust the torch position in the x, y and z planes. Adjust until maximum sensitivity and stability are achieved.
6. Adjust the gas flows to gain maximum sensitivity and stability. The auxiliary and nebulizer gas flows are most critical. The cool gas rarely needs to be changed.
7. Finish the tuning procedure by again fine tuning each of the ion lenses (if necessary).
8. Once acceptable tuning is achieved, record all settings onto that days instrument log sheet (see Appendix E).

Notes:

- a. After the entire tuning procedure is performed (preferably on a Monday), only minor tuning of the ion lenses should be necessary throughout the remainder of the work week.
- b. The entire tuning procedure is required anytime the glassware is changed.
- c. There exists many, if not an infinite number of acceptable combinations of tuning settings. All of the adjustable parameters are interrelated and dependant upon each other.

Appendix D

Maintenance for the Plasma-Quad

A. Daily:

1. Verify acceptable sensitivity and stability.
2. Record all settings and operational parameters (see Appendix F).
3. Dump both waste reservoirs (spray chamber drain and probe rinse drain).

B. Weekly:

1. Perform mass calibration.
2. Perform detector calibration.
3. Complete system tuning.
4. Exchange/clean glassware.
5. Check water filter and change if necessary.
6. Check air filters and clean/exchange if necessary.
7. Inspect pump tubing and replace if necessary.
8. Inspect sample and skimmer cones and clean/exchange if necessary.
9. Inspect all tubing and lines for degradation and leaks.
10. Dust off the instrument and associated hardware.

C. Monthly:

1. Clean extraction lens.
2. Check rotary pump oil levels.
3. Check oil mist filters.

4. Archive all analytical data onto 3.5" floppy disks and then purge the data from the computer's hard drive.

D. Semi-Annually:

1. Examine lens stack and clean if necessary.
2. Examine penning gauge and clean if necessary.
3. Change rotary pump oil.
4. Examine slide valve and check operation.

E. Annually:

Replace detector (or when necessary).

Appendix E

Daily Instrument Log Sheet

1. **Vacuum Pressures:** Record pressures while in pumping mode, and then while in operate mode. All measurements are in mbars.
2. **ICP20 Generator:** Record power readings after the plasma has been ignited and burning for at least 5 minutes. Units are Watts.
3. **Argon Gas Flows:** Record the gas flows after the instrument has been tuned for the day. Gas flows are in L/min and the Neb Pressure in bar.
4. **Torch Box Tune Position:** Record this value after the plasma has been successfully ignited.
5. **Lens Settings:** Record these settings after the instrument has been fully tuned for the day.
6. **Response:**
 - a. Record signal intensities for the tuning elements after final tuning adjustments have been made. Indicate the isotope, its concentration and the signal intensities from the signal monitor (both pulse counting and analog).
 - b. Record the signal intensity at the background mass of 220 (in both pulse counting and analog modes).
7. **Resolution:** Record setting and check the OK box if resolution is acceptable (view Pb and Mg isotopes).
8. **Delta M:** Record setting and check OK if resolution is acceptable.
9. **Peak Shape:** Check OK if peaks are of acceptable shape.
10. **Mass Cal:** Check OK if a mass calibration is performed that day.
11. **Cross Cal:** Check OK if a detector calibration is performed that day.
12. **Instrument Faults / Service Work:** Enter any problems encountered and any service or maintenance performed.

PLASMAQUAD INSTRUMENT LOG

DATE: _____

OPERATOR:

VACUUM

	Pumping	Operate
Expansion		
Intermediate		
Analysar		

ICP20 GENERATOR

Reflected Power	
Incident Power	

GAS PANEL

Cool	
Aux	
Neb 1	
Neb 2	
Neb Pressure	

LENS SETTINGS

Ext (2.0)	
Col (7.8)	
L1 (7.7)	
L2 (5.4)	
L3 (5.0)	
L4 (3.8)	
P.B. (4.5)	
HT1	
HT2	

Torch box tuning position (Plasma ON):

RESPONSE (MHz/ppm)

Mass	Analog	Pulse Counting
Background at Mass 220:		

	OK	Setting
Resolution		
Delta M		
Peak Shape		
Mass Cal		
Cross Cal		

INSTUMENT FAULTS NOTED/SERVICE WORK DONE[illegible]

Appendix F

Sample Preparation

Samples to be run by ICP-MS must first be properly prepared. The specific preparation given a sample depends on the type of sample. The following paragraphs summarize sample preparation for the ICP-MS.

A. For drinking water samples that have been properly preserved (and allowed to stand for 16 hours) and have a turbidity of < 1 NTU, no digestion is required.

1. Cu/Pb Analysis: Pipette 2 mL of sample into a properly labeled 10 mL autosampler tube. Adjust the final volume to 10 mL by adding 8 mL of 1% nitric acid diluent. This produces a dilution factor of 5:1.

2. 12 Metal Primary/Secondary Analysis: Pipette 5 mL of sample into a 10 mL autosampler tube. Adjust the final volume to 10 mL. This produces a DF of 2:1.

3. Matrix and blank spikes are prepared by adding 1 mL of the appropriate spiking solution to the sample prior to final volume adjustment.

4. After adjusting the final volume to 10 mL, add 0.100 mL of the 2000 ppb internal standards solution. Stopper the tube and mix. The sample is now ready for analysis.

B. Samples digested by Methods 3020 and 3050-furnace can be analyzed via ICP-MS by following the same steps as for a drinking water (A.1-4). Samples digested by 3020 should be prepared to produce a minimum DF of 10:1 (1 mL of actual extract). Samples digested by 3050-furnace should be prepared to produce a minimum DF of 10:1 (1 mL of actual extract). Higher DF's may be required depending on the TDS of the sample extract. In general, sample TDS must be kept below 0.2% (2000 mg/L).

Note: 3010 and 3050-flame extracts should be avoided due to high levels of hydrochloric acid used in the extraction process.

C. Samples that are digested/extracted expressly for analysis by ICP-MS are done so using the digestion Method 200.2 (see the SOP for this method). Method 200.2 is applicable for both solids and liquids. It utilizes both nitric and hydrochloric acids, but at relatively low concentrations (compared to Methods 3010, 3020 and 3050).



96-161
Redder
Jake
Barker
File

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

George Allen
Governor

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Thomas L. Hopkins
Director

Becky Norton Dunlop
Secretary of Natural Resources

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

Certified Mail
Return Receipt Requested

October 28, 1996

Sorry -
Do we need a
letter updating
our closure plan?
Candy

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

RE: Radford Army Ammunition Plant (RAAP)
EPA ID# VA1210020730
Incinerator Spray Pond, Closure Plan Amendment Review

Dear Ms. Jake:

Your letter requesting an amendment to the approved closure plan for RAAP's incinerator spray pond was submitted to the Department of Environmental Quality (DEQ) on October 1, 1996. RAAP submitted this letter in response to the DEQ comment letter dated May 28, 1996.

Based on the information submitted, the amendment requested is approved. An update to Table 3-2 is attached and will need to be added to the closure plan. Please update your closure plan, as needed.

As noted in the amendment request, the analytical method revisions are for soils only. Use of analytical methods with higher quantitation limits for antimony, barium, chromium, lead, mercury, nickel, and thallium are only being approved because the background data indicated the presence of these constituents [Note, future closure plans for other units may not be acceptable with these methods]. Therefore, RAAP will only need to resample background for arsenic, di-n-butyl-phthalate, diethyl phthalate, and resorcinol. Once this resampling is

RAAP Incinerator Spray Pond
Background Data Review
Page 2

completed, resubmittal of all background data will need to be submitted to the DEQ in accordance with the closure plan §3.7.1.

As provided in Rule 2A:2 of the Supreme Court of Virginia, you have 30 days from the date of service of this decision to initiate an appeal by filing a notice of appeal with:

Thomas L. Hopkins, Director
Virginia Department of Environmental Quality
629 East Main Street
P.O. Box 10009
Richmond, Virginia 23240-0009

In the event that this decision is served to you by mail, the date of service will be calculated as three days after the postmark date. Please refer to Part Two A of the Rules of the Supreme Court of Virginia, which describes the required content of the Notice of Appeal, including specifications of the Circuit Court to which the appeal is taken, and additional requirements concerning appeals from decisions of administrative agents.

If you should have any questions, concerning this matter, please contact Debra Miller, Environmental Engineer Senior, of my staff at (804) 698-4206.

Sincerely,



 Thomas L. Hopkins
Director

Attachment

cc: Jerry Redder, Alliant Techsystems-RAAP
Robert Greaves, EPA Region III
Leslie Romanchik, DEQ/Waste-OPM
Lisa Ellis, DEQ/Waste-OPM
Debra Miller, DEQ/Waste-OPM
Glenn VonGonten, DEQ/Waste-GCA
Claire Slaughter, DEQ/Waste-OTA
Aziz Farahmand, DEQ/RRO-Compliance



96-154
C. Jake
Radford
Olsen
Barker
ENV File

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

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Becky Norton Dunlop
Secretary of Natural Resources

Certified Mail
Return Receipt Requested

October 10, 1996

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
Incinerator Spray Pond Closure Amendment
EPA ID# VA12100207306
Extension to Closure Schedule**

Dear Ms. Jake:

Your letter requesting an extension to the closure schedule for the Incinerator Spray Pond closure activities was received on October 1, 1996. In addition to the extension request, a closure amendment to modify the sampling methods was also requested. Review of the methods modification will commence shortly and shall be addressed in a separate correspondence.

As the closure activities will, of necessity, take longer to complete than the approved closure schedule, the DEQ will approve an extension until April 1, 1997, for completion of closure activities at the RAAP's Incinerator Spray Pond. Please update your approved closure plan with the revised closure schedule submitted with this request. During this extension period, RAAP shall continue to take all steps to prevent threats to human health and the environment from the Incinerator Spray Pond that is no longer operating but has not undergone formal closure.

RAAP Closure Extension
Incinerator Spray Pond
Page 2

If there are any additional questions, please contact Debra Miller, Environmental Engineer Senior, of my staff at (804) 698-4206. Please note, any further requests for an extension to the closure period should be submitted with detailed justification at least 30 days prior to the expiration date, as required by VHWMR 9 VAC 20-60-580.D.3.b. [previously VHWMR §9.6.D.3.b].

Sincerely,



for Thomas L. Hopkins
Director

cc: Leslie Romanchik, DEQ
Lisa Ellis, DEQ
Debra Miller, DEQ
Glenn Von Gonten, DEQ
Claire Slaughter, DEQ
Aziz Farahmand, DEQ-RRO

Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

September 25, 1996

96-815-243

Debra Miller
Environmental Engineer Senior
Department of Environmental Quality
Office of Permitting Management, Hazardous Waste
629 East Main Street, Suite 406
Richmond, VA 23219

Subject: Response to Virginia Department of Environmental Quality (VaDEQ) letter
Concerning EQL (PQL) Revisions for HWMU 39 the Incinerator Spray Pond.

Dear Ms. Miller:

This letter addresses the Virginia Department of Environmental Quality (VaDEQ) concerns regarding background sampling performed January 3, 1996. After reviewing your comments concerning the background sampling at the Incinerator Spray Pond, the Radford Army Ammunitions Plant feels that resampling will be necessary to correct errors that arose in the sampling and analysis of the background soils. Two Amendments to the closure plan are enclosed for your review. The first is an amendment to the schedule and the second is an amendment to the methods and their EQL (PQL) in Table 3-2 "Hazardous Constituents of Concern"; this amendment is for soils only.

Please find attached amended Table 3-5 "Closure Schedule". Revisions to the Schedule were necessitated by our inability to obtain viable background data.

After reviewing the methods used, MDLs, EQLs, and the results from the January 3, 1996 background sampling an amendment to the closure plan has been compiled. All methods in the amendment come from SW-846 third edition. Methods and EQLs for Antimony, Barium, Beryllium, Cadmium, Chromium, Lead, Mercury, Nickel, Silver, Thallium, 2,4-Dinitrotoluene, and 2,6-Dinitrotoluene were chosen based on the results from the original sampling event.

For Antimony, Barium, Chromium, Lead, Mercury, Nickel and Thallium the January 3, 1996 sampling indicated that these constituents were present in the background soil in

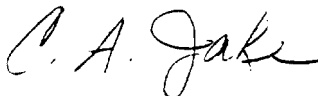
quantities greater than the MDL for each individual method used in the January 3, 1996 sampling. Therefore, the January 3, 1996 method is proposed in the amendment to the Closure Plan at the Incinerator Spray Pond.

For Beryllium, Cadmium, Silver, 2,4-Dinitrotoluene and 2,6-Dinitrotoluene the methods used in the January 3, 1996 background sampling resulted in lower EQLs than EQLs approved for method 6020 and 8090 in a previously approved closure plan (Site 10 Closure Plan). Therefore, the January 3, 1996 method is proposed in the amendment to the Closure Plan at the Incinerator Spray Pond.

Method 8270B is proposed for di-n-butyl-phthalate and diethyl phthalate, as approved in a previously approved closure plan (Site 10 Closure Plan). In the closure plan for the Incinerator Spray Pond Method 8270 is indicated as the method to test for Resorcinol; we propose the use of Method 8270B to reduce lab costs. Method 8270B for Resorcinol will produce an EQL consistent with the detection limit of other constituents using Method 8270B. The EQL for method 8270B for Resorcinol will be documented with QA/QC data. Method 6020 is proposed for the analysis of Arsenic. Method 6020 was approved for Arsenic in a previously approved closure plan (Site 10 closure plan). Di-n-butyl-phthalate, diethyl phthalate, Resorcinol and Arsenic whose EQL's or Methods changed from the sampling and analysis conducted on January 3, 1996 will be retested. The data from the sampling conducted on January 3, 1996 will be used for all other constituents. Revisions to Table 3-2 "Hazardous Constituents of Concern" are enclosed.

Hopefully these amendments to the Closure Plan for Site 39, the Incinerator Spray Pond, will be approved and resampling can commence. If you have any question please contact, Jerry Redder at (540)639-7536 or Arne Olsen at (540)639-8220.

Sincerely,



C. A. Jake, Supervisor
Environmental Affairs

Enclosure

AEOlsen:V:\815-243

Debra Miller
Response to VaDEQ Letter
September 26, 1996
Page 3

Coordination: R. L. Richardson
R. L. Richardson

V. Wolodkin
V. Wolodkin

bc: Administrative File
R. L. Richardson
C. A. Jake
Lisa Ellis
Doug Brown
Env. File



COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

MAY 28 1996

Peter W. Schmidt
Director

P. O. Box 10009
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(804) 762-4000

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

**RE: Radford Army Ammunition Plant (RAAP)
EPA ID# VA12100207306
Incinerator Spray Pond
Closure Plan Amendment/Background Data Review**

Dear Ms. Jake:

Your letter providing the laboratory data for the background sampling of RAAP's incinerator spray pond was submitted to the Department of Environmental Quality (DEQ) on April 2, 1996. Unfortunately, the original copy could not be located; therefore, another copy was submitted to the DEQ on May 3, 1996. Please forgive the delay in this response.

Based on the information submitted, the analytical methods used are not the methods approved in the August 24, 1995, closure plan. A request for amendment of the approved closure plan was submitted on November 14, 1995, and the DEQ responded to this request via a letter from Clifton L. Parker IV, Environmental Engineer Senior, on November 15, 1995. Mr. Parker's letter requested that RAAP review the provided information and resubmit a revised closure plan amendment for our review. RAAP will have to revise and re-submit to the DEQ a request for amendment of the closure plan. Additionally, at this time, the DEQ cannot approve the background sampling as it is not in compliance with RAAP's approved closure plan. It should also be noted, if the methods/PQL modifications utilized by RAAP for this background sampling cannot be approved as acceptable alternatives, then resampling of background will be required.

Based on the information submitted, the following comments are provided for your review. However, the first step in the process must be submittal of the closure plan amendment. Note, all Test Methods listed are SW-846, Third Edition, as updated.

96-077 Reel
Richardson
Jake
Due 6-17-96

1. The data provided is in the form of summary sheets. Copies of the original laboratory analysis sheets with the appropriate certificate of analysis and internal laboratory QA/QC will need to be submitted.
2. For some constituents, the data reported are less than the PQL listed (chromium, lead, mercury, nickel, and thallium); however, no qualifiers are noted. In most cases, when data is detected above the detection limit but less than the quantitation limit, the data reported are estimated. Please provide information as to the accuracy of the values listed.
3. During statistical analysis, use of the PQL for non-detects may not be appropriate. For all data, values reported as less than the minimum detection limit and/or less than the PQL will be treated in accordance with the methods outlined in the draft *Guidance on Statistical Methods for Groundwater Data Analysis at a Solid Waste or Hazardous Waste Site*, Virginia Department of Environmental Quality, 1994, and by procedures summarized in the *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance*, EPA, June, 1992. Outliers will also be checked and handled according to the DEQ guidance.
4. Please explain the difference regarding the detection limit (DL) and the PQL as indicated on the analytical results sheets. Is the DL the method detection limit or the laboratory determined detection limit for the soil matrix analyzed?
5. For all the methods, the PQL listed is ten times the DL, please explain the justification for this multiplication factor for each of the methods. When a study is performed to determine the detection limit, it is also appropriate to determine the quantitation limit using the appropriate calculation.
6. The approved analytical method was Method 6020 for determination of antimony, arsenic, barium, beryllium, cadmium, chromium, lead, nickel, silver, and thallium concentrations. Closure to background requires the use of the SW-846 analytical method with the lowest PQL in order to determine any possible contamination by hazardous constituents. For these constituents, background analysis was accomplished using test methods with higher PQLs than the approved methods. Appropriate justification for the methods and PQLs utilized will have to be submitted with the closure amendment.
7. For arsenic and cadmium, non-detects were indicated. In these two cases, the PQLs were 5000 $\mu\text{g}/\text{kg}$ for arsenic using Method 7060, which is 25,000 times the approved Method 6020's PQL, and 50 $\mu\text{g}/\text{kg}$ for cadmium using Method 7131, which is 250 times the approved Method 6020's PQL. For the non-detect values, it is impossible to determine whether the approved method would have detected these constituents. Therefore, the background

analysis for arsenic and cadmium may not be appropriate, unless the necessary justification for use of the alternate method can be approved.

8. For the analysis of arsenic and cadmium, it shall also be noted that the alternative methods used were updated by EPA to Method 7060A and 7131A, respectively.

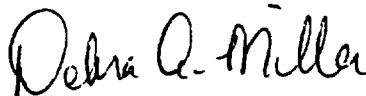
9. The background locations utilized are not specified on the map provided. It will be necessary to list where each sample was taken (i.e. which was location BG-1, BG-2, BG-3, etc...). Information to support the choice of background location shall be included. This information shall confirm that the location is uncontaminated by previous facility activities.

10. Please provide an explanation as to why there is no diethyl phthalate data for Method 8061's BG-5, BG-6, BGD-3, and the blanks and, for Method 8270, no diethyl phthalate data for BG-1, BG-2, BG-3. A complete analysis of all diethyl phthalate samples should have been performed using one method. An expansion of the explanation given will need to be submitted along with the lab analysis sheets.

11. For all methods listed where the corresponding PQL exceeds the PQL as listed in the November 15, 1995, DEQ letter, appropriate justification for the PQL increase will need to be submitted (i.e. sample preparation, matrix interference, etc...). Please be method specific with regard to the justification for the PQL increase.

RAAP is requested to submit a revised closure plan amendment for all alternative methods proposed and for any other modifications from the approved closure plan once review of these comments and the November 15, 1995, letter is completed. Please note that submittal of a closure plan amendment shall be in accordance with the *Virginia Hazardous Waste Management Regulations* §9.6.C.3. If there are any questions regarding the information provided, please contact me at (804) 698-4206.

Sincerely,



Debra A. Miller
Environmental Engineer Senior

cc: Christel Ackerman, ERM
Lisa Ellis, DEQ 
Claire Slaughter, DEQ
Mike Scott, DEQ-RRO

PM96-006& PM96-0006

Christel Ackerman
ERM
3140 Chaparral Dr. SW
Suite 201
Roanoke, VA 24018



COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

96-066
[Redacted]
Richardson
Jude

Peter W. Schmidt
Director

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Richmond, Virginia 23240-0009
(804) 762-4000

**CERTIFIED MAIL
RETURN RECEIPT REQUESTED**

C.A. Jake
Environmental Manager
Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

**RE: RAAP Incinerator Spray Pond Closure Amendment
Extension to Closure Schedule
EPA ID# VA12100207306**

Dear Mr. Jake:

Your letter requesting an amendment to the Incinerator Spray Pond's approved closure plan was received by the Department of Environmental Quality (DEQ) on January 30, 1996. Please forgive the delay in this response as the original engineer assigned to this project left the agency and the amendment request was only recently reassigned. In addition to the extension request, the background sampling analysis was also submitted. This data was revised and review of the background data will commence shortly and will be addressed in a separate correspondence.

As the closure activities will, of necessity, take longer to complete than the approved closure schedule, the DEQ will approve an extension until October 1, 1996, for completion of closure activities at the RAAP's Incinerator Spray Pond. Please update and submit a revised closure schedule to reflect this extension. During this extension period, RAAP shall continue to take all steps to prevent threats to human health and the environment from the Incinerator Spray Pond that is no longer operating but has not undergone formal closure.

RAAP Closure Amendment
Incinerator Spray Pond
Page 2

If there are any additional questions, please contact Debra Miller, Environmental Engineer Senior, of my staff at (804) 698-4206.

Sincerely,

Leslie A. Romanchik

for Peter W. Schmidt
Director

Attachment

cc: Leslie Romanchik, DEQ
Lisa Ellis, DEQ
Debra Miller, DEQ
Glenn Von Gonten, DEQ
Claire Slaughter, DEQ

28 March 1996
Reference: 176E4.07

Mr. Clifton Parker
Environmental Engineer Senior
Virginia Department of Environmental Quality
629 East Main Street
Richmond, VA 23219



Re: Alliant Techsystems, Inc., Radford Army Ammunition Plant,
Incinerator Spray Pond Closure, Background Soil Samples.

Dear Mr. Parker:

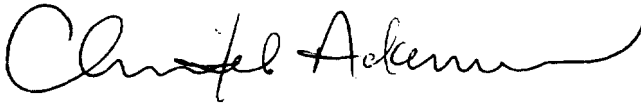
On behalf of Alliant Techsystems, Inc., Environmental Resources Management, Inc. (ERM) is submitting the additional information which you requested 15 February 1996 regarding the background soil samples collected in support of closure for the Incinerator Spray Pond.

We have provided a check for data normality and a test to ensure that the appropriate number of background soil samples were collected. The test for the appropriate number of samples was conducted using U.S.EPA's SW-846 Chapter 9 Sampling Plan. The check for data normality was conducted using the Data Distribution Report which statistically determines and describes the distributional properties of the sampling results.

The results of each test are enclosed. With the exception of Barium, six background soil samples appear to be adequate for characterization in support of closure of the site. ERM believes additional samples for Barium are not necessary for the successful closure of this unit. Barium is not a constituent of primary concern for closure of this unit and the naturally occurring mean concentration for the eastern United States is 280 mg/kg. The only data identified as non-normally distributed are those for which all results were non-detect.

If you have any questions regarding this information, please contact Mr. Jerry Redder, Alliant Techsystems, Inc. at 540/639-7536 or myself at 540/776-3545.

Sincerely,



Christel E. Ackerman
Project Engineer

cea

enclosures: Adequate Sample Calculations
Background Soil Sample Normality Check

cc: **Mr. Jerry Redder, Alliant Techsystems, Inc.** (with
enclosures)

Commonwealth of Virginia
Department of Environmental Quality
PS&H, DIVISION OF WASTE OPERATIONS
Office of Permitting Management
Facsimile Transmittal

Date:	April 29, 1996	Page 1 of 2
TO:	Jerry Redder	
TITLE:		
ORGANIZATION:	Alliant Techsystems	
FAX NUMBER:	(540) 639-7214	
FROM:	Debra A. Miller	
TITLE:	Environmental Engineer Senior	
PHONE:	(804) 698-4206 FAX: (804) 698-4234	
SUBJECT:	Info Request on SW-846, Method 6020	

Please deliver!



Jerry,

As promised, I talked to our Chemists and they provided me with the attached list of labs doing 6020. Please note, this is not all the labs that can perform this analysis, it is just a short list of ones that we had contacted. No recommendation intended. Hope it helps!!

-Debble

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

**LABS OFFERING METALS ANALYSIS
BY SW-846 METHOD 6020**

<u>NAME</u>	<u>PHONE</u>	<u>CONTACT</u>
Gascoyne	800-GAS-COYN	lab manager
Quanterra	Denver, W. Sacramento	
EMI	540-396-3661	Mark Brooks
Environmental Health Labs.	219-233-4777	Paul Bowers
Synergic Atlantics, Inc	616-538-8700	Sam Yazadani
Aquatech	800-783-5991	
Montgomery Watson Labs	818-568-6486	Rick Zimmer
American Water Works Belleville, Il	XXX- 35-3600	Rick Bessee

NOTE: *This list should not be construed as a recommendation, endorsement, or solicitation for, or on behalf of, any companies listed. It is merely intended to demonstrate that this method is available for use. These are not all the labs using the method, only those we contacted.*

**INCINERATOR SPRAY POND BACKGROUND DATA NORMALITY CHECK
DATA DISTRIBUTION
FOR ALL DATES**

COMPANY: Radford Army Ammunition Plant
SITE: Incin. Spray Pond
PROGRAM: Closure
PROGRAM TYPE: Soil
DATA GROUP: Normality Check

All Duplicates Used
Significance Level (1 - alpha): 99%

Non-Detects = Detection Limit/2

LOCATION ID	SAMPLE SIZE	% N-Ds	SHAPIRO-WILK DISTRIBUTION	CALCULATED W	TABULAR W	SKENNESS	KURTOSIS	COEFFICIENT OF VARIATION

RAAP LIST

PARAMETER: 2,4-DINITROTOLUENE

UNIT: PPB

Background

6	100		Non-Normal	0.0000	0.7130	0.00	0.00	0.00

PARAMETER: 2,6-DINITROTOLUENE

UNIT: PPB

Background

6	100		Non-Normal	0.0000	0.7130	0.00	0.00	0.00

PARAMETER: ANTIMONY

UNIT: PPM

Background

6	0		Normal	0.9687	0.7130	0.25	1.77	0.30

PARAMETER: ARSENIC

UNIT: PPM

Background

6	100		Non-Normal	0.0000	0.7130	0.00	0.00	0.00

PARAMETER: BARIUM

UNIT: PPM

Background

6	0		Normal	0.9173	0.7130	-0.01	1.00	0.16

(continues)

**INCINERATOR SPRAY POND BACKGROUND DATA NORMALITY CHECK
DATA DISTRIBUTION
FOR ALL DATES**

LOCATION ID	SAMPLE SIZE	Z N-Ds	SHAPIRO-WILK DISTRIBUTION	CALCULATED W	TABULAR W	SKEDNESS	KURTOSIS	COEFFICIENT OF VARIATION
PARAMETER: BERYLLIUM								UNIT: PPM
Background	6	0	Normal	0.9127	0.7130	-0.27	1.08	0.27
PARAMETER: CADMIUM								UNIT: PPM
Background	6	50	Normal	0.7418	0.7130	0.02	0.73	0.41
PARAMETER: CHROMIUM								UNIT: PPM
Background	6	100	Non-Normal	0.0000	0.7130	0.00	0.00	0.00
PARAMETER: DI-N-BUTYL PHTHALATE								UNIT: PPB
Background	6	100	Non-Normal	0.0000	0.7130	0.00	0.00	0.00
PARAMETER: DIETHYL PHTHALATE								UNIT: PPB
Background	6	100	Non-Normal	0.0000	0.7130	0.00	0.00	0.00
PARAMETER: LEAD								UNIT: PPM
Background	6	100	Non-Normal	0.0000	0.7130	0.00	0.00	0.00
PARAMETER: MERCURY								UNIT: PPM
Background	6	100	Non-Normal	0.0000	0.7130	0.00	0.00	0.00
PARAMETER: NICKEL								UNIT: PPM
Background	6	50	Normal	0.7761	0.7130	0.07	0.78	0.53

(continues)

**INCINERATOR SPRAY POND BACKGROUND DATA NORMALITY CHECK
DATA DISTRIBUTION
FOR ALL DATES**

LOCATION ID	SAMPLE SIZE	Z N-Ds	SHAPIRO-WILK DISTRIBUTION	CALCULATED W	TABULAR W	SKEWNESS	KURTOSIS	COEFFICIENT OF VARIATION
PARAMETER: RESORCINOL								UNIT: PPB
Background	6	100	Non-Normal	0.0000	0.7130	0.00	0.00	0.00
PARAMETER: SILVER								UNIT: PPM
Background	6	0	Normal	0.8693	0.7130	0.71	1.84	0.56
PARAMETER: THALLIUM								UNIT: PPM
Background	6	100	Non-Normal	0.0000	0.7130	0.00	0.00	0.00

----- End of Report -----

The Monitor System, TM

Copyright (C) 1992-94, Entech Systems Incorporated

ALLIANT TECHSYSTEMS, INC.
INCINERATOR SPRAY POND BACKGROUND SOIL SAMPLES
APPROPRIATE NUMBER OF SAMPLES CHECK
SW-846 CHAPTER 9 SAMPLING PLAN

Variance of Sample, s^2

$$s^2 = \frac{\sum X_i^2 - (\sum X_i)^2 / n}{n - 1}$$

where n=number of sample measurements.

Appropriate Number of Samples, n

$$n = \frac{t^2 s^2}{RT - X}$$

where RT = regulatory threshold

X = sample mean

The results for the following parameters were non-detect and, therefore, an appropriate number of samples could not be calculated:

2,4-Dinitrotoluene
2,6-Dinitrotoluene
Arsenic
Di-n-butyl phthalate
Diethyl phthalate
Resorcinol

Although many of the results for most of the following parameters were below the PQL, an appropriate number of samples was calculated using the laboratory detection limit.

Antimony =	2.68
Barium =	16.45
Beryllium =	0.08
Cadmium =	0.0
Chromium =	1.25
Lead =	1.17
Mercury =	0.01
Nickel =	3.34
Silver =	0.44
Thallium =	0.04

Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

March 25, 1996

96-815-098

Clifton L. Parker^{IV}
Department of Environmental Quality
Office of Permitting Management, Hazardous Waste
629 East Main Street, Suite 406
Richmond, VA 23219

Subject: Incinerator Spray Pond Closure Plan, Resubmission of Background Soil Samples
Radford Army Ammunition Plant, Radford Virginia, EPA ID# VA12100207306

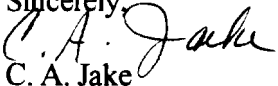
Dear Mr. Parker:

Please reference our January 25, 1996 letter in which we submitted the background samples. At your suggestion the laboratory provided us with more information to assist the determination of background. Attached is the resubmission of the background samples with the Practical Quantitation Limit (PQL) added to the data and a map showing the background sampling locations. The PQL will be used in the statistical evaluation for any results that are non-detectable.

The background soil sampling results were tested using the method in Chapter 9 of SW-846. The data is normal and does not exceed the upper confidence level. The sample numbers remained under six samples, except for barium. According to our calculations the number of samples required for barium would be sixteen. We feel that the additional samples for barium will not benefit the closure or change the data for clean closure. We are requesting that six samples for barium be acceptable to determine background for this closure.

Please copy our consultant ERM with correspondence on the closure plan. If you have any questions concerning the attached information or require additional information please contact Jerry Redder of my staff (540) 639-7536, or Christel Ackerman, ERM (540) 776-3545.

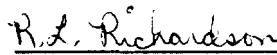
Sincerely,


C. A. Jake
Environmental Manager

Attachments

Coordination:


Woolwine


R. L. Richardson

c: Christel Ackerman, ERM, 3140 Chaparral Dr. SW, Suite 201, Roanoke, VA 24018
R. L. Richardson, RAAP ACO

Clifton L. Parker^{IV}
March 26, 1996
Page 2

bc: Adm. File
 R. L. Richardson
 D. W. Ratcliff
 C. A. Jake
 J. J. Redder

Alliant Techsystems Inc.
Radford Army Ammunition Plant
Route 114
P.O. Box 1
Radford, VA 24141-0100

January 25, 1996

96-815-028

Clifton L. Parker^{IV}
Department of Environmental Quality
Office of Permitting Management, Hazardous Waste
629 East Main Street, Suite 406
Richmond, VA 23219

Subject: Incinerator Spray Pond Closure Plan, Background Soil Samples
Radford Army Ammunition Plant, Radford Virginia, EPA ID# VA12100207306

Dear Mr. Parker:

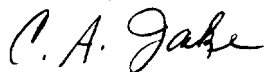
In accordance with the approved closure plan for the Incinerator Spray Pond enclosed are the background samples and the required SW-846 QA/QC data. The samples were taken in the locations as delineated on the Figure 2-5 of the closure plan. We will perform the statistical comparison upon receiving your approval.

The analytical methods for chromium and lead differ from the closure plan because the detection of these metals was in the PPM range as opposed to the PPB range. A detection limit of 0.1 PPM was used for mercury because the required detection limit of 2 PPB was the method detection for the laboratory. We did have detects for mercury at this limit.

A contractor will not be able to be on site until April because of inclement weather. The closure plan was approved August 24, 1995. According to Table 3-5 we had 90 days to obtain funding. We were able to verify that adequate funding was available to commence work on November 13, 1995. This would put the original schedule to complete by May 10, 1996. In order to complete the clean closure attempt we are requesting an extension until October 1, 1996.

Please copy our consultant ERM with correspondence on the closure plan. If you have any questions concerning the attached information or require additional information please contact either myself (540) 639-8266, Jerry Redder of my staff (540) 639-7536, or Christel Ackerman, ERM (540)-776-3545.

Sincerely

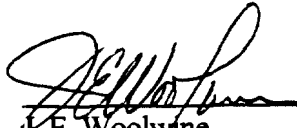


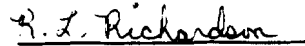
C. A. Jake
Environmental Manager

Enclosures

Clifton L. Parker^{IV}
January 25, 1996
Page 2

Coordination:


J. E. Woolwine


R. L. Richardson

w/o enclosures

c: West Central Regional Office- Roanoke
Christel Ackerman, ERM, 3140 Chaparral Dr. SW, Suite 201, Roanoke, VA 24018

w/ enclosures

R. L. Richardson, RAAP ACO

bc: Adm. File
C. A. Jake
D. W. Ratcliff
J. J. Redder
Env. File

/JJRedder



CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS, INC.

P.O. Box 10918 Lynchburg, Virginia 24506
OFFICE: 3109 Odd Fellows Road • (804) 847-2852 • 800-296-1470 • FAX (804) 847-2830

Christel Ackerman
Environmental Resources Management, Inc.
3140 Chaparral Drive, Suite 201
Roanoke, Virginia 24018

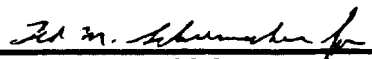
PROJECT NAME:		RAAP Site 39	RAAP Site 39	RAAP Site 39	RAAP Site 39
PROJECT NUMBER:		176E4.07.01	176E4.07.01	176E4.07.01	176E4.07.01
CUSTOMER ID:		BG - 1 (4.5')	BG - 2 (4.5')	BG - 3 (4.5')	BG - 4 (4.5')
CVLC ID:		96-00061	96-00062	96-00063	96-00064
COLLECTION DATE :	Grab:	01/02/96	01/02/96	01/02/96	01/02/96
COLLECTION TIME (hours):	Grab:	1115	1130	1150	1215
RELINQUISHED DATE:		01/03/96	01/03/96	01/03/96	01/03/96
RELINQUISHED TIME (hours):		1050	1050	1050	1050
RECEIVED DATE:		01/03/96	01/03/96	01/03/96	01/03/96
RECEIVED TIME (hours):		1715	1715	1715	1715

NG = Not Given

Comments:

The presence of Diethyl Phthalate detected by method SW 8061 in several of the samples was not confirmed by mass spectrometry. Therefore, Diethyl Phthalate for these samples was reported by SW-846 Method 8270.

Respectfully Submitted,


Janet M. Zwetolitz
Laboratory Director

January 16, 1996

Report Date

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

PROJECT NAME:		RAAP Site 39	RAAP Site 39	RAAP Site 39	RAAP Site 39
PROJECT NUMBER:		176E4.07.01	176E4.07.01	176E4.07.01	176E4.07.01
CUSTOMER ID:		BG - 5 (4.5')	BG - 6 (4.5')	BGD - 3 (4.5')	Field Blank
CVLC ID:		96-00065	96-00066	96-00067	96-00068
COLLECTION DATE :	Grab:	01/02/96	01/02/96	01/02/96	01/02/96
COLLECTION TIME (hours):	Grab:	1230	1255	1200	1040
RELINQUISHED DATE:		01/03/96	01/03/96	01/03/96	01/03/96
RELINQUISHED TIME (hours):		1050	1050	1050	1050
RECEIVED DATE:		01/03/96	01/03/96	01/03/96	01/03/96
RECEIVED TIME (hours):		1715	1715	1715	1715

NG = Not Given

Comments:

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

PROJECT NAME:		RAAP Site 39	RAAP Site 39
PROJECT NUMBER:		176E4.07.01	176E4.07.01
CUSTOMER ID:		Equip Blank	Trip Blank
CVLC ID:		96-00069	96-00070
COLLECTION DATE :	Grab:	01/02/96	12/19/95
COLLECTION TIME (hours):	Grab:	1310	1200
RELINQUISHED DATE:		01/03/96	01/03/96
RELINQUISHED TIME (hours):		1050	1050
RECEIVED DATE:		01/03/96	01/03/96
RECEIVED TIME (hours):		1715	1715

NG = Not Given

Comments:

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

			BG - 1 (4.5')	BG - 2 (4.5')	BG - 3 (4.5')	BG - 4 (4.5')
			<u>96-00061</u>	<u>96-00062</u>	<u>96-00063</u>	<u>96-00064</u>
INORGANIC COMPOUNDS	SW-846 Method	DL (MG/KG)	MG/KG	MG/KG	MG/KG	MG/KG
Antimony, Total	7041	0.150	3.37	3.25	3.70	5.48
Arsenic, Total	7060	0.50	ND	ND ¹	ND	ND
Barium, Total	6010A	0.100	66.1	82.3	63.0	93.3
Beryllium, Total	6010A	0.0100	0.702	0.538	0.451	0.920
Cadmium, Total	7131	0.0050	ND	ND	ND	0.058
Chromium, Total	7190	2.50	17.0	16.0	19.0	23.5
Lead, Total	7420	5.0	11.0	10.0	13.0	14.5
Mercury, Total	7471	0.10	0.25	0.25	0.20	0.15
Nickel, Total	7520	0.750	5.40	3.50	4.70	10.6
Silver, Total	7761	0.0010	0.0255	0.0170	0.0170	0.0765
Thallium, Total	7841	0.050	0.160	0.125	0.180	0.280

ND = Not Detected

¹The spike recovery was not within the acceptable range. Therefore, the reported result is estimated.

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

			BG - 5 (4.5')	BG - 6 (4.5')	BGD - 3 (4.5')
			96-00065	96-00066	96-00067
INORGANIC COMPOUNDS	SW-846 Method	DL (MG/KG)	MG/KG	MG/KG	MG/KG
Antimony, Total	7041	0.150	2.14	4.20	3.40
Arsenic, Total	7060	0.50	ND	ND	ND
Barium, Total	6010A	0.100	91.5	74.6	58.5
Beryllium, Total	6010A	0.0100	0.895	0.817	0.521
Cadmium, Total	7131	0.0050	0.054	0.053	ND
Chromium, Total	7190	2.50	21.5	21.5	19.5
Lead, Total	7420	5.0	11.5	14.5	11.5
Mercury, Total	7471	0.10	0.10	0.25	0.10
Nickel, Total	7520	0.750	11.5	9.40	4.50
Silver, Total	7761	0.0010	0.0450	0.0370	0.0205
Thallium, Total	7841	0.050	0.245	0.270	0.185

ND = Not Detected

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

INORGANIC COMPOUNDS	SW-846 Method	DL (MG/L)	Field Blank	Equip Blank	Trip Blank
			96-00068	96-00069	96-00070
			MG/L	MG/L	MG/L
Antimony, Total	7041	0.003	ND	ND	ND
Arsenic, Total	7060	0.001	ND	ND	ND
Barium, Total	6010A	0.002	ND	ND	ND
Beryllium, Total	6010A	0.0002	ND	ND	ND
Cadmium, Total	7131	0.0001	ND	ND	ND
Chromium, Total	7191	0.001	ND	ND	ND
Lead, Total	7421	0.001	ND	ND	ND
Mercury, Total	7470	0.0002	0.0002	0.0002	0.0002
Nickel, Total	7520	0.015	ND	ND	ND
Silver, Total	7761	0.0002	ND	ND	ND
Thallium, Total	7841	0.001	ND	ND	ND

ND = Not Detected

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

		<u>BG - 1 (4.5')</u>	<u>BG - 2 (4.5')</u>	<u>BG - 3 (4.5')</u>	<u>BG - 4 (4.5')</u>
		<u>96-00061</u>	<u>96-00062</u>	<u>96-00063</u>	<u>96-00064</u>
<u>SW-846 METHOD 8061</u>	<u>DL(UG/KG)</u>	<u>UG/KG</u>	<u>UG/KG</u>	<u>UG/KG</u>	<u>UG/KG</u>
Di-n-butyl-phthalate	220	ND	ND	ND	ND
Diethyl phthalate	170	ND	ND	ND	ND

ND = Not Detected

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

<u>SW-846 METHOD 8061</u>	<u>DL(UG/KG)</u>	<u>BG - 5 (4.5')</u>	<u>BG - 6 (4.5')</u>	<u>BGD - 3 (4.5')</u>
		<u>96-00065</u>	<u>96-00066</u>	<u>96-00067</u>
		<u>UG/KG</u>	<u>UG/KG</u>	<u>UG/KG</u>
Di-n-butyl-phthalate	220	ND	ND	ND

ND = Not Detected

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

SW-846 METHOD 8061	DL(UG/L)	Field Blank	Equip Blank	Trip Blank
		96-00068	96-00069	96-00070
		UG/L	UG/L	UG/L
Di-n-butyl-phthalate	3.3	ND	ND	ND

ND = Not Detected

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

		<u>BG - 1 (4.5')</u>	<u>BG - 2 (4.5')</u>	<u>BG - 3 (4.5')</u>	<u>BG - 4 (4.5')</u>
		<u>96-00061</u>	<u>96-00062</u>	<u>96-00063</u>	<u>96-00064</u>
<u>SW-846 METHOD 8090</u>	<u>DL(UG/KG)</u>	<u>UG/KG¹</u>	<u>UG/KG¹</u>	<u>UG/KG</u>	<u>UG/KG¹</u>
2,4-Dinitrotoluene	13	ND	ND	ND	ND
2,6-Dinitrotoluene	7	ND	ND	ND	ND

ND = Not Detected

¹The recovery for each surrogate was not within the acceptable range. Therefore, the reported results are estimated.

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

		<u>BG - 5 (4.5')</u>	<u>BG - 6 (4.5')</u>	<u>BGD - 3 (4.5')</u>
		<u>96-00065</u>	<u>96-00066</u>	<u>96-00067</u>
<u>SW-846 METHOD 8090</u>	<u>DL(UG/KG)</u>	<u>UG/KG</u>	<u>UG/KG¹</u>	<u>UG/KG</u>
2,4-Dinitrotoluene	13	ND	ND	ND
2,6-Dinitrotoluene	7	ND	ND	ND

ND = Not Detected

¹The recovery for each surrogate was not within the acceptable range. Therefore, the reported results are estimated.

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

SW-846 METHOD 8090	DL(UG/L)	Field Blank	Equip Blank	Trip Blank
		96-00068	96-00069	96-00070
		UG/L	UG/L	UG/L
2,4-Dinitrotoluene	0.2	ND	ND	ND
2,6-Dinitrotoluene	0.1	ND	ND	ND

ND = Not Detected

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

		<u>BG - 1 (4.5')</u>	<u>BG - 2 (4.5')</u>	<u>BG - 3 (4.5')</u>	<u>BG - 4 (4.5')</u>
		<u>96-00061</u>	<u>96-00062</u>	<u>96-00063</u>	<u>96-00064</u>
<u>SW-846 METHOD 8270</u>	<u>DL(UG/KG)</u>	<u>UG/KG</u>	<u>UG/KG</u>	<u>UG/KG</u>	<u>UG/KG</u>
Resorcinol ¹	330	ND	ND	ND	ND

ND = Not Detected

**¹Please Note: Values obtained above are based upon an NBS Mass Spectral Library Search only -
these values should be considered approximations.**

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

		BG - 5 (4.5')	BG - 6 (4.5')	BGD - 3 (4.5')
		96-00065	96-00066	96-00067
SW-846 METHOD 8270	DL(UG/KG)	UG/KG	UG/KG	UG/KG
Resorcinol ¹	330	ND	ND	ND
Diethyl phthalate	170	ND	ND	ND

ND = Not Detected

¹**Please Note: Values obtained above are based upon an NBS Mass Spectral Library Search only - these values should be considered approximations.**

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

SW-846 METHOD 8270	DL(UG/L)	Field Blank	Equip Blank	Trip Blank
		96-00068	96-00069	96-00070
		UG/L	UG/L	UG/L
Resorcinol ¹	100	ND	ND	ND
Diethyl phthalate	2.5	ND ²	ND ²	<5.9 ²

ND = Not Detected

¹ Please Note: Values obtained above are based upon an NBS Mass Spectral Library Search only - these values should be considered approximations.

² The recovery for each surrogate was not within the acceptable range. Therefore, the reported results are estimated.

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

		BG - 1 (4.5')	BG - 2 (4.5')	BG - 3 (4.5')	BG - 4 (4.5')
		96-00061	96-00062	96-00063	96-00064
<u>SURROGATE COMPOUND</u>	<u>RECOVERY RANGE</u>	<u>PERCENT RECOVERY (%)</u>			
SW-846 Method 8061					
Diphenyl Phthalate	40 - 125	98	75	98	83
SW-846 Method 8090					
Dibutyl Chlorendate	40 - 125	24 ¹	37 ¹	40	38 ¹
SW-846 Method 8270					
Phenol-d6	24 - 113	127 ¹	77	84	70
2-Fluorophenol	25 - 121	90	70	74	67
2,4,6-Tribromophenol	19 - 122	77	74	61	59
Nitrobenzene-d5	23 - 118	30	62	61	68
2-Fluorobiphenyl	30 - 115	21 ¹	99	40	48
p-Terphenyl-d14	18 - 137	20	60	51	64

¹The recovery for each surrogate was not within the acceptable range. Therefore, the reported results are estimated.

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

		BG - 5 (4.5')	BG - 6 (4.5')	BGD - 3 (4.5')
		96-00065	96-00066	96-00067
<u>SURROGATE COMPOUND</u>	<u>RECOVERY RANGE</u>	<u>PERCENT RECOVERY (%)</u>		
SW-846 Method 8061				
Diphenyl Phthalate	40 - 125	88	103	102
SW-846 Method 8090				
Dibutyl Chlorendate	40 - 125	56	39 ¹	48
SW-846 Method 8270				
Phenol-d6	24 - 113	70	74	54
2-Fluorophenol	25 - 121	68	70	55
2,4,6-Tribromophenol	19 - 122	64	56	47
Nitrobenzene-d5	23 - 118	65	70	49
2-Fluorobiphenyl	30 - 115	46	48	35
p-Terphenyl-d14	18 - 137	65	53	52

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

		Field Blank	Equip Blank	Trip Blank
		96-00068	96-00069	96-00070
<u>SURROGATE COMPOUND</u>	<u>RECOVERY RANGE</u>	<u>PERCENT RECOVERY (%)</u>		
SW-846 Method 8061				
Diphenyl Phthalate	40 - 125	81	55	101
SW-846 Method 8090				
Dibutyl Chlorendate	45 - 120	93	54	71
SW-846 Method 8270				
Phenol-d6	10 - 94	40	41	36
2-Fluorophenol	21 - 100	54	56	48
2,4,6-Tribromophenol	10 - 123	65	83	60
Nitrobenzene-d5	35 - 114	63	34 ¹	56
2-Fluorobiphenyl	43 - 116	42 ¹	22 ¹	40 ¹
p-Terphenyl-d14	33 - 133	47	30	46

¹The recovery for each surrogate was not within the acceptable range. Therefore, the reported results are estimated.

LEGEND

Spike Failure

The matrix spike sample analysis provides information about the effect of each sample matrix on the digestion and measurement methodology. Spike recoveries must be within specified limits. However, according to EPA Document No. EPA/540/R/94/082, **LABORATORY DATA VALIDATION FUNCTIONAL GUIDELINES FOR EVALUATING ORGANIC ANALYSES**, December, 1994 (Laboratory Functional Guidelines), if the sample result is outside the acceptable range, the results are reported as estimated.

Surrogate Failure

Laboratory performance on individual samples is established by means of spiking activities. All samples are spiked with surrogate compounds prior to sample preparation. The evaluation of the results of these surrogate spikes is not necessarily straightforward. The sample itself may produce effects due to such factors as interferences and high concentrations of analytes. Since the effects of the sample matrix are frequently outside the control of the laboratory and may present relatively unique problems, the review and validation of data based on specific sample results is frequently subjective and demands analytical experience and professional judgement.

Elevated Detection Limit

Often during analysis, an Interferant or high concentration of a compound may create the need to dilute a sample. When the sample is diluted, the Method Detection Limit is elevated by the factor of the dilution.

Method Detection Limit

The Method Detection Limit is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero.



95-129

COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

Office of Permitting Management

Peter W. Schmidt
Director

November 15, 1995

P. O. Box 10009
Richmond, Virginia 23240-0009
(804) 762-4000

Mr. Jerry J. Redder, P.E.
Environmental Engineer
Alliant Techsystems, Inc.
Radford Army Ammunition Plant
P.O. Box 1
Radford, Virginia 24141-7536

**SUBJECT: Incinerator Spray Pond (HWMU-39) Closure Plan Modification
Radford Army Ammunition Plant, Radford, Virginia, EPA ID# VA12100207306**

Dear Mr. Redder:

Environmental Resources Management submitted a "variance request", or what is called a "proposed closure plan modification" by VDEQ, for the Incinerator Spray Pond, dated November 9, 1995, and received November 14, 1995. The request to change certain SW-846 analytical test methods from 6020 to an alternate method is acceptable since the 6020 method is not yet widely available; however, certain methods proposed by Radford do not appear to be the lowest practical quantitation limit. A modified list is being submitted to you for your review and consideration, and is attached. Please note that the **bolded** methods and quantitation limits indicate the lowest detection limit(s) which must be used for establishing background, or when necessary during sampling to "see" at or below the required performance standard; (i.e., if the background level or health based number is 100, then any method which can quantify less than 100 satisfies the requirement, otherwise, the lowest detection must be used.)

Please revise the proposed closure plan modification as necessary and resubmit for further review and approval. If there are any questions about this, or if a meeting is needed to discuss closure issues, please do not hesitate to contact me at (804) 762-4142. Please note that VDEQ headquarters' three digit phone number prefix in Richmond will change from 762-, to 698-, on or around December 1, 1995.

Sincerely,

A handwritten signature in black ink, appearing to read "Clifton L. Parker IV", with a long horizontal flourish extending to the right.

Clifton L. Parker^{IV}
Environmental Engineer Senior

COPY

9 November 1995

Mr. Clifton Parker
Virginia Department of Environmental Quality
P.O. Box 10009
Richmond VA 23240-0009

Reference: Radford Army Ammunition Plant (RAAP), Incinerator
Spray Pond Closure at HWMU 39, Analytical Method
Variance



Dear Mr. Parker:

Environmental Resources Management, Inc. (ERM) is assisting the Radford Army Ammunition Plant (RAAP) in the closure of the Incinerator Spray Pond at HWMU 39. RAAP received DEQ approval of its "Closure, Contingent Closure and Contingent Post-Closure Plans for Radford Army Ammunition Plant's Incinerator Spray Pond (HWMU 39)" (The Plan) on 24 August 1995. The Plan includes Table 3-2 "Hazardous Constituents of Concern" that list parameters, analytical methods, and PQL's for ground water and soils to be used for clean closure of the site. On behalf of RAAP, ERM is requesting to use Method 6010A instead of Method 6020 for metals analysis in the closure demonstration.

While evaluating contractors and laboratories for the closure project, RAAP discovered that only a very small number of laboratories throughout the United States, and no local laboratories, have the equipment necessary for conducting SW-846 Method 6020 analyses. The necessary equipment is an ICP-Mass Spectrometer (MS). Very few laboratories have the ICP-MS because it is expensive to purchase and costly to operate.

Most laboratories use USEPA Method 6010A which utilizes the ICP Trace. A Revised Table 3-2 is enclosed and indicates the ICP Trace PQL's for ground water and soils. Although the PQL's are higher, clean closure requires comparisons with background water and soil values. Based on USGS data, it is evident that metals concentrations occurring naturally in soils are generally above the revised PQL's. USGS data were not available for mercury and thallium and the method 6010A PQL for antimony slightly exceeded the USGS mean concentration. Therefore, the PQL's for mercury and antimony were compared to the USEPA Region III Risk Based Concentration (RBC) for exposure to residential

soils via ingestion. In both cases, the method 6010A PQL was one to two orders of magnitude below the respective RBC. An RBC was not available for thallium. Based on the above evaluation, the lower PQL's would not provide any additional information and would be expensive and time-consuming to achieve.

A column has been added to Revised Table 3-2 that indicates the mean values of metals naturally occurring in the soils in the eastern United States. These values were obtained from the USGS "Elemental Concentrations in Soils and Other Surficial Materials of the Conterminous United States." Values for metals in soils are typically in the mg/kg range versus the µg/kg range. Therefore, the precision and expense of using an ICP-MS is not necessary for clean closure at this site.

Laboratories encourage the use of Method 6010A versus other methods for several reasons. Method 6020 is a new method and, as mentioned before, very few laboratories have the necessary equipment. In addition, the sample digestion method (Method 3050) uses hydrochloric acid, which, when introduced into the graphite furnace, interferes with the furnace and can result in false readings. However, it is preferable to use the hydrochloric acid because it results in a more vigorous digestion, therefore, providing more accurate results. This digestion method is ideal for the ICP methodology (Method 6010A).

Finally, it will be necessary to use 24-hour turnaround for the metals analysis during closure activities, which will require the services of a local laboratory. Contractors will be on site awaiting laboratory results making 24-hour turnaround the preferred period for analysis during closure activities. This will reduce the time necessary for clean closure without sacrificing the quality and level of the closure activities. It is therefore requested that RAAP utilize USEPA Method 6010A for the metals analysis during closure of the incinerator spray pond. Because background samples will need to be obtained to remain on the approved schedule, RAAP would appreciate your prompt attention.

Mr. Clifton Parker
9 November 1995
Page 3

Environmental
Resources
Management, Inc.

Please send a reply and/or call Jerry Redder, Alliant TechSystems, Inc.,
540-639-7536, if you have any questions regarding this letter.

Sincerely,



C.B. Huggins V, P.G., P.Hg.
Branch Manager and Associate

CBH:mm

Enclosure: Revised Table 3-2

cc: C. Ackerman, ERM, Inc.
J. Redder, Alliant TechSystems, Inc.

Revised Table 3-2
Hazardous Constituents of Concern
Incinerator Spray Pond Closure (HWMU 39)
Radford Army Ammunition Plant

Contaminant	SW-846 Method	PQL Soil	USGS Mean (mg/Kg)
2,4-Dinitrotoluene	8090	13 µg/Kg	
2,6-Dinitrotoluene	8090	7 µg/Kg	
Di-n-butylphthalate	8270	220 µg/Kg	
Diethylphthalate	8270	170 µg/Kg	
Resorcinal	8270		
Antimony	6010A	1.0 mg/Kg	0.52/31.0*
Arsenic	6010A	1.0 mg/Kg	4.8
Barium	6010A	0.2 mg/Kg	290
Beryllium	6010A	0.2 mg/Kg	0.55
Cadmium	6010A	0.1 mg/Kg	4.0
Chromium	6010A	1.0 mg/Kg	33
Lead	6010A	1.0 mg/Kg	14
Mercury	7470 /7471	0.1 mg/Kg	NA/23.0*
Nickel	6010A	1.0 mg/Kg	11
Silver	6010A	0.5 mg/Kg	3.0
Thallium	7841	0.2 mg/Kg	NA

NA: Not available

* USEPA Region III Residential Risk Based Concentration

**COMMONWEALTH of VIRGINIA****DEPARTMENT OF ENVIRONMENTAL QUALITY**

Office of Permitting Management

Peter W. Schmidt
Director

August 24, 1995

P O Box 10009
Richmond, Virginia 23240-0009
(804) 782-4000

Mr. Joe D. Wilson, Chief Engineer
Department of the Army
Radford Army Ammunition Plant
Caller Service 2
Radford, Virginia 24141-0298

**SUBJECT: Incinerator Spray Pond (HWMU-39) Closure Plan
Radford Army Ammunition Plant, Radford, Virginia
EPA ID# VA12100207306**

Dear Mr. Wilson:

Radford Army Ammunition Plant submitted Closure, Contingent Closure, and Contingent Post Closure Plans for the Incinerator Spray Pond on July 14, 1993. DEQ staff comments were provided to Radford via a revised closure plan sent on February 10, 1995. Radford responded to the draft closure plan with comments in a letter dated June 8, 1995. Based on the Department's response to Radford on June 22, 1995, Radford resubmitted the closure plan on July 18, 1995, and again on August 22, 1995. Public notice was advertised in the "The News" on May 22, 1995, and the comment period ended on June 22, 1995. No comments were received. The groundwater monitoring plan for this site was conditionally approved by Department letter dated August 17, 1995, upon Radford making appropriate changes and submitting them to VDEQ by September 8, 1995.

The latest revised copy of the closure plan was received by the Department on August 21, 1995, and is hereby approved.

As provided by Rule 2A:2 of the Supreme Court of Virginia, you have 30 days from the date of the service of this decision to initiate an appeal of this decision, by filing a notice of appeal with:

Peter W. Schmidt, Director
Virginia Department of Environmental Quality
ATTN: Waste Division
P. O. Box 10009
Richmond, Virginia 23240-0009

In the event that this decision is served to you by mail, three days are added to that period. Please refer to Part Two A of the rules of the Supreme Court of Virginia, which describes the required content of the Notice of Appeal, including specification of the Circuit Court to which the appeal is taken, and additional requirements governing appeals from decisions of administrative agencies.

Mr. Joe D. Wilson, Chief Engineer
Page 2

If you have any questions about the approval, please contact Clifton Parker^N at (804) 762-4142.

Sincerely,



Hassan Vakili
Director, Waste Operations

cc: Jerome J. Redder, P.E., Alliant Tech Systems (w/enclosure)
Mary Beck, EPA Region III
Glenn von Gonten, VDEQ
Lisa Ellis, VDEQ
Claire Slaughter, VDEQ
Debbie Miller, VDEQ
Clifton Parker, VDEQ (w/enclosure)
West Central Regional Office - Roanoke (w/enclosure)
Central File (w/enclosure)

DEPARTMENT OF THE ARMY
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA 24141

July 12, 1993

Engineering Division

Mr. Henry R. Pollard, V
Enforcement Specialist
Department of Environmental Quality
James Monroe Building, Eleventh Floor
101 North Fourteenth Street
Richmond, Virginia 23219

Dear Mr. Pollard:

Reference is made to the enforcement order concerning the incinerator spray pond at the Radford Army Ammunition Plant.

In accordance with the Schedule of Compliance in Appendix A of the Order, enclosed for your review and approval is the Groundwater Monitoring Program Plan for the incinerator spray pond and the Closure Plan for the incinerator spray pond.

If additional information is needed, please contact Mr. Robert L. Richardson at (703) 639-8641.

Sincerely,

JOE D. WILSON
Chief Engineer

Joe D. Wilson
Chief Engineer

Enclosures

Copy Furnished:

Mr. James Small, HQ, AMCCOM, AMSMC-EQE, Rock Island, IL
(w/enclosures)
Mr. Bill Hendon, Hercules Inc., Radford, VA (wo/enclosures)
Mr. Dave Lieving, Hercules Inc., Radford, VA (wo/enclosures)

Table 1(a)

Closure Schedule - Groundwater Monitoring Plan

<u>Activity</u>	<u>Days</u>
Groundwater Monitoring Plan approved	
Design monitoring wells / secure drilling contractor	60
Well Siting and Preliminary Field Work	70
Commence Well Drilling/Soil Sampling	80
Well Installation/Soil Sample Analysis	90
Well Development	95
Initial Quarter Groundwater Sampling*	100
Hydrologic Study - Pump Testing	100
Pump Testing/Soil Sample Analysis	150
Geologic Report	180

*-This individual sampling program will be incorporated into the Radford AAP Groundwater Monitoring Program.



Hercules Aerospace Ordnance Group
Radford Army Ammunition Plant
P.O. Box 1
Radford, VA 24141-0100

July 7, 1993

Reference: 93-815-214

bc: Administrative File
D. W. Ratcliff
J. A. Morris
C. A. Jake
T. S. Lyon
D. E. Lieving
W. C. Hendon

Administrative Contracting Officer
Radford Army Ammunition Plant
Radford, Virginia 24141

Attn: SMCRA-EN

Dear Sir:

Schedules for Spray Pond Closure Plan
and Groundwater Monitoring Plan

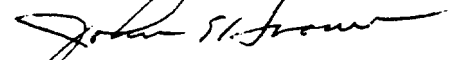
Reference: Hercules letter 93-815-154 dated May 14, 1993

Please find attached a complete copy of the closure plan for the incinerator spray pond and a schedule for the groundwater monitoring plan. The schedule for the closure plan was revised as stated in the referenced letter to allow for the time required to obtain funding. It requests the Department of Environmental Quality (DEQ) to start the 180-day closure period when funding is received rather than when the DEQ approves the closure plan. Also, typographical errors in the original plan have been corrected.

As verbally requested, a schedule is provided for the groundwater monitoring plan. It can be added to the plan already submitted.

Please transmit the closure and groundwater monitoring plans to the Department of Environmental Quality for approval.

Very truly yours,


H. M. HARVEY, MANAGER
FACILITIES ENGINEERING

/DELieving

Coordination:


R. P. Best

Attachment
W:\815-214

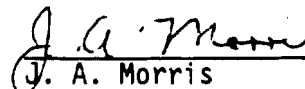

J. A. Morris

Table 1(a)

Closure Schedule - Groundwater Monitoring Plan

<u>Activity</u>	<u>Days</u>
Groundwater Monitoring Plan approved	
Design monitoring wells / secure drilling contractor	60
Well Siting and Preliminary Field Work	70
Commence Well Drilling/Soil Sampling	80
Well Installation/Soil Sample Analysis	90
Well Development	95
Initial Quarter Groundwater Sampling*	100
Hydrologic Study - Pump Testing	100
Pump Testing/Soil Sample Analysis	150
Geologic Report	180

*-This individual sampling program will be incorporated into the Radford AAP Groundwater Monitoring Program.

CLOSURE PLAN
FOR THE INCINERATOR SPRAY POND
RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA
EPA ID# VA1210020730

July, 1993

I-1

SPRAY POND CLOSURE PLAN

The spray pond was operated from 1979 until May 1992 for evaporative cooling of water from the incinerator scrubber. After cooling, water was recirculated from the spray pond to the scrubber. In August 1990 it was discovered that water in the spray pond was contaminated with lead from the incineration process to the extent that sludges formed in the spray pond met the standards for a characteristic hazardous waste under Part III of the Virginia Hazardous Waste Management Regulations (VHWMR). The spray pond is not permitted as a hazardous waste surface impoundment and, therefore, will be closed according to the requirements in VHWMR 9.6, 10.6 and 10.10.1.

I-1a

Closure Performance Standard

The surface impoundment will be closed in a manner that minimizes the need for further maintenance. All wastes, waste residues, contaminated structures and equipment, and contaminated subsoils will be decontaminated or removed at closure. Clean closure will be demonstrated by sampling the subsoil to show that constituent concentrations are no higher than background levels.

I-1b

Partial and Final Closure Activities

The activities involved in closure of the surface impoundment include:

- (1) Allowing water level to drop to the minimum pump intake level during operation of the incinerator;
- (2) Removal and proper disposal of any water and sludge remaining in the impoundment;
- (3) Demolition, removal, and decontamination of piping, pumps, and concrete;
- (4) Subsoil sampling to identify any contaminated soil requiring removal;
- (5) Filling, compacting and shaping soil to promote drainage; and
- (6) Revegetating the soil.

I-1c

Maximum Waste Inventory

The spray pond is a concrete-lined pit 76 feet by 60 feet by 5 feet deep. The maximum water level is three feet for a maximum volume of 102,326 gallons. The pond is a surface impoundment that is used for evaporative cooling of recirculated scrubber water. The scrubber is installed at the exhaust from the explosive waste incinerator. The incinerator sometimes burns waste propellant that contains lead compounds. The lead content of the water and sludge in the spray pond has at times been above 5 ppm, resulting in classification of the spray pond as a hazardous waste surface impoundment. The spray pond contains varying amounts of lead at any given time, depending on the quantity of lead-containing propellant burned. Traces of other heavy metals have also been detected in the spray pond water, although not at high enough concentrations to be a toxic hazardous waste.

I-1d

Inventory Removal, Disposal and Decontamination of Equipment

All hazardous waste inventory and contaminated materials will be removed during closure. Water in the spray pond will be pumped down during changeover to the new scrubber water system. The level will be allowed to drop to the minimum pump intake level (approximately six inches off the bottom of the spray pond). The remaining water and sludge will be pumped to a tank truck for disposal in accordance with applicable regulations. The concrete liner will be rinsed with a high pressure water hose to ensure that all sediment and/or sludge is removed during emptying of the impoundment. Piping, valves and pumps will be dismantled and placed in a washdown station constructed in accordance with the specifications in Attachment I of this closure plan. Decontaminated piping will be disposed of as scrap metal. If in good condition, decontaminated pumps and valves will be placed in storage for possible future use. The concrete liner will be demolished and hauled to the debris landfill at RAAP. If subsoils are determined to be nonhazardous, equipment (excavation equipment, sampling equipment, etc.) will be cleaned with a water hose with rinse water draining to the sewer system that goes to the Biological Wastewater Treatment Plant with approval from the Department of Environmental Quality (DEQ). If subsoils are determined to be hazardous, all contaminated equipment will be decontaminated at the washdown station. Decontamination will be performed by using a steam cleaner with a soap feed and a HCl rinse followed with a water rinse.

Decontamination of equipment will be determined by sampling the rinse water before and after rinsing the equipment. Four pre-rinse and four post-rinse samples will be obtained and tested for the

parameters listed in Section I-1d(1) using the test methods and detection limits specified to determine if cleaning was adequate. Decontamination is achieved when the post-rinse samples are not statistically significant when compared to pre-rinse samples using the procedure outlined in Section I-1d(1). Wash and rinse waters will be collected in the decontamination containment unit and transferred to drums for storage until test results are received. If the water tests to be hazardous, it will be accumulated in accordance with VHWMR 6.4.E., transported via a Virginia permitted hazardous waste transporter and disposed of off-plant at an approved hazardous waste facility. If it is nonhazardous, it will be disposed of in the Biological Wastewater Treatment Plant with approval from the DEQ. For large equipment, four samples will be taken of post-rinse water from that portion of the equipment that was exposed to the contaminated materials such as the bucket of the backhoe or loader used to move material out of the contaminated area.

I-1d(1)

Closure of Surface Impoundments

Clean closure of the surface impoundment will be demonstrated by sampling of the soil after removal of the waste, contaminated structures and contaminated equipment. Since the joints in the concrete liner (Figure 1A) are the most likely sources of contamination, sampling locations will be selected based on the joint locations. A grid pattern will be established across the impoundment bottom (Figure 1B). It will consist of 19 foot by 20 foot sections. This pattern will place the boundaries of each section and each boundary intersection at the former location of a joint in the concrete liner. Each grid intersection will be numbered and a random number table will be used to select eight of these locations for sampling. Selection of constituents for analysis was based on those detected in previous analyses of water from the spray pond. The laboratory analysis will use the method with the lowest detection level and will be as follows:

<u>Constituent</u>	<u>SW-846 Test Method</u>	<u>Detection Limit</u>
Antimony	7041	3.0 ug/l
Barium	6010	2.0 ug/l
Beryllium	7091	2.0 ug/l
Cadmium	7131	0.1 ug/l
Chromium	7191	1.0 ug/l
Copper	7211	1.0 ug/l
Lead	7421	1.0 ug/l
Nickel	6010	15 ug/l
Silver	6010	7.0 ug/l
Thallium	7841	1.0 ug/l
Zinc	7951	0.05 ug/l

The randomly selected locations will be sampled every six inches in depth. The samples will be discrete samples. Results of analysis from the first six inches will be compared to the established background concentration for each constituent, using the procedure described in Attachment II. If contamination is found, another six inches of soil will be removed and samples will again be taken. This procedure will be repeated until all contamination has been removed to background levels. Contaminated soils will be disposed at an approved TSD facility. Any storage of the soil will be subject to the accumulation requirements of Section 6.4.E. of the VHWMR. Transportation will be via a Virginia permitted hazardous waste transporter.

Background sample will be taken at the two locations shown in Figure 2. Location No. 1 is approximately 500 ft northwest of the spray pond and location No. 2 is approximately 400 ft southwest of the spray pond. These locations are upwind of the incinerators and should not be affected by their emissions, nor are they near any other operating areas. Sampling intervals will be at the surface, six, 12 and 18 inches for a total of eight samples. The samples will be analyzed for the constituents noted above. QA/QC procedures will follow SW-846, 3rd edition, 1986, Chapter 1 procedures and any additional procedures required by the specific method. All background sample results, along with the QA/QC, will be submitted to the DEQ for approval in accordance with the closure schedule.

I-1e

Schedule for Closure

The closure schedule is presented in Table 1. It is requested that the 180-day period for closure start with receipt of funding from the Army rather than with closure plan approval. The time required for the funding approval process could take up to 90 days after DEQ approval of the closure plan. Based on this schedule, closure activities will be completed within 180 days after receipt of funding. Any extensions to the closure period will be requested in accordance with VHWMR 9.6.D.2.

I-1f

Certification of Closure

RAAP will submit by registered mail, in accordance with the closure schedule, a certification by the Army or Hercules and by a Virginia registered professional engineer that the unit has been closed in accordance with the approved closure plan. All documentation supporting such certification, including all laboratory analyses and QA/QC data and all statistical calculations, will also be provided.

I-1g

Contingent Closure and Post-Closure Plans

If "clean" closure cannot be achieved, RAAP will immediately notify the Department to that effect in writing. Within 30 days of the notification, RAAP shall submit to the DEQ for approval a modified closure plan to address closure of the unit as a landfill under VHWMR 10.13. The corresponding post-closure plan will be submitted within 90 days of the notification. Additionally, a modified post-closure permit application will be submitted within 180 days following this determination to address the post-closure care requirements of VHWMR 10.6.H.

I-2

Closure Cost Estimate

Federally owned facilities are exempt from the financial requirements of 10.7 as stated in 10.7.A.3.

I-3

Financial Assurance Mechanism for Closure

Federally owned facilities are exempt from the financial requirements of 10.7 as stated in 10.7.A.3.

Table 1

Closure Schedule

<u>Activity</u>	<u>Days</u>
Closure plan approved	
Interim activities to obtain Army funding	Up to 90 days
-Cost estimate	
-Scope of work	
-Legal review	
Receive funding from Army	0
Take background soil samples	10
Submit background soil sample results to DEQ	30
Remove and decontaminate piping, pumps, concrete, etc.	60
Take soil samples	70
Receipt of laboratory analyses	90
Statistical evaluation	
Remove contaminated soil/resample*	100
Receipt of laboratory analyses*	120
Statistical evaluation	
Equipment decontamination	130
Receipt of laboratory analysis of pre- and post-rinses and statistical evaluation	150
Inspection and remedial action	160
Certification of closure	180

* These steps will be repeated until clean closure is achieved, or until it is determined that clean closure cannot be achieved and the unit will close as a landfill.

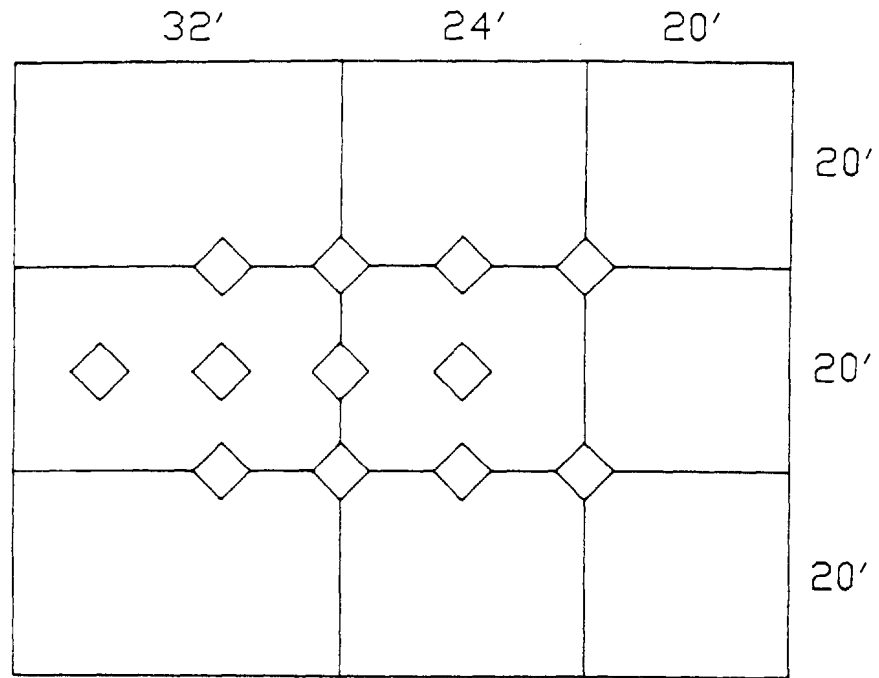


FIGURE 1A. LOCATION OF JOINTS IN CONCRETE LINER

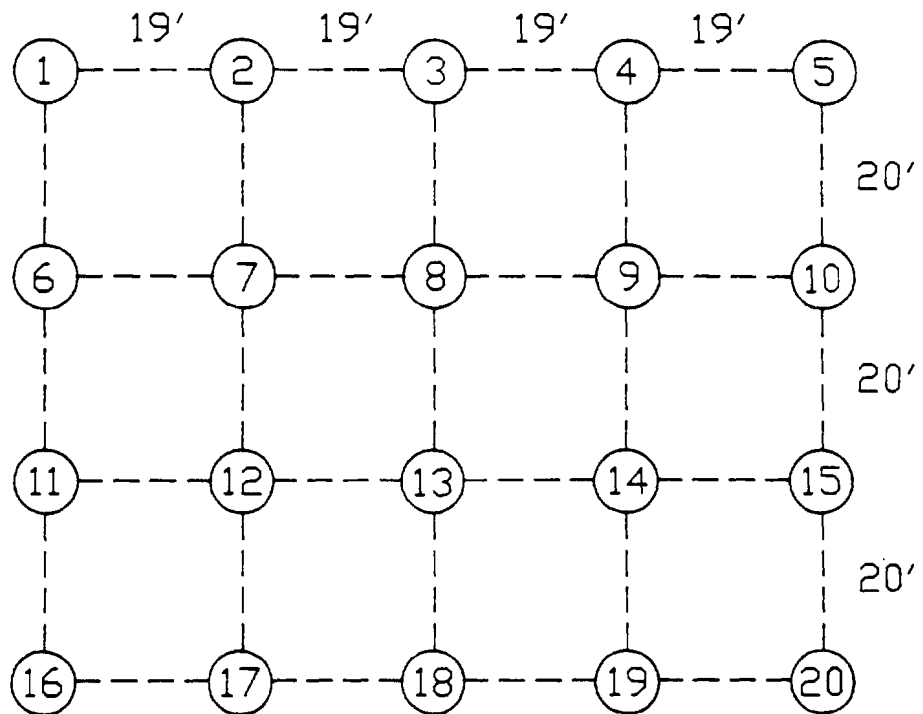


FIGURE 1B. LOCATION OF POSSIBLE SAMPLING POINTS

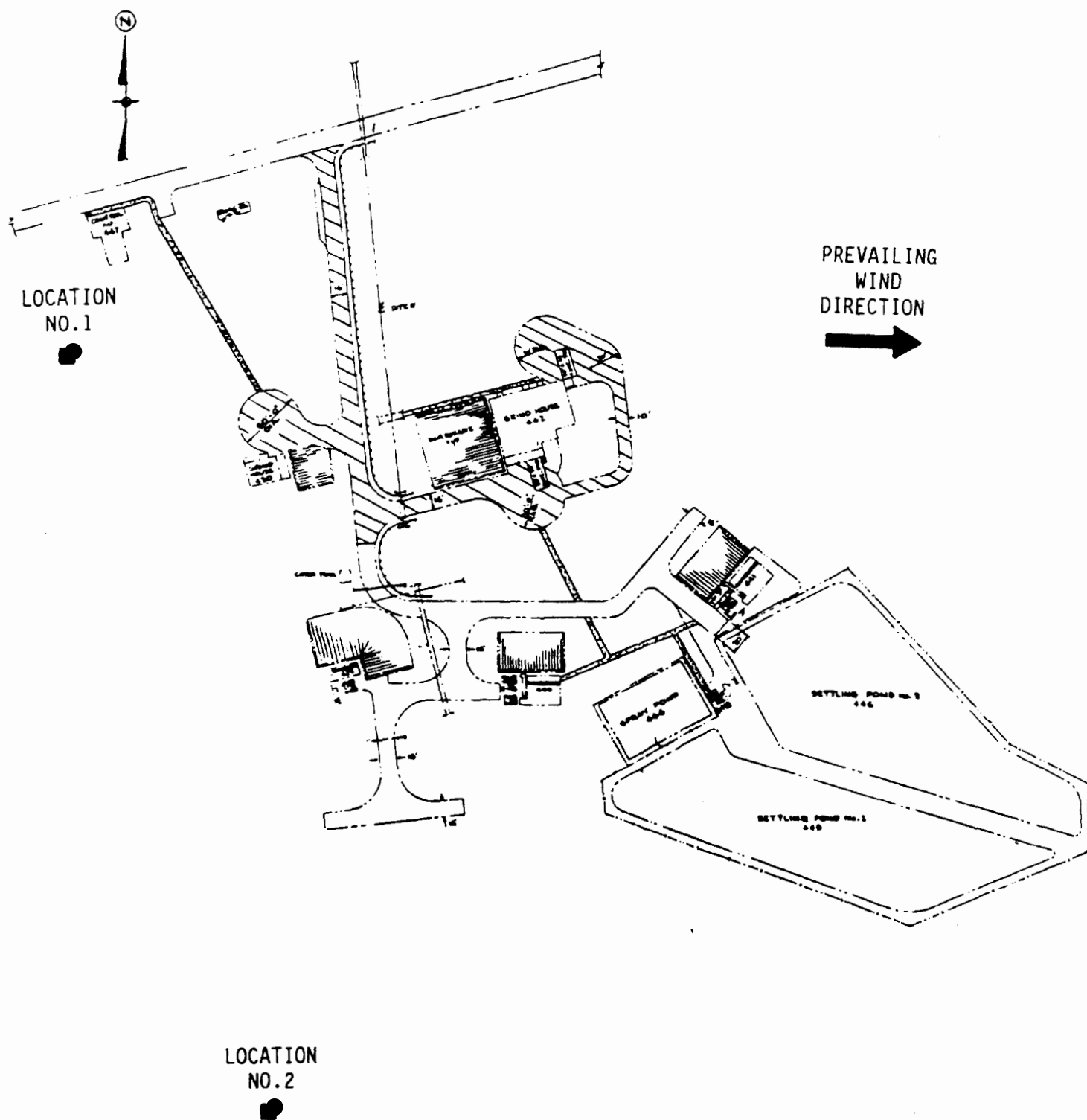


FIGURE 2. BACKGROUND SAMPLING LOCATIONS

ATTACHMENT I

WASHDOWN STATION AND EQUIPMENT DECONTAMINATION

1. GENERAL: Equipment used during closure of the spray pond shall be decontaminated at the washdown station before leaving the site.
2. SUBMITTALS: The Contractor shall submit to the Contracting Officer shop drawings for the washdown stations. Shop drawings shall be approved prior to commencement of work.
3. WASHDOWN STATION LOCATION AND SERVICE PERIOD: The Contractor shall provide vehicle and equipment washdown stations for the spray pond as indicated. The washdown stations shall be available for service during the demolition, soil excavation and soil sampling tasks.
4. CONSTRUCTION OF WASHDOWN STATION: The washdown station shall consist of, at a minimum, a washwater containment unit, a wash station pad, and a 30-mil PVC membrane to line the containment unit and wash pad as indicated. The PVC liner shall be installed on compacted smooth surfaces. The station shall be equipped with a steam cleaner, portable pressure water sprayer, pump, hoses and nozzles necessary to wash equipment and to transfer the washdown water to drums prior to disposal. Washdown water is to be provided by the Contractor.
5. OPERATION:
 - 5.1 Operation During Demolition: All equipment which made direct contact with the contaminated material, except for the cargo area of the transportation vehicles, shall be cleaned prior to leaving the site. The cleaning shall consist of scraping off soils from all contaminated parts of equipment. The cargo area of the transportation vehicles shall be cleaned only once when transportation of all contaminated material is completed.
 - 5.2 Operation During Soil Excavation: All equipment which was used to excavate subsoil shall be decontaminated at the wash station prior to leaving the site. All soil shall be removed from the equipment.
 - 5.3 Operation During Soil Sampling: Drilling and sampling tools which make direct contact with the subsurface soil at the spray pond location shall be decontaminated at the wash station by scraping and washing with pressure water.
6. CONTROL OF WASHDOWN WATER AND SEDIMENT: The washdown water and sediment shall be contained within the containment unit. The washdown water accumulating in the containment unit shall be removed by pumping into drums and saved for analysis. Nonhazardous washdown water shall be disposed of in a manhole in the immediate area of the impoundment that goes to the Biological Wastewater Treatment Plant with approval from the SWCB. Washdown water determined to be hazardous shall be disposed as a hazardous waste at a permitted or interim status

TSD facility.

7. REMOVAL OF WASHDOWN STATION: The washdown station will be removed and the liner and sediment will be disposed as a hazardous waste at a permitted or interim status TSD facility.

* The washdown containment unit shall meet the VHWMR Part I definition of "tank" or "container".

ATTACHMENT II

STATISTICAL ANALYSIS PROCEDURE

For each constituent except pH the hypothesis to be tested is:

$$H_0: \mu_m \leq \mu_b$$

$$H_1: \mu_m > \mu_b$$

for pH:

$$H_0: \mu_m = \mu_b$$

$$H_1: \mu_m \neq \mu_b$$

Where:

H_0 = the null hypothesis

H_1 = the alternative hypothesis

μ_m = the mean of constituent "i" in the unit area

μ_b = the mean of constituent "i" in the background.

In words, the null hypothesis (H_0) asserts that the mean of constituent "i" in the unit area is equal to or less than the mean of constituent "i" in the background (i.e., no contamination). If the data do not support H_0 , then the alternative hypothesis (H_1) is to be accepted, which says that the mean of constituent "i" in the unit area is greater than the mean of constituent "i" in the background (i.e., there is contamination in the unit area).

The following test statistic is to be used for testing the above hypothesis:

$$t_0 = \frac{\bar{x}_m - \bar{x}_b}{s_p * (1/n_m + 1/n_b)^{1/2}} \quad \text{if } \sigma_m^2 = \sigma_b^2$$

$$t_0 = \frac{\bar{x}_m - \bar{x}_b}{(s_m^2/n_m + s_b^2/n_b)^{1/2}} \quad \text{if } \sigma_m^2 \neq \sigma_b^2$$

Where:

$\bar{x}_m$ = the mean of the sample of constituent "i" in the unit area

$\bar{x}_b$ = the mean of the sample of constituent "i" in the background

n_m = the number of samples from the unit area

n_b = the number of samples from the background

* = Multiplication sign

s_p^2 = the pooled estimate of the variance, and is given by:

$$\frac{(n_m - 1)s_m^2 + (n_b - 1)s_b^2}{n_m + n_b - 2}$$

s_m^2 = the variance of constituent "i" in the unit area

s_b^2 = the variance of constituent "i" in the background

Decision criteria:

a) For all constituents except pH:

Conclude that the unit area is still contaminated; if t_0 is greater than $t_{.05, df}$ (the value of $t_{.05, df}$ depends on the

degrees of freedom, and is to be obtained from the attached t-table). If t_0 is less than $t_{.05, df}$ conclude that the data do not

show evidence of contamination in the unit area.

If $\sigma_m^2 = \sigma_b^2$; $df = n_m + n_b - 2$, and if $\sigma_m^2 \neq \sigma_b^2$ then

$$df = \frac{(s_m^2/n_m + s_b^2/n_b)^2}{((s_m^2/n_m)^2/n_m + 1) + ((s_b^2/n_b)^2/n_b + 1)} - 2$$

b) For pH:

Conclude that pH is significantly different from the background pH; if the absolute value of t_0 is greater than $t_{.025, df}$.

Otherwise conclude that there is no significant difference between the unit area's pH and the background area's pH.

How to test the equality of the variances of the constituents in the unit area and the background area:

The test statistic for

$$H_0: \sigma_m^2 = \sigma_b^2$$

$$H_1: \sigma_m^2 \neq \sigma_b^2$$

is the ratio of the sample variances

$$F = \frac{s_1^2}{s_2^2}$$

To make the F-test at 5% level, put the larger of s_m^2 , s_b^2 in the numerator of F and read the 2.5% level of F from the percentage points of the F-distribution (F-distribution table is attached). If the calculated F is greater than the F obtained from the table, the variances are not equal.

PERCENTAGE POINTS, F-DISTRIBUTION

$$F(F) = \int_0^F \frac{\Gamma\left(\frac{m+n}{2}\right) \frac{m}{2} x^{\frac{m}{2}-1} (n+mx)^{-\frac{m+n}{2}} dx = .975$$

m \ n	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	647.8	799.5	864.2	899.6	921.8	937.1	948.2	956.7	963.3	968.6	976.7	984.9	993.1	997.2	1000	1006	1010	1014	1018
2	38.51	39.00	39.17	39.25	39.30	39.33	39.36	39.37	39.39	39.40	39.41	39.43	39.45	39.46	39.47	39.48	39.49	39.50	39.50
3	17.44	16.04	15.44	15.10	14.88	14.72	14.62	14.54	14.47	14.42	14.34	14.25	14.17	14.12	14.08	14.04	13.99	13.95	13.90
4	12.22	10.63	9.98	9.60	9.36	9.20	9.07	8.98	8.90	8.84	8.75	8.66	8.56	8.51	8.46	8.41	8.36	8.31	8.26
5	10.01	8.43	7.76	7.39	7.15	6.98	6.85	6.76	6.68	6.62	6.52	6.43	6.33	6.28	6.23	6.18	6.12	6.07	6.02
6	8.81	7.26	6.60	6.23	5.99	5.82	5.70	5.60	5.52	5.46	5.37	5.27	5.17	5.12	5.07	5.01	4.96	4.90	4.85
7	8.07	6.54	5.89	5.52	5.29	5.12	4.99	4.90	4.82	4.76	4.67	4.57	4.47	4.42	4.36	4.31	4.25	4.20	4.14
8	7.57	6.06	5.42	5.05	4.82	4.65	4.53	4.43	4.36	4.30	4.20	4.10	4.00	3.95	3.89	3.84	3.78	3.73	3.67
9	7.21	5.71	5.08	4.72	4.48	4.32	4.20	4.10	4.03	3.96	3.87	3.77	3.67	3.61	3.56	3.51	3.45	3.39	3.33
10	6.94	5.46	4.83	4.47	4.24	4.07	3.95	3.85	3.78	3.72	3.62	3.52	3.42	3.37	3.31	3.26	3.20	3.14	3.08
11	6.72	5.26	4.63	4.28	4.04	3.88	3.76	3.66	3.59	3.53	3.43	3.33	3.23	3.17	3.12	3.06	3.00	2.94	2.88
12	6.55	5.10	4.47	4.12	3.89	3.73	3.61	3.51	3.44	3.37	3.28	3.18	3.07	3.02	2.96	2.91	2.85	2.79	2.72
13	6.41	4.97	4.35	4.00	3.77	3.60	3.48	3.38	3.31	3.25	3.15	3.05	2.95	2.89	2.84	2.78	2.72	2.66	2.60
14	6.30	4.86	4.24	3.89	3.66	3.50	3.38	3.28	3.21	3.15	3.05	2.95	2.85	2.79	2.73	2.67	2.61	2.55	2.49
15	6.20	4.77	4.15	3.80	3.58	3.41	3.29	3.20	3.12	3.06	2.96	2.86	2.76	2.70	2.64	2.59	2.52	2.46	2.40
16	6.12	4.69	4.08	3.73	3.50	3.34	3.22	3.12	3.05	2.99	2.89	2.79	2.68	2.63	2.57	2.51	2.45	2.38	2.32
17	6.04	4.62	4.01	3.66	3.44	3.28	3.16	3.06	2.98	2.92	2.82	2.72	2.62	2.56	2.50	2.44	2.38	2.32	2.25
18	5.98	4.56	3.95	3.61	3.38	3.22	3.10	3.01	2.93	2.87	2.77	2.67	2.57	2.51	2.44	2.38	2.32	2.26	2.19
19	5.92	4.51	3.90	3.56	3.33	3.17	3.05	2.96	2.88	2.82	2.72	2.62	2.51	2.45	2.39	2.33	2.27	2.20	2.13
20	5.87	4.46	3.86	3.51	3.29	3.13	3.01	2.91	2.84	2.77	2.68	2.57	2.46	2.41	2.35	2.29	2.22	2.16	2.09
21	5.83	4.42	3.82	3.48	3.25	3.09	2.97	2.87	2.80	2.73	2.64	2.53	2.42	2.37	2.31	2.25	2.19	2.11	2.04
22	5.79	4.38	3.78	3.44	3.22	3.05	2.93	2.84	2.76	2.70	2.60	2.50	2.39	2.33	2.27	2.21	2.14	2.08	2.00
23	5.75	4.35	3.75	3.41	3.18	3.02	2.90	2.81	2.73	2.67	2.57	2.47	2.36	2.30	2.24	2.18	2.11	2.04	1.97
24	5.72	4.32	3.72	3.38	3.15	2.99	2.87	2.78	2.70	2.64	2.54	2.44	2.33	2.27	2.21	2.15	2.08	2.01	1.94
25	5.69	4.29	3.69	3.35	3.13	2.97	2.85	2.75	2.68	2.61	2.51	2.41	2.30	2.24	2.18	2.12	2.05	1.98	1.91
26	5.66	4.27	3.67	3.33	3.10	2.94	2.82	2.73	2.65	2.59	2.49	2.39	2.28	2.22	2.16	2.09	2.03	1.95	1.88
27	5.63	4.24	3.65	3.31	3.08	2.92	2.80	2.71	2.63	2.57	2.47	2.36	2.25	2.19	2.13	2.07	2.00	1.93	1.85
28	5.61	4.22	3.63	3.29	3.06	2.90	2.78	2.69	2.61	2.55	2.45	2.34	2.23	2.17	2.11	2.05	1.98	1.91	1.83
29	5.59	4.20	3.61	3.27	3.04	2.88	2.76	2.67	2.59	2.53	2.43	2.32	2.21	2.15	2.08	2.03	1.96	1.89	1.81
30	5.57	4.18	3.59	3.25	3.03	2.87	2.75	2.65	2.57	2.51	2.41	2.31	2.20	2.14	2.07	2.01	1.94	1.87	1.79
40	5.42	4.05	3.46	3.13	2.90	2.74	2.62	2.53	2.45	2.39	2.29	2.18	2.07	2.01	1.94	1.88	1.80	1.72	1.64
60	5.29	3.93	3.34	3.01	2.78	2.63	2.51	2.41	2.33	2.27	2.17	2.06	1.94	1.88	1.82	1.74	1.67	1.58	1.48
120	5.15	3.80	3.21	2.89	2.67	2.52	2.39	2.30	2.22	2.16	2.05	1.94	1.82	1.76	1.69	1.61	1.53	1.43	1.31
∞	5.02	3.69	3.12	2.79	2.57	2.41	2.29	2.19	2.11	2.05	1.94	1.83	1.71	1.64	1.57	1.48	1.39	1.27	1.00

$F = \frac{s_1^2}{s_2^2} = \frac{S_1/m}{S_2/n}$, where $s_1^2 = S_1/m$ and $s_2^2 = S_2/n$ are independent mean squares estimating a common variance σ^2 and based on m and n degrees of freedom, respectively.

STUDENT'S *t*-DISTRIBUTION

$\frac{P}{D.F.}$	.25	.10	$\oplus$.05	$**$.025	.01	.005	.0025	.001
1	1.000	2.078	6.314	12.708	31.821	63.657	127.321	318.309
2	.818	1.886	2.920	4.203	6.965	9.926	14.089	22.327
3	.766	1.638	2.353	3.182	4.841	6.841	7.463	10.214
4	.741	1.633	2.142	2.776	3.747	4.604	5.898	7.173
5	.727	1.476	2.015	2.571	3.365	4.032	4.773	5.893
6	.718	1.440	1.943	2.447	3.143	3.707	4.317	5.208
7	.711	1.415	1.893	2.366	2.998	3.499	4.029	4.783
8	.706	1.397	1.860	2.306	2.896	3.383	3.833	4.601
9	.703	1.383	1.833	2.262	2.821	3.250	3.690	4.297
10	.700	1.372	1.812	2.228	2.764	3.189	3.581	4.144
11	.697	1.363	1.796	2.201	2.718	3.106	3.497	4.023
12	.695	1.356	1.782	2.179	2.681	3.053	3.428	3.930
13	.694	1.350	1.771	2.160	2.650	3.012	3.372	3.852
14	.692	1.345	1.761	2.145	2.624	2.977	3.326	3.787
15	.691	1.341	1.753	2.131	2.602	2.947	3.286	3.733
16	.690	1.337	1.746	2.120	2.583	2.921	3.252	3.686
17	.689	1.333	1.740	2.110	2.567	2.896	3.223	3.646
18	.688	1.330	1.734	2.101	2.552	2.878	3.197	3.610
19	.688	1.328	1.729	2.093	2.539	2.861	3.174	3.579
20	.687	1.325	1.725	2.086	2.528	2.845	3.153	3.553
21	.686	1.323	1.721	2.080	2.518	2.831	3.135	3.527
22	.686	1.321	1.717	2.074	2.508	2.819	3.119	3.503
23	.685	1.319	1.714	2.069	2.500	2.807	3.104	3.483
24	.685	1.318	1.711	2.064	2.492	2.797	3.090	3.467
25	.684	1.316	1.708	2.060	2.485	2.787	3.078	3.450
26	.684	1.315	1.706	2.056	2.479	2.779	3.067	3.435
27	.684	1.314	1.703	2.052	2.473	2.771	3.057	3.421
28	.683	1.312	1.701	2.048	2.467	2.763	3.047	3.408
29	.683	1.311	1.699	2.045	2.462	2.756	3.038	3.396
30	.683	1.310	1.697	2.042	2.457	2.750	3.030	3.383
35	.682	1.306	1.690	2.030	2.438	2.724	2.996	3.340
40	.681	1.303	1.684	2.021	2.423	2.704	2.971	3.307
45	.680	1.301	1.679	2.014	2.413	2.690	2.962	3.281
50	.679	1.299	1.676	2.009	2.403	2.678	2.937	3.261
55	.679	1.297	1.673	2.004	2.396	2.668	2.925	3.245
60	.678	1.296	1.671	2.000	2.390	2.660	2.915	3.232
70	.678	1.294	1.667	1.994	2.381	2.648	2.899	3.211
80	.678	1.292	1.664	1.990	2.374	2.639	2.887	3.193
90	.677	1.291	1.662	1.987	2.368	2.632	2.878	3.180
100	.677	1.290	1.660	1.984	2.364	2.626	2.871	3.174
200	.676	1.286	1.652	1.972	2.345	2.601	2.838	3.131
300	.676	1.283	1.648	1.965	2.334	2.586	2.830	3.107
1,000	.675	1.282	1.646	1.962	2.330	2.581	2.813	3.098
2,000	.675	1.282	1.645	1.961	2.328	2.578	2.810	3.094
10,000	.675	1.282	1.645	1.960	2.327	2.576	2.808	3.091
∞	.674	1.282	1.645	1.960	2.326	2.576	2.807	3.090

$\oplus$ Use this column for all constituents except PH.

$**$ Use this column for PH.



COMMONWEALTH of VIRGINIA

RICHARD N. BURTON
DIRECTOR

DEPARTMENT OF ENVIRONMENTAL QUALITY

(804) 225-2667
TDD (804) 371-8737

JUN 28 1993

CERTIFIED MAIL---
RETURN RECEIPT REQUESTED

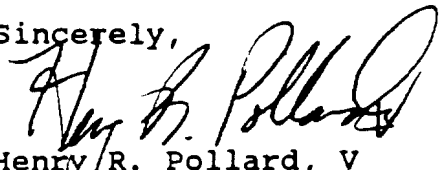
Mr. Joe D. Wilson
Chief Engineer
Engineering Division
U.S. Department of the Army
Radford Army Ammunition Plant
Caller Service 2
Radford, Virginia 24141-0298

Dear Mr. Wilson:

Enclosed please find duplicate originals of the fully executed enforcement order concerning the incinerator spray pond at Radford Army Ammunition Plant. One duplicate is for the Department of the Army, and one is for Hercules, Inc.

Thank you for your cooperation in this matter. If you have any questions, please let me know at (804) 786-8299.

Sincerely,


Henry R. Pollard, V
Enforcement Specialist
Office of Compliance and
Enforcement
Waste Division

Enclosure

cc: Julia King-Collins (w/ enclosure)



COMMONWEALTH of VIRGINIA
DEPARTMENT OF ENVIRONMENTAL QUALITY

VIRGINIA WASTE MANAGEMENT BOARD

ENFORCEMENT ORDER

RE: Radford Army Ammunition Plant
Incinerator Spray Pond

EPA ID No. VA1210020730

SECTION A: PREAMBLE AND AUTHORITY

This is an Enforcement Order issued by the Virginia Waste Management Board ("the Board") to the United States Department of the Army ("the Army") and Hercules Incorporated ("Hercules"), located in Radford, Virginia. This Enforcement Order is issued by the Board, through the Director ("Director") of the Department of Environmental Quality ("the Department"), pursuant to the authority granted to the Board and the Director under §§ 10.1-1402, -1405, -1455, -1183, -1184, and -1185 of the 1950 Code of Virginia, as amended ("Va. Code").

Pursuant to 42 U.S.C. § 6926, the U.S. Environmental Protection Agency ("EPA") has granted the Commonwealth of Virginia interim and final authorization to administer and enforce its hazardous waste program (Phase I and Phase II Components A and B) in lieu of the federal hazardous waste program as published in the Federal Register on November 3, 1981, August 17, 1983, and December 4, 1984.

SECTION B: FINDINGS

1. The Army is the owner of the Radford Army Ammunition Plant ("Radford"), located in Radford, Virginia and operated by Hercules. A Notification of Hazardous Waste Activity was filed for Radford with the EPA on August 14, 1980, declaring Radford to be engaged in the generation, treatment, storage, and disposal of hazardous waste under Title 40, Code of Federal Regulations, Part 261.

2. Since 1979, Radford operated a spray pond for the collection of incinerator scrubber waste waters. The water was then reused as scrubber water for the incinerator.

3. In August 1990, the Army and Hercules discovered that the scrubber waters collected in the spray pond had been contaminated with lead from the incineration process to the level that sludges formed in the spray pond met the standards for a characteristic hazardous waste under Part III of the Virginia Hazardous Waste Management Regulations ("VHWMR").

4. The Army and Hercules notified the then existing Department of Waste Management ("VDWM") of the contamination by letters of August 2 and 9, 1990. Subsequent discussions between the Army, Hercules, and VDWM resulted in the installation of a liner and the imposition of operational controls for the spray pond to prevent the introduction of further contamination and the agitation of the scrubber water in the spray pond to prevent hazardous waste sludges from forming.

5. By letter dated March 3, 1992, the Army and Hercules informed the Director of VDWM and the Director of the then existing State Water Control Board that sludges contaminated with lead meeting the levels of toxicity required for classification as a characteristic hazardous waste under Part III of the VHWMR were accumulating in the spray pond.

6. Neither the Army nor Hercules has applied for or been granted interim status or a permit for the operation of the incinerator spray pond as a hazardous waste surface impoundment. Therefore, the Army owns and Hercules operates an hazardous waste surface impoundment without interim status or a permit to do so, in violation of applicable provisions of Parts IX, X, and XI of the VHWMR.

7. On April 1, 1993, pursuant to Chapter 11.1, Article 1, of the Va. Code Ann. (1950), the Department of Environmental Quality and its Director assumed the authority and obligations of the Department of Waste Management and its Director, respectively.

SECTION C: ORDER

As a result of an informal conference on September 14, 1992, between agents of the parties, the parties enter into this Order after due consideration. It is the intent of the Department that laws and regulations of this Commonwealth be most expeditiously served and that the environment and public health be protected by entering into this Order. It is the intent of the Army and Hercules to demonstrate its desire to fully comply with the laws and regulations and to avoid litigation between the parties.

Therefore, in order to ensure that the Army and Hercules takes appropriate and timely action to meet its obligations, the Board, through the Director, hereby ORDERS and the Army and Hercules agree to comply with the Schedule of Compliance in Appendix A of this Order, which is incorporated herein by reference.

SECTION D: ADMINISTRATIVE PROVISIONS

1. For the purpose of this proceeding, the Army and Hercules do not contest the jurisdictional and factual allegations contained herein.
2. For the purpose of this proceeding, the Army and Hercules waive the right to request further hearing on any issue of fact or law herein and consent to the terms and issuance of this Order.
3. The Army and Hercules declare that fair and due process under the Administrative Process Act, Title 9, Chapter 1.1:1, § 9- 6.14 has been received.
4. This Order shall remain in effect as follows:
 - a. Any obligation imposed under Paragraph 1 of Appendix A will terminate on the date that the Army and Hercules comply with all stated requirements.
 - b. This Order shall remain in effect until terminated in writing by the Director of the Department of Environmental Quality or his designee. The Army or Hercules may petition the Director to terminate this Order after five (5) years from the effective date of the Order.
 - c. Termination of this Order, or of any obligation imposed in this Order, shall not operate to relieve the Army or Hercules from its obligation to comply with any statute, regulation, permit condition, other order, certification, standard, or requirement otherwise applicable.
5. The Army and Hercules shall not be responsible for failure to comply with any of the terms and conditions of this Order if such noncompliance is caused by earthquake, flood, or other act of God, fire, war, strike, or other occurrences resulting in impossibility of compliance and if the Army and Hercules shows that such occurrences and noncompliance were beyond their control and were not due to a lack of good faith or diligence on the part of the Army or Hercules. When circumstances are anticipated to occur, or are occurring, or have occurred which may delay compliance with or cause violation of any requirement of this

Order, the Army or Hercules shall notify the Director of the Department, in writing, of the reason(s) for and projected duration of such delay or violation, the measures taken and to be taken by the Army or Hercules to prevent or minimize such delay or violation, and the timetable by which such measures will be implemented. Failure to so notify the Director shall constitute a waiver of any claim of inability to comply with a requirement of this Order.

6. If any provision of this Order is found to be unenforceable for any reason, the remainder of the Order shall remain in full force and effect.

7. This Order is binding on the parties hereto, their successors in interest, designees, and assigns, jointly and severally.

8. This Order shall become effective upon receipt by the Army and Hercules of true and correct originals of the fully executed Order signed by both the Director of the Department of Environmental Quality and authorized agents of the Army and Hercules.

This is an Order of the Virginia Waste Management Board and the Director of the Department of Environmental Quality in accordance with §§ 10.1-1455, -1183, -1184, and -1185 of the Code of Virginia (1950), as amended.

For James C. Adams
Richard N. Burton
 Director
 Department of Environmental Quality

The foregoing instrument was acknowledged before me on

June 22, 1993, by James C. Adams,
Director Waste Division (title), on behalf of Richard N. Burton, Director of the Department of Environmental Quality, in the City of Richmond, Virginia.

My Commission expires:

My Commission Expires August 31, 1993
 Date

Carol Gibbs Nixon
 Notary Public

Seen and Agreed to:

Bill W. Forrester

23 Apr 93
 Date

The United States Department of the Army
 Radford Army Ammunition Plant
 Caller Service 2
 Radford, VA 24141

State of Virginia

County/City of Radford

The foregoing instrument was acknowledged before me on

4/23, 1993, by BILL W. FORRESTER, LTC, CM,

Commanding (title), of the United States Department of the Army, on behalf of the Department of the Army and Radford Army Ammunition Plant.

My Commission expires:

3/30/96
 Date

Caroline D. Latta
 Notary Public

Seen and Agreed to:

E. K. Hurley

April 23 1993
Date

Hercules Incorporated
Caller Service 1
Radford, VA 24141-0299

State of Virginia

County/City of Radford

The foregoing instrument was acknowledged before me on

4/23, 1993, by E. K. HURLEY

V.P. and G.M. (title), of Hercules Incorporated, a
Delaware corporation, on behalf of the corporation.

My Commission expires:

3/30/96
Date

Carla D. Baker
Notary Public

APPENDIX A
SCHEDULE OF COMPLIANCE

Radford Army Ammunition Plant
Incinerator Spray Pond
EPA ID NO. VA1210020730

1. Within sixty (60) days of the effective date of this Order, the Army and Hercules shall submit to the Department a groundwater monitoring program for the incinerator spray pond surface impoundment which meets the requirements of VHWMR § 9.5 modified as necessary to meet the closure performance standards of VHWMR § 10.10.I.1.a. The Department will approve or modify and approve this program in accordance with the VHWMR. The Army and Hercules shall implement this program within thirty (30) days of receipt of the Department's written notice of approval.
2. Within sixty (60) days of the effective date of this Order, the Army and Hercules shall submit to the Department a closure plan for the surface impoundment. This closure plan shall meet the requirements of VHWMR §§ 9.6., 10.6 and 10.10.I.1. as made applicable by VHWMR § 9.6.L. The Department shall approve, or modify and approve, these plans in accordance with the VHWMR. The Army and Hercules shall complete closure of the surface impoundment in accordance with the approved closure plan. If the surface impoundment has been closed under VHWMR § 10.10.I.1. ("clean closure"), the Army and Hercules shall provide the Department with owner/operator and professional engineer certifications as required under VHWMR § 9.6.F. If the Army and Hercules are unable to achieve closure under VHWMR § 10.10.I.1. in accordance with approved closure plan, the Army and Hercules shall immediately notify the Department of this fact. This notification shall constitute a determination that the unit must be closed as a landfill in accordance with VHWMR § 10.13. Upon such determination, the Army and Hercules shall submit to the Department a modified closure plan within thirty (30) days, a post-closure plan within ninety (90) days, and a permit application within one hundred eighty (180) days, in accordance with the requirements set forth in VHWMR § 9.6.L. The Department shall approve, or modify and approve, the closure and post-closure plans in accordance with the VHWMR. Following completion of closure in accordance with the modified and approved closure plan and until such time as a permit is issued, the Army and Hercules shall follow the approved post-closure plan referenced above.

DEPT OF
ENVIRONMENTAL QUALITY
AUG 22 1995
CIVIL PERMITTING

**CLOSURE, CONTINGENT CLOSURE AND CONTINGENT POST-CLOSURE PLANS
FOR RADFORD ARMY AMMUNITION PLANT'S**

**INCINERATOR SPRAY POND (HWMU-39)
RADFORD**

**RADFORD, VIRGINIA
EPA ID VA1210020730**

**RADFORD ARMY AMMUNITION PLANT
RADFORD, VIRGINIA
EPA ID VA1210020730
August 18, 1995**

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LIST OF ACRONYMS

CEI Comprehensive Evaluation Inspection
CFR Code of Federal Regulations
CHESNAVFACENGCOM Chesapeake Division, Naval Facilities Engineering Command
CQA Construction Quality Assurance
EEA Explosive Experimental Area
EPA Environmental Protection Agency
FFCA Federal Facility Compliance Agreement
GWMP Groundwater Monitoring Plans
HCOG Hazardous Constituents of Concern
MDL Method Detection Limit
NAVSWCDC Naval Surface Warfare Center - Dahlgren, Virginia
ND Not Detectable
NPL National Priority List
PQL Practical Quantitation Limit
PVC Polyvinyl Chloride
QA/QC Quality Assurance/Quality Control
RAAP Radford Army Ammunition Plant
RCRA Resource Conservation and Recovery Act
RDT&E Research, Development, Test and Evaluation
RFDs Reference Doses
RSDs Risk Specific Doses
RFI RCRA Facility Investigation
SCS Soil Conservation Service
SPLT Synthetic Precipitation Leach Test
VDEQ Virginia Department of Environmental Quality
VPDES Virginia Pollutant Discharge Elimination System Permit
VHWMR Virginia Hazardous Waste Management Regulations
WWTP Wastewater Treatment Plant

1.0 INTRODUCTION

1.1 Purpose of Study

The following closure plan is submitted in accordance with the requirements of the Commonwealth of Virginia's Hazardous Waste Management Regulations (VHWMR), Section 9.6.L. The plan identifies the necessary steps to close the incinerator spray pond (surface impoundment) located at the Radford Army Ammunition Plant in Radford, Virginia (Radford; EPA ID No.VA1210020730).

Questions regarding this report should be submitted to:

Mr. Joe D. Wilson
Chief Engineer
US Department of the Army
Radford Army Ammunition Plant
Caller Service 2
Radford, Virginia 24141-0298

Information about this report can also be obtained from Mr. Robert L. Richardson at (703) 639-8641, or Jerome J. Redder, P.E. at (703) 639-7536.

1.2 Background

The facility has operated a hazardous waste management facility subject to regulations promulgated under the Resource Conservation and Recovery Act. The Army is the owner of the Radford Army Ammunition Plant (Radford), located in Radford, Virginia and operated by Alliant Tech Systems (Alliant) which was the then existing Hercules Incorporated (Hercules). A Notification of Hazardous Waste Activity was filed for Radford with the EPA on August 14, 1980, declaring Radford to be engaged in the generation, treatment, storage, and disposal of hazardous waste under Title 40, Code of Federal Regulations, Part 261.

Since 1979, Radford operated a spray pond for the collection of incinerator scrubber waste waters. The wastewater was then reused as scrubber water for the incinerator. In August 1990, the Army and Hercules discovered that the scrubber waters collected in the spray pond had been contaminated with lead from the incineration process to the level that sludges which formed in the spray pond met the standards for a characteristic hazardous waste under Part III of the Virginia Hazardous Waste Management Regulations (VHWMR).

The Army and Hercules notified the Department of Waste Management (VDMW), [predecessor of the Department of Environmental Quality], of the contamination by letters of August 2 and 9, 1990. Subsequent discussions between the Army, Hercules, and VDMW resulted in the installation of a liner and the imposition of operational controls for the spray pond to prevent the introduction of further contamination and the agitation of the scrubber water in the spray pond to prevent hazardous waste sludges from forming.

By letter dated March 3, 1992, the Army and Hercules informed the Director of VDMW and the Director of the then existing State Water Control Board that sludges contaminated with lead meeting the levels of toxicity required for classification as a characteristic hazardous waste under Part III of the VHWMR were accumulating in the spray pond.

Neither the Army or Hercules has applied for or been granted interim status or a permit for the operation of the incinerator spray pond as a hazardous waste surface impoundment. Therefore, the Army owns and Hercules operates a hazardous waste surface impoundment without interim status or a permit to do so, in violation of applicable provisions of Parts IX, X, and XI of the VHWMR.

Thus, the incinerator spray pond which had begun operation in 1979 ceased operations in May 1992. An enforcement order ("order") was signed by the Department of Environmental Quality, the US Army, and Hercules which became effective on June 22, 1993. A Schedule of Compliance contained in the order required submission and implementation of a closure plan.

2.0 FACILITY DESCRIPTION

2.1 Site Location

The Radford Army Ammunition Plant (Radford or RAAP) is a government owned industrial complex located in southwestern Virginia. The Radford Army Ammunition Plant encompasses approximately 4,104 acres and is located in Pulaski and Montgomery Counties. The facility is located approximately 5 miles northeast of the city of Radford, 10 miles west of Blacksburg, and 47 miles southwest of Roanoke, (see figures 2-1, 2-2, 2-3, 2-4, 2-5, 2-6). The New River separates Pulaski and Montgomery Counties and also divides the RAAP into two portions commonly known as the "Horseshoe Area" and the "Main Manufacturing Area." The "Main Manufacturing Area" of Radford is located south of the New River meander in Montgomery County, and the "Horseshoe Area" of Radford is located within the New River meander in Pulaski County. The incinerator spray pond unit is located in the "Horseshoe Area", the north west area, Pulaski County. Table 2-1 summarizes the propellants which are manufactured at the facility.

2.2 Incinerator Spray Pond Description

The spray pond is a concrete-lined impoundment which is rectangular with dimensions of 76 x 60 x 5 feet deep. The maximum water level is three feet deep for a maximum volume of 13,680 cubic feet or 102,340 gallons. There are perforated pipes in the spray pond which were used to try to prevent sludges from forming by blowing air and creating turbulence in the water which must be removed and decontaminated. Currently there is rain water in the impoundment. The sludge and liquids which precipitated the sludge formation have been removed. The lead content of the water and the sludge in the spray pond has at times been above 5 ppm, which resulted in the hazardous waste surface impoundment designation.

FIGURE 2-1 VICINITY MAP

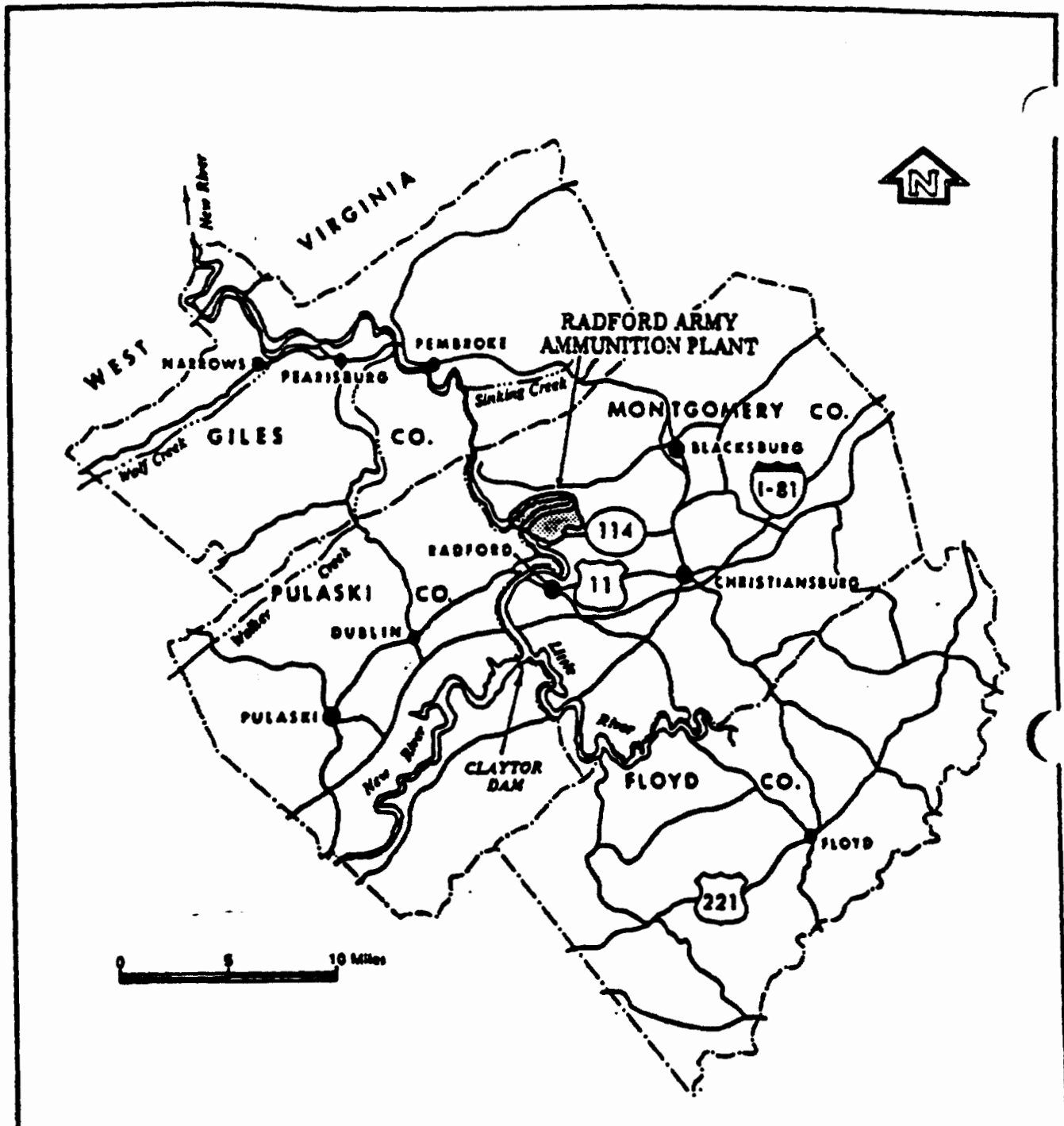


FIGURE 2-2 SITE BOUNDARY

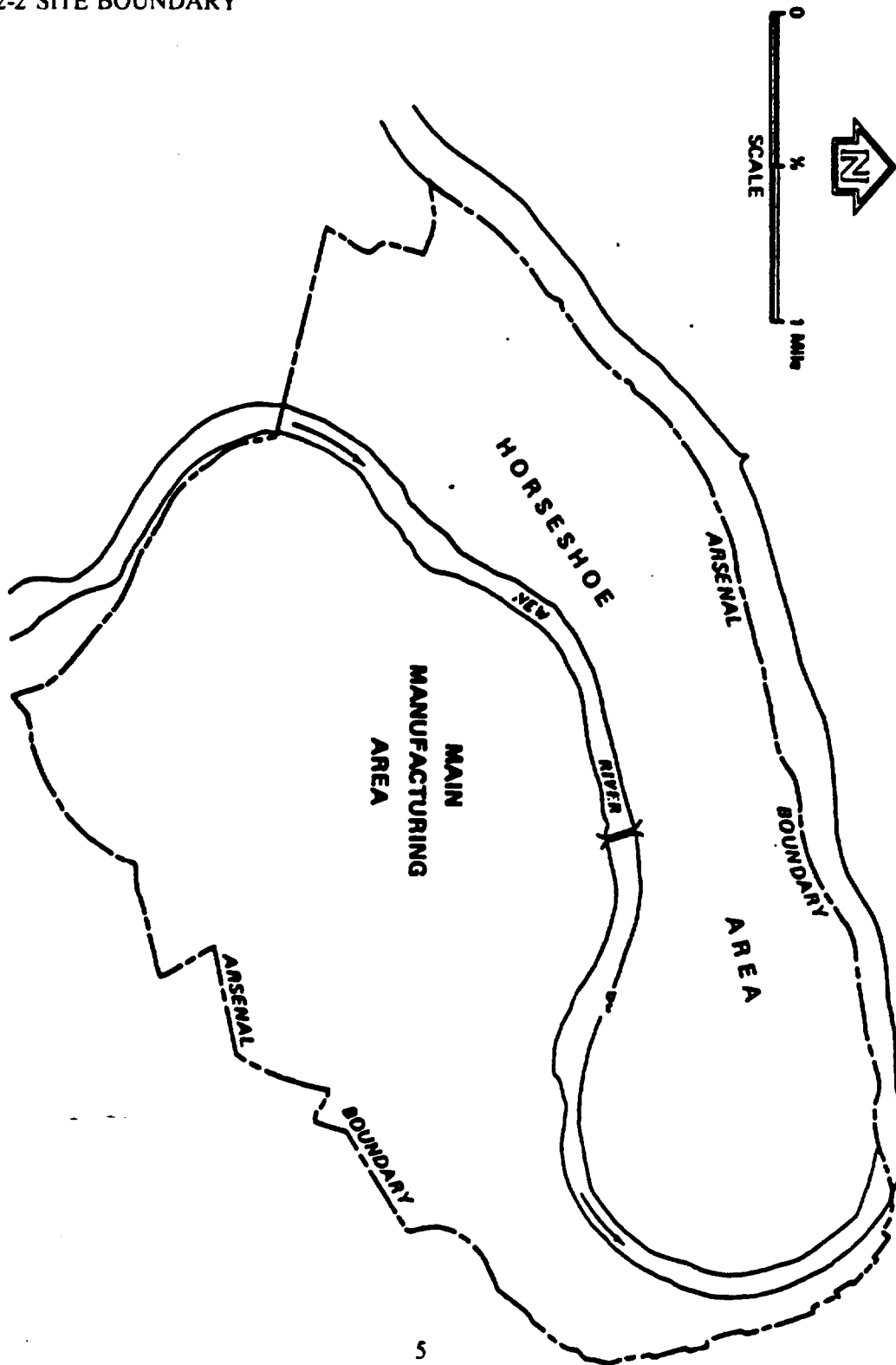


FIGURE 2-3 TOPOGRAPHIC MAP



FIGURE 2-4 INCINERATOR SPRAY POND

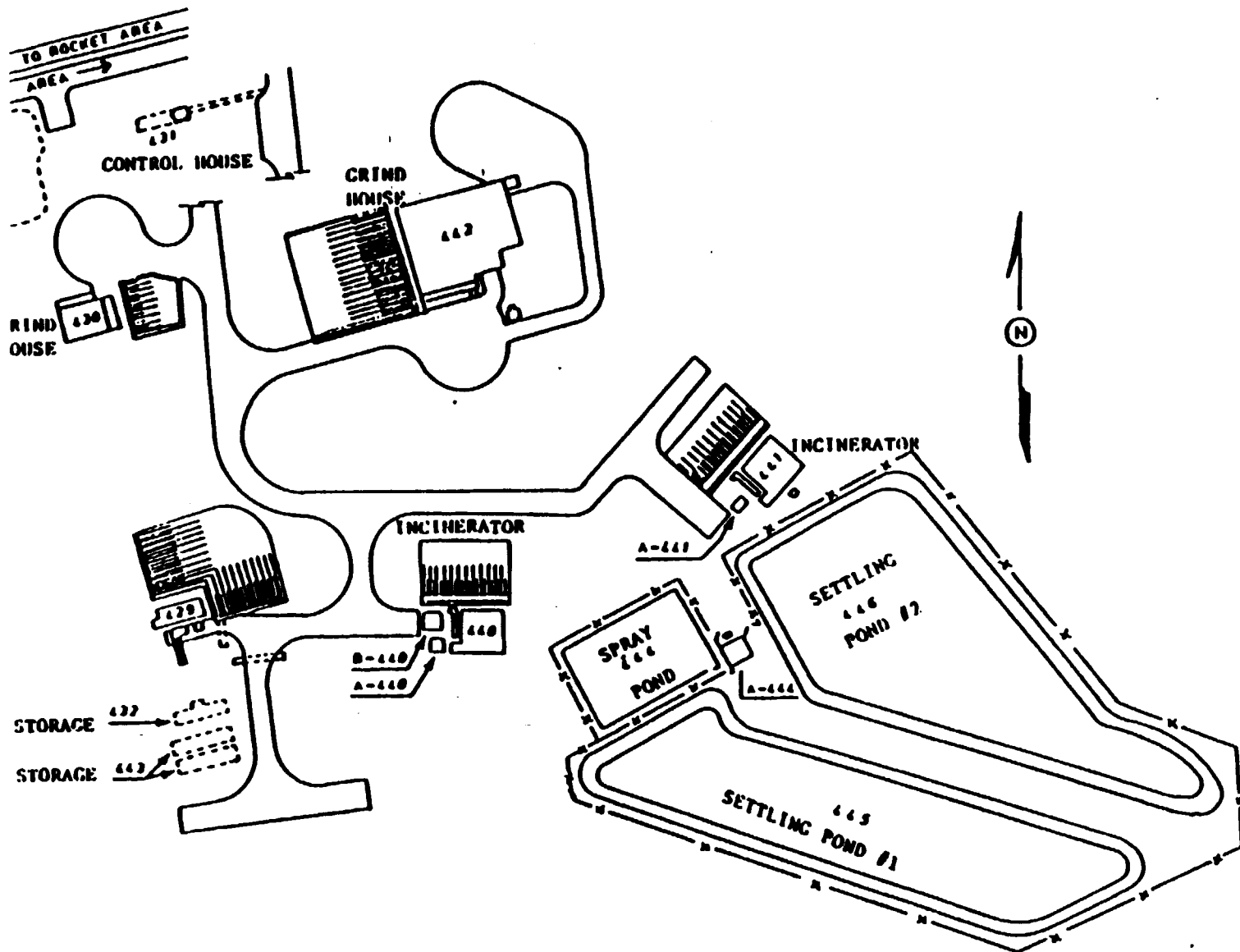


FIGURE 2-5 BACKGROUND SAMPLING LOCATIONS

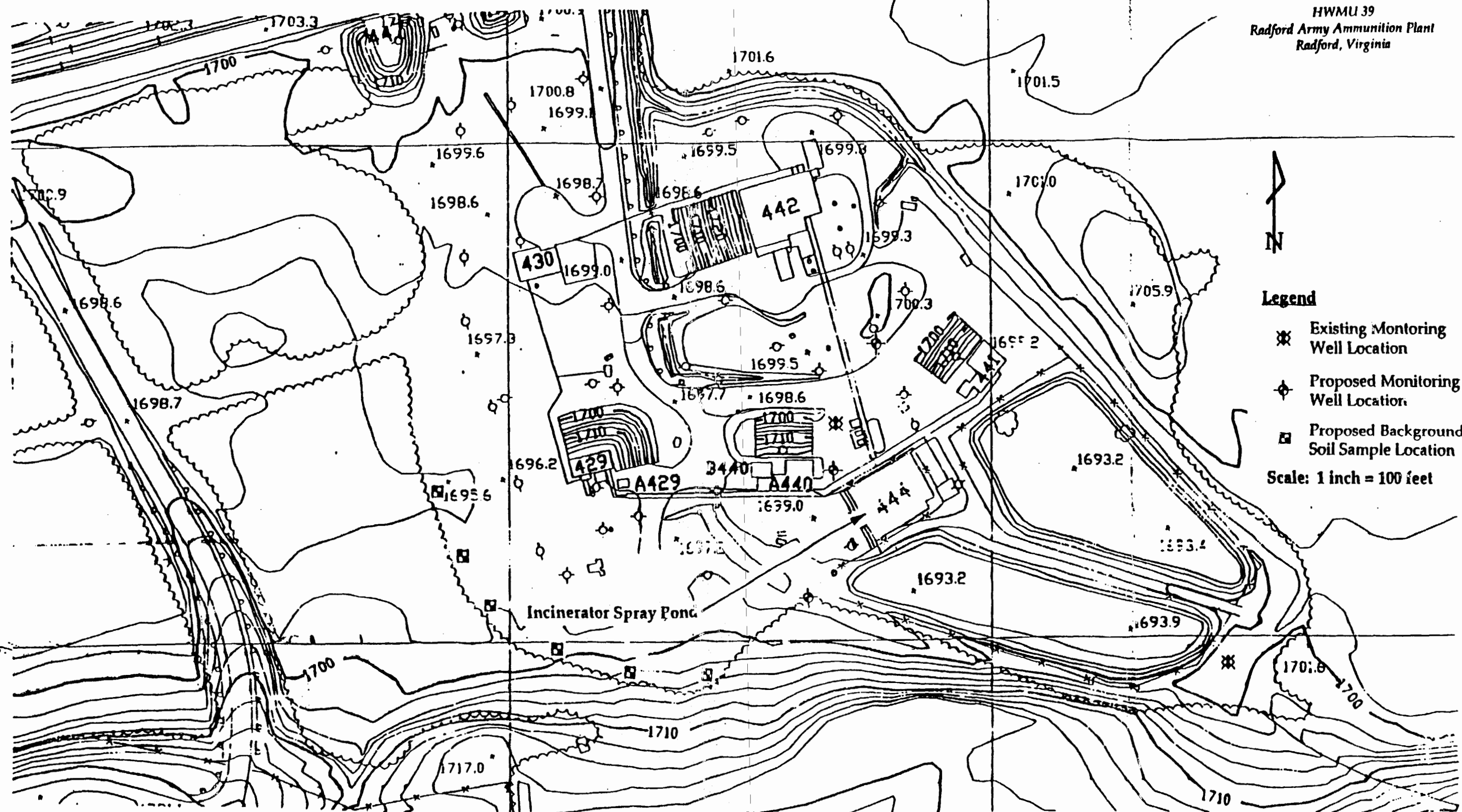
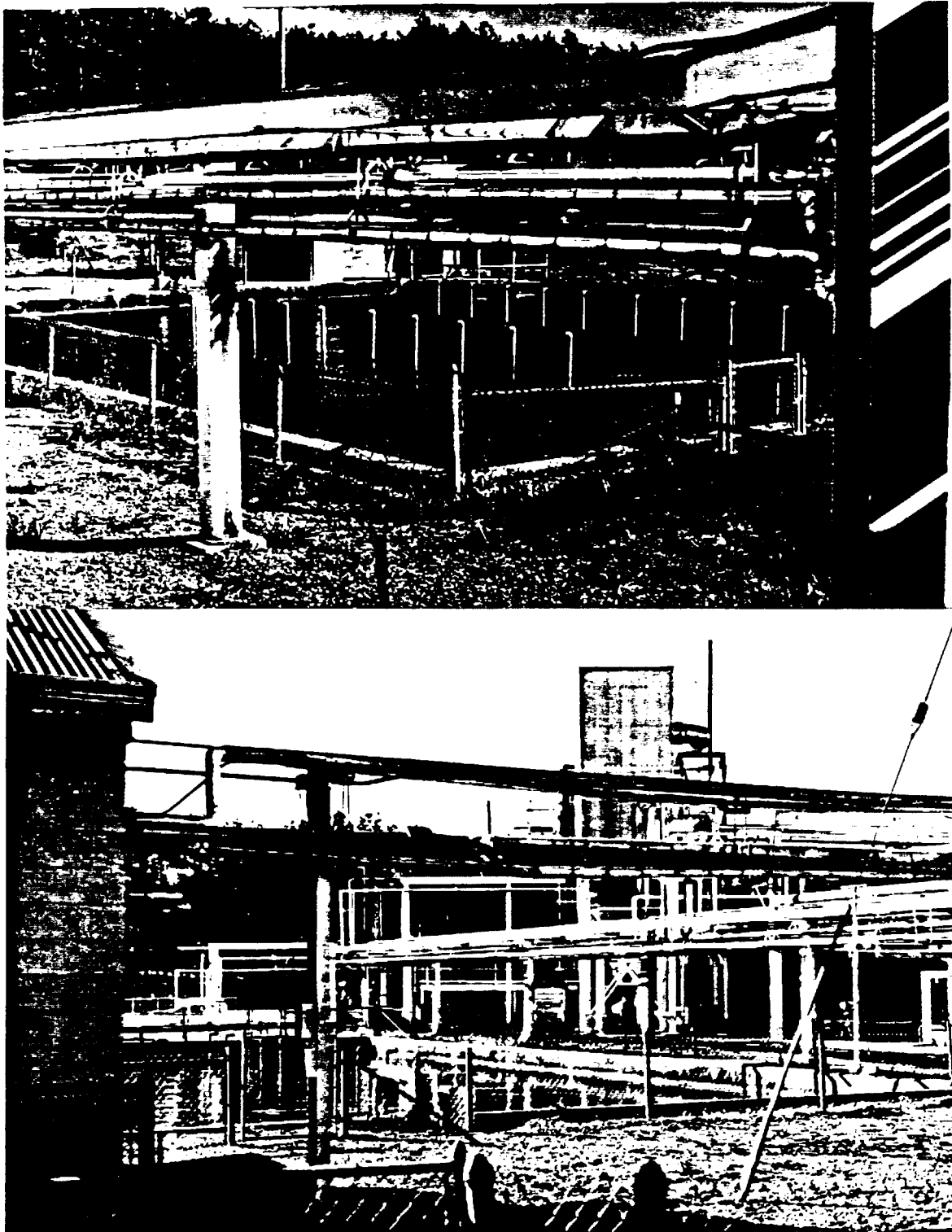


FIGURE 2-6 INCINERATOR SPRAY POND PICTURES



TABLES 2-1 PROPELLANTS MANUFACTURED BY RADFORD

SINGLE-BASE PROPELLANTS

Waste Feed: Benite

Commercial Use: Single-base propellant

Physical Form: Solid pellets at $> 0^{\circ}\text{F}$

Mixture Composition: (% by weight)

Nitrocellulose ^{1,4}	40 ± 1.0
Potassium Nitrate ¹	44.3 ± 1.0
Sulfur ¹	6.3 ± 0.3
Charcoal ¹	9.4 ± 0.3
Ethyl Centralite ^{2,4}	0.5 added
Total Volatiles ³	2.23 max.
Moisture ³	1.00 max.
Specific Gravity	1.65 gm/cc

Notes:

¹Percent on ethyl centralite, volatiles, and moisture - free basis

²Added to propellant

³Byproducts of manufacture; volatiles are diethyl ether and ethyl alcohol; percent based on propellant weight

⁴See Appendix D

Waste Feed: BS-NACO

Commercial Use: Single-base propellant

Physical Form: Solid

Mixture Composition: (% by weight)

Nitrocellulose	93.55 nominal
n-Butyl Stearate ¹	3.0 $\pm$ 0.3
Ethyl Centralite	1.2 $\pm$ 0.2
Basic Lead Carbonate	1.0 $\pm$ 0.2
Potassium Sulfate	1.25 $\pm$ 0.3
Graphite ¹	0.1 (added)
Moisture ²	1.0 to 3.0 (residual)
Total Volatiles ²	5.0 (residual)
Specific Gravity	0.85 gm/cc

Notes:

¹Added to propellant

²Byproducts of manufacturer; volatiles are diethyl ether and ethyl alcohol

³See Appendix D

Waste Feed: CBI Powder

Commercial Use: Single-base propellant

Physical Form: Solid

Mixture Composition: (% by weight)

Nitrocellulose ¹	98.0% (remainder, minimum)
Diphenylamine ^{1,4}	1.5 ± 0.2
Potassium Nitrate ²	0.1 max (added)
Graphite ²	0.2 max (added)
Total Volatiles ³	1.3 (residual)
Specific Gravity ³	32.0 lb/ft ³

Notes:

¹Based on graphite, potassium nitrate, and total volatiles - free basis

²Added to propellant

³Byproducts of manufacture; volatiles are diethyl ether and ethyl alcohol

⁴See Appendix D

Waste Feed: HES 6706.1

Commercial Use: Flash suppressant

Physical Form: Solid

Mixture Composition: (% by weight)

Nitrocellulose ¹	69.0 nominal
Ethyl Centralite ¹	0.8 (minimum)
Potassium Sulfate ¹	30.0 nominal
Graphite ¹	0.03 added
Total Volatiles ²	0.40 (residual)
Specific Gravity	1.70 g/cc

Notes:

¹Based on total volatiles - free basis

²Byproducts of manufacture; volatiles are diethyl ether and ethyl alcohol

Waste Feed: IMR 5010

Commercial Use: Single-base propellant

Physical Form: Solid

Mixture Composition: (% by weight)

Nitrocellulose	Remainder
Diphenylamine	0.50-1.25
Graphite	0.4 max
Potassium Sulfate	0.1-1.00
Total Volatiles ¹	2.35 max
Residual Solvents ¹	1.10 max
Moisture and Volatiles ¹	1.00 $\pm$.25
Specific Gravity	0.910-1.025 gm/cc

Notes:

¹Total volatiles are sum of moisture and solvents from production process (diethyl ether and ethyl alcohol)

Waste Feed: M1

Commercial Use: Single-base propellant

Physical Form: Solid

Mixture Composition: (% by weight)

Nitrocellulose ¹	85.00 $\pm$ 2.00
Dinitrotoluene ¹	10.00 $\pm$ 2.00
Diphenylamine ²	0.90 $\pm$ 1.20 (added)
Dibutylphthalate ^{1,4}	5.00 $\pm$ 1.00
Potassium Sulfate ²	1.00 $\pm$.3 (added)
Total Moisture ³	0.60 $\pm$ 0.2
Residual Solvent ³	0.8 max

Notes:

¹Based on total volatiles, diphenylamine, and potassium sulfate - free basis

²Added to propellant

³Byproducts of manufacture; diethyl ether and ethyl alcohol

⁴See Appendix D

Waste Feed: M6

Commercial Use: Single-base propellant

Physical Form: Solid

Mixture Composition: (% by weight)

Nitrocellulose ¹	87.00 $\pm$ 2.00
Dinitrotoluene ¹	10.00 $\pm$ 2.00
Dibutylphthalate ^{1,2}	3.00 $\pm$ 1.00
Diphenylamine ³	0.90 $\pm$ 1.20
Potassium Sulfate ³	1.00 $\pm$ 0.3
Total Volatiles	
Moisture ⁴	0.6 $\pm$ 0.2
Volatile Solvents ⁴	

Notes:

¹Based on total volatiles, diphenylamine, and potassium sulfate - free basis

²See Appendix D

³Added to propellant

⁴Byproducts of manufacture; diethyl ether and ethyl alcohol

Waste Feed: M10 Flake/All M10 Formulations

Commercial Use: Single-base propellant

Physical Form: Solid

Mixture Composition: (% by weight)

Nitrocellulose ¹	98.00 $\pm$ 1.00
Potassium Sulfate ¹	1.00 $\pm$ 0.30
Diphenylamine ¹	1.00 $\pm$ 0.30
Graphite ²	0.25 max
Total Volatiles ³	2.00 max
Moisture ³	0.50-1.20

Notes:

¹Total volatiles and graphite - free basis

²Added to propellant

³Byproducts of manufacture; volatiles include diethyl ether and ethyl alcohol

Waste Feed: M6 + 2

Commercial Use: Single-base propellant

Physical Form: Solid

Mixture Composition: (% by weight)

Nitrocellulose ¹	87.00 $\pm$ 2.00
Dinitrotoluene ¹	10.00 $\pm$ 2.00
Dibutylphthalate ¹	3.00 $\pm$ 1.00
Diphenylamine ²	0.90 - 1.20
Potassium Sulfate ²	2.00 $\pm$ 0.30
Total Volatiles ³	1.62 Max
Moisture ³	0.60 $\pm$ 0.20

Notes:

¹Calculated on total volatiles, potassium sulfate and diphenylamine - free basis

²Added to propellant

³Byproducts of manufacture; volatiles include diethyl ether and ethyl alcohol

Waste Feed: IMR 4895

Commercial Use: Single-base propellant

Physical Form: Solid

Mixture Composition: (% by weight)

Nitrocellulose	Remainder
Diphenylamine	0.50 to 1.25
Graphite	0.4 max
Dinitrotoluene	5.0-9.0
Potassium Sulfate	0.10-1.00
Total Volatiles ¹	2.35 max
Moisture and Volatiles	1.00 $\pm$ 0.25
Residual Solvents ¹	1.10 max
Specific Gravity	0.905-0.950 gm/cc

Notes:

¹Total volatiles is sum of moisture and volatile solvents (diethyl ether and ethyl alcohol)

Waste Feed: IMR 7383

Commercial Use: Single-base propellant

Physical Form: Solid

Mixture Composition: (% by weight)

Nitrocellulose	Remainder
Diphenylamine	0.50-1.25
Graphite	0.40 max
Dinitrotoluene	9.5-13.5
Dibutylphthalate	2.00-4.00
Potassium Sulfate	0.10-1.00
Total Volatiles	1.90 max
Moisture and Volatiles	0.50 $\pm$ 0.20
Residual Solvents	1.10 max
Specific Gravity	0.790-0.875 gm/cc

Waste Feed: IMR 8097

Commercial Use: Single-base propellant

Physical Form: Solid

Mixture Composition: (% by weight)

Nitrocellulose	Remainder
Diphenylamine	0.50-1.25
Graphite	0.40 max
Dinitrotoluene	0.0-5.0
Potassium Sulfate	0.10-1.00
Total Volatiles	2.35 max
Moisture and Volatiles	1.00 $\pm$ 0.25
Residual Solvents	1.10 max
Specific Gravity	0.870-0.920 gm/cc

Waste Feed: M14 MP

Commercial Use: Single-base propellant

Physical Form: Solid

Mixture Composition: (% by weight)

Nitrocellulose ¹	90.00 $\pm$ 2.00
Dinitrotoluene ¹	8.00 $\pm$ 2.00
Dibutylphthalate ¹	2.00 $\pm$ 1.00
Diphenylamine ²	1.00 $\pm$ 0.10
Total Volatiles ³	1.25 maximum
Moisture ³	0.60 $\pm$ 0.20
Volatile Solvents ³	0.55, nominal

Notes:

¹Calculated on total volatiles, potassium sulfate and diphenylamine - free basis

²Added to propellant

³Byproducts of manufacture; volatiles include diethyl ether and ethyl alcohol

Waste Feed: 25 mm Bushmaster

Commercial Use: Single-base propellant

Physical Form: Solid

Mixture Composition: (% by weight)

Nitrocellulose	Remainder
Diphenylamine	0.5-1.3
Potassium Nitrate	1.0 (min)
Dinitrotoluene	3.1 (nominal)
Graphite	0.4 (max)
Total Volatiles	2.9 max
Moisture	1.1 $\pm$ 0.4
Residual Solvent	1.7 max
Specific Gravity	0.99 gm/cc (min)

Waste Feed: IMR 8208 M³

Commercial Use: Single-base propellant

Physical Form: Solid

Mixture Composition: (% by weight)

Nitrocellulose	100.00
Potassium Sulfate ¹	1.00
Diphenylamine ¹	1.00
Total Volatiles ²	2.35 max
Moisture ²	0.75-1.25
Residual Solvent ²	1.10

Notes:

¹Added to propellant

²Byproducts of manufacture; volatiles include diethyl ether and ethyl alcohol

³Data same for IMR 8138 M and 4475

Waste Feed: DIGL-RP

Commercial Use: Propellant

Physical Form: Solid

Mixture Composition: (% by weight)

Nitrocellulose	62.5 $\pm$ 2.00
Diethylene Glycol Dinitrate ¹	36.70 $\pm$ 1.50
Ethyl Centralite	0.25 $\pm$ 0.05
Akardit II ¹	0.45 $\pm$ 0.15
Magnesium Oxide	0.05 max
Graphite	0.05 max

Notes:

¹See Appendix D

DOUBLE-BASE PROPELLANTS

<u>Parameters</u>	<u>M7 TOW Launch Motor</u>	<u>M7 LAW Unit</u>
Physical Form	Solid	Solid
Chemical Composition		
Nitrocellulose	54.60, nominal	58.70
Nitroglycerin	35.50, nominal	32.00
Potassium perchlorate	8.05, max	7.80-8.05
Carbon black	1.20, nominal	0.60
Ethyl centralite	0.80, min	0.8-0.9
Total volatiles ¹	0.80	0.8, max
Specific gravity (gm/cc)		1.60-1.70

Notes:

¹Byproducts of manufacture; volatiles include acetone and ethyl alcohol; based on weight of propellant; free basis

<u>Parameters</u>	<u>AHH Casting Powder</u>	<u>ARP Casting Powder</u>	<u>M26</u>
Physical Form	Solid	Solid	Solid
Chemical Composition:	1	5	1
Nitrocellulose	83.0 $\pm$ 1.3	75.00 $\pm$ 1.20	67.25 $\pm$ 1.80
Nitroglycerin ²	11.4, nominal	17.00 $\pm$ 1.00	25.00 $\pm$ 1.00
Lead salicylate	2.3, nominal ²	3.00 $\pm$ 0.25	---
Lead 2-ethylhexoate	2.3, nominal ²	---	---
2-nitrodiphenylamine ²	1.0 $\pm$ 0.15	2.00 $\pm$ 0.15	---
Graphite	0.03-0.06 ³	0.04 $\pm$.01 ³	0.30 $\pm$ 0.1 ³
Lead beta resorcyate	---	3.00 $\pm$ 0.25 ²	---
Carbolac I (carbon black)	---	0.30 $\pm$ 0.10 ²	---
Total volatiles	1.50, max ⁴	1.75, max ⁴	2.00, max ⁴
Barium nitrate	---	---	0.75 $\pm$ 0.20
Potassium nitrate	---	---	0.70 $\pm$ 0.20
Ethyl centralaite	---	---	6.00 $\pm$ 0.50
Total moisture	---	---	0.70, max
Specific gravity (gm/cc)	0.95	1.638-1.701	

Notes:

¹Graphite and volatiles - free basis; percent by weight

²See Appendix D

³Added to propellant

⁴Byproducts of manufacture; percent based on propellant weight; volatiles include acetone and ethyl alcohol

⁵Carbolac, graphite and volatiles - free basis; percent by weight

<u>Parameters</u>	<u>M26 E1</u>	<u>PNJ Casting Powder (TOW)²</u>	<u>M9</u>
Physical Form	Solid	Solid	Solid
Chemical Composition:	1	2	1
Nitrocellulose	68.70 $\pm$ 1.80	74.84	57.75 $\pm$ 1.50
Nitroglycerin	25.00 $\pm$ 1.00	16.58	40.00 $\pm$ 1.50
Ethyl centralite	6.00 $\pm$ 0.50	0.02	0.75 $\pm$ 0.10
Graphite	0.30 $\pm$ 0.10	0.17	0.40 max ³
Total volatiles	0.50, max ³	---	0.50, max ³
Potassium sulfate	---	0.75 $\pm$ 0.10	---
2-nitrodiphenylamine	---	1.95	---
Carbolac 1	---	0.17	---
Lead 2,4 dihydroxybenzoate	---	2.93	---
Lead Salicylate	---	2.93	---
Potassium nitrate	---	---	1.50 $\pm$ 0.50
Density (lb/cu ft)			46.0, min

Notes:

¹Graphite and volatiles - free basis; percent by weight

²All percentages nominal, except potassium sulfate

³Byproducts of manufacture; based on propellant weight; volatiles include acetone and ethyl alcohol

⁴Added to propellant

⁵See Appendix D

<u>Parameters</u>	<u>M7 Subscriber LAN Unit</u>	<u>M2</u>	<u>M5</u>
Physical Form	Solid	Solid	Solid
Chemical Composition:	1	3	1
Nitrocellulose	58.70	77.45 $\pm$ 2.00	81.95 $\pm$ 2.00
Nitroglycerin	32.00	19.50 $\pm$ 1.00	15.00 $\pm$ 1.00
Potassium perchlorate	7.80 ^{2,4}	—	—
Carbon black	0.60	—	—
Ethyl centralite	0.80 - 0.90	0.60 $\pm$ 0.15	0.60 $\pm$ 0.15
Total volatiles	0.80, max	2.10, max	1.25, max
Barium nitrate	—	1.40 $\pm$ 0.25	0.50 - 1.60
Potassium nitrate	—	0.75 $\pm$ 0.25	0.25 $\pm$ 1.00
Graphite ¹	—	0.30 $\pm$ 0.10	0.30 $\pm$ 0.10
Total moisture	—	0.70, max	0.70, max
Specific gravity (gm/cc)	1.60 - 1.70	—	0.42, min

¹Volatiles - free basis; percent by weight

²Blended with 0.5% by weight magnesium oxide and 0.5% magnesium stearate

³Graphite and volatiles - free basis

⁴See Appenix D

<u>Parameters</u>	<u>M 16</u>	<u>JA-2</u>	<u>M-21</u>
Physical Form	Solid	Solid	Solid
Chemical Composition:	1	1	1
Nitrocellulose	55.12	59.50 $\pm$ 2.00	53.00
Nitroglycerin	27.68	14.90 $\pm$ 1.00	31.00
Diethylene glycol dinitrate	—	24.80 $\pm$ 1.50 ²	—
Akradit II	—	0.70 $\pm$ 0.20 ²	—
Magnesium oxide	—	0.05, max	—
Graphite	—	0.05, max	—
Dinitrotoluene	10.66	—	—
Ethyl centralite	3.97	—	2.00
Potassium sulfate	1.56	—	—
Carbon black	0.50	—	0.03
Lead stearate	0.50	—	0.50 ²
Triacetin	—	—	11.00 ²
Lead salicylate	—	—	2.50

Notes:

¹Percent by weight

²See Appendix D

<u>Parameters</u>	<u>2680 DQ</u>	<u>ABL 2776 Casting Powder Type II</u>	<u>N-4</u>
Physical Form	Solid	Solid	Solid
Chemical Composition:	1,4	1	1
Nitrocellulose	25.00, nominal	27.56	51.02
Nitroglycerin	12.50 $\pm$ 1.00	10.03	34.63
Resorcinal	1.50 $\pm$ 0.30 ²	1.68	—
Ammonium perchlorate	50.00 $\pm$ 2.00 ²	49.78	—
2-nitrodiphenylamine	1.00 $\pm$ 0.20	1.00	2.09
Aluminum	10.00 $\pm$ 0.50	9.95	—
Total volatiles	0.5, max ³	0.5, max	—
Diethylphthalate	—	—	10.90 ²
Potassium sulfate	—	—	0.75
Lead stearate	—	—	0.51 ²
Carbon black	—	—	0.10
Specific gravity, (gm/cc)	—	1.78	—

Notes:

¹Percent by weight

²See Appendix D

³Byproducts of manufacture; volatiles include acetone and ethyl alcohol

⁴ABL 2901 DQ/D propellant has some composition

<u>Parameters</u>	<u>N-8</u>	<u>N-12 Standard</u>	<u>HEN-12 High Energy</u>
Physical Form	Solid	Solid	Solid
Chemical Composition:	1	1	1
Nitrocellulose	49.55	50.0 $\pm$ 1.5	48.8
Nitroglycerin	37.69	38.0 nominal	40.6
Diethylphthalate	6.65	---	---
2-Nitrodiphenylamine	1.98	2.00 $\pm$ 0.5	2.0
Wax	0.10	0.15	0.1
Carbon black	0.05	---	---
Lead 2,4 dihydroxybenzoate	1.99	2.0 nominal	2.5 ²
Lead salicylate	1.99	---	---
Di-normal-propyl adipate	---	5.85 nominal	3.5 ¹
Cupric salicylate	---	2.0, nominal	2.5 ²

¹Percent by weight

²See Appendix D

<u>Parameters</u>	<u>M8</u>	<u>N-5</u>	<u>N-14</u>
Physical Form	Solid	Solid	Solid
Chemical Composition:	1	1	1
Nitrocellulose	52.15 $\pm$ 1.50	48.5 - 52.0	48.0 $\pm$ 1
Nitroglycerin	43.0 $\pm$ 1.50	34.9, nominal	44.5
Diethylphthalate	3.00 $\pm$ 0.50	10.5, nominal	—
Potassium nitrate	1.25 $\pm$ 0.25	—	—
Ethyl centralite	0.50 $\pm$ 0.20	—	—
Total volatiles	0.40, max ²	—	—
Wax	—	0.2, nominal	0.1, nominal
2-Nitrodiphenylamine	—	1.5 - 2.0	2.0 $\pm$ 0.
Moisture	—	0.60, max	0.60, max
Lead 2-ethylhexoate ³	—	1.2, nominal	—
Lead salicylate	—	1.2, nominal	—
Di-n-propyl adipate	—	—	0.4, nominal
Lead betaresorcylate, monobasic	—	—	2.5, nominal
Cupric salicylate	—	—	2.5, nominal

Notes:

¹Percent by weight; volatiles - free basis

²Byproducts of manufacture based on propellant weight; volatiles include acetone and ethyl alcohol

³See Appendix D

<u>Parameters</u>	<u>NOSIH-AA-2</u>	<u>NOSIH-AA-6</u>	<u>M30</u>
Physical Form	Solid	Solid	Solid
Chemical Composition:	1	1	1,2
Nitrocellulose	51.0 $\pm$ 1.5	49.0 - 50.5	48.0 - 51.0
Nitroglycerin	38.6	38.8, nominal	40.0
2-Nitrodiphenylamine	2.0 $\pm$ 0.5	1.8 - 2.0	1.5 - 2.5
Di-n-propyl adipate	1.6	2.0, nominal	3.0
Triacetin	2.7	3.25, nominal	---
LC-12-15	4.0	---	---
Wax	0.10	0.1, nominal	0.1
Moisture	0.60, max	0.60, max	0.60, max
Cupric salicylate, monobasic	---	1.50, nominal	---
Lead salicylate	---	3.30, nominal	---
R-303 Type II	---	0.30, nominal	---
Aluminum	---	1.50, nominal	---
Carbon black	---	0.05, nominal	---
LC-12-6	---	---	5.4

Notes:

¹Percent by weight; nominal unless noted

²Moisture-free basis

<u>Parameters</u>	<u>NOSIH-AA-2</u>	<u>N-12</u>	<u>NOSOL-18</u>
Physical Form	Solid	Solid	Solid
Chemical Composition:	1	1,2	1,4
Nitrocellulose	45.0 $\pm$ 1.5	50.0 - 1.5	46.0 $\pm$ 1.25
Nitroglycerin/Metritrinitrate	NG 44.2	NG 38.0	MIN 38.5 $\pm$ 1.00 ³
Aluminum	2.5	—	—
Di-n-propyl adipate	1.2	5.85	—
2-Nitrodiphenylamine	2.0 $\pm$ 0.5	2.0 $\pm$ 0.5	—
Cupric salicylate, monobasic	2.5	—	—
Lead betaresorcyate ¹	0.3	—	—
Lead betaresorcyate, monobasic	2.2	—	—
Wax	0.1	0.15	0.1 $\pm$ 0.05
Moisture	0.60, max	0.6, max	0.5, max
Cupric salicylate	—	2.0	—
Triethylene glycol dinitrate	—	—	3.0 $\pm$ 0.3 ³
Dibutylphthalate	—	—	8.1 $\pm$ 0.5
Lead Carbonate	—	—	1.0 $\pm$ 0.2
Ethyl centralite	—	—	2.0 $\pm$ 0.3
Potassium sulfate	—	—	1.3 $\pm$ 0.2

Notes:

¹Percent by weight; nominal unless noted

²Moisture-free basis

³See Appendix D

⁴Volatile - free basis

<u>Parameters</u>	<u>Roland II Booster</u>	<u>HDDR-A</u>
Physical Form	Solid	Solid
Chemical Composition:	1	1
Nitrocellulose	54.65	30.0
Nitroglycerin	33.50	10.0
2-Nitrodiphenylamine	1.34 - 1.96	1.0
Diethylphthalate	5.88	---
Copper chromite	0.98	---
Potassium cryolite	0.58 ²	---
Lead stearate, dibasic	2.45	---
Total volatiles	0.8, max	---
Acetylene black	1.00 $\pm$ 0.5	---
HMX	---	15.0 ²
Ammonium perchlorate	---	15.0
Aluminum	---	27.5
Resorcinol	---	1.7 ²

Notes:

¹Percent by weight; nominal unless noted

²See Appendix D

TRIPLE-BASE PROPELLANT

<u>Parameters</u>	<u>M30¹</u>	<u>M30A1¹</u>	<u>M30A2¹</u>
Physical Form	Solid	Solid	Solid
Chemical Composition:	1,2	1,2	1,2
Nitrocellulose	28.00 ± 1.30	28.00 ± 1.30	27.00 ± 1.30
Nitroglycerin	22.50 ± 1.00	22.50 ± 1.00	22.50 ± 1.00
Nitroguanidine	47.70 ± 1.00 ³	47.00 ± 1.00	46.25 ± 1.00
Ethyl centralite	1.50 ± 0.10	1.50 ± 0.10	1.50 ± 0.10
Cryolite	0.30 ± 0.10 ³	—	—
Graphite	0.2, max	0.15, max	0.15, max
Total volatiles	0.50, max ⁴	0.50, max ⁴	0.5, max ⁴
Potassium sulfate	—	1.00 ± 0.30	—
Potassium nitrate	—	—	2.75 ± 0.25
Specific gravity	63.0 lb/ft ³	—	—

Notes:

¹Percent by weight; nominal unless noted

²Graphite and volatiles - free basis; volatiles include pentane and methylene chloride

³See Appendix D

⁴Volatiles include methylene chloride and pentane

<u>Parameters</u>	<u>M31A1</u>
Physical Form	Solid
Chemical Composition:	1
Nitrocellulose	20.00 $\pm$ 1.30
Nitroglycerin	19.00 $\pm$ 1.00
Nitroguanidine	54.00 $\pm$ 1.00
Dibutylphthalate	4.50 $\pm$ 0.30
2-Nitrodiphenylamine	1.50 $\pm$ 0.30
Potassium sulfate	1.00 $\pm$ 0.30
Graphite	0.15, max
Total volatiles	0.30, max ²

Notes:

¹Percent by weight on graphite and volatile - free basis

²Volatiles include methylene chloride and pentane

CAST AND EXTRUDED PROPELLANTS

<u>Parameters</u>	<u>Rocket Assisted Projectile (RAP) f/155mm, M549</u>	<u>PNJ for TOW</u>	<u>Bermite Grain</u>
Physical Form	Solid	Solid	Solid
Chemical Composition:	1,2	3	4
Nitrocellulose	53.9 min	49.23	53.00
Nitroglycerin	31.6	36.29	31.00
Triacetone	8.8	8.16	11.00
2-nitrodiphenylamine	0.9	1.62	
Lead salicylate	1.2	1.93	2.50
Lead 2-ethylhexoate	2.0	---	
R-303	---	1.93	
Ethyl centralite	---	0.02	2.00
Potassium sulfate	---	0.4-0.6	
Carbolac I	---	0.19	
Graphite	---	0.03	
Lead stearate	---	---	0.50
Carbon black	---	---	0.03
Moisture	---	---	0.5, max

¹Percent by weight; on volatiles - free basis

²Same composition for Rocket Assisted Projectile (RAP) f/8-inch, XM650 propellant

³Nominal composition unless noted; percent by weight

⁴Moisture and carbon black - free basis

MISCELLANEOUS ITEMS

<u>Parameter</u>	<u>MR-23 Adhesive</u>	<u>Otto Fuel II</u>	<u>Multiperforated Propellant L5460 (JA2)</u>
Physical Form			Solid
Chemical Composition:	1	1	3
Acetone	56.9 ± 1.5	---	---
Nitromethane	27.0 ± 1.0 ²	---	---
Nitrocellulose	9.5 ± 0.5	---	59.50 ± 2.00
Nitroglycerin	6.3 ± 0.5	---	14.90 ± 1.00
Ethyl centralite	0.3 ± 0.1	---	---
Propylene glycol dinitrate	---	75.8 - 76.2 ²	---
Di-n-butyl sebacate	---	22.5, nom ²	---
2-nitrodiphenylamine	---	1.4-1.6	---
Diethylene glycol dinitrate	---	---	24.80 ± 1.50
Akardit II	---	---	0.70 ± 0.20
Magnesium oxide	---	---	0.05, max
Moisture	---	---	0.50 ± 0.3
Graphite	---	---	0.05, max
Specific gravity gm/cc			1.56
Percent solids	11.0		

Notes:

¹Percent by weight; moisture - free basis

²See Appendix D

³Percent by weight

<u>Parameter</u>	<u>Single-perforated Powders (I5420, 5421, 5422, 5423)</u>
Physical Form	Solid
Chemical Composition:	1
Nitrocellulose	62.50 $\pm$ 2.00
DEGDN	36.70 $\pm$ 1.50 ²
Ethyl centralite	0.20 - 0.50
Akardit II	0.30 - 0.70
Graphite	0.05, max
Magnesium oxide	0.05, max
Moisture	0.5 $\pm$ 0.3
Specific gravity (gm/cc)	1.56

Notes:

¹Percent by weight

²Diethylene glycol dinitrate

2.3 Facility Background

Although Radford is owned by the US Government, it has been operated under contract by Hercules Aerospace Corporation since 1941. This facility, which contains over 1,696 buildings and occupies close to 3,649,965 square feet, is the top manufacturer of solid propellants in the United States. The major products manufactured at this facility are solvent and solventless propellants that include single phase (nitrocellulose), double-phase (nitrocellulose and nitroglycerin), and triple phase (nitrocellulose, nitroglycerin, and nitroguanidine) propellants; cast propellants; and high energy propellants. These propellants are ultimately used in small arms, anti-tank weapons, anti-aircraft weapons, rockets, torpedoes, missile systems, igniters, and other numerous ordnance-related items.

2.4 Incinerator Background

The Army and Hercules have been manufacturing explosives and rocket propellants at the facility since 1941. In 1979 two incinerators were completed and the incineration of waste and off-specification explosives and propellants began. These incineration operations became regulated subsequent to the promulgation of the federal hazardous waste regulations under RCRA in 1980. On November 15, 1980, the facility submitted Part A of the RCRA permit application and was granted "interim status" by the United States Environmental Protection Agency on November 30, 1981. On December 3, 1984, the facility submitted Part B of the RCRA permit application. After several reviews and revisions of the Part B application, a final permit was issued by the Virginia Department of Waste Management on November 9, 1989.

On December 7, 1989, the Army and Hercules filed a Notice of Appeal of the final permit. The primary basis of the appeal was the claim that operating conditions in the permit, specifically the minimum kiln operating temperature, were not reasonable. On January 31, 1990, the Director of the Department of Waste Management granted a stay of the Department's November 9, 1989, decision issuing the permit. On July 23, 1990, the Department of Waste Management, the Army, and Hercules entered into a compliance agreement. This agreement continued the stay of the November 9, 1989, permit and required the Army and Hercules to conduct a new trial burn in order to re-establish incinerator operating parameters. In April 1993, the facility conducted a trial burn and on July 10, 1993, the facility submitted a trial burn report as required by the compliance agreement. The DEQ Waste Division, reviewed the new

trial burn report and found it to be complete and adequate. Pursuant to VHWMR § 11.19., the DEQ simultaneously revoked the November 9, 1989, permit and issued a new permit. The incinerator spray pond is no longer used in conjunction with the incinerators.

2.5 Type of Wastes Managed at the Facility

The major products of manufacture at the RAAP are explosives and rocket propellants. There are five major categories of propellants produced at the facility. These categories are:

- Single base propellants (primary constituent nitrocellulose);
- Double base propellants (primary constituents nitrocellulose and nitroglycerine);
- Triple base propellants (primary constituents nitrocellulose, nitroglycerine, and nitroguanidine);
- Cast and extruded propellants; and
- Miscellaneous items

"Off-specification" propellants which do not meet Army production standards and "NG slums" are the waste materials which are treated and incinerated at the facility. NG slums are generated from cleanup of nitroglycerine (NG) in the production process and contain nitroglycerine, sawdust (to absorb the liquid), and triacetin (to desensitize the NG).

All of the waste materials described above are regulated as hazardous waste by virtue of the fact that they exhibit the hazardous characteristic of reactivity pursuant to VHWMR § 3.8.

Hazardous wastes incinerated at the facility may contain hazardous constituents as specified VHWMR Appendix 3.6. Such constituents include:

- Dinitrotoluene
- Nitroglycerine
- 2,4 and 2,6 Dinitrotoluene
- Dibutylphthalate
- Diethylphthalate
- Resorcinol
- Antimony
- Arsenic

- Barium
- Beryllium
- Cadmium
- Chromium
- Lead
- Mercury
- Silver
- Thallium

During the April 1993 trial burn, the facility demonstrated adequate destruction and removal efficiency (DRE) for these constituents. In addition, the maximum content of these constituents fed to the incinerator, and maximum emissions of the constituents from the incinerator are specified in the incinerator permit.

2.6 Waste Management Operations at the Facility

Hazardous waste from manufacturing operations at the facility is placed into containers at the point of generation. These containers are transferred to the facility hazardous waste accumulation area where they are held until they are transferred to the permitted treatment area.

At the permitted treatment area, the solid materials are ground and then mixed with water to form a slurry. The slurry is then pumped from the tank to one of two incinerators. Each incinerator system has a rotary kiln incinerator followed by an afterburner, a gas cooler, a fabric filter, a liquid scrubber, an exhaust draft fan, and a 35 foot exhaust stack.

The rotary kiln incinerators are natural gas fired units manufactured by Bartlett-Snow. Waste slurry is fed into the burner end of the kilns. The inclined rotating kilns create a tumbling action which allows the liquid portion of the slurry to boil off and the remaining solids to be burned.

The afterburners, gas coolers, fabric filters, liquid scrubbers, draft fans, and exhaust stacks comprise the air pollution control systems (APCS). The afterburners are also natural gas fired and they serve to combust any unburned gases evolved from the primary kiln. The gas coolers are wet systems utilizing water to cool the exhaust gas from the afterburners. The fabric filter is a series of Gore-Tex bags designed

to capture particulate matter in the gas stream. The scrubbers are wet scrubbers with hydro filters designed to further cool the exhaust gases and dissolve or precipitate vapors in the gas stream.

Operating conditions for the kilns and APCS are specified in the incinerator permit. Should any of the monitored parameters vary beyond the prescribed operational limits, the waste feed to the incinerator will automatically shut off. Waste feed will not resume until operating conditions are again within the specified limits.

2.7 Scrubber Description

The scrubber is installed at the exhaust from the explosive waste incinerator. The scrubber water contacts the incinerator exhaust gases which exchange heat and dissolve contaminants from the hot incinerator gas. Currently, the scrubber water does not flow to the spray pond, but stays in a tank and is part of the incinerator's operating permit. Previously, the scrubber water was pumped back to the spray pond where evaporative cooling took place. Water in the spray pond was re-used until the sludges which formed in the spray pond met the standards for a characteristic hazardous waste under Part III of the VHWMR. The spray pond contained varying amounts of lead at any time depending on the quantity of lead containing propellant incinerated. Traces of other heavy metals have also been detected in the spray pond water, although not at high enough concentrations to be a toxic hazardous waste.

Currently, the incinerator process has been modified so that the scrubber currently evaporates to the atmosphere while lead and other metals are deposited into a dust hopper after the water is evaporated, with no excess scrubber water which could contain leaded sludges.

3.0 CLOSURE PLAN

3.1 Introduction

The following closure plan for the incinerator spray pond has been prepared to meet the requirements of VHWMR Sections 9.6.L, 10.6 and 10.10.I.

3.2 Closure Performance Standards (VHWMR Section 10.6.B)

The following paragraphs describe the closure plans for the incinerator spray pond. These plans are intended to provide for closure of these units in a manner that will:

- Minimize the need for further maintenance, and
- Control, minimize or eliminate, to the extent necessary to prevent threats to human health and the environment, post-closure escape of hazardous waste, hazardous waste constituents, leachate, contaminated rainfall, or waste decomposition products to the ground or surface waters or to the atmosphere.

The closure performance standards will be accomplished by (1) the removal of the pond's contents; (2) removal or decontamination of any contaminated liner components, as well as aeration piping, ancillary piping, and pumps; (3) the sampling, testing, analysis, and possible removal of contaminated subsoils; and (4) assess groundwater contamination by implementation of the approved groundwater management plan. Sampling of the subsoils to show that constituent levels are no higher than background concentration will be the demonstration for clean closure. If subsoils cannot feasibly be shown to have less than or equal to background levels of constituents statistically, then the facility can attempt a clean closure by use of health based standards. The facility retains the option at any time to not attempt clean closure and to close as a landfill as delineated in § 9.13., VHWMR Amendment 13.

3.3 General Closure Approach

The free liquid in the ponds was drained to the minimum pump intake level during operation of the incinerator leaving approximately 6 inches of liquids and sludge on the floor of the pond shortly after the enforcement order became effective. The remaining water and sludge was removed and properly disposed of according to the VHWMR by transporting the waste residues to a permitted RCRA hazardous waste

disposal facility by a permitted hazardous waste transporter. The hazardous waste manifest forms are on file with VDEQ. The spray pond has subsequently been inactive and has filled with rainwater.

The water in the ponds will be analyzed for COD, Lead, and pH for Radford's hazardous waste generation reporting requirements, and the liquids will be sent to the waste water treatment plant via the adjacent forcemain. The pond's concrete liner will be demolished. Any bedding material under the concrete will be removed. Pumps and ancillary piping will be removed and decontaminated. Soil sampling and testing will identify sub-soils to be removed for disposal. Testing of the subsoils will be performed to confirm that the closure performance standards have been met. Once any contamination has been removed, the excavation will be back-filled with clean soils, graded to promote positive drainage, and re-vegetated. Equipment will be decontaminated in an approved manner. The contaminated materials (i.e. possibly soils, sludges, concrete, pipes, pumps and equipment rinsate) will be analyzed for all hazardous constituents of concern identified in this document and disposed of in accordance with VHWMR and VSWMR.

3.4 Inventory of Wastes (VHWMR § 10.6.C.2.c)

The inventory of wastes includes both a description of the amount of waste as well as its characteristics.

3.4.1 Maximum Waste Inventory

An estimate of the maximum waste inventory for the incinerator spray pond is shown in Table 3-1.

TABLE 3-1 MAXIMUM WASTE INVENTORY	
Waste Type	Quantity
liquid/sludge	76' x 60' x 3' = 13,680 cf = 102,336 gallons

3.4.2 Waste Characterization

The spray pond was used to cool scrubber water by evaporation. The water contacted the incineration exhaust to cool the hot gas and precipitate and dissolve contaminants. Heavy solids settled to the bottom of the spray pond and formed a layer of sludge beneath the liquid. The sludge was determined to be toxic for lead (>5 ppm), or EPA Hazardous Waste code D008.

3.5 Cleanup Targets

The development of cleanup targets is a two step process. First the hazardous constituents of concern (HCOCs) are identified. In this case, the incinerator's permit has identified certain VHWMR, Appendix 3.6 constituents be considered as potential hazardous constituents of concern. Appropriate cleanup levels are then developed for the constituents.

Target levels for cleanup will be developed by analyzing the background samples for the constituents of concern using the analysis methods outlined in Table 3-2. Using the analysis results, the tolerance limits for a normal distribution are calculated with 95% coverage and a 95% confidence. Analysis results for each constituent of concern for the pond will be compared to the upper tolerance limit. If the constituent level in the unit exceeds the upper tolerance limit for the background, the soil will be considered contaminated, and will be removed from the site. Disposal will be in accordance with VHWMR and VSWMR using analytical results from the wastes.

3.5.1 Hazardous Constituents of Concern

Hazardous constituents of concern are defined as those materials which may have come into contact with the unit during its lifetime. Hazardous constituents of concern for this closure are based on a review of off-specification product incinerated at Radford from the incinerator's operating permit. The following table 3-2 lists the hazardous constituents for this closure. The associated analysis methods and detection limits are also provided.

TABLE 3-2 HAZARDOUS CONSTITUENTS OF CONCERN

Contaminant	SW-846 Method	PQL Water ($\mu\text{g/L}$)	PQL Soil ($\mu\text{g/Kg}$)
2,4-Dinitrotoluene	8090	0.2	13
2,6 Dinitrotoluene	8090	0.1	7
Di-n-butylphthalate	8061	3.3	220
Diethylphthalate	8061	2.5	170
Resorcinol	8270	100	—
Antimony	6020	0.2	0.2
Arsenic	6020	0.2	0.2
Barium	6020	0.2	0.2
Beryllium	6020	0.2	0.2
Cadmium	6020	0.2	0.2
Chromium	6020	0.2	0.2
Lead	6020	0.2	0.2
Mercury	7470 or 7471	2	2
Nickel	6020	0.2	0.2
Silver	6020	0.2	0.2
Thallium	6020	0.2	0.2

Note: — = Not determined. Method 8270 may be used. The detection limit must be consistent with the detection limit of other constituents using this method, and documented through the QA/QC.

3.5.2 Development of Cleanup Targets

Closure to background levels will constitute soil's clean closure. Background levels will be determined from soil samples collected in areas that have not been affected by the operation of the incinerator spray pond. Background soil samples will be collected in an area with a depositional environment similar to the sediments underlying the incinerator spray pond, i.e., same approximate depth, color, odor, etc.

Background soil samples will be collected from selected locations in uncontaminated areas near and around the incinerator spray pond. By distributing the sample collection points within a geographic area with similar underlying sediments, the background sampling group will not be unduly influenced by any unknown local "hot spots".

3.6 Procedures for Removing, Transporting, Treating and Disposing of Wastes from the Incinerator Spray Pond (VHWMR Sections 10.6.C.2.c, 10.6.C.2.d and 10.10.I.1.a)

VHWMR Section 10.10.I.1.a requires that all sludge and other contaminated components of the pond (i.e. piping, concrete, bedding material, subsurface soils, etc.) be removed or decontaminated for surface impoundment soils to be "clean closed". To meet these requirements, Radford will remove all contaminated materials.

3.6.1 Incinerator Spray Pond Dewatering

The free liquid in the ponds was drained to the minimum pump intake level during operation of the incinerator leaving approximately 6 inches of liquids and sludge on the floor of the pond (prior to this closure plan's approval). The remaining water and sludge was removed and properly disposed of according to the VHWMR by transporting the waste residues to a permitted RCRA hazardous waste disposal facility by a permitted hazardous waste transporter. The hazardous waste manifest forms for the transport of the waste are on file with VDEQ.

The spray pond has subsequently been inactive and has filled with rainwater. The water in the ponds will be tested for hazardous characteristics for the facility's waste generation/record keeping purposes, and the liquids will be sent to the waste water treatment plant via the adjacent forcemain. When the ponds' free liquid has drained, a visual inspection will inspect for any remaining or newly formed sludge. If sludge is found, it will be tested for hazardous characteristics and handled in accordance with the VHWMR. All

hazardous waste generator requirements of VHWMR Parts V and VI will be followed. It is expected that no solids will have formed since the pond has not been in use since it was thoroughly cleaned.

3.6.2 Concrete Liner and Bedding Material Removal

The concrete liner will be demolished. One representative sample of the concrete will be taken and tested for hazardous characteristics in accord with VHWMR Part III. If the concrete tests positive for a hazardous characteristic, then the concrete liner will be transported by a permitted hazardous waste transporter to a RCRA approved hazardous waste treatment, storage, or disposal facility. All hazardous waste generator requirements of VHWMR Parts V and VI will be followed. If the concrete liner representative sample tests negative for hazardous characteristics, then the concrete will be disposed of in a permitted debris landfill.

A sand and gravel bedding material may exist under the concrete liner. One representative sample of the bedding material will be taken and tested for hazardous characteristics. If the bedding material tests positive for a hazardous characteristic, then the bedding material will be transported by a permitted hazardous waste transporter to a RCRA approved hazardous waste treatment, storage, or disposal facility. All hazardous waste generator requirements of VHWMR Parts V and VI will be followed. If the bedding material representative sample tests negative for hazardous characteristics, then the bedding material will be disposed of in a permitted debris landfill.

3.6.3 Pipes and Pump Removal

In cooperation with concrete demolition, the piping, drains, and pumps will be removed and decontaminated according to Section 3.8.3. Piping, valves, and pumps will be dismantled and placed in a washdown station. Decontaminated piping will be disposed of as scrap metal. If in good condition, decontaminated pumps, valves, and piping will be placed in storage for possible future use. Pipes, pumps, and valves which cannot be decontaminated will be transported to a permitted RCRA hazardous waste disposal facility by a permitted hazardous waste transporter. The materials will be transported by a permitted hazardous waste transporter to a RCRA approved hazardous waste treatment, storage, or disposal facility. All hazardous waste generator requirements of VHWMR Parts V and VI will be followed.

3.6.4 Subsoil Assessment

The investigation/assessment described herein will be implemented to determine whether residual hazardous waste constituents (as defined under the VHWMR) associated with the scrubber water leached into the underlying subsoils, and to determine if clean closure of the soils is achievable. If it appears achievable, Radford will excavate contaminated subsoils. The materials will be transported by a permitted hazardous waste transporter to a RCRA approved hazardous waste treatment, storage, or disposal facility. All hazardous waste generator requirements of VHWMR Parts V and VI will be followed.

The pond will be excavated as rapidly as possible to lessen the possibility of a precipitation event that may transport contaminants through the unsaturated zone. Radford will be responsible for scheduling and planning the excavation to limit the occurrence of this potential situation.

Data will be collected by performing the following tasks:

- Collect sufficient data to determine the horizontal and vertical extent of contamination in the subsoils.
- Collect sufficient data to calculate the quantities of affected subsoils.
- Statistically compare samples to representative background samples for designated closure parameters to evaluate achievement of clean closure.

3.7 Sampling and Analysis Plan

The following soil sampling and analysis plan details the necessary sampling procedures and analysis methods that will be employed to verify clean closure of the soils.

3.7.1 Background Sampling for Soil Assessment

Background conditions will be established as follows. Four background samples are the minimum number to achieve statistically usable background data. VDEQ recommends 6 to 8 background sampling locations for Radford's Incinerator Spray Pond Closure. It is Radford's option to select more than eight background sampling locations to provide variance in the statistical background. The sampling locations shall be in soil similar to the soil under the concrete spray pond liner. These background sample locations will be

selected from an area of the plant reasonably assumed (based on general knowledge of the area and plant operations) to be uncontaminated by any industrial activities that could have resulted in past or present releases of hazardous constituents. Background soil sample results along with the quality assurance/quality control (QA/QC) documentation required by SW-846 will be submitted to the VDEQ prior to performing statistical comparisons for approval of background soil sample locations.

Standard statistical methods will be used to test assumptions of normality and to check for possible data outliers; techniques supported by the statistical literature will be used, and relevant references will be cited; (i.e., "Outliers in Statistical Data," V. Barnett and T. Lewis, 1984).

Any outlier data identified will either be:

- Replaced by data obtained in a subsequent supplemental background sampling effort;
- Replaced by the sample value closest to the outlier value (if no further supplemental background sampling is conducted); or
- If any other method(s) are identified to handle outliers, justification will be provided for the use of the selected method(s).

Data transformations will be applied, as needed, to ensure that the key assumptions are met when computing interval estimates and/or conducting hypothesis tests. However, the analytical methods to be employed are robust (in the statistical sense), and will likely apply even if the underlying assumptions are not fully met.

The minimum number of valid background samples to be utilized is four. Radford Army Ammunition Plant reserves the option to take additional background samples for purposes of determining whether collected data are non-normal so that appropriate adjustments can be made.

Special handling will be required for samples with "not-detected" values as the analytical result. One-half of the corresponding lower detection limit value for the analytical method employed will generally be used as the numerical replacement for "not detected."

After an appropriate assessment of the background data is conducted and the data are formally approved by the VDEQ, a background critical value will then be calculated based on a one-sided upper tolerance limit.

With respect to the tolerance limit approach discussed below, many references can be cited, but the method and numbers quoted in this section come from Handbook 91, Experimental Statistics, United States Department of Commerce, National Bureau of Standards, issued August 1, 1963. From this reference (specifically pages 2 through 14 subsection 2.5.3), the upper tolerance limit for a normal distribution is as follows:

$$X_{cv} = X_{\bar{m}} \pm (K)(s)$$

where, X_{cv} is the critical value computed for the one sided upper tolerance limit;

$X_{\bar{m}}$ is the computed average of the background samples;

s is the computed standard deviation of the background samples; and,

K is a theoretically-determined value given in a table.

The parameter K (or $K_{95(95,n)}$) establishes the upper tolerance limit such that there is a 95% chance that at least 95% of the time, the actual constituent background concentration will be below this upper bound. The value of this parameter for eight samples ($n=8$) is 3.188. To establish clean closure of the soil, the results of the analyses of each sample will be compared to the upper tolerance limit for the HCOCs. If the values for each HCOC are below the respective upper tolerance limit, then the sample has been demonstrated to be "clean."

The established statistical conditions are to be 95% confident that at least 99.75% of the background population can be expected to lie below the critical value, X_{cv} . Therefore, if a clean closure parameter observed in a spray pond soil sample yields a value that exceeds X_{cv} , then it will be concluded that the soil (in the sample's representative location) is statistically greater from background and must be removed to establish clean closure of the soil.

3.7.2 Subsoil Testing

This section describes the specific assessment protocols to be utilized to determine if clean closure can be achieved for the incinerator spray pond subsoils. The methodology presented below is based on meeting the data requirements outlined. Figure 3-1 shows the 20 grid nodes developed based on the outlay of expansion joints. Since the joints in the concrete liner are the most likely sources of contamination, sampling locations will be selected based on the joint locations. The grid consists of 19x20 foot sections.

The plan described below was developed in accordance with sound standard statistical methods. All data obtained will be reviewed, summarized, and analyzed according to the methods described in this section. Statistical techniques used throughout the analysis will be clearly explained and will be supported by citing appropriate references. Full citations can be found in the References. The closure plan consists of the followings aspects:

- Background characterization
- Initial random sampling of the subsoils
- Possible excavation, repeat sampling, or contingent closure
- Repeat excavation and sampling or contingently close
- Supplemental "hot spot" delineation sampling of the subsoils (if required)

FIGURE 3-1 SAMPLING GRID AND NODES

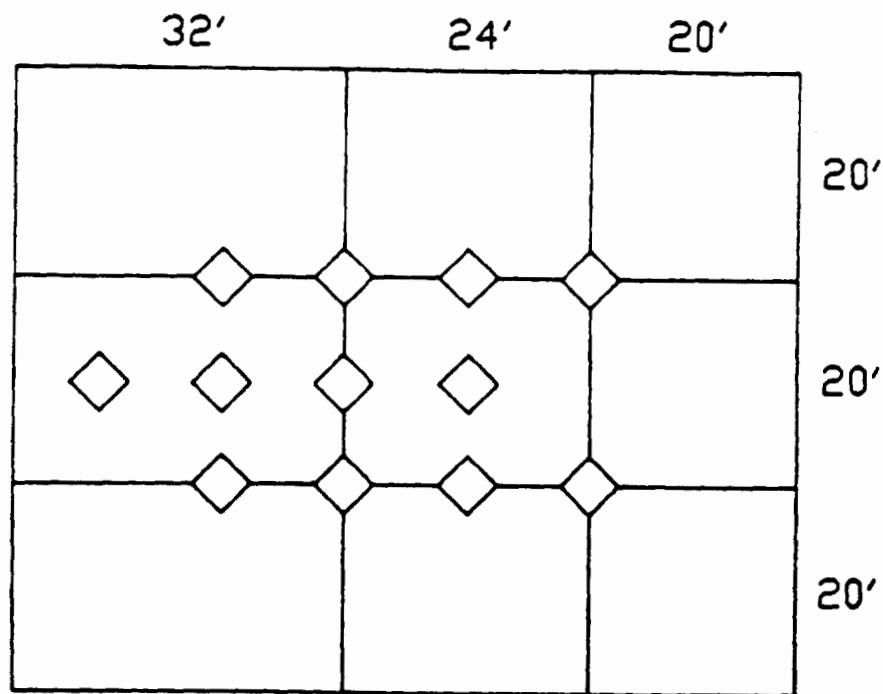


FIGURE 1A. LOCATION OF JOINTS IN CONCRETE LINER

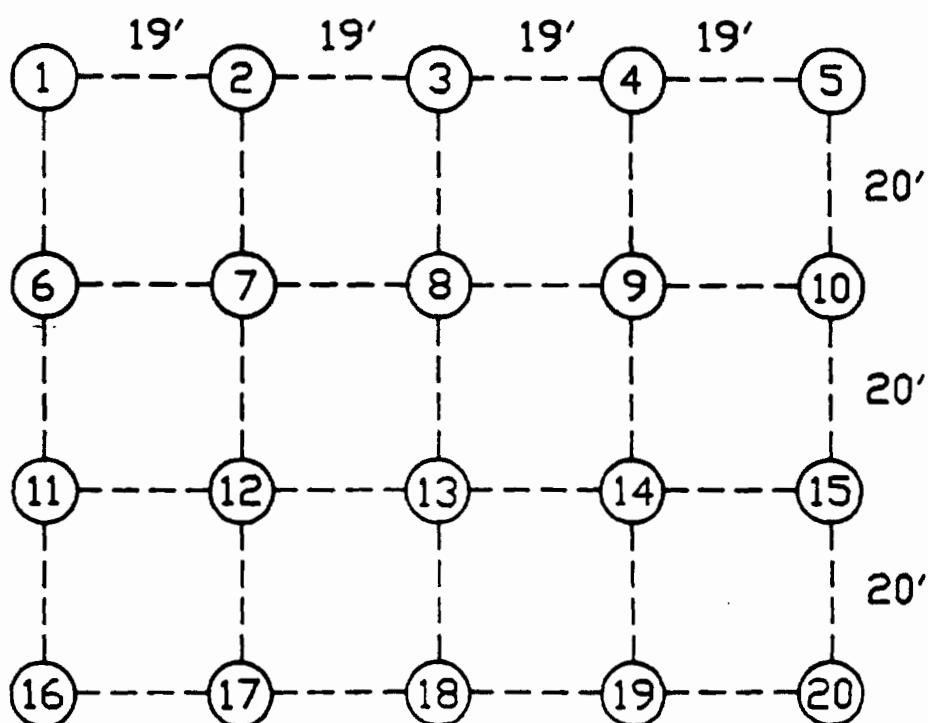


FIGURE 1B. LOCATION OF POSSIBLE SAMPLING POINTS

The initial random sampling will be conducted to determine if clean closure can be achieved and whether soil removal will be required to achieve clean closure. A "hot spot" sampling approach may be used to better delineate contaminated areas for excavation and subsequent disposal, depending on the results from random sampling. The samples will be discrete samples.

Radford Army Ammunition Plant reserves the option, at any point during the incinerator spray pond subsoils assessment, to abandon attempts to demonstrate clean closure and immediately implement contingent closure and post-closure.

The subsoils will be evaluated by collecting a minimum of eight soil borings, randomly distributed across the grid nodes which intersect the expansion joints in the concrete liner, (or identified cracks). Samples will be collected at the surface (0-3 inches), 6 inches, 12 inches, 18 inches, and 24 inches. The samples will be analyzed by vertical stratum for the established hazardous constituents of concern. If analytical results of the surface samples are below cleanup goals, the unit will be considered clean and no additional sampling and analysis will be performed.

If the surface samples' analytical results are statistically above background levels, each successive set of samples (6 inches, 12 inches, 18 inches, 24 inches) will be analyzed until all sample analytes are statistically below the background levels of constituents. The subsoils will be excavated to the depth where all sample analytes are below the background levels.

Alternatively, Radford may choose to sample, test, and compare each one of the 20 sampling node locations. The nodes located as "hot spots" by this testing will then be excavated to a point where the sample analytes are below clean-up goals.

If random sampling indicates that contamination is widespread across the spray pond in a layer, then the layer may be excavated without performing additional sampling to reduce costs on sampling. On the other hand, if it appears that contamination is localized, more sampling and testing can be performed with the intention of reducing costs on excavating only the contaminated subsoils.

The excavation of "hot spot nodes" will be the 19'x20' grid surrounding the node, (or half way between the successive nodes.)

A sufficient number of samples will be analyzed to statistically confirm clean closure. Sample values will be compared to the upper tolerance limits as discussed in "Background Sampling". Data values reported as less than the Practical Quantitation Limit will be treated as one half ($\frac{1}{2}$) the Practical Quantitation Limit (PQL) unless the facility chooses another method in accordance with the methods outlined in Guidance on Statistical Methods for Groundwater Data Analysis at a Solid Waste or Hazardous Waste Site, Virginia Department of Environmental Quality, Office of Waste Resource Management, 1994, and by the procedures summarized in Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Interim Final Guidance (April, 1989).

If the samples taken at any level contain hazardous constituents of concern statistically above the background levels, a decision may be made to continue sampling and excavation or to implement the contingent closure plan. A determination of the appropriate point to discontinue excavation and begin implementation of the contingent closure plan will be based on actual field conditions encountered.

3.7.3 Initial Physical Observation of Subsoils and Excavation

Radford Army Ammunition Plant may observe physical signs of contamination including discoloration of subsoils, odor, X-ray fluorescence (XRF), or others. If physical signs of contamination are observed, Radford reserves the option to excavate potentially contaminated subsoils until the physical signs of contamination are no longer apparent prior to initial random sampling. XRF will analyze the soils samples for total lead. The XRF data will be used to guide the excavation and aid in removal of contaminated soils prior to initial random sampling.

3.7.4 Initial Random Sampling and Excavation

The sample grid will be assembled by field personnel prior to sampling. Wooden stakes or other suitable material will be used to mark all points along the sample grid.

A minimum of eight soil borings, distributed randomly across the 20 grid nodes will be advanced to a depth of 24 inches. The eight nodes selected for sampling will be determined via use of a random number generator. All eight samples taken will be analyzed for each of the hazardous constituents of concern specified in this closure plan. Additional borings may be placed in areas of suspected contamination, such as an area where the liner was found to be cracked. Samples will be collected at the surface, 6 inches, 12 inches, 18 inches, and 24 inches.

In the event that the contaminated soils cannot be practically removed, then the contingent closure plan will be implemented. A determination of the appropriate point to discontinue excavation and begin implementation of the contingent closure plan will be based on actual field conditions encountered.

The surface samples will be collected using stainless steel hand corers. A stainless steel auger will be used for collecting the 6, 12, 18, and 24 inch samples. The auger will be forced down into the soil and then withdrawn. The bottom of the six inch soil layer will be placed in the sample container. If the desired depth cannot be reached using the hand auger or if the soil is tightly packed, then a portable power auger will be used for sample collection. Soil sampling will be performed in accordance with the representative sampling methods contained in VHWMR Appendix 3.2.

For a particular clean closure parameter, if all of the individual random sample values are at or below the established critical value (X_{α}), then the pond will be considered "clean" with respect to that clean closure parameter and no further sampling for that parameter will be required. However, if any of the individual lagoon random sample values for that clean closure parameter are above the critical value supplemental "hot spot" delineation sampling (discussed below) may be performed based on actual field conditions encountered.

3.7.5 "Hot Spot" Delineation Sampling and Excavation

Based on the results of the initial random sampling, supplemental "hot spot" delineation sampling will be conducted for all clean closure parameters. (However, as previously noted, Radford reserves the option at any point in the sampling process to abandon attempts to achieve clean closure and immediately implement the Contingent Closure and Post-Closure Plans.)

If implemented, the hot-spot delineation method will proceed as follows:

1. Additional sampling of the existing surface soil (0-6) inch layer will be conducted at the remaining (20-8=12) twelve grid nodes not previously sampled under the previous random sampling effort. These additional samples will be analyzed for all clean closure parameters for which clean closure was not confirmed under the previous random sampling effort.
2. For all 20 grid nodes sampled, independent comparisons will be made of each individual node sample value to the background critical value (X_{cn}).
3. If the background critical value (X_{cn}) is equal to or greater than the individual pond node sample value, that particular node is considered "clean" with respect to the closure parameter being evaluated. If, on the other hand, the background critical value (X_{cn}) is less than the node sample, then:
 - a. Based on the results from surrounding sample location nodes, hot spot area(s) within the defined areal extent of the pond will be delineated for subsequent soil removal efforts.
 - b. Additional subgrid sampling may be performed to further refine delineation of identified "hot spots" for soil excavation.
 - c. After excavation of the existing surface soil (0-6 inch) layer within defined hot spot(s), resampling will be performed at all established grid nodes within the "hot spot" area(s). Samples will be analyzed for all clean closure parameters (HCOC's) for which clean closure has not been demonstrated.

- d. Following resampling, comparison to background¹ along with additional 6-inch soil layer excavation (if required) will be performed in accordance with the protocols previously outlined.

If, upon following these protocols in an attempt to achieve clean closure, the pond surface soils have been removed from the hot spot(s) down to a sufficient level without achievement of clean closure for all closure parameters, Radford Army Ammunition Plant (RAAP) will:

- * Implement the contingent closure and post-closure procedures of this plan; or
- * Continue with removal activities and sampling of soil layers, as detailed above; or
- * Perform closure to risk based standards as detailed in §3.7.6 of this closure plan.

As previously stated, the facility reserves the option, at any point during the incinerator spray pond subsoils assessment, to abandon attempts to demonstrate clean closure to either background or risk based standards, and immediately implement contingent closure and post-closure.

3.7.6 Risk-Based Closure

As an alternative to clean closure to background standards, specified above, or in conjunction with background standards, RAAP may propose to demonstrate that the concentrations of hazardous constituents detected do not pose an unacceptable level of risk to human health and the environment. The facility may present this proposal to the DEQ following the requirements as outlined in this section and as detailed in Appendix A.

In order to estimate the risk for HCOCs, a risk assessment will be conducted according to the DEQ document titled "Guidance for development of health based cleanup goals using decision tree/REAMS program (herein after "Virginia Risk Guidance"), November 1, 1994, prepared by Old Dominion University and the approved closure plan. The risk goals/performance standards will be a hazard index of 1.0 for non-carcinogens and an individual carcinogenic risk of 1×10^{-6} and cumulative carcinogenic risk of 1×10^{-4} . This risk assessment will be conducted assuming a future residential use of the property.

The Department will review the risk assessment report to determine that it conforms to risk assessment requirements for residential risk-based protocols. If acceptable, attainment of the closure standards may then be demonstrated using the residential risk-based assessment in lieu of the clean closure to background standards established under §3.7.1 Background Sampling For Soil Assessment.

If the Incinerator Spray Pond cannot meet the residential risk closure standards, then RAAP may propose to modify this closure plan for industrial risk-based closure. Modification will require notification of the DEQ and the submittal of a closure amendment, in accordance with 9 VAC 20-60-580.C (previously, VHWMR §9.6.C).

¹(Optional) The background critical value described thus far will have been computed from the top layer (0-6 inches) of the background area. It may be necessary to sample background at lower intervals (6-12 inches, 12-24 inches) for comparison at lower intervals to avoid bias. This option should be implemented if, for example, distinctly different soil types are encountered at depth, thereby necessitating re-establishment of background.

Note, for the remaining sections of the closure plan, any discussions of "clean" closure of the incinerator spray ponds' subsoils, will signify either clean closure to background levels and/or closure to risk based closure standards, as described in this section.

3.8 Field Quality Control

To ensure the collection of representative samples, the following field quality control procedures will be utilized during the closure operations.

Equipment blanks will be collected after every 20th sample. If equipment blanks indicate contamination, then resampling will occur only if sample results are above cleanup levels. Samples will be analyzed for the hazardous constituents of concern identified in this document. Laboratory quality control will be according to the methods detailed in SW-846.

Laboratory quality control will be according to the methods detailed in SW-846.

3.8.1 Sample Preservation and Maximum Holding Times

Soil samples usually require no preservation other than storing at 4°C until analyzed. The maximum holding times vary for different measurements. Table 3-3 provides the maximum holding times for certain inorganic and organic analyses. Although these criteria were specifically designed and tested for water samples, they are also applicable for soil sampling studies (Barth and Mason, 1984).

TABLE 3-3 REQUIRED CONTAINERS AND MAXIMUM HOLDING TIMES FOR SOIL SAMPLES (This table was adapted from Tables 2-16 and 4-1 of SW-846)		
Name	Container	Maximum Holding Time
<u>Inorganic Tests:</u> Acidity	P,G	14 days
Alkalinity	P,G	14 days
Ammonia	P,G	28 days
Chemical Oxygen Demand	P	28 days
Cyanide, total and amenable to chlorination	P,G	14 days
<u>Metals:</u> Chromium VI	P,G	24 hours
Mercury	P,G	28 days
Metals, except chromium VI and mercury	P,G	6 months
Nitrate	P,G	48 hours
Nitrate-nitrite	P,G	28 days
Nitrite	P,G	48 hours
Oil and grease	G	28 days
Organic carbon	P,G	28 days
Orthophosphate	P,G	48 hours
Phenols	G only	28 days
Phosphorus (elemental)	G	48 hours
Phosphorus, total	P,G	28 days
Sulfate	P,G	28 days
Sulfide	P,G	7 days
Sulfite	P,G	Analyze immediately
<u>Organic Tests:</u> Volatile Organics	4 ounce, (120 ml) wide mouth glass with teflon liner	14 days
Semivolatile Organics/Organochlorine Pesticides/PCBs	8 ounce, wide mouth glass with teflon lined lid.	Samples must be extracted within 14 days and extract analyzed within 40 days following extraction.

Notes: Soil samples collected for purgeable organic compounds analyses shall be thoroughly mixed and containerized as soon as possible after sampling. The samples shall be placed in the sample container so that no head space is left in the container after the container is closed.

3.8.2 Split Samples, Spiked Samples and Blanks

Blanks, split samples and spiked samples are collected to provide a measure of the internal consistency of the sample collection and handling methodology and to provide an estimate of the components of variance and the bias in the analytical process.

Samples can be split to:

- Provide a measure of the within sample variability.
- Provide material for spiking in order to test recovery.
- Provide a measure of the sample extraction error.

The component of variation that is measured by a split sample is determined by the location of the sample splitting. A field split measures errors associated with field handling and within sample variation. A split of samples made in the laboratory for extraction purposes measures the extraction error (Barth and Mason, 1984).

A true split of sediment, soil or sludge samples is almost impossible to accomplish under field conditions. The difficulty of splitting a sample increases as the sample's moisture content increases. The sample should be considered a duplicate sample, rather than a split sample (EPA Region IV, Standard Operating Procedures and Quality Assurance Manual, 1986).

Spike samples are made by adding a known amount of a reference chemical to one of a pair of split samples. The recovery of the analytical process is measured by comparing the analysis results of the spiked sample with the non-spiked sample. The difference in results provides a measure of the analytical bias.

Spike samples are difficult to prepare with soil material. Usually, the spike solution is added to the extract of the soil. Utilizing this procedure avoids the problem of mixing, etc., but does not provide a measure of the interaction of the chemicals in the soil with the spike nor does it provide an evaluation of the extraction efficiency. Due to these constraints, field spikes are not commonly used (Barth and Mason, 1984). Field spikes will not be used in these investigations.

Blanks are collected to provide measures of various cross-contamination sources, background levels in the reagents, decontamination efficiency and any other potential errors that can be introduced from sources other than the sample. The blanks associated with field QA/QC include the trip blank, field blank and equipment blank. A trip blank measures any contamination that may be introduced into the sample during

shipment of containers from the laboratory to the field and back to the laboratory. A field blank measures input into the sample from contaminated air or dust. An equipment blank measures chemicals that may have been in the sample container or on the tools after equipment decontamination is complete.

EPA's Third Edition of Test Methods for Evaluating Solid Wastes, (SW-846) recommends that QA/QC samples be collected at least once with every analytical batch with a minimum of once per twenty samples. This sampling frequency has also been stated in the document Soil Sampling Quality Assurance Users Guide (Barth and Mason 1984).

Table 3-4 presents a breakdown of the recommended field QA/QC procedures for soil sampling. The contracting laboratory may desire to collect more QA/QC samples than detailed. Prior to sampling, Radford will consult with the contracting laboratory about the appropriate QA/QC procedures. These procedures will be in accordance with EPA's Third Edition of Test Methods for Evaluating Solid Waste (SW-846).

TABLE 3-4 FIELD QA/QC PROCEDURES FOR SOIL SAMPLES

PROCEDURE	COMMENTS
1. Field Blank	Field blanks are metal-and/or organic free water aliquots that contact sampling equipment under field conditions and are analyzed to detect any contamination from sampling equipment, cross-contamination from previously collected samples, or contamination from conditions during sampling (i.e. airborne contaminants that are not from the waste being sampled). One sample of site tap water will be collected every day in which tap water is used for decontamination purposes.
2. Duplicate Samples	Field duplicates are employed to document precision. The precision in sample duplicates is a function of the variance of waste composition, the variance of the sampling technique, and the variance of the analytical technique. Duplicate samples should be collected in the field by aliquotting a sample into separate containers. One duplicate sample will be collected for every twenty samples. The containers should be labeled as duplicate samples.
3. Trip Blanks	Trip blanks are used to detect any contamination or cross-contamination during handling and transportation. Trip blanks should accompany sample containers to and from the field. The appropriate trip blank containers should be filled with analyte-free water. Preservatives and additives will be added as required for each parameter group. Trip blanks should be sealed and stored in an ice chest where real samples will be stored and transported. A pair of trip blanks will accompany each cooler containing empty or filled volatile sample containers.
4. Equipment Blanks	An equipment blank should be prepared for each parameter group sampled where a particular piece of sampling equipment was employed for sample collection and subsequently decontaminated in the field for use in additional sampling. The equipment blank should be composed in the field by collecting, in the appropriate container for the parameter group, a blank water rinse from the equipment (auger, pump tubing, etc.) after execution of the last step of the proper field decontamination protocol. Preservatives or additives must be added to the equipment blank where appropriate for each parameter group. The type and frequency of these samples are specified within the text discussing the extent of contamination sampling.
NOTES: 1) Reference: SW-846, Chapter Nine, Pages Nine 61-63; Chapter One Page 1-10. 2) Field QA/QC samples should be collected at least once with every analytical batch with a minimum of once per twenty samples.	

3.8.3 Sampling Equipment Decontamination

All non-disposable sampling equipment will be decontaminated between each sample. Those sampling implements which cannot be decontaminated effectively will be containerized and properly disposed of based on sample analytical results.

The decontamination of sampling equipment (hand auger, scooplula, trowel, etc.) will be performed as follows and follows the decontamination procedures for sampling equipment (EPA Region IV, Standard Operating Procedures and Quality Assurance Manual, 1986,):

1. Clean with tap water and a soap solution (A phosphate-free laboratory detergent such as Alconox, Aliquinox, Liquinox will be used for cleaning) using a brush if necessary to remove particulate and surface films.
2. Rinse thoroughly with the Radford's potable water.
3. Rinse thoroughly with deionized water.
4. Rinse thoroughly with organic-free water and allow to air dry as long as possible. If organic-free water is not available, allow equipment to air dry as long as possible. Do not rinse with distilled or deionized water.
5. Wrap with aluminum foil, if appropriate, to prevent contamination if equipment is going to be stored or transported.

All rinsate waters will be contained and analyzed for the constituents of concern prior to discharge. Disposal of rinsate will be performed based on sampling results and in accordance with the VHWMR. All sampling equipment will be decontaminated prior to sampling, between sample depths, and between samples unless new or dedicated (i.e, used only for one sample) equipment is used. Sampling equipment will be disposed of as hazardous waste at the conclusion of the sampling program, where appropriate.

Large equipment used for closure activities will be cleaned prior to its use on site. The decontamination of the larger sampling equipment will occur in a temporary constructed decontamination area. A 20-ft x 30-ft area will be graded with at least a 2% slope towards one corner of the area. The area will be lined with an appropriate plastic liner to prevent infiltration of decontamination water into the soils. The area will drain into a polyethylene container. Rinsate and other wastes generated during decontamination will be placed into 55 gallon drums. This proposed decontamination area has been designed so as not to meet the definition of a surface impoundment (40 CFR Part 260.10). Following closure, the large sampling equipment will be decontaminated using steam cleaning followed by a potable water rinse.

All wastes generated during the decontamination process will be accumulated in 55 gallon drums for less than 90 days storage.

The decontamination area's synthetic liner will be disposed of in accord with the VHWMR and the VSWMR. If analytical results show the liner is a hazardous waste by characteristic, then the liner will be transported via a Virginia permitted hazardous waste transporter and disposed of off-plant at an approved hazardous waste facility. If it is not hazardous, it will be disposed of in a permitted debris or sanitary landfill.

The rinsate collected during the decontamination process will be transferred to 55-gallon drums for storage until test results are received. If the water in the drums tests to be hazardous, it will be accumulated according to VHWMR, § 6.4.E., transported via a Virginia permitted hazardous waste transporter and disposed of off-plant at an approved hazardous waste facility. If it is not hazardous, it will be disposed of in the biological waste water treatment plant with VDEQ approval. Equipment blanks will be collected for decontamination quality control.

3.8.4 Sample Handling

Each sample jar should be clearly labeled with an identifying number, the point of sampling as documented on a diagram of the area, the time and date of sample collection, the name of the individual responsible for sample collection, and the parameters for analysis.

When the sample jars are shipped to the laboratory, a seal will be placed on the shipping container in such a way that the containers cannot be opened in transport without breaking the seal.

A chain-of-custody record will be maintained to document the responsibility for sample possession from the time of collection until the analysis is completed.

A field log book will be maintained. The sample location, the time, date, parameters for analysis, and approximate volume of each sample will be recorded. The appearance of the sample, the conditions at the time of sampling and any other relevant field observations will be recorded.

3.9 Sample Custody

3.9.1 Introduction

Sample identification and chain-of-custody establishes the documentation and control required to identify and trace a sample from collection to completion of analysis. Sample identification and chain-of-custody

will be maintained during all closure activities conducted at Radford Army Ammunition Plant through the following chain-of-custody procedures and documentation:

- Sample labels, which prevent misidentification of samples;
- Custody seals to preserve the integrity of the sample from the time it is collected until it is opened in the laboratory;
- Field logbook and pictures to record information about closure activities and sample collection;
- Chain-of-custody record to establish the documentation necessary to trace sample possession from the time of collection to laboratory analysis; and
- Sample analysis request sheet to inform the laboratory of pertinent information noted in the field logbook.

The purpose of these procedures is to ensure that the quality of the sample is maintained during its collection, transportation, storage and analysis.

3.9.2 Chain-Of-Custody

A sample is in custody if it is (1) in someone's physical possession or view, (2) locked up, or (3) kept in a secure area that is restricted to authorized personnel.

3.9.3 Field Custody Procedures

As few persons as possible should handle samples in the field. The sample collector is personally responsible for the care and custody of samples collected until they are transferred to another person. The site team leader for the closure activities will determine whether proper custody procedures were followed during field work and decide if additional samples are required.

3.9.4 Sample Labels

Identification sample labels are to be attached to the field sample containers. Gummed paper labels or tags should be used. The tags should contain the following information:

1. Name of collector
2. Date and time of sample collection
3. RAAP-#39-XX-YY-ZZ

where: RAAP = Site name (RAAP)

#39 = Unit Number

XX = Grid Location Number

YY = Sample Depth (As depth below datum, i.e., bottom of concrete liner)

ZZ = Special Code as follows:

- 01-Normal Sample
- 02-Duplicate Sample
- 03-Field Blank
- 04-Trip Blank

4. Type of sample with brief description (i.e., grab, composite, background, soil, liquid, concrete, bedding material; random, "hot spot", decontamination test, etc.)

Sample information will be printed on the label in a legible manner using waterproof ink. The identification on the label must be sufficient to enable cross reference with the laboratory logbook.

Sample labels will be affixed to the sample containers prior to or at the time of sampling. The labels will be filled out at the time of collection.

3.9.5 Custody Seals

Custody seals are reprinted adhesive-backed seals with security slots designed to break if the seals are disturbed. Seals are placed over the cap of the individual sample bottle and in as many places as possible on shipping containers. The seals will be affixed to the sample bottles and shipping containers before the samples and containers leave the custody of the sampling personnel. The custody seals will at a minimum contain the following information:

- Sample number (This number must be identical with the number on the sample label)
- Name of collector
- Date and time of sampling
- Place of collection

3.9.6 Field Logbook

Field logbooks are necessary to provide sufficient data to enable field participants to reconstruct events that occurred during the closure activities.

All pertinent sampling and field survey information will be recorded in a logbook. All logs will be kept in a waterproof bound notebook with numbered pages (8-1/2 by 11 inches). All entries will be printed in waterproof ink. No pages will be removed and corrections will be made by drawing a single line through the incorrect data and initializing and dating the correction that was made to the side of the error. Entries in the logbook should contain at a minimum the following information:

- Location of sampling point (and location code XX-YY-ZZ as stated above)

- Name and address of field contact
- Type of waste (i.e. soil, sludge, wastewater)
- Suspected waste composition, including concentrations (i.e., D008)
- Number and volume of samples taken
- Purpose of sampling (i.e. contract number, closure activities)
- Description of sampling point and sampling methodology
- Date and time of collection
- Collector's sample identification number
- Sample distribution and how transported (i.e. name of laboratory, UPS, Federal Express)
- References, such as maps or photographs, of the sampling site
- Field observations
- Any field measurements made (i.e. pH, conductivity)
- Signatures of personnel responsible for observations

3.9.7 Chain of Custody Record

A chain-of-custody record will accompany every sample. The record should contain the following information:

- Sample number
- Signature of collector
- Date and time of collection
- Place and address of collection
- Waste type
- Signature of persons involved in the chain of possession
- Inclusive dates of possession

3.9.8 Photographs

Documentation of a photograph is crucial to its validity as a representation of an existing situation. Therefore, the following information regarding photographs will be recorded in the Field Logbook:

- Date, time, location of photograph
- Photographer
- Weather conditions
- Reasons why photograph was taken
- Sequential number of photograph and the film role number
- Camera lens system used

Once the photographs have been developed, this information will be recorded on the back of the photograph.

Photographs cannot be readily taken without the permission of Radford Army Ammunition Plant's Commanding Officer. Thus, prior to closure activities, a request will be made to the Commanding Officer asking for permission to photograph the closure activities.

3.9.9 Sample Analysis Request Sheet

A sample analysis request sheet will accompany the sample on delivery to the laboratory. The person who collects the sample will complete the field portion of the form. All pertinent information recorded in the field logbook will also be included on the sample analysis request sheet. The laboratory portion of the form will be completed by laboratory personnel. The following minimal information will be recorded:

- Name of person receiving the sample
- Laboratory sample number
- Date and time of sample receipt
- Sample allocation
- Analyses to be performed

All samples will be delivered to the laboratory as soon as practicable (usually within 1 or 2 days after sampling and samples must always be kept at 4°C). The sample will be accompanied by a chain-of-custody record and also by a sample analysis request sheet. The sample will be delivered to the laboratory personnel who is authorized to receive samples.

3.9.10 Sample Designation

Sampling locations at the pond will be marked with stakes and surveyed to determine the coordinate and elevation where possible. Once the stake is marked and in place, the area will be photographed. The stake will be marked with the appropriate station and/or sample number.

Samples collected from each location, other than those collected for on-site field measurements or analyses, will be identified by using a standard label which is attached to the sample container.

3.9.11 Sample Handling, Packaging, and Shipping (VHWMR § 3.1.D.2)

For sampling packing and shipping, Radford Army Ammunition Plant will comply with the U.S. Postal Service Regulations, Department of Transportation Regulations and/or the Virginia Regulations Governing Transportation of Hazardous Materials.

3.10 Data Reporting

During the Incinerator Spray Pond Closure, the following data reporting will be conducted:

- Background soil sampling results along with the QA/QC documentation required by Chapter 1 of SW-846 will be submitted to the VDEQ prior to performing statistical comparisons for approval of background soil sample locations.
- Upon completion of the sub-soil assessment sampling, the data will be tabulated and the required statistical comparisons performed. The results will be submitted to the VDEQ for review. Based on the results, either:
 - Clean closure will be achieved and the corresponding closure certification report will be prepared and submitted to the VDEQ.
 - Additional soil removal efforts will be conducted in an attempt to achieve clean closure.
 - Contingent closure and post closure will be implemented as detailed in this plan.

3.11 Groundwater Closure

Groundwater will be monitored in accordance with the Groundwater Monitoring Plan (as updated) until:

- "Clean" closure for both saturated soils (groundwater) and unsaturated soils (the incinerator spray pond subsoils) have been demonstrated; or,
- A post-closure care permit for cap maintenance and/or groundwater monitoring requirements is obtained.

The specific procedures and criteria for determining "clean" closure with respect to groundwater will be specified in the groundwater monitoring plan. The following procedures are outlined in more detail in the groundwater monitoring plan:

- For all monitoring wells, initial background concentrations of all designated monitoring parameters will be established based on quarterly sampling for 1 year.

For each parameter on the "clean" closure list, specific statistical methods listed in the groundwater monitoring plan will be used to make statistical comparisons. The comparison will consider each of the wells individually in the monitoring system.

After the fifth quarter statistical comparison is performed, the following scenarios are possible:

- If "clean" closure with respect to both the soil and groundwater is achieved, then no further groundwater monitoring will be required.
- If the soils are determined "clean" closed and the groundwater is not "clean" closed, then the groundwater will have been determined to have been contaminated. Therefore, quarterly sampling of the groundwater will be required, pursuant to the VHWMR § 9.5.D, during the post-closure care period.
- If the soils are not clean closed and the groundwater is determined to be clean closed, then at least semiannually monitoring of the groundwater will be required pursuant to the VHWMR § 9.5.C, during the post-closure care period. In addition, a final cover system will be placed over the area to address non-clean closure of soils.

After five quarters, the frequency of groundwater sampling and analysis (if required) will be determined by the VDEQ based on the closure scenarios noted above.

These procedures/criteria should also be contained in the groundwater monitoring plan for the incinerator spray pond closure. (The reader is referred to the separate Groundwater Monitoring Plan document for further details on the groundwater monitoring system and sampling/analytical protocols.

3.12 Certification of Closure (VHWMR Section 10.6.F)

Radford Army Ammunition Plant will provide for an independent Professional Engineer in the Commonwealth of Virginia to verify that the Incinerator Spray Pond was closed in accordance with this closure plan. Closure activities will be monitored by a Professional Engineer. The independent engineer's certification will include all documentation such as daily reports, test results, observations, photographs, etc. which demonstrate that the closure was completed in accordance with this approved plan.

The certification of closure will be submitted, by registered mail, to the Director of the Commonwealth of Virginia's Department of Environmental Quality. The certification will be submitted within 60 days of the completion of final closure. The certification will be signed by both the independent Professional Engineer and the responsible official for Radford Army Ammunition Plant.

3.13 Closure Schedule (VHWMR Section 10.6.C.2.f)

VHWMR 10.6.D.1 requires that the closure activities be implemented within 90 days of formal approval of this closure plan by the Commonwealth of Virginia. The regulations require that the final closure of a hazardous waste unit be completed within 180 days of receipt of the Commonwealth of Virginia's written notice of approval (VHWMR Section 10.6.D.2). The regulations also state that an extension to the closure process may be approved by the Commonwealth of Virginia if the final closure activities will take longer than 180 days (VHWMR Section 10.6.D.2.a(1)). Table 3-5 shows the closure schedule during the clean closure attempt.

TABLE 3-5 CLOSURE SCHEDULE	
Activity	Day
Closure Plan Approved	(-90)
Army Cost estimate, Scope of Work, Legal Review, Receive Funding	(-90)-0
Sample Background/ Calculate Background Critical Value/ Submit Results to VDEQ for approval of background (DEQ response 7 days)	0 25 32 60
Remove and Decontaminate Piping, Pumps, Concrete	90
Take Soil Samples in Subsoil Assessment	100
Receive Lab Analyses/ Statistical Analysis and Submit to VDEQ	110
Remove contaminated soil/ resample/ or contingent close	120
Receive Lab Analyses/ Statistical Analysis and Submit to VDEQ	130
Submit Monthly QA/QC Reports as Work Continues	140
Remove contaminated soil/ resample/ or contingent close	150
Repeat Sampling and Excavation as Necessary to "Clean" Close or submit a letter to VDEQ and go to Contingent Closure Plan	
Equipment Decontamination	160
Receive Lab Analyses of Pre- and Post- Rinses	170
Submit Final Report of QA/QC on Work Performed	180
Letter submitted for Certification of Closure Submitted or Contingent Closure	180

Please see the contingent closure plan's contingent closure schedule for estimates of construction times for the cap, etc.

3.14 Clean Closure Excavation Filling

Once any contamination has been removed, the excavation will be back-filled with clean soils, graded to promote positive drainage, and re-vegetated.

4.0 CONTINGENT CLOSURE PLAN

4.1 Introduction

In the event that all contaminated soils cannot be practically removed, Radford will notify the Virginia Department of Environmental Quality, Waste Division and begin implementation of the following contingent closure plan and the contingent post-closure plan.

Knowledge of the incinerator spray pond's dimensions, plus knowledge gained from attempting clean closure will be utilized in determining the area and boundaries of the landfill. The entire open area will be covered by the RCRA cap. If, during cap construction, additional information becomes available, cap coverage will be extended or reduced accordingly. All changes to the cap boundaries will be fully documented.

4.2 VHWMR Contingent Closure Plan Requirements (VHWMR Sections 10.10.1.1.b and 10.10.1.3.a(1))

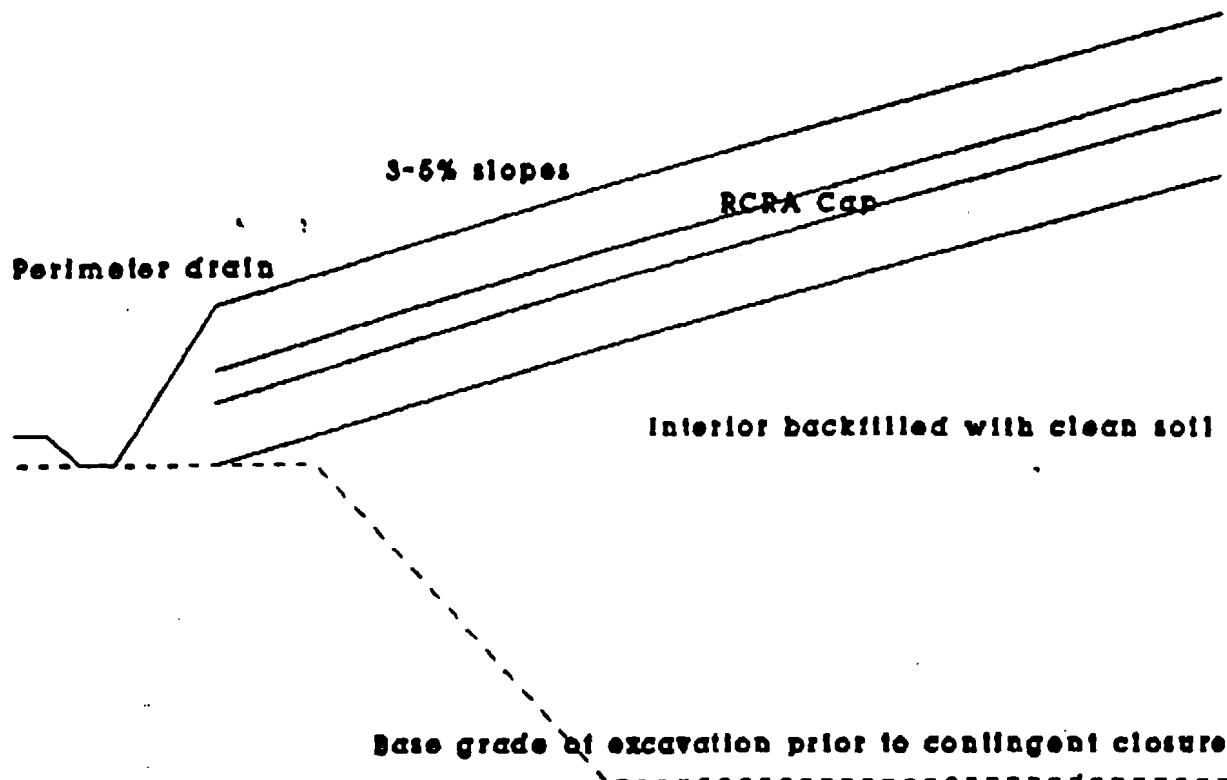
Contingent closure plan requirements are outlined in VHWMR Section 10.10.1.1.b. These requirements consist of three main elements: (1) elimination of free liquids; (2) stabilization of remaining wastes to a bearing capacity sufficient to support a final cover; and (3) construction of a final cover designed and constructed to:

- Provide long-term minimization of the migration of liquids through the closed pond;
- Function with minimum maintenance;
- Promote drainage and minimize erosion or abrasion;
- Accommodate settling and subsidence so that the cover's integrity is maintained; and
- Have a permeability less than or equal to the permeability of any native subsoils present.

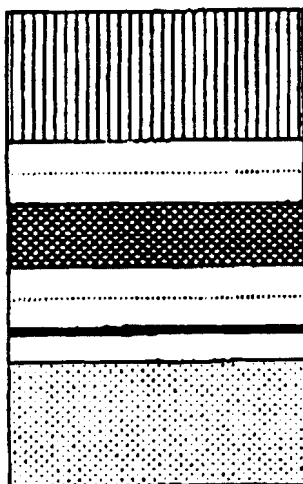
4.3 Contingent Closure Implementation

All free liquid will be removed. Any sludge, the concrete layer, associated drains and piping and bedding materials will be removed. Contaminated subsoils will then be removed as practicality dictates and as detailed in this plan. A final cover will then be installed if clean closure is no longer to be attempted.

FIGURE 4-1 RCRA 2-1-2 CAP



RCRA CAP



2 feet of unspecified erosion protection
top six inches can sustain native vegetation

10 oz non-woven geotextile for separation

Drainage layer (minimum 1×10^{-2} cm/s)

10 oz non-woven geotextile protection
60 mil HDPE or 30 mil PVC membrane

2 feet of clay (1×10^{-7} cm/s)

4.4 Final Cover Design

A typical schematic of the multi-layer RCRA cover is illustrated in Figure 4-1. The cover will contain three layers. From the surface down these are: a top layer consisting of vegetation and soil; a soil drainage layer, and a low-permeability bottom layer. The design requirements for each layer are discussed below.

4.4.1 Plans and Discussion

Available information from previous closure activities will determine the boundary of the landfill. All changes to the area capped will be documented with photographs and surveyed so the final as-built drawings are accurate. Photographs also will be taken to document each stage of cap construction. An independent, professional engineer registered in the Commonwealth of Virginia will be on-site during all cap construction activities to ensure that the cover system is constructed in accordance with this closure plan. The Quality Control/Quality Assurance (QA/QC) Plan discussed in this document will be followed during cap construction; the contractor's quality control officer (CQCO) will maintain complete QA/QC records as outlined.

4.4.2 Specifications

The construction specifications for this closure plan are to be provided in a report, *Specifications for Incinerator Spray Pond Closure*, once it is decided that clean closure will no longer be attempted and submitted to VDEQ from Radford. In the case of conflicting information between the construction specifications and the closure plan, the closure plan will take precedence. Radford Army Ammunition Plant will develop final construction drawings and specifications for the incinerator spray pond final cover. These construction drawings and specifications will meet the design requirements detailed herein. Also, Radford will finalize the Construction Quality Assurance (CQA) plan for the final cover system.

The following sections, at a minimum, will be included in the construction specifications:

- General Paragraphs
- Clearing and Grubbing
- Excavation
- Filling
- Clay Cap Placement
- FML Cap
- Geofabrics
- Drainage Layer Construction
- Erosion Layer Construction
- Erosion and Sediment Control
- Leachate Collection and Removal System
- Decontamination Area Construction
- Geofabrics
- Fencing
- Turf

- Cast-in-Place Concrete (Minor Construction)
- Signs
- Groundwater Monitoring System

The following plan sheets will be submitted to VDEQ:

- Cover Sheet
- Pre-Closure Conditions
- Existing Conditions
- Final Grading Plan
- Gas, Leachate, and Groundwater Monitoring Plan Sheet
- Erosion and Sediment Control
- Cross Section of Incinerator Spray Pond
- Details

4.4.3 Cap Design

Closure will be initiated by grading the site to slopes between 3-5% slope and constructing a RCRA cap to cover all areas where waste is left in place. The landfill cap will consist of a 24-inch clay liner with a maximum permeability of 1×10^{-7} cm/sec, a 60-mil high density polyethylene (HDPE) flexible membrane cap (FMC) in direct and uniform contact with the clay liner, a 10-ounce geotextile fabric filter, a 12-inch drainage layer designed to maintain less than 12 inches of head above the FMC, a second 10-ounce geotextile filter fabric, an 18-inch erosion layer, and a 6-inch topsoil layer which can sustain native plant growth.

4.4.4 Cap Foundation

The site will be cleared of existing vegetation in preparation for placement of the RCRA cap.

It will be graded to provide a slope of at least 3-5 percent over the area. Clean backfill will be obtained from an off-site borrow area to establish the base for the cap. The buried waste will not be disturbed during construction activities.

4.4.5 Settlement Potential

Since all the waste materials and containment structures will be removed from the incinerator spray pond prior to placement of the cover, the foundation material beneath the cover will be predominately native soil or compacted soil fill. Installation of the cap will not introduce loading rates on the foundation in excess of those historically observed. For these reasons, the potential for further settlement, consolidation, or creep of these foundation materials is minimal. Each soil layer of the cover is compacted as it is placed and it is therefore not anticipated that objectionable settlement of the cap will occur. Settlement is not anticipated in the final cover and thus the ability of the cap to minimize infiltration should not be compromised.

The average depth of frost penetration in the Radford area is 15 inches (EPA). The top layer (the soil and root zone layer) will be constructed at a thickness of 24 inches. Frost penetration will only extend into the top layer of the cover and not to the low permeability compacted clay layer. Frost will not adversely affect the cover performance.

4.4.6 Bearing Capacity and Stability

The existing area is judged to have sufficient bearing capacity for the cap system. The HDPE cap material was selected for its flexibility and durability in the event settlement does occur. Preparation and placement of a protective bedding layer is required to cushion and support the FMC. The compacted subgrade and protective bedding layer will support the FMC and protect it from irregularities in the foundation soil during the post-closure period. The bedding layer for this RCRA cap is the uppermost lift of the clay layer. This bedding material will be free of rock, fractured stone, debris, cobbles, rubbish, and roots. The surface of this layer will be fine-finished with a vibrating roller prior to placement of the FMC.

A 10-ounce, non-woven polypropylene geotextile filter fabric with a puncture resistance of at least 600 N will cover the FMC and prevent penetrations from angular stones in the drainage layer. Calculation 2 demonstrates that the puncture resistance of the geotextile is sufficient to resist puncture from the drainage layer.

The upper bedding layer will be placed soon after installation, seaming, and seam testing of the FMC. As sections of the FMC are approved by the CQCO and Radford representative, placement of the drainage layer will begin. No vehicles will be allowed to drive directly on the FMC. The geotextile and drainage layer stone will be placed on the FMC with the drainage stone spread to its full depth before vehicles are driven on the FMC. The drainage stone layer will be used as a bridge for equipment movement on the FMC. The drainage stone will be placed at the base of the slopes and pushed up the slopes to minimize damage to the underlying geotextile and FMC. Equipment used in construction of the cap will be limited to 6 psi or less ground contact pressure. Materials will be placed on the liner using only rubber tired or tracked vehicles.

As sections of the drainage layer are completed, the second geotextile fabric filter will be placed followed by the 18-inch erosion and 6-inch topsoil layers.

The QA/QC Plan discusses inspections, monitoring, and testing needed to ensure the foundation is properly installed to support the FMC.

4.4.7 Cap System

The cap will be constructed and closure will proceed as follows:

- The site will be cleared and grubbed (as necessary) to ensure adhesion between the existing soil and the cap system. Backfill will be placed to establish the slopes for the cap system.
- No gas vents will be required due to the nature of the waste.

A 2-foot thick low-permeability clay barrier with an in-place saturated hydraulic conductivity of no more than 1×10^{-7} cm/sec will be constructed over the cap foundation to provide a base for the flexible geomembrane liner and minimize liquid infiltration should the geomembrane fail.

A geomembrane liner will be placed on the clay layer to prevent infiltration of precipitation through the cover and into the underlying waste. The geomembrane cap will provide maximum flexibility to conform with any settlement which may occur. The liner will be textured to provide added stability to the side slopes and allow increased friction necessary for support of the drainage media. The liner will have enough tensile strength and durability to withstand the applied force of the topsoil layer for the duration of the closure and post-closure periods without breakdown or reduced ability to perform as designed.

A 10-ounce per square yard non-woven geotextile fabric filter, designed to protect the FMC from puncture by the overlying drainage layer, will serve as the upper bedding layer for the FMC. The synthetic filter material will be non-woven polypropylene mat with sufficient tensile strength and durability to withstand the applied force of the drainage and soil layers for the duration of the closure and post-closure periods without breakdown or a reduction in its ability to perform as designed.

A 12-inch drainage layer of VDOT No. 8 clean crushed stone (containing no calcium carbonate) with a minimum permeability of at least 1.1 cm/sec will be placed on the geotextile. This layer is designed to remove surface water which infiltrates the top layer and maintain a head of less than 12 inches on the FMC.

A geotextile filter layer designed to allow surface water infiltration and separate the overlying soil layer from the underlying drainage layer will be placed over the drainage layer. The filter layer will be an 10 oz/sy non-woven geotextile fabric filter designed to prevent clogging of the drainage layer. The synthetic filter material will be non-woven polypropylene mat with a minimum permittivity of 0.8/sec and tensile strength and durability to perform as designed throughout closure and post-closure.

An 18-inch erosion layer of common fill will be placed over the geotextile filter fabric and drainage layer. A 6-inch layer of topsoil capable of sustaining vegetation will be placed over the erosion layer. These soil layers will protect underlying layers from mechanical and frost damage.

The entire area will be seeded to stabilize the soil and prevent erosion. Seed will be applied at a rate of 200 lbs/acre in the following percentages:

Kentucky 31 on Turf Type Tall Fescue	95-100%
Kentucky Bluegrass	0-5%

Fertilizer (10-20-10) will be applied at 28 lbs/1000 square feet (sf) and lime (pulverized agricultural grade limestone) will be applied at 90 lbs/1000 sf. All seeding operations will be conducted in accordance with the *Virginia Sediment and Erosion Control Handbook*, Third Edition (1992).

4.4.8 Clay Liner

A 2-foot thick low-permeability clay barrier will be constructed over the cap foundation to provide a base for the flexible geomembrane liner and to reduce liquid infiltration should the geomembrane fail. The clay soil used in the liner will be free of rock, clods, and soil, debris with a minimum of 20% fines (20% passing the No. 200 sieve), maximum of 10% retained on the No. 4 sieve, plasticity index between 10 and 35 percent, and maximum in-place permeability of 1×10^{-7} cm/sec. The layer will be placed in 6-inch lifts and compacted to 95% of its maximum dry density and within 2 to 4 percent wet of optimum moisture content as determined in the Standard Proctor test (ASTM Method D-698). In-place hydraulic conductivity will be measured using the two-stage borehole method.

If the water content of the clay borrow is less than specified during the design, water will be added by spraying from a truck or large hose before the clay is compacted. Adequate curing time must be allowed. If the clay is too wet, it will be allowed to dry before compaction. Efforts will be made to reduce clod size during excavation and placement to achieve the required permeability. The clay will be compacted using equipment such as sheepsfoot rollers to achieve the required compaction/permeability and bonding between lifts. The surface of each lift will be scarified so there will be an adequate bond with the lift above it. The edges of the lifts will be beveled or overlapped to ensure complete coverage. The final lift of the clay layer will be compacted with a steel drum roller to obtain a uniform, smooth surface for the FMC. To prevent drying resulting in cracking, the clay layer will be kept moist until the geomembrane is placed. The maximum slope of the capped area is 5%. Material will be placed at the toe of the slope and worked upward to the top.

The low permeability layer must be entirely below the maximum depth of frost penetration estimated for the area in which the facility is located. According to the EPA, the frost depth is approximately 15 inches in the Radford area. The top of the clay liner will be 3 feet below grade which is well below the frost penetration depth.

A small-scale construction test pad will not be constructed on the cap because of the relatively small size of the incinerator spray pond.

4.4.8.1 Clay Material Specifications

The 2-foot clay layer of the cap will be constructed of borrow materials. The material must possess an in-place recompressed coefficient of permeability (k) equal to or less than 1×10^{-7} cm/sec. Testing and inspection methods necessary to ensure this in-place permeability are detailed in the subsequent sections.

The clay material will meet the following requirements in order to be classified as select clay fill for use in construction of the clay liner.

Clay will be classified according to the Unified Soil Classification System (USCS) as CH or CL (ASTM D 2487-83). A liquid limit of at least 30, plasticity index (PI) equal to or greater than

15, and a fines content of greater than 50% passing the No. 200 sieve will be considered for proper classification.

Select clay fill materials will be reasonably free of gypsum, ferrous, and/or calcareous concretions and nodules, refuse, roots, or other deleterious substances.

4.4.8.2 Preconstruction Testing

All soil to be used for construction of the clay cap will be inspected by the CQA inspection personnel. Rock fragments, boulders and cobbles contained in the soil will not exceed 3 inches in any dimension. Material will be inspected to remove limbs, roots, and other deleterious materials to the extent practical. Continuous and repeated visual inspection of the materials being used will be performed by the Contractor to ensure that proper soils are being used.

The Quality Assurance tests specified in the following tables will be performed on material proposed for liner construction at the specified frequencies and whenever a change in material occurs. Tables 4-1 and 4-2 delineate the quality controls for construction of the two foot thick relatively impermeable clay cap.

TABLE 4-1 CLAY BORROW SOURCE TESTING

Factor to be Inspected	CQA Inspection Method/Test	Sampling Frequency
Grain Size Analysis	ASTM D-422 and ASTM D-1140	1 per 1000 CY
Moisture Content	ASTM D-2216	1 per 1000 CY
Specific Gravity	ASTM D-854	1 per 5000 CY
Soils Classification	ASTM D-2487	1 per 5000 CY
Atterburg Limits	ASTM D-4318	1 per 5000 CY
Moisture Density Curve	D-698, D-1557, and/or reduced proctor (15 blows per inch)	1 per borrow source
Lab Permeability	ASTM D-5084	1 per 10,000 CY

TABLE 4-2 TESTING METHODS AND FREQUENCIES DURING CONSTRUCTION OF THE LINER

Factor to be Inspected	CQA Inspection Method	Sampling Frequency
Clay Layer Thickness	Observation and Field Measurement	5/lift
Moisture Content	ASTM D-3017, D-4643, D-4944, or D-4959 calibrated against ASTM D-2216	5/lift
Density	ASTM D-2922 or D-2937 calibrated against ASTM D-1556 or D-2167	5/lift
Classification	ASTM D-2487	1/lift
Atterburg Limits	ASTM D-4318	1/lift
In-situ Permeability	Two-Stage Borehole Test, ASTM Draft Test Method	3
Lab Permeability	ASTM D-5084	3/lift

The moisture/density relationship to control actual field placement of the clay cap will be established using a laboratory procedure. The coefficient of permeability relative to minimum compaction will be determined in the laboratory as follows:

- A sample of the selected material which will be used to construct the clay cap will be taken to the laboratory.
- A standard moisture-density curve will be developed to determine optimum moisture content and maximum dry density of the compacted soil in accordance with the Standard Proctor Test, ASTM D698.
- A sample will be compacted at or above optimum moisture content to a density of not less than 90% of the maximum dry density.
- Permeability tests will be conducted in accordance with ASTM D 5084 to determine the coefficient of permeability (k). If k is less than 1×10^{-7} cm/sec., the soil will be placed in accordance with the permitted plans at a density of not less than 90% of the maximum dry density (as determined in ASTM D698). If k is greater than 1×10^{-7} cm/sec, the soil will either be considered to be unsuitable and another source(s) will be located and tested, until the permeability requirement is met, or a series of tests varying moisture content and density will be conducted to determine an alternate moisture or density standard which conforms to the specified maximum permeability.

4.4.8.3 Clay Cap Construction

Select clay fill material will be applied such that the lift thickness (after compaction) will be no greater than 6 inches. Thinner lifts are permissible. Prior to compaction, each lift of select clay fill material will be thoroughly disced to provide soil particle sizes less than 4 inches in diameter. Equipment or truck traffic on the surface will not be permitted during the period between scarifying and placement of the following lift. In order to ensure that the clay liner becomes one continuous mass of clay from bottom to top of the liner, the surface of each lift must be maintained at the specified moisture content and it must be scarified (lightly chopped with a disc), not smooth, when covered by the succeeding lift.

After scarifying of the underlying lift, representative samples of the new lift will be taken and tested for moisture content prior to any compactive efforts. If the moisture content is within the specified range (range determined by laboratory testing of borrow source), compaction may begin. If the moisture content is outside of this range, the select clay fill will be wetted or dried and reworked accordingly. The select fill should be sprinkled or sprayed with water (most probably from a water truck) and dozed, wind-rowed, and/or disc-plowed to uniformly increase moisture content of the clay if the material is below the optimum moisture content. The select clay fill should be dozed, wind-rowed, and/or disc-plowed to help air dry the clay if the moisture content is too high.

Each lift will be thoroughly compacted and satisfy moisture and density controls through field testing before a subsequent lift is placed. Compaction of lifts will be conducted as follows:

- Compaction of lifts will be performed with an appropriately heavy, properly ballasted, penetrating-foot compactor (such as a CAT 815 or equivalent) subject to approval from the CQA inspection personnel. A minimum of 6 passes will be required on each lift regardless of whether the lift meets density specifications. This requirement is to allow thorough remolding of the clay by kneading action.
- The daily work area will extend a distance no greater than necessary to maintain moist soil conditions (facilitate bonding) and continuous operations. Desiccation and crusting of the lift surface will be avoided as much as possible.
- If desiccation and crusting of the lift surface occurs before placement of the next lift, this area will be sprinkled with water and then scarified and tested for water content to ensure uniform moisture before placement of a subsequent lift.
- Transition from full depth liner to beginning of adjacent new section will be accomplished by sloping (cutting back) the end of a full depth section at 5:1 (horizontal to vertical) or flatter for tying in a new lift. Alternatively, each new lift will be benched into the previously constructed liner at 2-foot horizontal intervals.
- Dozer or scraper equipment will not be used for primary compaction efforts.

The select fill will be compacted to meet or exceed the density determined from the Standard Proctor Test, described in the previous preconstruction testing section. Densities less than the specified density will be recompacted and/or removed and reworked to meet density objectives. In addition, unless laboratory testing indicates otherwise, the compacted material's dry density/moisture content will lie within the 80% saturation line, to be established from tested specific gravities.

No select fill will be placed or compacted during a sustained period of temperatures below 30°F. Select fill may be placed and compacted during periods of early morning and evening freezing temperatures with warming trends above freezing during the day. During construction, finished lifts or sections of compacted clay liner may be sprinkled with water as needed to prevent drying and desiccation. At the end of each construction day's activities, completed lifts or sections of compacted clay liner will be sealed by rolling with a rubber tired or smooth drum rollers and sprinkled with water as needed.

The compacted clay cap will be a minimum of 24 inches. Thickness of the clay liner on the side slopes will be measured perpendicular to the slope face. The as-built thickness of the compacted clay liner will be determined by non-destructive survey methods as described below. An individual lift may be sampled upon completion (but prior to subsequent lift placement) with an approved sampler or other investigative tool, but the resulting penetration will be properly backfilled with hand tamped select clay fill or bentonite. Samples of the in-place compacted clay liner will be tested and evaluated prior to acceptance.

After completion of a segment of compacted clay cap, but before installation of the subsequent layers of the cap. The top of the clay will be surveyed to ensure that: (a) the specified thickness of compacted clay liner has been achieved; (b) the top of the clay liner slopes across the cell at the grades specified on the permitted plans.

4.4.9 Flexible Membrane Cap

4.4.9.1 Materials Specification

The geomembrane will be constructed of 60-mil HDPE, 30 mil VLDPE, or 30 mil PVC. Raw polymer specifications and manufactured sheet specifications for the HDPE membrane are as follows:

HDPE	TEST METHOD	VALUE
Gauge	---	60 mils
Density	ASTM D1505	0.94
Melt Flow Index (g/10 min.) (max)	ASTM D1238 Condition E (190°C, 2.16 kg.)	0.5
Minimum Tensile Properties	ASTM D 638 Type IV (Dumbbell at 2 ipm)	
1. Tensile at Break (lbs/inch width)		216
2. Tensile at yield (lbs/inch width)		126
3. Elongation at Break (%)		630
4. Elongation at Yield (%)		12
5. Modulus of Elasticity	ASTM D882	1.1
Tear Resistance	ASTM D1004	41
Low Temp Brittleness	ASTM D746	-112
Dimensional Stability	ASTM D1203	-2
Carbon black content	ASTM D-1603	2%

These specifications may be superseded by more stringent specifications of the manufacturer. Radford will submit the exact type of membrane proposed for use and the manufacturer's product specifications.

4.4.9.2 Differential Settlement in the Foundation Soils

Due to the small area to be capped and minimal depth of backfill soil the differential settlement effects are negligible. During clearing and grubbing operations and placement of soil fill to establish the final grade for cap placement compaction will occur. Settlement resulting in foundation compression and soil liner compression will be minimal. There is no solid waste in place like landfills to biodegrade and cause settlement or gas production.

4.4.9.3 Strain Requirements at the Anchor Trench

The membrane and geotextile will be anchored in a trench at the toe of the cap. In the case of the membrane, the anchor trench does not affect the potential for sliding because it is at the toe rather than at the top of the slope. For these reasons, calculation of strain requirements of the anchor trench is not applicable.

4.4.9.4 Strain Requirements Over Side Slopes

The membrane and geotextile must be strong enough to resist tensile forces acting from the weight of the soil above. The selection of membrane provides maximum strength during installation. The steepest slope of the capped area will 5%. At such "flat" slopes, the membrane will support its own weight and not slide. The membrane will be beneath 2 feet of cover soil and 1 foot of granular drainage material which is well below the 8-inch frost penetration depth, reducing stresses associated with climatic conditions.

4.4.9.5 Chemical Compatibility

Polyethylene and PVC liners are non-reactive with most leachate constituents (Koerner, 1986). The liner will be placed above the waste constituents in the "landfill" and, therefore, will not contact chemicals in the "landfill." The liner will be in direct contact with the clay barrier soil layer and the granular drainage layer. The only liquid contacting the liner will be precipitation that percolates into the granular drainage layer.

4.4.9.6 Liner Strength Requirements and Integrity Under Mechanical Stresses

The membrane must be capable of withstanding both the stresses of installation and stresses after placement. The 60-mil HDPE membrane, 30 mil VLDPE, or 30 mil PVC membrane is suitable for both conditions. The 60-mil thickness and strength of the HDPE will provide sufficient strength to withstand installation stresses such as wind, temperature and seaming. The flexibility and strength of 30 mil PVC or VLDPE liner will provide sufficient strength to withstand installation stresses such as wind, temperature and seaming. As previously discussed, the membrane will be placed on a smooth clay foundation, free of rocks, clods, and other debris that might puncture the geomembrane. A geotextile fabric filter will be placed over the membrane to protect it from the overlying stone drainage layer. No vehicles will be driven on the membrane until the geotextile and 12-inch stone drainage layer have been placed.

Prior to installation, the membrane will be protected from sunlight and the weather by a cover or under a temporary shelter. After placement, the liner will be covered with the geotextile and stone layer as quickly as possible after approval of seaming. The 3-foot cover (1-foot granular drainage layer and 2-foot soil layer) will provide long-term protection from mechanical and thermal stresses. Except during installation, the geomembrane will not be exposed to wind, sunlight, or direct precipitation.

4.4.9.7 Friction Factors

The literature (Mitchell, Kettleman Hills) indicates a friction angle of approximately 11 to 14 degrees for polyethylene sheets and clay, and a friction angle of 16 degrees between the polyethylene sheets and overlying geotextile. These friction angles are more than adequate for use on a small relatively "flat" cap design for an impoundment closure.

4.4.9.8 Best Anchorage Configuration for the FMC

The anchorage of the membrane is not a design issue. The liner will be anchored in a one-foot wide, two-foot deep trench located at the edge of the cap system around the perimeter of the "landfill." This is a typical anchoring method shown in EPA guidance documents.

4.4.9.9 Soil Cover Stability on Top of FMC

Stability of cover soil is an important concern in designing a landfill cap. However, due to the small size, and relatively flat slopes, sliding instability is negligible. A geotextile will be placed between the flexible membrane and the drainage layer to provide reinforcing and increase friction. Another layer of geotextile will be provided between the drainage layer and the soil erosion protection layer. Calculations show that

the erosion layer will be stable, and universal soil loss is much less than 2 for 5% slopes, less than 100 feet of slopes, and a moderate stand of grass.

4.4.9.10 Installation

The earthwork contractor will be responsible for preparing and maintaining the subgrade in a condition suitable for liner installation. The clay liner subgrade will be smooth and firm. Sharp stones, gravel, debris, or any other objects which could penetrate the liner will be removed. Any ruts caused by the compaction equipment or the geomembrane placement equipment will be leveled. The subgrade will be visually inspected prior to installation of the membrane.

The membrane will be delivered to the site on rolls, stored off the ground in small stacks, and protected with a covering or stored in a temporary storage shelter. The storage space will be protected from theft, vandalism, and passage of vehicles. Geosynthetics will be handled in a manner to prevent physical damage, contamination, and exposure.

Before moving a roll from the storage site, an anchor trench 2-feet and 1-foot wide will be completed. Slightly rounded corners will be provided where the geomembrane adjoins the trench to avoid sharp bends in the geomembrane.

The construction contractor will submit a geomembrane layout plan to the owner and CQCO for approval prior to placing the membrane. The membrane will be installed during dry, moderately warm weather to minimize the effects of thermal expansion and contraction. The manufacturer's instructions will be followed for liner placement and seam overlap. The method used to unroll the panels will not cause scratches or crimps in the geomembrane. Sandbags will be placed along the edges of the geomembrane to prevent uplift pressures of up to 37 psf and the resulting wind damage. Field panels will be placed one at a time in a manner which minimizes wrinkles.

The panels will be seamed immediately after placement following the manufacturer's recommended seaming procedures. The ambient temperature should be above 5° F during seaming. Surfaces to be seamed will be clean and dry when the seams are made. Seams will be oriented parallel to the line of maximum slope. All field seams will be non-destructive tested in accordance with ASTM D 4437 seam evaluation using the vacuum box technique. Destructive tests will be performed on test specimens in accordance with ASTM D-413 and ASTM D-638 for peel and shear of geomembrane seams. One sample will be taken for destructive testing every 500 linear feet of weld.

The liner will be covered within the time limits specified by the manufacturer. The geotextile fabric will be placed on the geomembrane as soon as possible after approval of the geomembrane placement. The stone drainage layer will be placed on the geotextile using equipment which will either not need to move on to the cap area or rubbered tired equipment. Vehicles will be driven only on the full depth stone drainage layer or subsequent soil cover. Vehicles will not be allowed to drive directly on the geomembrane or geotextile layers.

QA/QC procedures to be followed during cap installation, including inspections, material certifications, and testing will be discussed in Section 7 of this document.

4.4.10 Filter Layer

The design properties of concern for the geotextile filter layer above the drainage layer are permittivity and clogging potential. The minimum permittivity required for the geotextile is 6.0×10^{-3} /sec. The permittivity of the geotextile specified in the design is 0.08/sec, well above the minimum. Therefore, the geotextile will easily allow surface water to flow through it to the drainage layer.

The potential for the geotextile to clog must be evaluated using site specific cover soil and recommended geotextile. The suggested test is the U.S. Army Corps of Engineers Gradient Ratio Test CW-02215 with the gradient ratio calculated value less than 3. The chosen geotextile must have an apparent opening size (O_{95}) meeting the following specifications:

$$O_{95}/D_{85} < 2.0$$

$$O_{95}/D_{15} > 2.0$$

Clogging potential will be determined by the contractor after the source of the backfill is selected and the specific geotextile is chosen.

The geotextile filter located above the FMC is designed as a protective layer and permittivity of this geotextile is not a concern.

4.4.11 Drainage Layer

The drainage layer is required to reduce the head of water on the soil barrier layer and also to prevent water backup into the vegetative layer. The minimum thickness of the middle drainage layer will be 12 inches. The saturated hydraulic conductivity of the drainage materials will not be less than 1×10^{-2} cm/sec at the time of installation.

The upper portion of the drainage layer will be designed to prevent clogging, and will be overlain by a synthetic fabric filter or graded granular material. The upper slope will be at least 3-5 percent after allowance has been made for settling and subsidence, and will be overlain by granular materials such as sand. The granular material will be no coarser than 3/8 inch and classified as SP. The material will be crushed and angular with no debris that may damage the underlying flexible membrane liner, or fines that may lessen permeability, or dissolvable minerals such as lime.

Discharge from the drainage layer will flow freely so that fluid does not back up into the vegetative layer during a major sustained storm event. The drainage layer will be sloped to an exit drain which will allow the percolated water to drain.

4.4.12 Vegetative Layer

The top layer is required to retain soil moisture, minimize root penetration into the barrier layer, and provide greater tolerance to the adverse impact of erosion. The top layer will have a thickness of no less than 24 inches, of which a minimum of the top six inches will be topsoil and will contain sufficient nutrients necessary for the growth and sustenance of a vegetative cover.

The entire area will be seeded to stabilize the soil and prevent erosion. Seed will be applied at a rate of 200 lbs/acre in the following percentages:

Kentucky 31 on Turf Type Tall Fescue	95-100%
Kentucky Bluegrass	0-5%

Fertilizer (10-20-10) will be applied at 28 lbs/1000 square feet (sf) and lime (pulverized agricultural grade limestone) will be applied at 90 lbs/1000 sf. All seeding operations will be conducted in accordance with the *Virginia Sediment and Erosion Control Handbook*, Third Edition (1992). Cover vegetation should be drought resistant, persistent, erosion resistant and adapted to local conditions.

The surface drainage system will be capable of efficiently conducting runoff across the cap. The drainage ditches will be adequate to accommodate the runoff from a 24-hour, 25-year storm.

4.4.13 Drainage Evaluation

In order to limit runoff infiltration and to limit erosive velocities from runoff on the impoundment surface it is recommended that a uniform 3-5% grade be incorporated into the design of the final cover. One of the most effective ways to minimize surface water infiltration through the final cover is to divert runoff away from the closed structure. Since the site will be graded for positive drainage, and based on existing site topography, positive drainage will be maintained away from the site. Run-on from an off site source is not expected due to site specific conditions.

4.4.14 Survey Control

The following procedures will be followed with respect to the survey of the completed clay cap:

- The completed clay surface will be surveyed, before the placement of subsequent cover layers, to verify that grades are in accordance with the plans. In addition, a comparison of the pre- and post-clay cap construction surveys will be conducted to verify construction to the permitted thickness.
- A minimum of one cross-section for every 100 linear feet of cell length and width will be surveyed. At a minimum, survey points will be established at the top, mid-point, and bottom of each slope. These survey points will be coincident with those of the previous cross-section lines.
- Acceptable tolerances on survey coordinates will be ± 0.2 feet on elevations and ± 1.0 foot on coordinates. The clay cap will be greater than or equal to the thickness specified.

- The CQA inspection personnel certifying the survey results will be either a Registered Land Surveyor or a Professional Engineer.
- The CQA Officer will certify that the clay cap meets the requirements in the plans and specifications and submit documentation to the Project Manager.

4.5 Construction Quality Assurance Plan

The CQA plan will detail procedures for inspecting the quality of construction materials and the construction practices employed during their placement. The CQA plan will further provide assurance that: (1) the materials for each layer are as specified in the design specifications; (2) each layer is constructed as specified in the plans; and (3) all layers of the final cover are uniform and damage-free. The CQA plan can be found in the appendix.

4.6 Site Access

Access to the Radford Army Ammunition Plant is severely limited due to the on site security required for operations. All vehicles entering the Radford must pass through the main entrance and a second security checkpoint before approaching the site. Existing fences, gates, and vegetation will be utilized to restrict unauthorized access to the waste disposal area. A clearly visible and legible sign will be maintained at the closure area indicating the hazards.

4.7 Engineer's Certification of Contingent Closure (VHWMR Section 10.6.F)

Radford will provide for an independent Professional Engineer in the Commonwealth of Virginia to verify that the Incinerator Spray Pond was closed in accordance with the specifications in this closure plan. The independent engineer will be present during all closure activities. The independent engineer's certification will include all documentation such as daily reports, test results, observations, photographs, etc. which demonstrate that the closure was completed in accordance with the approved plan.

The certification of closure will be submitted, by registered mail, to the Director of the Commonwealth of Virginia's Department of Environmental Quality. The certification will be submitted within 60 days of the completion of final closure. The certification will be signed by both the independent Professional Engineer and the responsible official for Radford Army Ammunition Plant.

4.8 Notification of Type, Quantity and Location of Wastes (VHWMR Section 10.6.J.1)

No later than 60 days after certification of closure of the incinerator spray pond, Radford will submit to the County Board of Supervisors and to the Director of the Commonwealth of Virginia's Department of Environmental Quality a record of the type, location, and quantity of hazardous waste located in the closed incinerator spray pond.

4.9 Survey Plat Submittal (VHWMR Section 10.6.G)

Within 60 days of closure, a survey plat indicating the location and dimensions of the incinerator spray pond closure as a landfill with respect to permanently surveyed benchmarks will be submitted to the local

zoning authority and to the Director of the Commonwealth of Virginia's Department of Environmental Quality. The plat will be prepared and certified by a Professional Land Surveyor in the Commonwealth of Virginia. Radford will submit a certification to the Director that a survey plat and record of the type, quantity, and location of the hazardous wastes has been submitted to the local zoning authority.

4.10 Deed Restriction (VHWMR Section 10.6.J.2)

Within 60 days of certification of closure of the pond, Radford will record in accordance with state and local law, a notation on the deed to the facility property, or on some other instrument which is normally examined during title search, that will in perpetuity notify any potential purchaser of the property that:

- The land has been used to manage hazardous wastes; and
- Its use is restricted under VHWMR Section 10.6; and
- The survey plat and record of the type, location, and quantity of hazardous wastes disposed of within each hazardous waste unit required by VHWMR Sections 10.6.G and 10.6.J.1., have been filed with the local government and with the Director of the Commonwealth of Virginia's Department of Environmental Quality.

Radford will submit to the Director a certification stating that the facility has recorded the notation specified in VHWMR Section 10.6.J.2.a. A copy of the document in which the notation has been placed will also be submitted.

4.11 Post Closure Care Permit Application (VHWMR 11.1)

Within 180 days of contingent closure, an application for a post-closure care permit with the applicable permit fee will be submitted to the Virginia Department of Environmental Quality, Waste Division.

4.12 Contingent Closure Schedule (VHWMR Section 10.6.C.2.f)

The contingent closure schedule for the pond is detailed in Table 4-3.

TABLE 4-3 CONTINGENT CLOSURE SCHEDULE	
Activity	Days
If contaminated soils cannot be practically removed, then begin construction of final cover	0
Survey Excavation-----	0
Backfill with Clean Soils-----	10
Prepare Plan Sheets, Geomembrane Type & Layout, Erosion Control Plan with Support Calculations, and Specifications-----	20
Submit to DEQ for Approval Plan Sheets, Geomembrane Type & Layout, Erosion Control Plan with Support Calculations, and Specifications-----	90
Obtain DEQ Approval-----	-
Request Additional Army Funding-----	-
Receive Additional Funding from Army-----	0
Begin Construction of Cap-----	45
clay-----	60
geomembrane-----	70
geotextile-----	80
drainage layer-----	90
geotextile-----	100
soil-----	110
topsoil spread-----	140
topsoil seeded and erosion controls placed-----	150
Submit Monthly QA/QC Reports-----	160
Submit Final Report of QA/QC on Work Performed-----	170
Submit Certification of Closure-----	180
Within 60 Days of Completed Cap Construction Submit: Record of Type, Location, and Quantity of Waste Closed in Place Certification Letter that Survey Plat was Submitted to Local Zoning Authority with copy of Survey Plat Certification Letter that Permanent Notation was made on Property Deed, with Wording Submitted to VDEQ for Approval	180-240
Within 180 Days of Completed Cap Construction Submit: Application for Post Closure Care Appropriate Application Fee	180-360
Upon Completion of the 30 Year Post-Closure Care Period: Within 60 Days of Completion of the Post Closure Care Period Submit a Certification Letter that Post-Closure is Completed	30 years + 60 days

5.0 CONTINGENT POST-CLOSURE PLAN

5.1 Introduction

Post-closure care will begin after completion of contingent closure and continue throughout the post-closure care period. Post-closure care consists of maintaining the final cover and performing monitoring, and response, as necessary, to prevent adverse impacts to human health and the environment (VHWMR Sections 10.6.II through 10.6.K, 10.10.1.2, and 10.10.1.3.a.(2)).

Post-closure activities will be directed by the requirements of this plan until the post-closure permit becomes effective. The post-closure requirements will be as follows.

5.2 Post-Closure Care Period

Unless extended or reduced by subsequent modification of this plan or by permitting action, the post-closure care period will begin after closure of the unit and continue for 30 years after that date.

5.3 Ground Water Monitoring and Reporting (VHWMR Sections 10.6.H.1.a and 10.10.1.2.b)

The ground water monitoring system, detailed in the document Ground Water Monitoring Plan for the Incinerator Spray Pond (1995), will be maintained for continuous ground water compliance monitoring throughout the post-closure care period.

5.4 Maintenance of Final Cover (VHWMR Sections 10.6.H.1.a.(2) and 10.10.1.2.a)

The integrity and effectiveness of the final cover will be maintained for a period of thirty years. The vegetative cover will be mowed at least twice yearly and re-fertilized in accordance with the recommendations of the local office of the U.S. Department of Agriculture's Soil Conservation Service (SCS). The cover and drainage system will be inspected quarterly during the first year and every 6 months thereafter by a qualified person. These inspections will determine if there have been any changes to the structural integrity of the cover due to settling, subsidence, erosion, and if the vegetative cover is well established and healthy. During the first 6 months, the drainage system will be inspected immediately following each major precipitation event to initially establish the effectiveness of the drainage system design. Any damage or failure of the cover and/or drainage system will be repaired within 30 days of inspection.

Any erosion or ponding will be repaired by backfilling and regrading the surface to prevent surface water infiltration and runoff and to prepare the cover surface for re-vegetation. Bald and spottily vegetated areas will be disced and otherwise prepared for re-vegetation. New topsoil will be added as necessary. Re-vegetation will stabilize the surface from further erosion by wind and water and will contribute to the development of a naturally fertile and stable surface environment. Mulching, seeding with native grasses, and fertilizing will be performed as soon as possible after regrading/discing, and in accordance with the recommendations of the local SCS office.

5.5 Maintenance of Groundwater Monitoring Wells

Ground water monitoring wells require regular inspections and maintenance over time in order to maintain them in the originally completed condition. Over extended time periods (one year or longer) monitoring wells should be inspected and maintained for the following potential conditions or problems:

- Aboveground portions of monitoring wells should be inspected for evidence of tampering or actual physical damage each time the well is sampled or checked for static ground water level. At a minimum, an annual physical inspection should be performed.
- At similar intervals, the total depth of monitoring wells should be checked in order to ascertain if there has been excessive sediment influx into the well casing that could potentially clog the well screen.
- During all rounds of pre-sampling well purging, the ground water should be checked for unusually high levels of Ph (10 to 12) which could indicate that the bentonite seal in the well has failed or partially dissolved and washed into the screened portion of the well. Bentonite has been documented to cause high Ph levels when present in well water.
- Other unusual well conditions may warrant using downhole geophysical tools or a downhole camera in order to properly assess deep hole well conditions of both riser casing and well screen.
- Extreme or unexpected water level changes may also be indicators of downhole casing or screen problems. Very low levels may indicate a problem such as screen clogging with sediment or bacterial growth. Unusually high water levels could indicate a bentonite seal or riser casing failure that would allow surface runoff water or water from a different aquifer to be entering the well bore.
- Maintenance should be performed on ground water monitoring wells at least annually, and should consist of surging and purging the well to clear any sediment influx over time and to allow checking for unusual or unexpected well conditions that may have developed since initial well completion.

5.6 Maintenance of Run On and Runoff Control Structures

The Commonwealth of Virginia requires a plan for continued maintenance of storm water management facilities. Where local government does not choose to accept maintenance responsibility the responsible entity is required to accept maintenance responsibility and a maintenance agreement must be entered into with the local government.

In order to guard against the cumulative effects of erosion and storm damage it is important to prepare and follow a maintenance plan for the facility. Inspections will be conducted as indicated in the inspection reports in the appendix. Maintenance will be conducted as indicated below.

- The cap surface, adjacent swales, storm water management area will be inspected quarterly and after major storm events.
- Berms shall be specifically inspected for evidence of slope failure, erosion and overall integrity.

Evidence of erosion, outlet structure blockage, vegetation over-growth, and other features which may effect the function of the drainage system for the facility shall be noted.

After an inspection is conducted, if required, areas of erosion shall be filled and seeded with appropriate cover vegetation, swales and berms shall be inspected by qualified personnel and assessments of the integrity of the structures made, the storm water management pond outlet structure including outlet structure, orifice and outlet culvert shall be cleaned of all extraneous debris, trash, sediment and vegetation.

5.7 Benchmark Integrity

Numerous USGS benchmarks are located at Radford Army Ammunition Plant. All survey work will be conducted using at least one of these benchmarks. Due to the controlled nature of RAAP, the benchmarks should be secure.

5.8 Post-Closure Inspection Log [VHWMR Section 10.6.H.1.a.(2)]

The Post-Closure Inspection Log form is included in the Appendices. This form will be utilized to guide and document the above-described inspection activities.

5.9 Recordkeeping/Contact Persons

The post-closure care plan and records (i.e. inspection logs) will be maintained at the facility. The plan and records will be available for review by the Commonwealth of Virginia's Department of Environmental Quality. The Radford Army Ammunition Plant representative to contact about post-closure care will be: Mr. Joe D. Wilson, Chief Engineer, US Department of the Army, Radford Army Ammunition Plant, Caller Service 2, Radford, Virginia 24141-0298. Information about this report can also be obtained from Mr. Robert L. Richardson at (703) 639-8641, or Jerome J. Redder, P.E. at (703) 639-7536.

5.10 Certification of Completion of Post-Closure Care (VHWMR 10.6.K)

No later than 60 days after completion of the established post-closure care period, Radford Army Ammunition Plant will submit to the Commonwealth of Virginia's Department of Environmental Quality Director, by registered mail, a certification that the post-closure care period for the incinerator spray pond was performed in accordance with the specifications in this approved post-closure plan. The certification will be signed by the official representative for Radford and an independent Professional Engineer registered in the Commonwealth of Virginia.

5.11 Post Closure Inspection Form

SAMPLE POST CLOSURE INSPECTION LOG SHEET SURFACE IMPOUNDMENT CLOSURE

Scheduled Inspection (Yes or No): _____

Supplemental Inspection (Yes or No): _____

Date: _____ Time: _____ Inspector: _____

<u>Inspection Item</u>	<u>Potential Problems</u>	<u>Status</u>
1. <u>Security Controls</u>	Missing	_____
Fencing	Damaged	_____
Warning Signs	Inadequate	_____
2. Erosion Controls	Inadequate slope/vegetation	_____
3. Final Cover	Erosion damage	_____
	Settlement/subsidence/ or displacement	_____
	Water pooling/inadequate drainage	_____
	Insect/rodent damage	_____
	Damaged/dead vegetation	_____
	Trees, shrubs, or other deep rooted growth	_____
4. Drainage System	Drainage Blocked	_____
(Runon Runoff Controls)	Debris Present	_____
	Inadequate Drainage	_____
5. Benchmarks	Missing/damaged	_____
	No Identification	_____
6. Groundwater Monitoring System	Not capped/locked	_____
	Damaged	_____
	No identification	_____

Overall Status (Acceptable or Unacceptable): _____

OBSERVATIONS: _____

CORRECTIVE ACTION TAKEN AND DATE: _____

6.0 QUALITY ASSURANCE QUALITY CONTROL (QA/QC) PLAN INTRODUCTION

6.1 Introduction

This QA/QC Plan is provided as part of the Contingent Closure for the Incinerator Spray Pond at the Radford Army Ammunition Plant. The purpose of this Plan is to establish standards that, when followed by the Owner's inspection personnel (Quality Control - QC Engineer or Officer), will ensure that the contractor constructs the cap in accordance with the plans and the VHWMR. Radford will be responsible for ensuring through the implementation of the QA/QC Plan that the terms and conditions of the closure plan are fulfilled during construction. The Radford representative on the site, hereinafter referred to as the Project Manager, will be responsible for coordination between Construction Contractor(s) and the QC Engineer (or Officer), as well as for the overall project management during construction and implementation of the full QA/QC Plan attached to this document as an appendix.

Prior to construction, the Project Manager, the Contractor and the QC Officer will review the proposed cover plans for clarity and completeness. In the event that additional clarification is required, the design engineer will be consulted for necessary clarification or modifications.

6.3 QC Engineer

A QC Engineer, who will be an independent party and not responsible to the Construction Contractor, will be contracted by Radford during construction of the cover. The QC Engineer must be a Professional Engineer, licensed in the State of Virginia. The QC Engineer will direct the construction inspection, testing and documentation efforts with specific responsibilities for the following activities:

- Ensure that the attached full QA/QC Plan is implemented so that the final structure constructed meets the design requirements and the VHWMR.
- Reviewing the construction plans and specifications for clarity and completeness.
- Reporting and documenting construction activities to the owner (and VDEQ in a final report) that the plans and specifications were followed by the contractor.
- Educating the QA/QC inspection personnel on the QA/QC requirements and procedures.
- Scheduling and coordinating the QA/QC inspection activities.
- Directing and supporting the QA/QC inspection personnel in performing observations and tests with respect to test equipment calibration, and data collection, validation, reduction, interpretation and reporting.
- Reviewing and interpreting all data sheets and reports associated with the construction activities and reporting them to Radford.
- Identifying work that should be accepted, rejected, or uncovered for observations, or work that may require special testing, inspection or approval, and reporting it to Radford.
- Rejecting defective work and verifying that corrective measures have been implemented.

- Furnishing to the facility representative and to the Contractor the results of all observations and tests as the work progresses, and coordinating with the Contractor when modifications to the plans are necessary to ensure compliance with the specified design.

6.4 QA\QC Inspection Personnel

The responsibilities of the QA\QC inspection personnel will include:

- Conducting independent on-site inspection of construction activities to assess compliance with the facility design plans and specifications.
- Verifying that the equipment used for testing meets the QA\QC specified test requirements, and that all tests are conducted according to the QA\QC Plan procedures.
- Reporting to the QC Engineer the results of all inspections, including work that is not of acceptable quality or that fails to meet the specified design.

6.5 Project Meetings

6.5.1 Preconstruction QA\QC Meetings

A meeting will be held to resolve any uncertainties following the award of the construction contract. The Project Manager, the QA\QC inspection personnel and the Contractor will be present. The topics of the meeting will include, but will not be limited to:

- Providing each organization representative with the QA\QC documents and the supporting information.
- Reviewing all aspects of the site-specific QA\QC Plan to ensure understanding of the responsibilities, duties and inspection/monitoring procedures.
- Discussing the established procedures or protocol for handling construction deficiencies, repairs and retesting.
- Reviewing methods for documenting and reporting inspection data, and for distributing and storing documents and reports.
- Identifying any changes to the QA\QC Plan necessary to ensure that construction will be conducted in accordance with the permit.
- Discussing procedures for the location and protection of construction materials and for the prevention of damage to the materials from inclement weather or other adverse events.

6.5.2 Daily Progress Meetings

A progress meeting will be held daily at the work area just prior to commencement or just following the completion of work. At a minimum, the meeting will be attended by the Contractor and the QA\QC inspection personnel. The purpose of the meeting will be to:

- Review the previous day's activities and accomplishments.
- Review the work locations and the activities for the day.
- Identify the Contractor's personnel, and the equipment assignments for the day.
- Discuss any potential construction problems.

Daily meetings will be documented by a member of the QA\QC inspection personnel, and copies of the documentation will be compiled into a weekly summary report for submission to Radford.

6.5.3 Problem or Work Deficiency

A special meeting may be held when and if a problem or deficiency is present or is likely to occur. At a minimum, the meeting will be attended by the Contractor and the QA\QC inspection personnel. The purpose of the meeting will be to define and resolve a problem or a recurring work deficiency as follows:

- Define and discuss the problem or deficiency.
- Review alternative solutions.
- Implement a plan to resolve the problem of deficiency.

These meetings will be documented by a member of the QA\QC inspection personnel, and the documentation will be included in the weekly summary report.

6.6 Test Equipment Calibration

All field test equipment will be kept under the control of the QA\QC inspection personnel. The QA\QC inspection personnel will be fully trained in the use of equipment, test procedures, and interpretation of results for each piece of test equipment. A copy of the calibration certificate will be kept by the QC Engineer. The equipment will be calibrated in accordance with the Quality Assurance procedures.

Calibration of nuclear density gauges will conform to the frequencies and methods outlined in ASTM D 2922-78 and D 3017-78. Unstable or erratic gauges will not be used for density testing and will be immediately removed from the site.

6.7 Non-Conforming Test Results

Density and moisture content test locations which fail to meet or exceed construction criteria will require reworking. The boundaries of the area to be reworked will be defined by the closest test locations which meet density and moisture content specifications. The non-conforming area will be

reworked, dried or wetted as necessary, and retested. A non-conformance report will be prepared for areas which do not meet construction specifications after reworking and retesting.

Laboratory permeability test results which demonstrate a permeability above 1×10^{-7} cm/sec will be immediately brought to the attention of the QC Engineer. Non-conforming permeability test results may result in a review of previous test results, retesting, and/or a reevaluation of compaction criteria. After review and/or retesting areas which do not meet the specified permeability will require reworking.

All non-conformance reports will be brought to the attention of the Project Manager by the QC Engineer and will be documented in the Quality Assurance files.

6.8 Documentation

6.8.1 Daily Recordkeeping

Standard daily reporting procedures will include preparation of a summary report with supporting inspection data sheets. When appropriate, problem identification and corrective measures reports will be appended.

6.8.2 Daily Summary Report

A standard Daily Summary Report will be prepared by the QC Engineer or the QA/QC inspection personnel. This report will summarize that day's construction activities and the chronological framework for identifying and recording all other reports. The Daily Summary Report will include the following information:

- Unique identifying sheet number for cross-referencing and document control.
- Date, project name, location, or other identification.
- Data on weather conditions.
- Reports on any meetings held and their results.
- Unit processes and locations of construction underway during the time frame of the Daily Summary Report.
- Equipment and personnel present on-site, including subcontractors.
- Descriptions of areas and/or activities being inspected and/or tested, and related documentation.
- Description of off-site materials received, including any Quality Control certifications received.
- Calibration of test equipment.
- Decisions made regarding approval or rejection of materials or construction activity, and any corrective actions taken.
- Reference to pertinent data sheets or corrective measures reports prepared.
- Signature of the QC Engineer or the QA/QC inspection personnel preparing the report.

6.8.3 Inspection Data Sheets

Pertinent observations and laboratory and/or field data will be recorded on inspection data sheets. A standard data sheet format will be developed by the QC Engineer. Where possible, a checklist will be used to ensure that no pertinent factors of a specific observation are overlooked. Inspection data sheets will include the following information:

- Unique identifying sheet number for cross-referencing and document control.
- Description of the inspection activity.
- Location of the inspection activity or location where sampling or testing activities occurred.
- Type of inspection activity and procedure used.
- Recorded observation or test data, with related calculations.
- Results of the inspection activity or test results and comparison with specification requirements.
- Personnel involved in the inspection activity.
- Signatures of the appropriate QA/QC inspection personnel and concurrence by the QC Engineer.

6.9 Acceptance Reports

All daily inspection summary reports and inspection data sheets will be reviewed by the QC Engineer. The documentation will be evaluated and analyzed for internal consistency and for consistency with similar work.

This information will periodically be assembled and summarized into acceptance reports for submittal to Radford. These reports should indicate that the materials and construction processes comply with the permitted plans.

6.10 Final Documentation

At the completion of the project, a final certification report will be issued by the QC Engineer and transmitted to Radford. This document will include, but not be limited to, the following:

- Scope of work.
- All daily field reports.
- All laboratory and field test results.
- Test methods.
- Evaluation of all test results with respect to project specifications.
- Any non-conformance reports.
- Personnel involved with the project and their respective qualifications.
- As-built drawings and survey notes.
- Certification of final construction as meeting or exceeding construction specifications. This certification should be signed and stamped by the QC Engineer.

At the completion of the project, Radford will submit a final report to the VDEQ - Waste Division. This report will include a summary of the observations and testing conducted during construction, deviations from design and material specifications (with justifying documentation), and as-built drawings. This document will be prepared and certified correct by the QC Engineer and included as part of the QA/QC Plan documentation.

6.11 Document Control

The QC Engineer will initiate a project filing system which will include, but not be limited to, the following:

- File copy of the Quality Assurance procedures, updated as necessary.
- Photographic construction documentation.
- Survey measurements.
- Field and laboratory test results.
- Daily and weekly field results and reports.
- Field certification reports including as-built drawings.
- Non-conformance and corrective action reports.
- Minutes of construction meetings.

6.12 Storage of Records

During all construction activities, the QC Engineer will be responsible for all facility QA/QC documents. This includes the QC Engineer's copy of the design plans, the QA/QC Plan, and the originals of all the data sheets and reports. Duplicate records will be maintained by the facility to avoid loss of this information if the originals are destroyed. A copy of all documents will be maintained by Radford throughout the post-closure care period.

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CONSTRUCTION QUALITY ASSURANCE PLAN
FOR
RADFORD ARMY AMMUNITION PLANT
CONTINGENT INCINERATOR SPRAY POND
CLOSURE
APPENDIX A

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this document is to provide the quality assurance/quality control (QA/QC) requirements for contingent closure system construction for the INCINERATOR SPRAY POND at the Radford Army Ammunition Plant. This document provides the minimum inspection, testing, manufacturing, material, and installation requirements needed to ensure that design requirements of the contingent closure system are met. Specifications and plan sheets are required for the construction of the landfill cap. The Quality Control Engineer (QC Engineer) will report to the owner, independent of the contractor, to ensure that the design requirements are met.

1.2 Scope

This document addresses the test methods, test frequencies, and documentation necessary to ensure adherence to the construction specifications in all phases of the contingent closure system construction. Protocol for reporting test results that confirm compliance with construction specifications, correcting construction deficiencies, and documenting such corrections are also provided.

1.3 Quality Assurance Organization

1.3.1 Quality Assurance Plan

The Radford INCINERATOR SPRAY POND Closure Construction Quality Assurance Plan (QAP) outlined herein will be administered by an engineering firm experienced in facility engineering, quality assurance, and construction management. The engineering firm, hereafter referred to as the "Engineer", reports to the Owner. The Engineer has the authority to halt any phase of construction due to quality-related concerns involving materials or installation. The Engineer will be responsible for the preparation of closure system construction reports to the Owner. A Professional Engineer will lead this effort.

1.3.2 Quality Control Engineer

A Quality Control Engineer (QC Engineer) shall be employed or retained by the Engineer for this project. The QC Engineer is responsible for tabulating all field and laboratory test data. Products that will be used in the construction of the cap will have physical properties in accordance with the QAP presented herein. The QC Engineer will report his findings and recommendations to the Engineer. The Engineer may reject

materials and/or modify construction operation based on these results.

1.3.3 Vendors

All vendors supplying materials used in the construction of the contingent closure system will implement a quality assurance/quality control (QA/QC) program or comply with the QA/QC Program outlined herein, and will report to the QC Engineer. The vendors shall submit physical test and chemical properties of materials and products that will be used in construction of the contingent closure system in accordance with the QAP presented herein and the vendor's QA document. Based on these results, the Engineer may reject materials and/or halt production and/or reject finished products.

1.3.4 Contractors

All contractors providing construction services for the contingent closure system shall comply with either a QA/QC program reviewed and approved by the Engineer or with the QA/QC program outlined herein. QC technicians will test and document all phases of the contingent closure system, including the testing of vendor-supplied materials and testing of completed construction to ensure adherence to construction specifications. QC technicians will report to the QC Engineer. Based on QC test results, the Engineer may reject construction materials and/or modify construction operation. Audits of all aspects of the QA/QC Plan for contingent closure system shall be conducted by the Engineer at least once during construction.

1.4 Qualifications of Personnel

All QA personnel will be properly trained and qualified to test and inspect the contingent closure system construction. The QC Engineer is the key to the inspection and certification program. This person will have sufficient education and technical and administrative experience to perform his responsibilities. He will have demonstrated knowledge of specific construction practices relating to geosynthetics, all regulations and specifications, observation and testing procedures, and documentation procedures.

Although qualifications for other QA personnel are not as stringent, adequate formal training in observation and testing procedures is required.

Vendors and Contractors will submit qualifications of their planned QA personnel to the Engineer. These qualifications will be kept on permanent file as a record of the construction process.

1.5 Definitions

Definitions of terms pertinent to the QA/QC include:

1. **Atterberg Limits** - The liquid limit and plastic limit for soils (ASTM D-4318-84). The water content when the soil behavior changes from the liquid to the plastic state is the liquid limit and from the plastic state to the semisolid state is the plastic limit.
2. **Classification System** - The Standard Test Method for Classification of Soils for Engineering Purposes (ASTM D-2487-85, Unified Soil Classification System).
3. **Compaction** - The process of increasing the density or unit weight of soil by rolling, tamping, vibrating, or other mechanical means.
4. **Density** - Mass density of a soil is its weight per unit volume; usually reported in pounds per cubic foot.
5. **Engineer** - The consulting engineering firm responsible for earthwork monitoring, soil and synthetic laboratory testing, and providing general supervision of all aspects of construction for conformance to the specifications and design drawings based on this QA/QC Plan. The Engineer is technically accountable to the owner.
6. **Geomembrane** - Very low permeability synthetic membrane liners or barriers used with any geotechnical engineering related material so as to control fluid migration in a man-made project, structure, or system.
7. **Geonet** - A synthetic mesh drainage net used in civil engineering for geotechnical projects. The material has a waffle-like cross section of openings that channel flow. Hydraulic transmissivity is dependent upon the slope gradient and the dimension of the geonet.
8. **Geotextile** - Any permeable textile material used with foundation soil, rock, earth, or any other geotechnical engineering related material, as an integral part of man-made product, structure, or system.
9. **Grain-Size Distribution** - The distribution of particle sizes within a soil. Applicable method: ASTM D-422-72.
10. **In Situ** - "As is", or as it exists in place naturally.
11. **Moisture Content** - The ratio of quantity of water in the soil (by weight) to the weight of the soil solids (dry soil), expressed in percentage; also referred to as water content.

12. Optimum Moisture Content (OMC) and Maximum Density - The moisture content corresponding to maximum dry density as determined in "Moisture Density Relations of Soils and Soil Aggregate Mixtures Using 4.54-Kg Hammer and .46-meter(m) Drop" (Modified Proctor ASTM 1557 unless otherwise stated).
13. Permeability - The ability of pore fluid to travel through a soil mass via interconnected voids. "High" permeability indicates relatively rapid flow. Rates of permeability are generally reported in centimeters per second (cm/sec).
14. Plasticity - The ability of soil mass to flow or be remolded without raveling or breaking apart. Generally, that range of soil water content between the liquid and plastic limit.
15. Sieve (200 Mesh) - Refers to soil particle size passing (smaller than or equal to) the U.S. Sieve No.200 (ASTM Specification E-11-81), which includes a 75-micrometer (0.00295-inch) opening.

1.6 Document Control

The Engineer will be responsible for the overall administration and control of the project QA/QC document. The Engineer will verify that a QA/QC filing system is implemented that will include, at a minimum, survey measurements, field and laboratory tests of soils, plant, field, and lab tests of synthetic materials, daily field reports, and certifications. A file index will be prepared to expedite retrieval of documents. QA/QC personnel will be required to update the filing system weekly with new data, test results, certifications, etc.

1.7 Preconstruction Meeting

A preconstruction meeting shall be held at the site prior to the start of construction. Representatives from the Engineer and the Contractor shall attend the meeting to review construction plans, the QA/QC Plan, and other phases of construction. This meeting should take place at least 1 week prior to construction.

2.0 STRUCTURAL FILL QUALITY ASSURANCE

The structural fill will be placed over the Incinerator Spray Pond area. The structural fill will be placed in a fashion that minimizes settlement and provides a uniform, smooth, compacted surface upon which to place the capping system's geomembrane. Material used for structural fill will be provided primarily by off-site sources that have a composition that meets the requirements of this section.

2.1 Preparation of the Area Receiving Structural Fill

Prior to placing structural fill within the Incinerator Spray Pond area, the entire subgrade area will be visually inspected, hand probed, and proof rolled by the Contractor. If any soft or loose areas are detected by the visual inspection/hand-probing activities, these areas will be recompacted with as many passes as necessary to density these materials to the satisfaction of the QC Engineer. If these materials cannot be densified sufficiently by the additional proof rolling, they shall be undercut and replaced with approved structural fill. Unsuitable soil will be checked for contaminants and will be disposed of in accordance with the lagoon closure plan.

2.2 Testing Prior to Structural Fill Placement

Prior to the placement of structural fill, geotechnical testing from each borrow source will be performed to verify that material properties are in conformance with the closure plan and specifications. The table of ASTM tests to be used on the borrow source and the placement of the clay cap in the closure plan will be followed. Clean fill for compacting into the excavation will be a clean earthen material free of large rock fragments, roots, or other objectionable matter. The Contractor will provide the certified test reports to the QC Engineer for approval of borrow material.

2.3 Delivery Tickets

When requested by the Engineer, the delivery tickets supplying the following information for each load of borrow material will be submitted by the Contractor:

- 1 Name and location of supplier.
- 1 Type and amount of material delivered.

2.4 Structural Fill Construction

Structural fill material will not be placed, spread, or compacted while it is frozen or thawing, or placed upon frozen or thawing ground, or installed during unfavorable weather conditions. When the work is interrupted by rain, fill operations will not resume until field tests indicate that the moisture content and density of the fill are within the specified limits. Before placement of the next layer occurs, a compacted layer that has been frozen will be reworked and recompactd to the required specified density after thawing.

The finished top elevation of the structural fill will represent the grades shown on the construction drawings. The structural fill will be constructed in 8-inch lifts (loose thickness) maximum, and compacted to a minimum of 92% of its maximum dry density as determined by the Modified Proctor Compaction Test (ASTM D-1557). For fine-grained material, a sheepsfoot roller (minimum 20-ton static load) with fully penetrating feet (8-inch minimum) will be used. If necessary, the material will be dried or water will be added to bring the moisture content to within 2% of its optimum moisture content.

The finished grade of the clay cap will be smooth, uniform, and free of any objects (i.e., stones) larger than 3/4-inch in diameter and any objects protruding from the surface that may damage the synthetic liner. A smooth drum roller (minimum 20-ton static load) will roll the area prior to acceptance and field survey. Final acceptance of the clay cap will not be given until synthetic liner installation. A final inspection by the Engineer will be made at this time and any damage due to erosion and general exposure will be remediated prior to membrane installation.

2.5 Field Density Testing

As the structural fill is placed and compacted, each lift will be tested by the quality control technicians as specified in the closure plan. Areas of the structural fill that fail to meet density construction specification criteria will be reworked and retested.

2.6 Removal of Undesirable Materials

All structural fill will be clean and inert; free of organics, waste or contamination, and miscellaneous or deleterious material; and will not contain particles larger than 3 inches in diameter. The maximum allowable particle size for final 6-inch lift will be no larger than 3/4 inch in diameter. If unsuitable

materials are observed during placement, they will be removed by the Contractor. Any voids created as a result of unacceptable materials removal will be filled with suitable material and recompact according to the QC Engineer's direction.

2.7 Final Surface of Structural Fill

The QC Engineer will visually inspect the surface of the compacted structural fill for smoothness and uniformity, including undulations caused by the roller. Any objects protruding from the final surface or coarse fragments within the material that may damage the synthetic liner will be removed.

2.8 Survey Control

Prior to structural fill placement, a topographic survey of the area will be conducted by the Contractor using a land surveyor registered in the State of Virginia. The completed surface will be surveyed to ensure that the actual depths and grades are in accordance with the plans and specifications. Two submittals comprised of as-built drawings before and after structural fill placement will be submitted to the Engineer by the Contractor. The Engineer will certify that the grades of the structural fill are in conformance with the planned elevation.

2.9 Review of Quality Control Information

The Engineer will be responsible for the overall administration and control of the project QA/QC document. The QC Engineer will be responsible for obtaining all of the laboratory test results and field test data from the Contractor, and for reviewing these data for conformance to the specifications/QAP. A copy of these data will be provided to the Owner. All non-conformance items not resolved between the Engineer and the Contractor will be brought to the Owner's attention. The QC Engineer will maintain a field log and record all observations with regard to conformance with the QAP. The daily log, which will be provided to the owner, will summarize daily activities and QA/QC inspections, testing, and documentation.

3.0 SYNTHETIC LINER QUALITY ASSURANCE

3.1 Quality Assurance Testing of Synthetic Liner Materials

The following quality assurance testing will be conducted on the synthetic membrane to be used as the barrier layer within the cap system. The geomembrane will be 30-mil polyvinyl chloride (PVC), 30-mil VLDPE, 60 mil HDPE, or an equivalent geomembrane. The Contractor will submit the test results of the following to the QC Engineer prior to geomembrane delivery. The QC Engineer will then inspect/review these data for conformance to the material specifications.

The membrane will be tested prior to shipment to ensure that the physical and chemical properties of the finished product are in conformance with the construction specifications. The Contractor is responsible for providing these test data prior to liner installation. Test frequencies shall be at minimum at least as stringent as the manufacture's recommendation. The mean, minimum, maximum, and standard deviation of the conformance testing results will also be provided to the Engineer.

3.2 Inspection of Material Handling and Storage

Materials will be delivered to the site after the required submittals have been furnished and approved. The QC Engineer will inspect the handling and storage of the geomembrane for conformance to the manufacturer's recommendations to prevent damage to the geomembranes. The Contractor will provide labor and equipment to properly unload material upon arrival at the site. The material will be stored in a reasonably level area, well drained, away from oils/fuels, brush, and poison oak or ivy. The material should be stored on a smooth surface that provides good support and in an area that facilitates easy access by inspectors. The protective covers used to wrap each material roll shall not be removed until immediately before the material is to be installed in the field. Geomembrane rolls will be stored in a flat area underlain by a bedding geotextile and will not be stacked more than three rolls high.

3.3 Foundation Preparation and Equipment

Prior to installation of the geomembrane, the lining contractor will verify the conditions of the clay cap fill to ensure that this surface represents an adequate surface for the geomembrane. The lining contractor will notify the facility representative in writing of his acceptance of the clay cap prior to installation of the geomembrane. This notification shall be consistent with the liner supplier's requirements for the

structural fill in order to preserve the warranty for the liner.

3.4 Field Installation Supervisor Requirements

The geomembrane liner will be installed by the liner manufacturer or an approved Contractor trained and licensed to install the manufacturer's geomembrane. Installation will be performed under the constant direction of a field installation supervisor who will remain on-site and be responsible, throughout the complete liner installation, for liner layout, seaming, patching, testing, repairs, and all other installation activities. The installation supervisor will have installed or supervised the installation and seaming of a minimum of 250,000 sf of geomembrane. Actual seaming will be performed under the direction of a master seamer (who may also be the installation supervisor) who has seamed a minimum of 250,000 sf of geomembrane using the same type of seaming apparatus specified for the geomembrane in this project. This installation supervisor and/or master seamer will be present during all seaming activities. The geomembrane shall be laid out and installed by trained technicians in accordance with the applicable Engineer-approved panel installation drawings. The geomembrane to be used in this project and the seaming layout will be submitted to VDEQ as specified in the closure plan narrative.

3.5 Weather Conditions

Geomembrane welding will not take place in temperatures less than 0°C (32°F) unless it can be proven via test strips that acceptable seams can be fabricated at lower temperatures. For cold weather seaming, it may be advisable to preheat the sheets with a hot-air blower, use a tent of some sort to prevent heat loss during seaming, change solvent to one appropriate for cold weather seaming, or decrease the seaming rate. The Contractor will submit, prior to liner installation, proposed cold weather seaming procedures for approval if it is anticipated that ambient temperatures will be below 32°F during welding operations. Ambient temperatures for seaming should be below 40°C (105°F), measured 2 ft above the liner.

3.6 Visual Inspection of Geomembrane During Placement

The lining contractor will be responsible for the inspection of the sheet rolls upon arrival at the job site. Should the rolls show damage from transit, they will be so identified by the lining contractor and set aside for either return to the manufacturer or repair in accordance with the manufacturer's recommendations. During unrolling of the lining material, the lining contractor and QC Engineer will perform visual

inspection of the sheet surface. Any faulty areas will be repaired by the lining contractor using pre-approved techniques.

Such repairs will be recorded on the shop drawings and reported to the Engineer by means of a daily quality control (QC) log. At any point in the work, if the daily QC log has not been submitted, the Engineer has the right to stop work at the cost of the Contractor. Work will resume upon receipt of the required daily QC log.

3.7 INSTALLATION PROCEDURES

The geomembrane liner will be laid out and installed by trained technicians in accordance with the applicable Engineer-approved panel installation drawings. The liner will be installed by the liner manufacturer or an approved representative. After the sheets are properly positioned, the pre-approved welders will then weld the liner using the accepted method. No work will begin until the Engineer has received proof of the welders' required qualifications.

The sheets will be placed in a configuration that permits termination at the edge of the perimeter trenches, as will be shown on the drawings. The layout will be designed to minimize the number and length of the field joints, consistent with proper methods of liner installation.

3.7.1 Field Panel Placement

Prior to commencement of the installation, the Contractor will provide the Engineer with a proposed panel layout drawing. The proposed panel layout drawing is tentative and may be modified by the Engineer or the field installation supervisor. In general, seams will be oriented parallel to the line of maximum slope. Seams where more than two panels are connected (Y and T seams) will be patched.

A seam numbering system compatible with a panel numbering system will be employed on the project. Field joints will be made by overlapping adjacent sheets a minimum of 4 inches. Areas cut to remove wrinkles or fishmouths will be cut along the ridge of the wrinkle and patched at the ends with a solvent weld or heat weld completely surrounding the patch perimeter. Small circles, approximately 3 to 5 inches in diameter, will be cut at the ends of the straight cuts to preclude propagation of these cuts under stress.

If panel overlap is excessive, the bottom sheet will be field cut. Where the overlap is inadequate, an oval or round patch extending 4 inches beyond the cut will be installed.

3.7.2 Seam Preparation

Prior to seaming, the seam area will be clean and free of moisture, dust, dirt, debris of any kind, and foreign material. Seams will be aligned to create the fewest possible number of wrinkles and fishmouths. Panels will be overlapped with the upgradient panel overlapping the downgradient panel. All seam interfaces will be visually examined for scratches, blemishes, flaws, and texture. All seam preparation, including cleaning and trimming, will be completed at least 50 ft ahead of the seaming operation so seaming may be continued with as few interruptions as possible. Trimming of seams and patches will be accomplished using scissors with blunt or round ends.

3.7.3 Seaming

The approved seaming techniques for this project are solvent seam and bodied solvent welding for PVC geomembrane or hot welding for the polyethylene (HDPE or VLDPE) products. The sheets which are overlapped for seaming must be clean and completely free of moisture in the seam area. Seam areas will be wiped clean with dry rags or towels, and will be dried with air blowers or infrared lamps unless the contractor has an abundance of dry rags, which would be acceptable for drying purposes.

Seaming activity will not be permitted during rain or snow unless the contractor provides an enclosure or another form of shelter to ensure moisture-free seaming. If PVC geomembrane is used all production seaming will be performed with a seaming board underlying the seam area. The seaming board will prevent sub-base moisture from being drawn into the seam area by the drying apparatus as well as provide a firm base for seaming.

3.7.3.1 Equipment Preparation

For PVC geomembrane there must be an ample supply of the manufacturer's recommended solvent available on-site prior to liner placement. Storage of the solvents will be away from any portion of the liner in an area sheltered from the elements and kept at room temperature. The Contractor will provide

an adequate quantity of plastic squirt bottles, fine bristle paint brushes for applying bodied solvents, natural fiber rags, rollers, brushes and seaming boards for the project. The plastic squirt bottles will be equipped with end appliances that will provide a uniform amount of solvent to the seam area. Bottles will be filled away from the liner area. The natural fiber rags will be of a compatible nature with the solvent so as not to deteriorate and interfere with the seaming process. Brushes provided will have fine bristles for quick and efficient dust removal from seam areas. Pressure will be applied to the bonded seam area by steel, rubber, nylon or wood rollers that are 2 inches to 3% inches in width. Roller surfaces will be clean to ensure smooth seaming. Several 1 inch by 10 inch wooden boards with rounded corners will be available for use as seaming boards. These "working platforms" will be at least 4 ft long but no longer than 16 ft long. A properly functioning small electric generator to power heat lamps or hot air blowers will be located within close proximity of the seaming area. The generator will be placed on a completely stable smooth plate that will pose no hazard to the lining system. Fuel for the generator will be stored away from the liner. The generator will be refueled over a scrub sheet that will protect the liner from the fuel. A small air compressor to be used to power air lance testing will also be provided. The same liner protection measures taken for the generator will apply to the air compressor.

For polyethylene (HDPE or VLDPE) products, they shall be stored in an area secure from adverse weather conditions, and protected from UV light, heavy winds or precipitation, temperature extremes, and vandals. The liner bedding should be observed and verified by the liner manufacturer's representative. The engineer shall: measure and confirm that required overlaps of adjacent membrane sheets are achieved; visually inspect each panel for tears, punctures, and thin spots; mark thin spots for repair; observe conditions while seaming operations proceed on the polyethylene sheets; observe that the sheets are free of dirt, dust, and moisture; observe and note that the seaming materials and equipment are as specified by the manufacturer; observe and note the weather conditions while seaming; take measurements of temperatures, pressures, and speed of seaming, when applicable, to ensure that they are as specified (i.e., gauges and dials shall be checked and reading recorded); make sure the double weld seaming heaters shall run a test seam which will be destructively tested before each shift's welding begins; verify that appropriate destructive and non-destructive tests are performed and that horizontal and vertical control is maintained; document that 100% of the seams are non-destructively tested; verify that any repairs made were made in accordance with the manufacturer's recommendations and specifications and then retested;

require additional testing in areas of discoloration or suspicious observations; document destructive test samples as to location, time, crew, and technique.

Prior to placement of the drainage layer or any temporary covers, QA personnel shall visually inspect the membrane for any damage that may have occurred during installation. If any damaged areas are located, they shall be marked and patched using approved repair methods. Any repairs made shall be non-destructively tested.

3.7.3.2 Test Seams

Prior to production welding, test seams will be prepared by each welder. This will be implemented every 4 hours or at the direction of the Quality Control Engineer. The purpose of the test seams is to establish proper preparation and welding procedures and subsequent seam evaluation. A large enough test seam will be obtained in order to field test one section, retain one section for laboratory testing at the direction of the QC Engineer, and retain one section for the project archives. Individual samples will be cut from the test seams and cured in a field oven. When curing is complete, the samples will be tested in a field tensiometer in both shear and peel. If a test seam fails to meet seam specifications, the seaming procedure and/or welder will not be accepted and will not be used in production welding until the deficiencies are corrected and two consecutive successful test seams are achieved.

3.7.3.3 Seaming Process

If PVC panels are used, the PVC geomembrane panels will be positioned in a manner that creates an overlap of at least 4 inches. Of the 4-inch overlap, the inner 2 inches will be left unbonded while the remaining width will make up the weld. The reason for the unbonded areas on the PVC sheets is that this will prevent excess solvent from ponding on the underlying soil, creating a possible hazard to the overlying PVC liner. The solvent will spread over the unbonded area, creating a wider weld instead of a concentrated area that would damage the liner. Once the panels are properly positioned, the wooden seaming board will be placed under the area to be welded. A fine bristle brush will be used to remove dust particles from the seaming area.

Where possible, seaming will begin at the midpoint of the panel and progress toward the ends in order

to prevent the occurrence of fishmouths in the center of the panel welds. Seaming will progress in the uphill direction when solvent seam welding is to be used. If the "dwell time" is negated due to solvent depletion, the bodied solvent will be used. At "T" connections, additional solvent will be used to ensure proper bonding.

The critical part of the solvent welding process is the application of the correct amount of the appropriate solvent. For solvent weld seams, the solvent will be applied with a squirt bottle until it has puddled on the bottom panel. For the bodied solvent seams, the bodied solvent is applied uniformly to the bottom of the upper panel and to the top of the bottom panel. For either process too little solvent will result in a weak seam, and excess solvent must be squeezed out of the seamed area with the roller. For this reason, the installer will be required to exercise great care during solvent application to ensure the correct amount of solvent applied.

After applying the solvent, the panels will not be mated to one another before the flash time or initial reaction time has elapsed. Flash times are a function of solvent, thickness, and type of thermoplastic liners and vary from 2 to 5 seconds. The flash time will be recommended by the manufacturer and confirmed in the field by the installer who will then wait the required time prior to panel mating. Once the flash time has elapsed, the panels will be mated together and pressure will be applied to the upper panel above the seam area. The pressure will be applied with the roller described previously. The rolling process will be accomplished in two phases. The first phase involves rolling parallel to the seam for five passes within a 2-ft-long seam increment. This will force excess solvent toward and out of the exposed edge of the overlap. The second phase involves rolling perpendicular to the seam. A minimum of eight perpendicular passes will occur in the 2-ft-long increment of the seam. This will ensure that no air pockets remain in the bonded area, hence providing close contact between the two PVC panels. The installer will make sure roller surfaces are clean and smooth at all times. Excess solvent will be immediately wiped from the top of the liner towards the leading edge of the seam to minimize spreading of the solvent.

The QC Engineer will ensure that these installation procedures are followed. If installation procedures deviate from those described herein, the Engineer will document it in the field and daily logbooks. If the deviation results in defect, the QC Engineer will note this and will ensure that proper repair procedures

are performed and recorded.

3.8 Inspections During and After Seaming

3.8.1 Weld Inspection

All site welds will be visually inspected immediately after production by the field QC technician and/or liner site manager. Any area of the liner containing spilled solvent or puncture holes will be cap stripped with the patch extending at least 4 inches beyond the affected areas. In addition, all field welds will be nondestructively tested over their full length for continuity and water tightness using tests described below. The results will be recorded daily on a Report of Welds Form.

3.8.2 Nondestructive Seam Continuity Testing

The Contractor will nondestructively test all field seams over their full length using an air lance, or other method approved by the Engineer. The purpose of the nondestructive tests is to check the continuity of seams. It does not provide information on seam strength. Continuity testing shall be conducted as the seaming work progresses, not at the completion of all field seaming.

3.8.3 Air Lance Testing

The equipment shall be comprised of the following:

- ⚡ An air compressor equipped with pressure gauge capable of generating and sustaining a pressure of at least 50 psi.
- ⚡ A nozzle with a 3/16-inch-diameter orifice.
- ⚡ A rubber pressure hose with fittings and connections.

The following procedure shall be followed:

- ⚡ Energize the air compressor until the tank pressure is at least 50 psi (10 inches of Hg).
- ⚡ Open the nozzle valve.
- ⚡ Direct air flow beneath the upper edge of the overlapped seam. Air nozzle should be no further than 3 inches from the seam area.
- ⚡ Examine the geomembrane for evidence of inflation and fluttering in the localized area for approximately 5 seconds.
- ⚡ Mark and repair all areas where inflation or fluttering appear in accordance with Subsection 3.8.5.
- ⚡ Record air lance-tested seams in the daily QC log.

3.8.4 Random Weld Samples (Destructive Seam Strength Testing)

Random weld samples will be cut from the installed welded geomembrane at a minimum frequency of

one sample for every 500 ft of weld. A maximum frequency will be agreed upon by the Contractor, Owner, and Engineer prior to liner placement. Additional locations will be determined during seaming at the Engineer's discretion. Selection of such locations may be prompted by suspicion of excess solvent, contamination of set welds, or any other potential cause of imperfect welding. In order to obtain test results prior to completion of liner installation, samples will be cut by the installer as the seaming progresses. Sampling times and locations will be determined by the QC Engineer based upon visual observation and experience. The QC Engineer must witness the obtainment of all field test samples, and the installer will mark all samples with their location, roll, seam number, and welder. The installer will also document the date, time, ambient temperatures, and pass or fail description. A copy of this information must be attached to each sample portion. All holes in the geomembrane resulting from obtaining the seam samples will be immediately repaired.

The installer will cut a 12-inch-wide by 40-inch-long sample with the seam centered lengthwise for each random (seam) sample. Two 1-inch-wide strips will be cut from each end of the sample. The installer will field test the two specimens from each end (total of four) for shear strength and peel adhesion using a laboratory-quality tensiometer. To be acceptable, all four test specimens must pass. Any specimen that falls through the weld is considered a failure.

The remaining sample will be cut into three parts ("coupons") and distributed as follows:

- ▲ One portion to the geomembrane installer for laboratory testing (12 inches by 12 inches).
- ▲ One portion for independent laboratory testing (12 inches by 12 inches).
- ▲ One portion to the Engineer for archive storage (12 inches by 12 inches).

The QC Engineer will package and ship seam samples for independent laboratory testing received from the installer for the determination of shear and peel strengths. The Contractor will be responsible for all independent laboratory testing. The test method and procedures to be used by the independent laboratory will be the same as those used in field testing, where seam samples are 1 inch wide. Four of five specimens per sample shall pass both the shear strength (ASTM D-3083, modified by NSF) and peel adhesion tests (ASTM D-413, modified by NSF) per the criteria listed above.

All test results from the geomembrane installer's laboratory and the independent laboratory will be submitted to the Engineer as soon as they become available. The Engineer will evaluate all test results and determine the required corrective action, if any.

The following procedure will apply whenever a sample fails the field destructive test. The geomembrane installer has two options:

1. The geomembrane installer can reconstruct the seam between the failed location and any passed test location.
2. The geomembrane installer can retrace the welding path to an intermediate location (at a 10-ft minimum for the location of the failed test) and take a 12 inch by 12-inch sample for an additional field test. If this additional sample passes the test, then the seam should be reconstructed between that location and the original failed location. If this sample fails, then the process is repeated.

In any case, all acceptable reconstructed seams must be bounded by two passed test locations (i.e., the above procedure should be followed in both directions from the original failed location), and one test must be taken within this reconstructed area.

In the event that a sample fails a laboratory destructive test (whether it is conducted by the independent laboratory or by the geomembrane installer's laboratory), the above procedure should be followed considering laboratory tests exclusively. Because the final seam must be bounded by two passed test locations, it may then be necessary to take one or more new samples for laboratory testing in addition to the one required in the reconstructed seam area.

3.8.5 Laboratory Testing of Welds

Laboratory testing of seaming operations will concentrate on the seams and joints in the membrane. Physical testing requirements for field seam coupon samples are listed below:

- ⌚ Seam Peel Stress (ASTM D-413 - NSF Modified).
- ⌚ Thickness (ASTM D-1593).
- ⌚ Shear Strength (ASTM D-3083 - NSF Modified).

Acceptable values for the thickness test are 100% or more of the values for the parent material. Peel and shear tests will meet NSF Standard 54 requirements, which includes FM or 10 pounds/inch width for both shear and peel tests.

Test location as-built drawings and results shall be submitted to the Engineer with certification that the geomembrane has met all of the requirements in the plans and specifications.

The approved destructive and nondestructive testing shall be carried out by the liner contractor in accordance with the approved procedures and plan. Repairs and replacements shall be made based on the test results.

3.8.6 Defects and Repairs

All seams and non-seam areas of the geomembrane will be evaluated by the QC Engineer for identification of defects, holes, blisters, undispersed raw materials, and foreign matter contamination. Because light reflected by the geomembrane aids in the detection of defects, the surface of the geomembrane should be clean at the time of inspection. The geomembrane surface should be swept or washed by the geomembrane installer if the amount of dust or mud inhibits inspection.

Each suspect location, both in seam and non-seam areas, will be nondestructively tested using the methods described previously. Each location that fails the nondestructive testing will be marked by the QC Engineer and repaired by the geomembrane installer. Repair procedures will be agreed upon between the Engineer, geomembrane installer, and inspector prior to geometric installation. Unless otherwise agreed, the procedure will be as follows:

- ⌚ Defective seams will be repaired by reconstruction, as described below.
- ⌚ Tears or pinholes that have penetrated the geomembrane will be repaired by patching.
- ⌚ Blisters, larger holes, undispersed raw materials, and contamination by foreign matter will be repaired with patches.
- ⌚ All seams used in repairing procedures must be approved and will be subjected to the same nondestructive test procedures as outlined for all other seams.

Each patch will be numbered and logged. Patches will be round or oval in shape, made of the same material as the geomembrane, and extend a minimum of 4 inches beyond all edges of the defect. Patches will be applied using the approved method as required in the manufacturer's specifications. The specifications will include the corners of the patches being rounded; and the patch extending a minimum of 6 inches from the area to be repaired.

Each repair will be nondestructively tested using the methods described previously. Repairs that pass the nondestructive test will be taken as an indication of adequate repair. Repairs that fail will be redone and retested until a passing test results. The QC Engineer will observe all nondestructive testing of repairs and will record the number of each patch, date, name of patcher, and test outcome.

3.9 Review of Quality Control Information

The Engineer will review all QC information, including raw material, conformance, fingerprinting, and field and independent laboratory test data. If test results or observations reveal that the work is not in conformance with the specifications, the Engineer will resolve the problem by the methods set forth in the construction specifications. If the method to be used is not in the specifications and the Engineer and Contractor agree on use of the method, the method will be recorded. A copy of all QC information recorded or received by the Engineer shall be given to the Owner.

3.9.1 Submittals

The lining manufacturer or supplier will submit to the Engineer for approval within 4 weeks after award of the contract the following information:

- ⬆ Manufacturer's QC program and/or manual that outlines the factory QC procedures. This shall address, at a minimum, delivery and use of raw materials, geomembrane roll production, and QA/QC of these activities.
- ⬆ Two sets of certified laboratory test results for the tests required prior to delivery of geomembrane. In addition, the Contractor shall provide a certified statement from the manufacturer that the geomembrane to be delivered to the site meets all of the physical property requirements.
- ⬆ Manufacturer's Certificate of Compliance for geomembrane raw materials conformance.

- ⚡ Manufacturer's certificate of compliance to the construction specification.
- ⚡ Manufacturer's warranty for the installed liner.
- ⚡ Proposed installation panel layout drawings, including seam identification, orientation, and roll numbers. The Contractor shall also provide on the drawings the corresponding panel and roll numbers from which coupons were taken by the manufacturer.
- ⚡ Manufacturer's recommended product defect repair and construction repair procedures.
- ⚡ Manufacturer's recommended field seaming procedures and techniques, including: methods, overlap, personnel identification, QA/QC of seaming operations, temperatures, and preparation of materials.
- ⚡ Manufacturer's nondestructive and destructive seam testing procedures, including type(s) of tests, a list of equipment required, frequency of tests with locations, methods, qualifications of personnel performing the tests, and acceptance/rejection criteria for tested seams.
- ⚡ Contractor's daily QC log format to be used during liner installation.
- ⚡ As-built drawings of the liner showing all seams, construction repairs, patches, coupon test locations, and repaired factory defects. All repair shall be recorded on the as-built drawings. The as-built drawings shall also indicate the panel and roll numbers from which coupons were taken prior to installation.

Using the construction drawings, the lining manufacturer will specify all components and details required for liner construction.

3.9.2 Daily Quality Control Log

The Contractor will maintain a daily QC log during all phases of liner installation. This log will document the daily progress of the liner installation from the delivery of the liner to final acceptance. The daily log will designate those construction activities that influence the integrity of the liner during installation. The log, at a minimum, will include entries and detailed documentation of the following:

- ⚡ Weather - temperature, winds, and precipitation.
- ⚡ Preparation activities, including removal of water, sediment, liner cleaning, or sub-base smoothing and repair.
- ⚡ Document roll number and sheet lot number placed in the required panel locations.

- ⚠ Repairs and replacements.
- ⚠ Document seaming activities, including name of welder(s) for each seam and any leakage detected in testing of that seam.
- ⚠ Results and locations of destructive and nondestructive testing performed as part of liner installation, including corrective action taken.
- ⚠ Equipment used to place the liner.
- ⚠ Inspection and backfilling of perimeter trench.

Prior to performing the work, the Contractor will submit the daily QC log format for approval by the Engineer.

4.0 DRAINAGE LAYER QUALITY ASSURANCE

The drainage layer will consist of a 12 inch crushed aggregate layer with a minimum permeability of 1×10^{-2} cm/s. The drainage layer will drain into a perimeter trench consisting of a coarse aggregate. PVC outlet pipes may be spaced to drain the perimeter trench. A perimeter drainage channel will drain the outlet pipes as well as cap runoff.

4.1 Drainage Layer Material Specifications

4.1.1 Geotextiles

Geotextiles will be used for filtration and separating applications in the drainage layer. An 8 oz/yd², non-woven, needle-punched geotextile will be used on top of the geonet and will be placed beneath the protective cover.

4.1.1.1 Conformance Testing

Geotextiles will be tested prior to shipment to ensure that the physical properties of the finished product are in accordance with the construction specifications. Samples of the geotextiles will be tested by the manufacturer or at the approved testing laboratory at a frequency of one sample (at least 4 ft by 4 ft) for every 25,000 ft² of material installed in the drainage layer. Geotextile samples will be tested to determine unit weight, thickness, grab strength, puncture strength, Mullen burst strength, trapezoidal tear, AOS, and permeability. Each sample of geotextile will have the roll, lot, and manufacturer clearly marked on or attached to the sample.

Certified test reports within the requirements of standards and testing methods specified herein will be submitted to the QC Engineer prior to delivery. The geotextile manufacturer and Contractor must assure the Engineer that the material they offer to furnish and install will meet every aspect of the construction specification requirements. The Contractor will transmit to the QC Engineer all information given to him by the manufacturer or supplier prior to approval for furnishing and installing any such material.

4.1.1.2 Delivery, Handling, and Storage

Materials will be delivered to the site after the required submittals have been furnished and approved. Storage and handling of the materials will conform to the manufacturer's recommendations and will be

conducted in such a manner as to prevent damage to any part of the work. The Contractor will provide labor and equipment to properly unload material upon arrival at the site. The material shall be stored in a reasonably level area, well drained, away from oils/fuels, brush, poison oak or ivy, in an accessible area for inspection, and on a smooth surface so that the material is well supported and not resting on sharp objects. Individual pieces or bundles shall be stored with safe walking space and clearance to allow full view for inspection purposes. The protective covers used to wrap each material roll shall not be removed until immediately before material installation.

All geotextiles will be covered within 14 calendar days following removal of their protective wrapping and their placement in the field to protect them from ultraviolet light degradation. Any geotextiles left exposed longer than the 14 calendar days will, at the QC Engineer's direction, be removed and replaced at no cost to the Owner.

4.1.1.3 Inspection of Geotextile Before and During Placement

The Contractor will be responsible for the inspection of the geotextile rolls upon arrival at the job site. Should the rolls show damage from transit, they will be so identified by the Contractor and set aside for either return to the manufacturer or repaired in accordance with the manufacturer's recommendations.

Prior to commencement of the installation of any geotextile, the Contractor will provide the Engineer with a proposed panel layout drawing, i.e. a drawing of the facility to be provided with geotextile based upon submitted engineering drawings. The proposed panel layout drawing is tentative and may be modified by the Engineer.

During placement of the geotextile, the Lining Contractor will conduct visual inspections of the material surface. Any faulty areas relating to fabric integrity, uniformity, rips or tears, sewing incompleteness, and seam overlap will be repaired by the lining contractor using pre-approved techniques. Such repairs will be reported to the Engineer by means of a daily QC log. At any point in the work, if the daily QC log has not been submitted, the Engineer has the right to stop work at the cost of the Contractor. Work will resume upon receipt of the required daily QC log.

QC technicians will verify that fabric placement conforms to the construction plans and specifications.

4.1.2 Perimeter Trench Coarse Aggregate

Material for use in the perimeter trench backfill will be obtained from an approved off-site borrow source. The material will be inorganic, environmentally clean, well-graded, gravel sized material that is non-calcareous and possesses a compacted hydraulic conductivity equal to or greater than 1.0×10^{-2} cm/sec. The material may not contain miscellaneous fill or other deleterious inclusions. Shales, clay-stones, silt-stones, and other rapidly degradable materials will not be acceptable as perimeter trench backfill.

Prior to delivery and placement of any perimeter trench backfill, the Contractor will notify the QC Engineer in writing of the location of his proposed aggregate source(s). Upon visual acceptance by the QC Engineer, a minimum of two representative 100-pound samples of the material from each borrow source will be obtained by the QC Engineer and transported by the Contractor to the approved geotechnical testing laboratory for testing. A complete series of tests will be conducted on each sample and will consist of determinations of moisture content (ASTM D-2216); grain-size distribution (ASTM D-442); maximum and minimum dry density (ASTM D-4253, 4254); and the hydraulic conductivity (ASTM D-2434) of a sample compacted to at least 75% relative density.

The geotechnical laboratory will prepare a certified test report and transmit these data to the Contractor. The Contractor will then transmit this report to the QC Engineer for review and approval.

The Contractor will submit certified test reports for the proposed aggregate source(s) before delivery of the primary leachate collection zone material. Each truckload of material delivered to the site will have a "transit slip" from the supplier that provides the following information: Owner's name; Contractor's name; borrow source; type of material; and other required geotechnical information.

4.1.3 Pipe Material Specifications

Pipe material, if used for perimeter trench drainage, will be 3-inch-diameter PVC slotted schedule 40 pipe. Drainage pipes will be metered in field to conform to cap slope.

The Contractor shall submit to the Engineer for approval certificates of compliance before delivery of materials for PVC pipe furnished by the Contractor for this project. Certificates will include the following information: a copy of the manufacturer's certified test reports; job location; the Contractor's name; types, classes, and strengths of pipe; and the pipe manufacturer's name.

4.2 Drainage Layer Installation

4.2.1 Installation of Geotextiles

The manufacturer's recommended installation procedures will be submitted by the Contractor for the sewing of the geotextiles, including procedures for repair. All seaming shall be performed by the manufacturer's trained personnel. The Contractor may also be requested to submit training or experience records of the installers to the Owner for approval.

Geotextile shall be placed by the geomembrane lining contractor at the locations shown on the drawings. All geotextile seams will be overlapped a minimum of 8 inches and tacked using a "Liester" gun or sewn securely in a prayer fashion using KEVLAR thread. End-of-roll seams will be offset a minimum of 5 ft between adjacent roll ends. Installed fabric shall be covered with the protective cover material as soon as possible, but in no case longer than 14 calendar days. During periods of high winds, sandbags or other methods approved by the manufacturer shall be used to secure any exposed fabric.

A minimum of 12 inches of earthen material will be placed upon the geotextile and spread in advance of construction equipment with high flotation/low ground pressure equipment. The Contractor will exercise extreme care during placement of the protective cover so as to cause no damage to the fabric. At no time will construction equipment be permitted to track directly on the fabric. Any damage to the fabric or lining system will be repaired by the Contractor (using approved methods) at no expense to the Owner.

4.2.3 Installation of the Perimeter Trench Backfill

The perimeter trench backfill consists of compacted coarse aggregate that meets the material requirements of Subsection 4.1.3.

The material shall be placed in horizontal lifts not to exceed 8 inches in loose thickness and compacted

until dense and stable as determined by the Engineer. Hand-manipulated compaction equipment such as vibrating plates or mechanical tampers should be used.

Equipment used for placing the perimeter trench backfill shall not be driven directly on the PVC liner or geotextiles. The perimeter trench backfill material will be placed before placing the protective cover. The Contractor will use a track extended-arm backhoe or other approved equipment to place the material in the perimeter trench. End dumping will be prohibited. The Contractor will submit to the Engineer for approval proposed installation procedures for the perimeter trench backfill.

The Contractor will measure perimeter trench backfill thickness and verify that the thickness required during construction is met, that final thickness is consistent with design, and that placement of material is completed in such a manner that geomembrane damage is unlikely.

4.2.4 Pipe Installation

Prior to pipe installation, if used, bedding material will be brought to grade along the entire length of pipe to be installed. The pipe will be installed to a true uniform line and graded as indicated with continuous bearing of barrel on bedding material. The exposed edge of pipe will then be metered to meet the finished slope of the cap. The Engineer will visually inspect the bedding to ensure that the pipes are bedded as described, so as to prevent movement.

4.3 Geotextile Clogging Potential

The clogging potential of the geotextile that separates the protective cover from the drainage layer has been addressed by the design, with an adequate factor of safety included against its primary clogging mechanisms (soil clogging, intrusion, and biological). If a geonet is used in place of the aggregate drainage layer, the reduction of geonet transmissivity has also been addressed in the design by similar safety factors. Experience has shown that geonets, aggregate drainage layers, and geotextiles on moderate slopes which only contact surface water are safe from clogging.

4.4 Review of Quality Control Information

Quality control information will be reviewed, recorded, and filed as described in Subsection 2.9.

5.0 PROTECTIVE COVER QUALITY ASSURANCE

The protective cover will consist of 18 inches of environmentally clean soil capable of supporting vegetative growth overlain by 6 inches of topsoil. The protective cover will protect the underlying geosynthetics from frost damage and vandalism.

5.1 Soil Design

Soils for use in the protective cover will be obtained from an approved off-site borrow source. The material will be clean, inert, inorganic, and free of waste, excess moisture, and miscellaneous or deleterious materials. It will meet the requirements set forth in the construction specifications for the contingent cover system.

5.1.1 Testing Prior to Placement of Soils

Prior to installation of any soils, geotechnical testing of the materials from each source will be performed to verify that the material properties are in conformance with the specifications. Compaction tests according to the Modified Proctor Test-Method (ASTM D-1557) will be performed at the frequency required by the specifications. Grain-size distribution (ASTM D-421 and 422), plastic and liquid limits (ASTM D-4318), and natural moisture content (ASTM D-2216) tests will also be performed.

5.1.2 Installation of Protective Cover

Compaction of the topsoil and protective vegetative cover will be achieved using appropriate compaction equipment. The lower 18 inches of soil will be compacted to 90% of the maximum dry density of the soil as determined by the Modified Proctor Test. The moisture content will be within 2% of the optimum moisture content of the soil. No heavy equipment will be placed on or over the geosynthetics placement of the protective cover. A minimum of 12 inches of soil will be placed over the geosynthetics before any heavy equipment is placed over same. No sharp or hot objects that may damage the liner may be used for placement of the protective cover. The Engineer will visually ensure that these conditions are enforced. Any violation of these conditions that may have damaged the liner will be recorded, along with the location of the damage and the repair procedure.

5.1.3 Field Testing

The Engineer will conduct a visual inspection of the soils of the cover system once they are placed and compacted. Prior to compaction, lift thickness and initial water content will be tested at least once per lift. Each lift will also be tested to determine the compacted density and water content before subsequent lifts are placed. This grid will shift on the next lift so that test locations are above an untested location of the previous lift. The results of the test must indicate that the in-place dry density values correspond to those required in the specifications. If the soil fails to meet this value, it will be reworked and retested.

As soils arrive on-site, the Engineer will check them for any organics, excessive moisture, waste, or other deleterious materials. If he finds unacceptable material, it will be removed, if possible. Otherwise, the soil will be rejected.

5.1.4 Topsoil Layer Placement

The topsoil will conform to the requirements set forth in the construction specifications for the contingent cover system. The uniformity of the application process will be monitored by the Engineer, who will check the loose thickness (before compaction) of the topsoil layer. To ensure that the soil is not overly compacted, a small test area of topsoil will be compacted and then tested. Topsoil will be compacted until it is dense and stable as determined by the Engineer. After placement of the topsoil, the facility will be surveyed at the identical locations of the previous surveys to ensure that the correct final grades have been achieved. The slope of the topsoil layer will follow the slope of the underlying layers.

5.1.5 Topsoil Seeding

Topsoil seeding will proceed as described in construction specifications for the contingent cover system. The Engineer will inspect the seed tag to determine if the seed meets the requirements of the specifications. If it does not, it will be rejected. The Engineer will record the weather condition of the time of seeding. If weather conditions are not favorable for seeding, the seeding will be performed as soon as weather conditions permit. The Engineer will also measure the tilling depth and record the application rate of seed. If they do not meet the requirements of the specifications, the Engineer will direct corrective action.

5.2 Survey Control

Prior to demobilization, a topographic survey of the final surface will be conducted by the Contractor using a land surveyor registered in the State of Virginia. The completed surface will be surveyed to ensure that the actual depths and grades are in accordance with the plans and specifications. The Contractor will establish a baseline for survey control. The Engineer will certify that the grades of the final cover are in conformance with the planned elevation.

5.3 Review of Quality Control Information

Quality control information will be reviewed, recorded, and filed. All-inspections will be performed by qualified technicians.

5.3.1 Security Controls

Access to the area is currently restricted by a fence that encloses property. This fence will be maintained as part of the Contingent Post-Closure Plan. The fence will be inspected and any damaged fence will be repaired or replaced, as necessary.

"Danger-Unauthorized Personnel Keep Out" or similar warning signs will be posted around the Incinerator Spray Pond area. These signs will be inspected weekly during security inspections.

5.3.2 Erosion Controls

The Incinerator Spray Pond area will be inspected weekly or after every major rainfall (approximately 2 inches per 8-hour period) until a post closure permit is developed which specifies another inspection schedule.

Erosion controls (slope/vegetation) will be maintained/repared in accordance with the original design for erosion controls. The final cover design specifies erosion control by grading the final cap to match the natural topography and a vegetative layer on top of the cap, thereby creating positive drainage. If necessary, new or additional vegetation will be applied.

5.3.3 Final Cover System

The final cover system is designed to ensure the integrity and to minimize surface water runoff and runoff

with a minimum of maintenance. No heavy equipment or vehicles will be permitted on the final cover area unless involved in maintenance or repair activities. No post-closure use of these areas is planned.

5.3.3.1 Settlement, Subsidence, and Displacement

The final cover will be maintained at the approximate slope and gradients described in Subsection 4.2. Slope and gradient will be checked when there is an apparent change detected during inspections due to settling, subsidence, or displacement.

5.3.3.2 Erosion Damage/Water Pooling

Inspections of the final cover will be conducted weekly or after heavy precipitation occurrences (approximately 2 inches per 8-hour period) for erosion, pooling of water, and visible damage. Erosion or pooling of water will be corrected. Topsoil is readily available, and if repair is necessary, this material will be used to correct the situation. Seeding procedures will be implemented if the cap must be repaired.

5.3.3.3 Insect and Rodent Control

Insect and rodent control will be provided as needed. The Incinerator Spray Pond area will be monitored for evidence of insects and rodents during weekly inspections. If required, insect and rodent control services will be contracted from commercial contractors. Should contractors be required, they will be informed of potential hazards and instructed not to disrupt cover materials.

5.3.3.4 Vegetative Cover

The condition of the Incinerator Spray Pond area's vegetative cover will be assessed during inspections. Maintenance will be performed as needed. Damaged or dead vegetation will be removed and replaced with equivalent vegetation. No trees, shrubs, or other deep-rooted plants will be allowed to grow on closed landfill units. Areas damaged by erosion will be repaired and re-vegetated. The vegetative layer will be maintained by fertilizing, irrigating, and cutting. Fertilizing will be performed as often as necessary to maintain the layer. Irrigating and cutting are seasonally dependent and will be performed as often as necessary.

5.3.4 Drainage (Runon/Runoff Control) System

All drainage controls will be maintained and kept free of debris or other blockage. Drainage controls will be inspected after major storms (approximately 2 inches of rain over an 8-hour period) and cleaned, as necessary. Repairs will include regrading and revegetation, if necessary. No ditches will be constructed on the Incinerator Spray Pond cover system.

5.3.5 Benchmarks

5.3.5.1 On-Site

All surveyed benchmarks will be maintained, repaired, or replaced as necessary. Benchmarks will be clearly identified and protected, and will be inspected quarterly. Permanent survey benchmarks will be constructed of concrete. These units are not typically degradable and should not require replacement during the post-closure care period.

5.3.5.2 Off-Site

The locations of on-site facility benchmarks will be established from United States Geological Survey (USGS) benchmarks. These USGS benchmarks are maintained by the USGS indefinitely.

5.3.6 Groundwater Monitoring Well Seem

All groundwater monitoring wells will be inspected quarterly (or during each groundwater sampling event if the soils are "clean" closed) and repaired or replaced, if necessary.

All monitoring wells will be inspected for general condition and integrity. This inspection will consist of the following:

- ⌚ Inspection of outer protective casing, locking cap, and concrete pad.
- ⌚ Inspection of inner cap and riser pipe.

The outer protective casing will be visually inspected to determine casing integrity. Well caps and locks will be visually inspected to ensure that both are in place and functioning properly. The concrete pad will be visually inspected for the presence of cracks and settlement. The inner cap and riser pipe will be visually inspected to ensure that they are intact and functioning properly. Based on visual inspection, monitoring wells will be maintained by conducting the following, as required:

- ▲ Replacement of well caps.
- ▲ Lubrication of locks.
- ▲ Replacement of locks.
- ▲ Painting of outer protective casing in high-visibility color.
- ▲ Replacement of concrete pad.
- ▲ Replacement of well.

5.4 Post-Closure Notifications

The following post-closure notifications will be made, as required:

- ▲ Post-closure requirements will be implemented and will continue for at least 30 years after the date of contingent closure unless the VDEQ reduces/extends the post-closure period as described in VHWMR 10.6.H. In the event that the facility desires a reduction of the post-closure period and can demonstrate justification, a request will be made for such a reduction to the VDEQ.
- ▲ Property on or in which waste residuals remain after contingent closure will not be used for any other purpose if the use will disturb the integrity of the final cover, liner(s), or any other component of the cover system or the function of the groundwater monitoring system unless the VDEQ approves of such use of the area in accordance with VHWMR 10.6.H. The facility will submit a request to the VDEQ for approval of such use.
- ▲ No later than 60 days after completion of the established post-closure care period, a certification will be submitted to the VDEQ that the post-closure care period was performed in accordance with the specifications in the approved Post-Closure Plan. The certification will be signed by the facility representative and an independent Virginia-registered professional engineer. Documentation supporting the certification will be furnished to the VDEQ upon request.

5.5 Reporting and Record Keeping

The results of the post-closure inspection program will be maintained on file at the facility and will be made available to the VDEQ upon request.

Appendix A

RISK-BASED CLOSURE

1. Introduction

This document discusses the protocol for conducting a risk assessment to implement closure of a hazardous waste management unit (HWMU) in accordance with the Virginia Hazardous Waste Management Regulations (VHWMR) as codified in Title 9 of the Virginia Administrative Code, Agency 20, Chapter 20 (9 VAC 20-60-10 et seq).

2. Risk-Based Evaluation

In order to estimate the risk for hazardous constituents of concern (HCOC) associated with the materials remaining in a HWMU, a risk assessment will be conducted according to the Virginia DEQ document titled "Guidance for Development of Health Based Cleanup Goals Using Decision Tree/REAMS Program (herein after "Virginia Risk Guidance") (November 1, 1994) prepared by Old Dominion University and the approved closure plan. The risk assessment report will contain the following sections:

- site evaluation,
- development of a site conceptual model,
- identification of contaminants of concern,
- identification of media and exposure pathways,
- toxicity assessment,
- estimation of contaminant concentration at the point of exposure, and
- summary of health risk.

The submission instructions contained in Appendix IX of the Virginia Risk Guidance will be reviewed prior to submitting the report to confirm that all necessary risk issues have been addressed. The risk goals associated with the closure performance standards (risk goals) will include:

- i. a hazard index of 1.0 or less for non-carcinogens;
- ii. a risk of 1E-06 or less for individual carcinogens;
- iii. cumulative risk of 1E-04 or less for all carcinogens; and
- iv. the concentrations of HCOC remaining in the HWMU will not result in contamination of other environmental media of concern, including the groundwater underneath the unit.

Compliance with the closure standard shall be verified by comparing the calculated individual and cumulative risk/hazard for all HCOC that failed the background statistical comparison (if such comparison is performed) to the risk goals.

The risk assessment will be conducted assuming a future residential/industrial use of the property. The methodology and equations for estimating the exposure concentration are presented in subsequent sections.

The initial step in the risk assessment will be to develop a site conceptual exposure model (SCEM) which depicts all potential exposure routes and media for the site and the receptors which may be exposed. Then HCOC for the risk assessment are identified (See Section 3 of this document).

In the next step, the exposure assumptions outlined in the Virginia Risk Guidance will be employed to estimate the risk. Information will also be taken as needed from U.S. EPA documents and databases (e.g., the Risk Assessment Guidance for Superfund (RAGS), and the Integrated Risk Information System (IRIS)). The chemical intake equations and exposure parameter assumptions used to estimate risk (obtained from the Virginia Risk Guidance) are shown in Tables 1 through 4. Additional details on the approach and assumptions used for each potential exposure pathway are provided below.

As a part of the Risk Exposure and Analysis Modeling System (REAMS) evaluation, fate and transport modeling is conducted to demonstrate that the residual soil concentrations of contaminants of concern would not result in contamination of other environmental media of concern including the groundwater underneath the closure unit. For this purpose, representative soil sample(s) will be collected around the unit (subjected to closure) for analysis of the properties listed on page 62 of the REAMS document. In certain situations, groundwater sampling is preferable.

3. Identification of Hazardous Constituents of Concern for Risk Assessment

For the purpose of REAMS evaluation associated with a HWMU, HCOC are those closure constituents present at concentrations statistically exceeding the background levels. If the concentrations of a closure constituent did not statistically exceed the background levels, no further risk-based evaluation for such constituent is required.

4. Exposure Assessment

The exposure assessment will identify transport mechanisms for the contaminants of concern that may potentially impact human receptors. The results of this assessment will be used to document the current and potential exposure posed by the HWMU.

With regard to the soil, a residential exposure will be assumed to document unrestricted closure of the soil. If the risk for potential residential exposure does not exceed the performance standards, unrestricted closure of soil will be accepted. If the site cannot be clean closed for residential use, then the option to pursue restricted closure (commercial/industrial) will be exercised. Closure to commercial/industrial scenario will require the facility to enact a deed restriction that eliminates the possibility of future residential use of the site. The requirements for establishing such a deed restriction are detailed in VDEQ's Guidelines for Developing Health-

Based Cleanup Goals Using Risk Assessment at A Hazardous Waste Site Facility for Restricted Industrial Use, dated June 1995. (A copy of this document is attached.)

Exposure routes will include ingestion, dermal absorption, and inhalation of vapors and dust particles.

With regard to impact to the groundwater underneath the HWMU, REAMS fate and transport modeling² will be required to assess impact from residual soil contamination to the groundwater. If the groundwater does not qualify for clean closure, the scope of future groundwater monitoring will be discussed with VDEQ. The groundwater exposure routes to be evaluated include ingestion, dermal absorption, and inhalation of volatiles emitted from the contaminated groundwater.

The exposure assumptions presented in the following sections are based on residential exposure. These constitute a reasonable maximum exposure scenario (RME), an exposure which is unlikely to occur but is reasonably possible. The exposure pathways for residential exposure include ingestion of soil, dermal contact with soil, inhalation of resuspended soil particulates, and inhalation of volatile organic compounds.

4.1 Ingestion of Soil

The equation for potential chemical intake by soil ingestion on-site is included in Table 1. This scenario also assumes that weather or other conditions (e.g., frozen ground/ snow /other cover) do not affect exposure and that all soil ingested is from contaminated areas of the site. These assumptions are protective of human health and the environment.

4.2 Dermal Contact with Soil

The equation for calculating the potential absorbed chemical dose by dermal contact with contaminated soil is provided in Table 1. This scenario assumes that weather or other conditions (e.g., frozen ground/ snow or other cover) do not affect exposure, that contaminated soil remains on the skin long enough for the HCOC to be absorbed and that all soil adhering to the skin is from contaminated areas of the site.

The skin surface areas (SA) used in the dermal pathway have been identified in Virginia Risk Guidance as 4,860 cm² for adults, which is the 50th percentile value for the arms, hands and lower legs (U.S. EPA, 1989b - See Attachment A).

REAMS includes the unsaturated zone fate and transport model SESOIL. The purpose of running the model is two fold: a) determine whether the contaminants will reach the groundwater table in next 30 years. b) calculate the risk associated with the estimated concentration in the groundwater. For constituents with a promulgated MCL, the estimated concentration will be directly compared against the MCL. However, prior to running the SESOIL model the facility should obtain all the information identified on page 62, of the Virginia Risk Guidance. The closure report must include evaluation of model results (concentrations reaching the groundwater) and a copy of SESOIL output file.

A skin-soil adherence factor of 1.45 mg/cm^2 will be used in the dermal intake calculations. The U.S. EPA guidance for dermal exposure assessment (*Dermal Exposure Assessment: Principles and Applications*, EPA/600/8-91/011B) states that a range of values from 0.1 mg/cm^2 to 1.5 mg/cm^2 per event appear possible for dermal adherence factors (AF). In order to estimate the amount of a particular HCOC which may potentially be absorbed through the skin, chemical-specific dermal absorption factors (ABS_{derm}) are used.

4.3 Inhalation of Resuspended Soil

The equation for potential chemical intake by inhalation of resuspended contaminated soil is included in Table 1. An inhalation rate of $0.83 \text{ m}^3/\text{hr}$ will be used as specified in the Virginia Risk Guidance. This scenario assumes that the concentration of HCOC in indoor dust will be equal to that in outdoor soil and that weather or other conditions, (e.g., frozen ground/snow or other cover) do not affect resuspension or exposure.

However, an appropriate model or equations in Table 1 will be used to estimate the potential amount of respirable particulate matter generated by wind erosion. The estimated generation rate for eroded particulate matter will then be used to derive an ambient air particulate concentration. Justification for and documentation of the model(s) used will be submitted to the Department as part of the risk assessment.

4.4 Inhalation of Volatilized HCOC in Soil

Since the HCOC have appreciable vapor pressures, they are expected to volatilize from soil. Inhalation of HCOC as volatilized vapors is considered for this risk assessment. The equations in Table 1 will be considered for estimating the intake for this condition.

5. Toxicity Assessment

The two principle indices of toxicity used in risk assessment are the reference dose (RfD) and the cancer slope factor (SF). An RfD is the intake or dose per unit of body weight (mg/kg-day) that is unlikely to result in toxic (non-carcinogenic) effects to human populations, including sensitive subgroups (e.g., the very young or elderly). The RfD allows for the existence of a threshold dose below which no adverse effects occur.

The SF is used to express the cancer risk attributable to a discrete unit of intake; that is, the cancer risk per milligram ingested per kilogram of bodyweight per day ($[\text{mg/kg-day}]^{-1}$). The SF is an estimate of the upper-bound probability of an individual developing cancer as a result of exposure to a particular carcinogen. Unlike the RfD, the SF assumes that there is no threshold dose below which the probability of developing cancer is zero. Note that SFs are only developed for those chemicals which have been shown to be carcinogens in man or in at least several animal species. A carcinogenic weight of evidence rating is used to describe the strength of the experimental evidence for carcinogenicity. The U.S. EPA has developed SFs for most chemicals

with weight of evidence ratings of "A" (known human carcinogen) or "B" (probable human carcinogen).

RfDs and SFs are derived by the U.S. EPA for the most toxic chemicals generally associated with chemical releases to the environment for which adequate toxicological data are available. If both the carcinogenic and non-carcinogenic effects of a particular compound are significant, both values may be established. However, in most cases only one value is available.

5.1 Inhalation and oral RfDs and SFs

RfDs and SFs pertinent to the oral and inhalation exposure pathways will be obtained from U.S. EPA's IRIS database. The IRIS (Integrated Risk Information System) on-line database was established by the U.S. EPA to provide risk assessors with peer reviewed toxicological data on chemicals commonly encountered at environmental sites of contamination. If data is not available from IRIS, it will be obtained from the Health Effects Assessment Summary Tables (HEAST), a compilation of toxicity values produced by the USEPA on a quarterly basis. The hierarchy presented in Appendix III of Virginia Risk Guidance will be followed for using these sources.

5.2 Dermal RfDs and SFs

Chemical specific oral-route absorption values (ABS_{oral}) are used to adjust the oral RfD or SF, which is computed from an administered dose, for use in the dermal exposure pathway. This correction is necessary due to the differences in absorption between the skin and the gastrointestinal tract. By correcting the administered-dose oral RfD or SF for the fraction expected to be absorbed in the gut, a dermal absorption factor can be used to estimate the correct dose received through the skin.

6. Evaluation of Risk

Using the toxicity criteria and identified exposure pathways discussed above, and the procedures described in the Virginia Risk Guidance, the risk presented by the HCOG will be estimated. The estimated risk will consider the effects from multiple constituents and all routes of exposure. The risk goals will be a total cumulative hazard index of 1.0 for multiple noncarcinogens and a total cumulative carcinogenic risk of $1E-04$ for multiple carcinogens. However, the risk from each individual carcinogen shall not exceed $1E-06$ (i.e., one case of cancer per 1,000,000 population).

6.1 Estimation of exposure concentration

For the contaminants detected at the site, an exposure point concentration (EPC) for each exposure pathway will be calculated for each contaminant by estimating the 95th upper confidence limit (UCL) on the arithmetic mean of the concentrations. If the calculated 95th UCL is greater than the maximum detected concentration, then the

maximum detected concentration will be used as the EPC. The risk for contaminants will be calculated as per the equations and assumptions described in Tables 1 through 4. If for a contaminant both carcinogenic and noncarcinogenic risk-based cleanup goal exists, the lower of the two will be used as a pathway specific to estimate the risk.

6.2. Risk Estimation

Health risk assessments are based on the relationship involving intake, contaminant concentration, risk, and toxicity. Chronic daily intake (CDI), a product of intake and contaminant concentration, are estimated using the exposure equations and assumptions associated with each route of exposure. CDIs are then combined with the RfDs or SFs to determine the resulting risk. For carcinogen(s), cumulative potential risk (RISK_c) can be calculated as follows:

$$\text{RISK}_c = \text{CDI}_{\text{ingestion}} * \text{SF}_{\text{ingestion}} + \text{CDI}_{\text{dermal}} * \text{SF}_{\text{dermal}} + \text{CDI}_{\text{inhalation-VOCs}} * \text{SF}_{\text{inhalation-VOCs}} \\ + \text{CDI}_{\text{inhalation-particles}} * \text{SF}_{\text{inhalation-particles}}$$

For noncarcinogen(s), cumulative hazard index (HI_c) can be calculated as follows:

$$\text{HI}_c = \text{CDI}_{\text{ingestion}} / \text{RfD}_{\text{ingestion}} + \text{CDI}_{\text{dermal}} / \text{RfD}_{\text{dermal}} + \text{CDI}_{\text{inhalation-VOCs}} / \text{RfD}_{\text{inhalation-VOCs}} \\ + \text{CDI}_{\text{inhalation-particles}} / \text{RfD}_{\text{inhalation-particles}}$$

where, taking into account all HCOC and relevant exposure pathways, the excess cancer risk is 10⁻⁶ or the hazard index is 1.0.

Table 1
Risk Assessment Algorithm for Carcinogenic Exposure

Exposure Route	Chronic Daily Intake (CDI), mg/L-day	
	Residential Exposure	Occupational/Industrial Exposure
Ground Water		
Ingestion	$CW \times IRW_{adj} \times EF$ ----- AT_c	$CW \times IRW_s \times EF_o \times ED_o$ ----- $BW_s \times AT_c$
Inhalation	$CW \times IRA_{adj} \times EF \times K$ ----- AT_c	$CW \times IRA_s \times EF_o \times ED_o \times K$ ----- $BW_s \times AT_c$
Dermal	$CW \times SAW_{adj} \times PC \times ET \times EF \times CF$ ----- AT_c	$CW \times SAW_s \times PC \times ET \times EF_o \times ED_o \times CF$ ----- $BW_s \times AT_c$
Soil		
Ingestion	$CS \times IRS_{adj} \times CF \times FI \times EF$ ----- AT_c	$CS \times IR \times CF \times FI \times EF_o \times ED_o$ ----- $BW_s \times AT_c$
Dermal	$CS \times CF \times SAS_{adj} \times AF \times ABS \times EF$ ----- AT_c	$CS \times CF \times SAS_s \times AF \times ABS \times EF_o \times ED_o$ ----- $BW_s \times AT_c$
Inhalation of vaporizing VOCs from soil	$VF \times IRA_{adj} \times ET \times EF$ ----- AT_c	$VF \times IRA_s \times ET \times EF_o \times ED_o$ ----- $BW_s \times AT_c$
Inhalation of emitting particles from soil	$PEF \times IRA_{adj} \times ET \times EF$ ----- AT_c	$PEF \times IRA_s \times ET \times EF_o \times ED_o$ ----- $BW_s \times AT_c$

Table 2
Risk Assessment Algorithm for Non-carcinogenic Exposure

Exposure Route	Chronic Daily Intake (CDI), mg/L-day	
	Residential Exposure	Occupational/Industrial Exposure
Ground Water		
Ingestion	$CW \times IRW_c \times EF \times ED_c$ ----- $BW_c \times AT_n$	$CW \times IRW_o \times EF_o \times ED_o$ ----- $BW_o \times AT_n$
Inhalation	$CW \times IRA_c \times EF \times ED_c \times K$ ----- $BW_c \times AT_n$	$CW \times IRA_o \times EF_o \times ED_o \times K$ ----- $BW_o \times AT_n$
Dermal	$CW \times SAW_c \times PC \times ET \times EF \times ED_c \times CF$ ----- $BW_c \times AT_n$	$CW \times SAW_o \times PC \times ET \times EF_o \times ED_o \times CF$ ----- $BW_o \times AT_n$
Soil		
Ingestion	$CS \times IRS_c \times CF \times FI \times EF \times ED_c$ ----- $BW_c \times AT_n$	$CS \times IRS_o \times CF \times FI \times EF_o \times ED_o$ ----- $BW_o \times AT_n$
Dermal	$CS \times CF \times SA_c \times AF \times ABS \times EF \times ED_c$ ----- $BW_c \times AT_n$	$CS \times CF \times SA_o \times AF \times ABS \times EF_o \times ED_o$ ----- $BW_o \times AT_n$
Inhalation of vaporizing VOCs from soil	$VF \times IRA_c \times ET \times EF \times ED_c$ ----- $BW_c \times AT_n$	$VF \times IRA_o \times ET \times EF_o \times ED_o$ ----- $BW_o \times AT_n$
Inhalation of emitting particles from soil	$PEF \times IRA_c \times ET \times EF \times ED_c$ ----- $BW_c \times AT_n$	$PEF \times IRA_o \times ET \times EF_o \times ED_o$ ----- $BW_o \times AT_n$

Note: Occupational noncarcinogenic risk assessment is based on adult exposure

Table 3
Age Adjusted Factors

$$IRA_{adj} = \frac{ED_c \times IRA_c}{BW_c} + \frac{(ED_{tot} - ED_c) \times IRA_a}{BW_a}$$

$$IRW_{adj} = \frac{ED_c \times IRW_c}{BW_c} + \frac{(ED_{tot} - ED_c) \times IRW_a}{BW_a}$$

$$SAW_{adj} = \frac{ED_c \times SAW_c}{BW_c} + \frac{(ED_{tot} - ED_c) \times SAW_a}{BW_a}$$

$$IRS_{adj} = \frac{ED_c \times IRS_c}{BW_c} + \frac{(ED_{tot} - ED_c) \times IRS_a}{BW_a}$$

$$SAS_{adj} = \frac{ED_c \times Sa_c}{BW_c} + \frac{(ED_{tot} - ED_c) \times Sa_a}{BW_a}$$

Note regarding age adjusted factor:

Because contact rate with tap water, ambient air, and residential soil are different for children and adults, carcinogenic risk during the first 30 years of life were calculated using age adjusted factor. These factors approximate the integrated exposure from birth until age 30 by combining contact rates, body weights, and exposure durations for two age groups - small children and adults.

Table 4
Exposure Variables Included in Tables 1, 2, and 3

Symbol	Term	Unit	Value	Reference
ABS	Absorption factor	-	User specified	
AF	Adherence factor	-	1.45	a, c
AT _c	Averaging time carcinogens	days	25550	
AT _n	Averaging time non-carcinogens	days	ED x 365	
BW ₁	Body weight adult	kg	70	c
BW ₂	Body weight child	kg	15	c
CF	Conversion factor	-	0.000001	-
CS	Chemical concentration in soil	mg/Kg-day	User specified	
CW	Chemical concentration in water	mg/L	User specified	
ED _c	Exposure duration child	years	6	c
ED _{total} ED	Exposure duration for carcinogen total or Residential	years	30	c
ED _o	Exposure duration occupational	years	25	c
EF	Exposure frequency residential	days	350	c
ET	Exposure Time General/Occupational Groundwater Surface Water - ingestion Surface water - dermal Air -inhalation	hrs/day	8.0 0.2 2.6 2.6 24.0	c, d
FI	Fraction ingested Residential Occupational	-	1.0 0.5	b
IRA ₁	Inhalation rate air adult	m ³ /day	20	b
IRA _{adj}	Inhalation rate - air adjusted	-	11.66	
IRA _c	Inhalation rate child	m ³ /day	12	b
IRA _a	Inhalation rate adult	m ³ /day	20	b
IR	Ingestion rate food Fruit/veggies Fish	kg/day	0.28 0.122 0.054	c,d

IRS _a	Ingestion rate soil adult	mg/day	100	b
IRS _c	Ingestion rate soil child	mg/day	200	b
IRS _{adj}	Ingestion - soil adjusted	-	114.29	
IRS _c	Ingestion rate soil child	mg/day	200	b
IRW _a	Ingestion rate water adult	L/day	2	b
IRW _{adj}	Ingestion - water adjusted	L-y/kg-d	1.09	
IRW _c	Ingestion rate water child	L/day	1	b
K	Volatilization factor, water to air	-	0.5	
PC	Permeability constant	cm/hr	User specified	b
PEF	Particulate emission factor	kg/m ³	6.789926E08	f
SAW _c	Surface area child groundwater dermal surface water dermal	cm ²	7500	b,e
SAS _a SAS _c	Surface area soil occupational - adult child	cm ² /event	4500 1875	e
SAS _{adj}	Surface area soil adjusted	cm ² /event	2290	
SAW _a	Surface area for water contact adult	cm ²	820	b
SAW _{adj}	Surface area for water contact	cm ² /event	9200	
VF	Volatilization factor, soil to air	kg/m ³	User specified	-

References:

- a. Risk Assessment Guidance for Superfund, Volume I. EPA/540/1-89/002, December 1989.
- b. Region III values
- c. Exposure Factors handbook, EPA/600/8-89/043, July 1989
- d. Human health evaluation manual supplemental guidance, OSWER Directive 9285.6-03, March 25, 1991.
- e. Dermal exposure Assessment, Principles and Applications, Interim Report. EPA/600/8-91/011b, January 1992.
- f. Technical Background Document for Draft Soil Screening Level Guidance. Office of Solid Waste and Emergency Response. EPA/540/R-94/101. December 1994.

**Risk Assessment and Closure
Certification for the Former
Incinerator Spray Pond at the
Radford Army Ammunition
Plant**

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ATTACHMENTS

ATTACHMENT 1 - OCTOBER 9, 1997 CLOSURE PLAN AMENDMENT

**ATTACHMENT 2 - BACKGROUND LEVEL DEVELOPMENT
INFORMATION**

ATTACHMENT 3 - CHAINS OF CUSTODY AND SAMPLE RESULTS

ATTACHMENT 4 - RISK TABLES FOR EXPOSURE PATHWAYS

ATTACHMENT 5 - PHOTOGRAPHS

Alliant Techsystems, Inc. (Alliant) has prepared this closure report for the former incinerator spray pond (HWMU-39).

The purpose of this report is to certify that closure of the Radford Army Ammunition Plant (United States Environmental Protection Agency (USEPA) ID No. VA1210020730) incinerator spray pond (ISP) was performed in accordance with the approved closure plan, dated 18 August 1995 and modified 9 October 1997. A copy of the 9 October 1997 modification is included as **Attachment 1**. This report will satisfy the following objectives:

- Facility history/description;
- ISP history/description;
- Documentation of closure procedures;
- Risk assessment for risk-based closure;
- Independent professional engineer certification; and
- Attachments providing figures, tables, photographs, chains-of-custody, sample analyses, photographs and other relevant information for this project.

Each of the objectives listed above will be discussed in the remaining sections of the report.

2.0 DESCRIPTION/SITE HISTORY

2.1 DESCRIPTION

2.1.1 Facility Description

The Radford Army Ammunition Plant (Radford AAP) is a government owned industrial complex located in southwestern Virginia. It encompasses approximately 4,104 acres and is located in Pulaski and Montgomery Counties. The facility is located approximately five miles northeast of the city of Radford, 10 miles west of Blacksburg, and 47 miles southwest of Roanoke (see **Figure 1**). The New River divides the Radford AAP into two portions commonly known as the "Horseshoe Area" and the "Main Manufacturing Area." The "Horseshoe Area" lies mainly to the north and west in Pulaski County. The "Main Manufacturing Area" lies in Montgomery County to the south and east.

The ISP is located in the northcentral portion of the "Horseshoe Area." (see **Figure 2**).

2.1.2 Spray Pond Description

The spray pond was a concrete-lined, rectangular impoundment with dimensions of 76 x 60 x 5 feet deep. The maximum water level was three feet deep for a volume of 13,680 cubic feet or 102,340 gallons. Perforated pipes in the spray pond were used to try to prevent sludges from forming by blowing air and creating turbulence in the water.

2.2 SITE HISTORY

2.2.1 Facility Background

Radford AAP was operated under contract by Hercules Aerospace Corporation from 1941 to 1995. Alliant purchased the operations of the Radford AAP from Hercules in 1995 and is the current facility contractor. This facility, which contains over 1,696 buildings and occupies close to 3.65 million square feet, is the top manufacturer of solid propellants in the United States. The major products

manufactured at this facility are solvent and solventless propellants that include single base (nitrocellulose), double base (nitrocellulose and nitroglycerin), and triple base (nitrocellulose, nitroglycerin, and nitroguanidine) propellants; cast propellants; and high energy propellants. These propellants are ultimately used in small arms, anti-tank weapons, anti-aircraft weapons, rockets, torpedoes, missile systems, igniters, and other numerous ordnance-related items.

2.2.2 *Incinerator Spray Pond Background*

In 1979, two incinerators were constructed and the incineration of waste and off-specification explosives and propellants began. These incineration operations became regulated subsequent to the promulgation of the federal hazardous waste regulations under the Resource Conservation and Recovery Act (RCRA) in 1980.

Beginning in 1979, Radford AAP operated a spray pond for the collection of incinerator scrubber wastewaters. The wastewater was then reused as scrubber water for the incinerator. In August 1990, the Army and Hercules discovered that the scrubber waters collected in the ISP contained lead from the incinerated propellants and the sludges which formed in the spray pond met the standards for a characteristic hazardous waste under Part III of the Virginia Hazardous Waste Management Regulations (VHWMR).

The Army and Hercules notified the Department of Waste Management (VDWM) of the contamination by letters dated 2 and 9 August 1990. Subsequent discussions between the Army, Hercules, and VDWM resulted in controls designed to prevent further contamination of the ISP and to introduce agitation of the scrubber water to prevent hazardous waste sludges from forming.

By letter dated 3 March 1992, the Army and Hercules informed the Director of VDWM and the Director of the then State Water Control Board that sludges contaminated with lead meeting the levels of toxicity required for classification as a characteristic hazardous waste under Part III of the VHWMR were continuing to accumulate in the ISP.

The ISP ceased operations in May 1992. An enforcement order was signed by the Virginia Department of Environmental Quality (VADEQ), the U. S. Army, and Hercules which became effective on 22 June 1993. A Schedule of Compliance contained in the order required

submission and implementation of a closure plan. A closure plan was completed 18 August 1995, with a subsequent revision dated 9 October 1997.

3.0

CLOSURE PLAN PROCEDURES

3.1

DEVELOPMENT OF BACKGROUND LEVELS

The hazardous constituents of concern (HCOCs) for this unit were identified in Table 3-2A of Section 3.5.1 of the ISP closure plan (see **Figure 3**). Background levels for these HCOCs were then developed.

The initial background soil sampling event occurred on 2 January 1996. Seven samples (six plus one duplicate) were collected in the vicinity of the ISP which were neither influenced by the activities at the ISP nor in an area likely influenced by past environmental activities. These results were submitted to the VADEQ on 25 March 1996. As indicated in the 28 May 1996 and the 28 October 1996 letters from the VADEQ, several analytical methods did not conform to Table 3-2 of the approved closure plan dated 24 August 1995. However, because most of the constituents were detected above the Practical Quantitation Limits (PQLs) or method detection limits (MDLs), VADEQ accepted the results for the constituents except for arsenic, di-n-butyl phthalate, diethyl phthalate, and resorcinol. Additional soil samples were collected on 5 December 1996 and analyzed for the aforementioned constituents using the analytical methods specified in Table 3-2A, which was updated and enclosed in the 28 October 1996 VADEQ letter.

Upon VADEQ's acceptance of the background soil sampling results, the tolerance limits for a normal distribution of the sample results were calculated with 95% coverage and 95% confidence. The upper tolerance limit became the reasonable background value for each constituent. These background levels were approved by VADEQ on 22 May 1997 and became the target cleanup levels for ISP closure.

Information pertaining to the development of the background levels, including copies of the correspondence between VADEQ and Alliant, can be found in **Attachment 2**.

Samples collected in the vicinity of the ISP during demolition and removal, and analyzed for the HCOCs in **Figure 3**, indicated that most of the analytes were below the calculated background values; however, there were ISP samples with levels of arsenic, barium, and

chromium exceeding the target cleanup levels. **Table 6** presents a comparison of the results of the ISP sample analyses and the calculated background levels.

Analytes of the ISP samples with results below the background values were not considered to be ISP contaminants; the constituent levels detected in the vicinity of the ISP were approximately equivalent to the same constituent levels in the surrounding, undisturbed soil. This process eliminated most of the constituents on Table 3-2A of the ISP closure plan from further consideration during the limited removal action and subsequent risk assessment (RA) contained herein. As stated above, some samples collected from the ISP produced results of arsenic, barium, and chromium above the background levels (see **Table 6**). Therefore, Radford AAP could not "clean close" the ISP based on comparison of sample results to the background constituents levels. In lieu of continued excavation of the soils at the ISP, Radford AAP elected to perform a RA to close this unit.

3.2 HEALTH AND SAFETY

Safety issues are a significant concern at Radford AAP. Each employee/contractor/visitor allowed access to the site is required to wear coveralls, a hard hat, safety shoes, and safety glasses. A face shield and gloves were utilized for power washing and other decontamination activities. Based on operational knowledge and early field sampling activities, no respirators or other PPE will be required.

3.3 PRE-DEMOLITION ACTIVITIES

The ISP consisted of a concrete basin with metal pipes through which air was circulated in order to prevent formation of sludges in the basin.

Recent rain events had caused storm water to accumulate in the basin. A sample of the accumulated storm water was collected and analyzed for the hazardous characteristic of RCRA heavy metals using the Toxicity Characteristic Leaching Procedure (TCLP). The result for lead was 5.3 mg/kg. All other metals were below the regulatory thresholds. Per discussions with VADEQ, the storm water was pumped to the wastewater treatment plant. Remaining sludges were placed in Department of Transportation (DOT) approved 55-gallon

drums and sent off-site for treatment as D008 characteristic hazardous waste.

Environmental Directions was contracted by Alliant to decontaminate the piping and the basin upon removal of the storm water and the sludges.

Copies of the manifests and analytical results can be reviewed in **Attachment 3**.

3.4 CONCRETE AND PIPING REMOVAL

Following decontamination of the basin and the piping and prior to demolition of the concrete, the piping was sold as scrap metal to a recycler.

Once the piping was removed, the approved contractor began the demolition of the bottom of the concrete basin. A representative sample of concrete was tested for the hazardous characteristic of lead using the TCLP. The result indicated a TCLP lead concentration of approximately 0.5 parts per million (ppm). Once the floor of the ISP had been removed, the sidewalls were removed. Proper care was exercised to prevent encroachment of the excavation to the natural gas pipelines that pass in the vicinity of the ISP. Trucks hauled the concrete to a state approved landfill in Roanoke, Virginia, owned by Joe Bandy and Son, Inc.

3.5 SOIL SAMPLING

3.5.1 On-Site Soil Screening

With the onset of concrete removal, preparations began for sampling according to the sampling grid described in the closure plan. **Figure 4** shows the approximate layout of the sampling grid. Initial samples were analyzed on-site using a PaceScan 3000 instrument, with a detection limit of 12.5 parts per million (ppm) for total lead. The screening efforts focused on lead since this was the metal which had been previously detected in the ISP sludges.

Samples of the surficial soil (soil directly beneath the 12 to 18 inch layer of concrete) were collected during the time of the concrete

demolition. Four samples exceeded the 19.0 ppm target level for total lead as analyzed by the PaceScan 3000 instrument, with ranges from approximately 21 ppm to 540 ppm.

Six samples were taken at varying depths (from 6 inches to 24 inches) below the level of the concrete. These sample results were below the detection limit (BDL) of 12.5 ppm.

With the sample results indicated above and the spread of concrete debris in the surficial soils, the decision was made to remove six inches of soil directly beneath the concrete prior to field testing according to the grid layout shown in **Figure 4**.

3.5.2 *Six Inch Layer On-Site Soil Screening*

Removal of the six inch layer occurred in stages. Initially, the northeast end was excavated with samples collected and analyzed for lead from grid nodes A1 to C4 using the PaceScan 3000. The results of the total lead analyses are shown in the table below:

<u>Sample</u> <u>Location</u>	<u>Result (ppm)</u>	<u>Sample</u> <u>Location</u>	<u>Result (ppm)</u>
A1	18	B3	18
A2	71.5	B4	35
A3	BDL	C1	18
A4	36	C2	27
B1	32	C3	16.5
B2	42.5	C4	33.5

Two additional samples were collected from the six inch layer: E1 and halfway between nodes D1 and D2 (labeled as D1/2) produced results of 18 ppm and 20.5 ppm, respectively. Based on the results above, sampling was halted at the six inch depth and begun at the twelve inch level.

3.5.3 *Twelve Inch Layer On-Site Soil Screening*

Instead of removing an additional six inches of soil prior to sampling, an auger was used to collect samples from the twelve inch level at the grid nodes. The following table presents the sample results for total lead at this depth:

<u>Sample</u>	<u>Result (ppm)</u>	<u>Sample</u>	<u>Result (ppm)</u>

<u>Location</u>		<u>Location</u>	
A1	BDL	C3	18
A2	BDL	C4	16.5
A3	BDL	D1	BDL
A4	BDL	D2	BDL
B1	BDL	D3	14
		D3 (dup.)	BDL
B2	BDL	D4	BDL
B3	BDL	E1	BDL
		E1 (dup.)	14
B4	18	E2	BDL
C1	BDL	E3	BDL
C2	BDL	E4	BDL

None of the samples collected from the 12 inch level exceeded the 19 ppm threshold for lead. To certify clean closure, confirmation sampling was performed at locations identified using a random number generator.

3.5.4 *Confirmation Sampling - 12 Inches*

The confirmation samples were collected from eight grid nodes identified by a random number generator. The collection equipment was decontaminated between each sampling event as specified in Section 3.8.3 of the ISP Closure Plan. The samples went to REIC Laboratory in Beaver, West Virginia, to be analyzed for the HCOCs shown in **Figure 3**. A copy of the results of the samples collected and analyzed from a depth of 12 inches can be found in **Attachment 3**, including results for the equipment blank, field blank, and the trip blank. A trip blank sample bottle was not included in the sample containers supplied by the laboratory; a separate sample container was filled with distilled water at the site and sent for analysis.

Most of the analytes from the 12 inch sample depth were below the calculated background values. No semi-volatile organic compounds were detected in any of the samples. Various metals were detected in the nine samples, but only three constituents were detected above background levels. Page 1 of **Table 6** presents a comparison of the results of the ISP sample analyses (at 12 inches in depth) and the calculated background values. The threshold exceedances at a depth of 12 inches are summarized below:

safety procedures as outlined in the ISP Closure Plan were followed. The excavated soil was staged on-site placed on and covered by plastic sheeting until analyses determined it was acceptable as cover material by the Montgomery County Regional landfill. At this time, Alliant exercised its option to perform a risk assessment for risk-based closure of the ISP as outlined in Section 3.7.6 of the amended ISP Closure Plan.

3.5.6 *QA/QC Findings*

Table 3-2 was amended with VADEQ's letter to Radford AAP dated 28 October 1996. Table 3-2A (Figure 3) changed some of the methods of analysis and the corresponding Practical Quantitation Limits (PQLs) for the HCOCs for soils only. PQLs for the samples collected on 8 September 1997 from depths of 18 and 24 inches below the bottom of the concrete correspond with the amended PQLs for soil in Table 3-2A with three exceptions: antimony, mercury, and silver.

The PQLs from the 8 September 1997 sample event for antimony and mercury are lower than the PQLs in Table 3-2A. Having antimony and mercury PQLs lower than the PQLs listed in Table 3-2A is a conservative situation, where detections of these two constituents are possible at levels below the minimum levels expected in the approved closure plan. Therefore, laboratory PQLs lower than the PQLs in Table 3-2A are acceptable.

The PQL for silver is listed as 25 ug/kg in the laboratory reports for the 8 September 1997 sample event. This was identified as the method detection limit for silver using method 7761. Table 3-2A shows the PQL to be 10 ug/kg. Because silver was detected in slightly more than half of the samples analyzed on 8 September 1997, and no samples exceeded the upper tolerance limit of 120 ug/kg, the PQL of 25 ug/kg was deemed acceptable.

3.5.7 *Closure of the Incinerator Spray Pond*

After completion of the risk assessment for risk-based closure (described in Section 4.0 of this closure report), backfilling of the ISP commenced. Clean soil was placed into the excavation and compacted in approximate one foot lifts. The excavation was graded to promote positive drainage and power-seeded to promote re-vegetation. Photographs documenting the progress of the excavation activities can be found in Attachment 5.

4.0 RISK ASSESSMENT FOR RISK-BASED CLOSURE

4.1 GENERAL

Once clean closure could not be established based on the results of the soil samples collected below the ISP, Radford AAP elected to perform a risk assessment (RA). The risk assessment detailed herein was conducted in accordance with the VADEQ document titled "Guidance for Development of Health Based Cleanup Goals Using Decision Tree/REAMS Program" (herein after "Virginia Risk Guidance"), and Section 3.7.6 of the amended closure plan. Successful risk-based closure would demonstrate that the concentrations of the HCOCs would not pose an unacceptable risk to the potentially exposed population.

4.2 SITE EVALUATION

At the time this RA was completed, the area encompassed by the former ISP was approximately eight to nine feet deep. This depth accounted for removal of the concrete from the ISP along with the excavation of an additional 18 to 24 inches of soil from beneath the concrete liner. The entire excavated area was approximately 90 feet by 70 feet which accounts for some side slope removal due to stability problems.

4.3 EXPOSURE ASSESSMENT

4.3.1 Media and Exposure Pathways

Exposure to the HCOCs potentially involves multiple receptors and various media pathways. We will look first at the current potential receptors and pathways.

Radford AAP continues to operate as an industrial complex; as such, access is limited by the use of gated entrances and security personnel. On-site workers in the vicinity of the ISP are one potentially significant human receptor. Because of the security associated with Radford AAP, we assume only escorted guests are subject to the risk associated

with the ISP area. In the unlikely event a trespasser crosses the area of concern, the trespasser would most likely be subject to the same risk associated with a site visitor. In either situation, visitors which frequent the area of concern are unlikely to experience the same risk associated with an on-site worker. Therefore, under the current scenario, a Radford AAP worker is the primary human receptor.

An Radford AAP worker can be subject to multiple exposure pathways: inhalation of particulate matter, ingestion, and dermal contact. Soil particles can become windborne and inhaled by the on-site worker. Additionally, a worker can physically handle the contaminated soil, which can lead to absorption by the skin or accidental ingestion. Risks associated with soil contamination can be assumed to be minimal in this instance, however. The soil samples that produced the contaminated soil results are located approximately eight and one-half feet below grade, beneath the former ISP concrete liner. The excavation has been backfilled with clean material. We have assumed that the eight to nine foot layer of clean soil is a sufficient barrier to soil particle inhalation, ingestion, and dermal contact. Because no complete pathways exist for ground water (no drinking water wells exist), we have assumed the risks corresponding to potential human receptors for the current working conditions is insignificant.

The closure plan for the ISP states that a future residential/industrial use of the property must be considered in the RA. Assuming residential homes are built on the property, on-site residents will experience a much greater potential risk than visitors or trespassers, simply by their proximity to the contamination source.

As with a Radford AAP worker, on-site residents will be subject daily to the contaminant concentrations of the soil and ground water. In addition to inhalation of soil particulates, ingestion, and dermal contact with the contaminated soil, no restrictions have been placed by Radford AAP on the use of ground water in the area. Therefore, residents can also be exposed through ingestion and dermal contact with ground water. Again, as with the Radford AAP worker, we can assume an incomplete pathway for risks associated with soil contamination; however, we have elected not to make this assumption for the assessment of risk. We conservatively assumed that soils excavated during housing construction or well construction have been evenly spread across the remainder of the parcel. This could bring

contaminated material to the surface, creating a complete exposure pathway via soil inhalation, ingestion, and/or dermal contact.

The potential pathways quantitatively modeled for this RA pertain to an on-site resident. The potential exposure routes include soil inhalation, ingestion, and dermal contact, and ground water ingestion and dermal contact. Each potential exposure pathway was quantitatively evaluated using the REAMS model exposure assumptions (where applicable), the March 1997 USEPA Region III Risk Based Concentration Table of toxicity values presented in Table 1, and default values provided in the existing closure plan.

4.3.2 *Site Conceptual Exposure Model (SCEM)*

The SCEM is based on existing and future site conditions and depicts the potential exposure routes and media for the site (Figure 5). The SCEM presents the primary applicable migration pathways and identifies the exposure routes and potentially affected populations which warrant either further consideration and/or quantitative risk characterization. Table 2 provides a summary of the exposure pathways to human populations. While there are multiple potential exposure pathways to humans, only the future on-site resident was quantitatively evaluated for this assessment. The remaining receptor pathways were qualitatively evaluated and determined to be insignificant when compared to the risk associated with a future on-site resident.

4.4 *HAZARDOUS CONTAMINANTS OF CONCERN (HCOC)*

To determine the HCOCs, samples were collected by ERM in the vicinity of the ISP to determine a statistical background value for various contaminants. This statistical background value became the threshold value against which future samples would be compared to determine if a particular sample was "contaminated," i.e., above the statistically generated threshold value.

ERM collected samples at the ISP at a depth of 18 inches to 24 inches below the base of the existing excavation. The following results indicate the three contaminants which exceed the background threshold concentrations as described above. It is these three contaminants for which this RA is being performed. The location of the samples with respect to the ISP excavation and the threshold

values for the listed contaminants are included. Only those tests which exceed the background (threshold) values are included in this table.

<u>Constituent</u>	<u>Location</u>	<u>Result (ppm)</u>	<u>Threshold (ppm)</u>
Arsenic	D1	6.46	5.43
Barium	E1	199	125.75
Chromium	A1	31.3	30.55
	A4	32.6	30.55
	C2	37.5	30.55
	D1	34.3	30.55
	D3	38.5	30.55
	E2	31.5	30.55

4.5 TOXICITY ASSESSMENT

The toxicological assessment involved the identification of adverse health effects associated with exposure to a chemical and the relationship between the extent of exposure and the likelihood of adverse health effects. Toxicity values for carcinogens are represented by potency slope factors (CPSs) and toxicity values for non-carcinogenic chemicals are represented by reference doses (RfDs). The toxicity values used in this risk assessment for the HCOCs were derived from the USEPA Region III Risk-Based Concentration Table-March 1997, and are presented in Table 5.

Of the three HCOCs for this RA, only arsenic exhibits carcinogenic effects. The USEPA Region III Risk-Based Concentration Table provides oral and inhalation slope factors for arsenic. Similarly, this table provides oral and inhalation reference doses for non-carcinogenic effects for each of the metals, except for the inhalation reference dose for arsenic. In this instance, no RfD exists for arsenic. Where a reference dose for one exposure pathway is not available (i.e., arsenic), the toxicity value for another exposure pathway of the same metal is substituted (if available). Therefore, the RfD for inhalation for the non-carcinogenic effects of arsenic is assumed to be equal to the RfD for the ingestion of arsenic. Although it is recognized that substitution of the exposure route-specific toxicity value may not be applicable for all compounds, it was determined that a more conservative risk estimate is derived by retaining the exposure route without a published toxicity value for consideration in the overall RA.

4.6

CONTAMINANT CONCENTRATION AT THE POINT OF EXPOSURE

The table in Section 4.4 provides the sample results which exceed the threshold values determined for the Radford AAP ISP site. The development of the concentrations at the points of exposure required selecting the sample with the highest concentration exceeding the threshold value. For arsenic and barium, only one sample exceeded the threshold. For chromium, we used 38.5 parts per million (ppm) in the calculations of risk and exposure point concentrations.

For migration of the contaminant from soil to ground water, the maximum contaminant levels (MCLs) for the HCOCs mark the starting points for determination of the contaminant concentrations. The MCL is the maximum contamination allowed in drinking water. Demonstrating a concentration at this level and below gives an acceptable risk for the contaminant in question.

4.7

RISK EVALUATION AND SUMMARY

This section combines the information developed in the exposure and toxicity assessment sections to estimate the potential risks to human health posed by the contaminants detected. The excess cancer risk (carcinogens) and the hazard quotient (HQ - non-carcinogens) for exposure to each chemical by each route of exposure, exposure pathway, category of receptor, and exposure case are initially estimated separately. The separate cancer risks are then summed across chemicals and across all exposure routes to obtain the total excess cancer risk for that population. The HQ is also summed across chemical, exposure routes, and pathways applicable to the same population.

For this RA, arsenic is the only HCOC which has demonstrated carcinogenic effects, and subsequently, has cancer slope factors for various media. Normally, the lifetime carcinogenic risk shall not exceed 1×10^{-6} (i.e., one case of cancer per 1,000,000 population) for individual carcinogens, and 1×10^{-4} cumulative risk for multiple carcinogens. In this instance, a cancer risk for arsenic of 1×10^{-3} is considered acceptable. The reason we used this risk level is discussed in the question and answer section of the USEPA Region III Risk-Based Concentration Table dated March 17, 1997, and summarized here. A 1988 risk management policy by USEPA suggests

carcinogenic risk for arsenic up to 1×10^{-3} is acceptable because cancers of this origin tend to have a low mortality rate. Therefore, this RA must demonstrate that the maximum concentration of arsenic must give a cumulative carcinogenic risk of less than 1×10^{-3} .

The risk tables for the exposure pathways can be found in **Attachment 4**, pages 1, 2, and 3; the results of the risk calculations are shown in **Table 3**. The cumulative carcinogenic risk associated with the inhalation, ingestion, and dermal absorption of arsenic in soil is approximately 2.93×10^{-5} , well below the allowable risk level of 1×10^{-3} .

All three HCOCs have quantified non-carcinogenic effects as indicated by the RfDs given in **Table 4**. The cumulative non-carcinogenic risk for the three HCOCs must have a hazard index (HI) of less than one, where the HI is the sum of the HQs calculated for each relevant route of exposure for each HCOC. Another aspect of non-carcinogenic risk calculations is that effects are not cumulative for a lifetime, and the susceptibility of effects differs between adults and children. Therefore, different equations and default parameters are necessary to calculate the risks attributed to adults and the risks attributed to children. Likewise, separate HIs must be calculated for both adults and children.

The risk tables for the exposure pathways can be found in **Attachment 4**, pages 4 through 9; the results of the HI calculations are shown in **Table 4** and summarized here. For adults, the HI is approximately 0.131; for children, approximately 0.515. Both values fall below the HI threshold of one.

Another potential area of contamination is the migration of contaminants to ground water. Percolation through the contaminated zone may generate leachate which can reach the ground water. As shown in **Table 5**, the Soil Screening Level Partitioning Equation was used to estimate the screening level in soil which will generate a concentration no greater than the MCL in the ground water. Using default parameters as necessary, the calculated screening level in soil for each contaminant was determined to be above the maximum concentration detected. The table on the following page illustrates the results.

<u>Constituent</u>	<u>Screening Level (mg/kg)</u>	<u>Maximum Level Detected (mg/kg)</u>	<u>Below Screening Level?</u>
Arsenic	29.2	6.46	Yes
Barium	1,648	199	Yes
Chromium	A	38.5	Yes

A = According to Appendix A of the 1996 *Soil Screening Guidance: Users Guide*, there is no generic soil screening value for chromium III because; "Pathway not a concern in any soil contamination concentration."

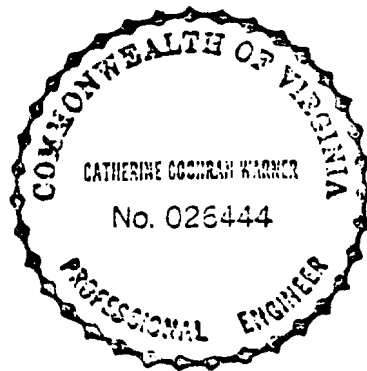
Therefore, potential impacts to ground water will not exceed the acceptable criteria (MCLs).

In summary, the maximum concentrations of the HCOCs pose an acceptable risk under the current use and to a potential future residential population. The cumulative carcinogenic risk associated with inhalation, ingestion, and dermal absorption of arsenic in soil is near 3×10^{-5} , well below the risk level of 1×10^{-3} . The non-carcinogenic risk for the same three pathways is approximately 0.13 and 0.52 for adults and children, respectively. These risks are below the target HI of one. Comparing the calculated soil screening values to the HCOC's maximum detected levels demonstrates the HCOCs do not pose a threat to migrate from the soil to the ground water at levels equal to or above the MCLs. Therefore, the soil concentrations of HCOCs remaining in the ISP area meet the acceptable risk levels as outlined in the ISP Closure Plan and the Virginia Risk Guidance for risk-based closure.

COMPLIANCE CERTIFICATION

Environmental Resources Management certifies that the closure of the incinerator spray pond at the Radford Army Ammunition Plant in Radford, Virginia, was performed and completed in accordance with the Virginia Department of Environmental Quality approved Closure Plan dated 18 August 1995, and amended 9 October 1997.

<u>Catherine Celia Warner 026444</u>	<u>VA</u>	<u>2-4-98</u>
Catherine C. Warner	Registration No.	State Date



K. C. Dalry
for Radford Army Ammunition Plant

RESIDENT MANAGER
Title

2/24/98
Date

Attachment 1

October 1997 Closure Plan Amendment



COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

George Allen
Governor

Becky Norton Dunlop
Secretary of Natural Resources

Street address: 629 East Main Street, Richmond, Virginia 23219
Mailing address: P.O. Box 10009, Richmond, Virginia 23240
Fax (804) 698-4500 TDD (804) 698-4021
<http://www.deq.state.va.us>

Thomas L. Hopkins
Director

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

Certified Mail
Return Receipt Requested

October 9, 1997

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

**RE: Radford Army Ammunition Plant (RAAP)
EPA ID# VA1210020730
Incinerator Spray Pond Closure Plan Amendment**

Dear Ms. Jake:

Your letter requesting an amendment to the approved closure plan for RAAP's incinerator spray pond was submitted to the Department of Environmental Quality (DEQ) on October 3, 1997. The amendment will allow for RAAP to pursue closure to risk-based standards for the referenced hazardous waste management unit.

Based on the information submitted, the amendment requested is approved. An update to the closure plan's pages are attached and will need to be added to the closure plan. Please update your closure plan as needed.

As provided in Rule 2A:2 of the Supreme Court of Virginia, you have 30 days from the date of service of this decision to initiate an appeal by filing a notice of appeal with:

Thomas L. Hopkins, Director
Virginia Department of Environmental Quality
629 East Main Street

P.O. Box 10009
Richmond, Virginia 23240-0009

In the event that this decision is served to you by mail, the date of service will be calculated as three days after the postmark date. Please refer to Part Two A of the Rules of the Supreme Court of Virginia, which describes the required content of the Notice of Appeal, including specifications of the Circuit Court to which the appeal is taken, and additional requirements concerning appeals from decisions of administrative agents.

If you should have any questions, concerning this matter, please contact Debra Miller, Environmental Engineer Senior, of my staff at (804) 698-4206.

Sincerely,

Leslie A. Romanchik

for Thomas L. Hopkins

Attachment

cc: Jerry Redder, Alliant Techsystems-RAAP
Robert Greaves, EPA Region III
Leslie Romanchik, DEQ (w/out Attachment)
Debra Miller, DEQ
Glenn VonGonten, DEQ
Claire Ballard, DEQ (w/out Attachment)
Aziz Farahmand, DEQ/RRO-Compliance
CENTRAL HW FILES

- d. Following resampling, comparison to background¹ along with additional 6-inch soil layer excavation (if required) will be performed in accordance with the protocols previously outlined.

If, upon following these protocols in an attempt to achieve clean closure, the pond surface soils have been removed from the hot spot(s) down to a sufficient level without achievement of clean closure for all closure parameters, Radford Army Ammunition Plant (RAAP) will:

- * Implement the contingent closure and post-closure procedures of this plan; or
- * Continue with removal activities and sampling of soil layers, as detailed above; or
- * Perform closure to risk based standards as detailed in §3.7.6 of this closure plan.

As previously stated, the facility reserves the option, at any point during the incinerator spray pond subsoils assessment, to abandon attempts to demonstrate clean closure to either background or risk based standards, and immediately implement contingent closure and post-closure.

3.7.6 Risk-Based Closure

As an alternative to clean closure to background standards, specified above, or in conjunction with background standards, RAAP may propose to demonstrate that the concentrations of hazardous constituents detected do not pose an unacceptable level of risk to human health and the environment. The facility may present this proposal to the DEQ following the requirements as outlined in this section and as detailed in Appendix A.

In order to estimate the risk for HCOCs, a risk assessment will be conducted according to the DEQ document titled "Guidance for development of health based cleanup goals using decision tree/REAMS program (herein after "Virginia Risk Guidance"), November 1, 1994, prepared by Old Dominion University and the approved closure plan. The risk goals/performance standards will be a hazard index of 1.0 for non-carcinogens and an individual carcinogenic risk of 1×10^{-6} and cumulative carcinogenic risk of 1×10^{-4} . This risk assessment will be conducted assuming a future residential use of the property.

The Department will review the risk assessment report to determine that it conforms to risk assessment requirements for residential risk-based protocols. If acceptable, attainment of the closure standards may then be demonstrated using the residential risk-based assessment in lieu of the clean closure to background standards established under §3.7.1 Background Sampling For Soil Assessment.

If the Incinerator Spray Pond cannot meet the residential risk closure standards, then RAAP may propose to modify this closure plan for industrial risk-based closure. Modification will require notification of the DEQ and the submittal of a closure amendment, in accordance with 9 VAC 20-60-580.C (previously, VHWMR §9.6.C).

¹(Optional) The background critical value described thus far will have been computed from the top layer (0-6 inches) of the background area. It may be necessary to sample background at lower intervals (6-12 inches, 12-24 inches) for comparison at lower intervals to avoid bias. This option should be implemented if, for example, distinctly different soil types are encountered at depth, thereby necessitating re-establishment of background.

Note, for the remaining sections of the closure plan, any discussions of "clean" closure of the incinerator spray ponds' subsoils, will signify either clean closure to background levels and/or closure to risk based closure standards, as described in this section.

3.8 Field Quality Control

To ensure the collection of representative samples, the following field quality control procedures will be utilized during the closure operations.

Equipment blanks will be collected after every 20th sample. If equipment blanks indicate contamination, then resampling will occur only if sample results are above cleanup levels. Samples will be analyzed for the hazardous constituents of concern identified in this document. Laboratory quality control will be according to the methods detailed in SW-846.

Laboratory quality control will be according to the methods detailed in SW-846.

Appendix A
RISK-BASED CLOSURE

1. Introduction

This document discusses the protocol for conducting a risk assessment to implement closure of a hazardous waste management unit (HWMU) in accordance with the Virginia Hazardous Waste Management Regulations (VHWMR) as codified in Title 9 of the Virginia Administrative Code, Agency 20, Chapter 20 (9 VAC 20-60-10 et seq).

2. Risk-Based Evaluation

In order to estimate the risk for hazardous constituents of concern (HCOC) associated with the materials remaining in a HWMU, a risk assessment will be conducted according to the Virginia DEQ document titled "Guidance for Development of Health Based Cleanup Goals Using Decision Tree/REAMS Program (herein after "Virginia Risk Guidance") (November 1, 1994) prepared by Old Dominion University and the approved closure plan. The risk assessment report will contain the following sections:

- site evaluation,
- development of a site conceptual model,
- identification of contaminants of concern,
- identification of media and exposure pathways,
- toxicity assessment,
- estimation of contaminant concentration at the point of exposure, and
- summary of health risk.

The submission instructions contained in Appendix IX of the Virginia Risk Guidance will be reviewed prior to submitting the report to confirm that all necessary risk issues have been addressed. The risk goals associated with the closure performance standards (risk goals) will include:

- i. a hazard index of 1.0 or less for non-carcinogens;
- ii. a risk of 1E-06 or less for individual carcinogens;
- iii. cumulative risk of 1E-04 or less for all carcinogens; and
- iv. the concentrations of HCOC remaining in the HWMU will not result in contamination of other environmental media of concern, including the groundwater underneath the unit.

Compliance with the closure standard shall be verified by comparing the calculated individual and cumulative risk/hazard for all HCOC that failed the background statistical comparison (if such comparison is preformed) to the risk goals.

The risk assessment will be conducted assuming a future residential/industrial use of the property. The methodology and equations for estimating the exposure concentration are presented in subsequent sections.

The initial step in the risk assessment will be to develop a site conceptual exposure model (SCEM) which depicts all potential exposure routes and media for the site and the receptors which may be exposed. Then HCOC for the risk assessment are identified (See Section 3 of this document).

In the next step, the exposure assumptions outlined in the Virginia Risk Guidance will be employed to estimate the risk. Information will also be taken as needed from U.S. EPA documents and databases (e.g., the Risk Assessment Guidance for Superfund (RAGS), and the Integrated Risk Information System (IRIS)). The chemical intake equations and exposure parameter assumptions used to estimate risk (obtained from the Virginia Risk Guidance) are shown in Tables 1 through 4. Additional details on the approach and assumptions used for each potential exposure pathway are provided below.

As a part of the Risk Exposure and Analysis Modeling System (REAMS) evaluation, fate and transport modeling is conducted to demonstrate that the residual soil concentrations of contaminants of concern would not result in contamination of other environmental media of concern including the groundwater underneath the closure unit. For this purpose, representative soil sample(s) will be collected around the unit (subjected to closure) for analysis of the properties listed on page 62 of the REAMS document. In certain situations, groundwater sampling is preferable.

3. Identification of Hazardous Constituents of Concern for Risk Assessment

For the purpose of REAMS evaluation associated with a HWMU, HCOC are those closure constituents present at concentrations statistically exceeding the background levels. If the concentrations of a closure constituent did not statistically exceed the background levels, no further risk-based evaluation for such constituent is required.

4. Exposure Assessment

The exposure assessment will identify transport mechanisms for the contaminants of concern that may potentially impact human receptors. The results of this assessment will be used to document the current and potential exposure posed by the HWMU.

With regard to the soil, a residential exposure will be assumed to document unrestricted closure of the soil. If the risk for potential residential exposure does not exceed the performance standards, unrestricted closure of soil will be accepted. If the site cannot be clean closed for residential use, then the option to pursue restricted closure (commercial/industrial) will be exercised. Closure to commercial/industrial scenario will require the facility to enact a deed restriction that eliminates the possibility of future residential use of the site. The requirements for establishing such a deed restriction are detailed in VDEQ's Guidelines for Developing Health-

Based Cleanup Goals Using Risk Assessment at A Hazardous Waste Site Facility for Restricted Industrial Use, dated June 1995. (A copy of this document is attached.)

Exposure routes will include ingestion, dermal absorption, and inhalation of vapors and dust particles.

With regard to impact to the groundwater underneath the HWMU, REAMS fate and transport modeling² will be required to assess impact from residual soil contamination to the groundwater. If the groundwater does not qualify for clean closure, the scope of future groundwater monitoring will be discussed with VDEQ. The groundwater exposure routes to be evaluated include ingestion, dermal absorption, and inhalation of volatiles emitted from the contaminated groundwater.

The exposure assumptions presented in the following sections are based on residential exposure. These constitute a reasonable maximum exposure scenario (RME), an exposure which is unlikely to occur but is reasonably possible. The exposure pathways for residential exposure include ingestion of soil, dermal contact with soil, inhalation of resuspended soil particulates, and inhalation of volatile organic compounds.

4.1 Ingestion of Soil

The equation for potential chemical intake by soil ingestion on-site is included in Table 1. This scenario also assumes that weather or other conditions (e.g., frozen ground/ snow /other cover) do not affect exposure and that all soil ingested is from contaminated areas of the site. These assumptions are protective of human health and the environment.

4.2 Dermal Contact with Soil

The equation for calculating the potential absorbed chemical dose by dermal contact with contaminated soil is provided in Table 1. This scenario assumes that weather or other conditions (e.g., frozen ground/ snow or other cover) do not affect exposure, that contaminated soil remains on the skin long enough for the HCOC to be absorbed and that all soil adhering to the skin is from contaminated areas of the site.

The skin surface areas (SA) used in the dermal pathway have been identified in Virginia Risk Guidance as 4,860 cm² for adults, which is the 50th percentile value for the arms, hands and lower legs (U.S. EPA, 1989b - See Attachment A).

REAMS includes the unsaturated zone fate and transport model SESOIL. The purpose of running the model is two fold: a) determine whether the contaminants will reach the groundwater table in next 30 years. b) calculate the risk associated with the estimated concentration in the groundwater. For constituents with a promulgated MCL, the estimated concentration will be directly compared against the MCL. However, prior to running the SESOIL model the facility should obtain all the information identified on page 62, of the Virginia Risk Guidance. The closure report must include evaluation of model results (concentrations reaching the groundwater) and a copy of SESOIL output file.

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A skin-soil adherence factor of 1.45 mg/cm^2 will be used in the dermal intake calculations. The U.S. EPA guidance for dermal exposure assessment (*Dermal Exposure Assessment: Principles and Applications*, EPA/600/8-91/011B) states that a range of values from 0.1 mg/cm^2 to 1.5 mg/cm^2 per event appear possible for dermal adherence factors (AF). In order to estimate the amount of a particular HCOC which may potentially be absorbed through the skin, chemical-specific dermal absorption factors (ABS_{derm}) are used.

4.3 Inhalation of Resuspended Soil

The equation for potential chemical intake by inhalation of resuspended contaminated soil is included in Table 1. An inhalation rate of $0.83 \text{ m}^3/\text{hr}$ will be used as specified in the Virginia Risk Guidance. This scenario assumes that the concentration of HCOC in indoor dust will be equal to that in outdoor soil and that weather or other conditions, (e.g., frozen ground/snow or other cover) do not affect resuspension or exposure.

However, an appropriate model or equations in Table 1 will be used to estimate the potential amount of respirable particulate matter generated by wind erosion. The estimated generation rate for eroded particulate matter will then be used to derive an ambient air particulate concentration. Justification for and documentation of the model(s) used will be submitted to the Department as part of the risk assessment.

4.4 Inhalation of Volatilized HCOC in Soil

Since the HCOC have appreciable vapor pressures, they are expected to volatilize from soil. Inhalation of HCOC as volatilized vapors is considered for this risk assessment. The equations in Table 1 will be considered for estimating the intake for this condition.

5. Toxicity Assessment

The two principle indices of toxicity used in risk assessment are the reference dose (RfD) and the cancer slope factor (SF). An RfD is the intake or dose per unit of body weight (mg/kg-day) that is unlikely to result in toxic (non-carcinogenic) effects to human populations, including sensitive subgroups (e.g., the very young or elderly). The RfD allows for the existence of a threshold dose below which no adverse effects occur.

The SF is used to express the cancer risk attributable to a discrete unit of intake; that is, the cancer risk per milligram ingested per kilogram of bodyweight per day ($[\text{mg/kg-day}]^{-1}$). The SF is an estimate of the upper-bound probability of an individual developing cancer as a result of exposure to a particular carcinogen. Unlike the RfD, the SF assumes that there is no threshold dose below which the probability of developing cancer is zero. Note that SFs are only developed for those chemicals which have been shown to be carcinogens in man or in at least several animal species. A carcinogenic weight of evidence rating is used to describe the strength of the experimental evidence for carcinogenicity. The U.S. EPA has developed SFs for most chemicals

with weight of evidence ratings of "A" (known human carcinogen) or "B" (probable human carcinogen).

RfDs and SFs are derived by the U.S. EPA for the most toxic chemicals generally associated with chemical releases to the environment for which adequate toxicological data are available. If both the carcinogenic and non-carcinogenic effects of a particular compound are significant, both values may be established. However, in most cases only one value is available.

5.1 Inhalation and oral RfDs and SFs

RfDs and SFs pertinent to the oral and inhalation exposure pathways will be obtained from U.S. EPA's IRIS database. The IRIS (Integrated Risk Information System) on-line database was established by the U.S. EPA to provide risk assessors with peer reviewed toxicological data on chemicals commonly encountered at environmental sites of contamination. If data is not available from IRIS, it will be obtained from the Health Effects Assessment Summary Tables (HEAST), a compilation of toxicity values produced by the USEPA on a quarterly basis. The hierarchy presented in Appendix III of Virginia Risk Guidance will be followed for using these sources.

5.2 Dermal RfDs and SFs

Chemical specific oral-route absorption values (ABS_{oral}) are used to adjust the oral RfD or SF, which is computed from an administered dose, for use in the dermal exposure pathway. This correction is necessary due to the differences in absorption between the skin and the gastrointestinal tract. By correcting the administered-dose oral RfD or SF for the fraction expected to be absorbed in the gut, a dermal absorption factor can be used to estimate the correct dose received through the skin.

6. Evaluation of Risk

Using the toxicity criteria and identified exposure pathways discussed above, and the procedures described in the Virginia Risk Guidance, the risk presented by the HCOG will be estimated. The estimated risk will consider the effects from multiple constituents and all routes of exposure. The risk goals will be a total cumulative hazard index of 1.0 for multiple noncarcinogens and a total cumulative carcinogenic risk of $1E-04$ for multiple carcinogens. However, the risk from each individual carcinogen shall not exceed $1E-06$ (i.e., one case of cancer per 1,000,000 population).

6.1 Estimation of exposure concentration

For the contaminants detected at the site, an exposure point concentration (EPC) for each exposure pathway will be calculated for each contaminant by estimating the 95th upper confidence limit (UCL) on the arithmetic mean of the concentrations. If the calculated 95th UCL is greater than the maximum detected concentration, then the

maximum detected concentration will be used as the EPC. The risk for contaminants will be calculated as per the equations and assumptions described in Tables 1 through 4. If for a contaminant both carcinogenic and noncarcinogenic risk-based cleanup goal exists, the lower of the two will be used as a pathway specific to estimate the risk.

6.2. Risk Estimation

Health risk assessments are based on the relationship involving intake, contaminant concentration, risk, and toxicity. Chronic daily intake (CDI), a product of intake and contaminant concentration, are estimated using the exposure equations and assumptions associated with each route of exposure. CDIs are then combined with the RfDs or SFs to determine the resulting risk. For carcinogen(s), cumulative potential risk (RISK_c) can be calculated as follows:

$$\text{RISK}_c = \text{CDI}_{\text{ingestion}} * \text{SF}_{\text{ingestion}} + \text{CDI}_{\text{dermal}} * \text{SF}_{\text{dermal}} + \text{CDI}_{\text{inhalation-VOCs}} * \text{SF}_{\text{inhalation-VOCs}} \\ + \text{CDI}_{\text{inhalation-particles}} * \text{SF}_{\text{inhalation-particles}}$$

For noncarcinogen(s), cumulative hazard index (HI_c) can be calculated as follows:

$$\text{HI}_c = \text{CDI}_{\text{ingestion}} / \text{RfD}_{\text{ingestion}} + \text{CDI}_{\text{dermal}} / \text{RfD}_{\text{dermal}} + \text{CDI}_{\text{inhalation-VOCs}} / \text{RfD}_{\text{inhalation-VOCs}} \\ + \text{CDI}_{\text{inhalation-particles}} / \text{RfD}_{\text{inhalation-particles}}$$

where, taking into account all HCOC and relevant exposure pathways, the excess cancer risk is 10⁻⁶ or the hazard index is 1.0.

Table 1
Risk Assessment Algorithm for Carcinogenic Exposure

Exposure Route	Chronic Daily Intake (CDI), mg/L-day	
	Residential Exposure	Occupational/Industrial Exposure
Ground Water		
Ingestion	$\frac{CW \times IRW_{adj} \times EF}{AT_c}$	$\frac{CW \times IRW_s \times EF_o \times ED_o}{BW_s \times AT_c}$
Inhalation	$\frac{CW \times IRA_{adj} \times EF \times K}{AT_c}$	$\frac{CW \times IRA_s \times EF_o \times ED_o \times K}{BW_s \times AT_c}$
Dermal	$\frac{CW \times SAW_{adj} \times PC \times ET \times EF \times CF}{AT_c}$	$\frac{CW \times SAW_s \times PC \times ET \times EF_o \times ED_o \times CF}{BW_s \times AT_c}$
Soil		
Ingestion	$\frac{CS \times IRS_{adj} \times CF \times FI \times EF}{AT_c}$	$\frac{CS \times IR \times CF \times FI \times EF_o \times ED_o}{BW_s \times AT_c}$
Dermal	$\frac{CS \times CF \times SAS_{adj} \times AF \times ABS \times EF}{AT_c}$	$\frac{CS \times CF \times SAS_s \times AF \times ABS \times EF_o \times ED_o}{BW_s \times AT_c}$
Inhalation of vaporizing VOCs from soil	$\frac{VF \times IRA_{adj} \times ET \times EF}{AT_c}$	$\frac{VF \times IRA_s \times ET \times EF_o \times ED_o}{BW_s \times AT_c}$
Inhalation of emitting particles from soil	$\frac{PEF \times IRA_{adj} \times ET \times EF}{AT_c}$	$\frac{PEF \times IRA_s \times ET \times EF_o \times ED_o}{BW_s \times AT_c}$

Table 2
Risk Assessment Algorithm for Non-carcinogenic Exposure

Exposure Route	Chronic Daily Intake (CDI), mg/L-day	
	Residential Exposure	Occupational/Industrial Exposure
Ground Water		
Ingestion	$CW \times IRW_c \times EF \times ED_c$ ----- $BW_c \times AT_n$	$CW \times IRW_o \times EF_o \times ED_o$ ----- $BW_o \times AT_n$
Inhalation	$CW \times IRA_c \times EF \times ED_c \times K$ ----- $BW_c \times AT_n$	$CW \times IRA_o \times EF_o \times ED_o \times K$ ----- $BW_o \times AT_n$
Dermal	$CW \times SAW_c \times PC \times ET \times EF \times ED_c \times CF$ ----- $BW_c \times AT_n$	$CW \times SAW_o \times PC \times ET \times EF_o \times ED_o \times CF$ ----- $BW_o \times AT_n$
Soil		
Ingestion	$CS \times IRS_c \times CF \times FI \times EF \times ED_c$ ----- $BW_c \times AT_n$	$CS \times IRS_o \times CF \times FI \times EF_o \times ED_o$ ----- $BW_o \times AT_n$
Dermal	$CS \times CF \times SA_c \times AF \times ABS \times EF \times ED_c$ ----- $BW_c \times AT_n$	$CS \times CF \times SA_o \times AF \times ABS \times EF_o \times ED_o$ ----- $BW_o \times AT_n$
Inhalation of vaporizing VOCs from soil	$VF \times IRA_c \times ET \times EF \times ED_c$ ----- $BW_c \times AT_n$	$VF \times IRA_o \times ET \times EF_o \times ED_o$ ----- $BW_o \times AT_n$
Inhalation of emitting particles from soil	$PEF \times IRA_c \times ET \times EF \times ED_c$ ----- $BW_c \times AT_n$	$PEF \times IRA_o \times ET \times EF_o \times ED_o$ ----- $BW_o \times AT_n$

Note: Occupational noncarcinogenic risk assessment is based on adult exposure

Table 3
Age Adjusted Factors

$$IRA_{adj} = \frac{ED_c \times IRA_c}{BW_c} + \frac{(ED_{tot} - ED_c) \times IRA_a}{BW_a}$$

$$IRW_{adj} = \frac{ED_c \times IRW_c}{BW_c} + \frac{(ED_{tot} - ED_c) \times IRW_a}{BW_a}$$

$$SAW_{adj} = \frac{ED_c \times SAW_c}{BW_c} + \frac{(ED_{tot} - ED_c) \times SAW_a}{BW_a}$$

$$IRS_{adj} = \frac{ED_c \times IRS_c}{BW_c} + \frac{(ED_{tot} - ED_c) \times IRS_a}{BW_a}$$

$$SAS_{adj} = \frac{ED_c \times Sa_c}{BW_c} + \frac{(ED_{tot} - ED_c) \times Sa_a}{BW_a}$$

Note regarding age adjusted factor:

Because contact rate with tap water, ambient air, and residential soil are different for children and adults, carcinogenic risk during the first 30 years of life were calculated using age adjusted factor. These factors approximate the integrated exposure from birth until age 30 by combining contact rates, body weights, and exposure durations for two age groups - small children and adults.

Table 4
Exposure Variables Included in Tables 1, 2, and 3

Symbol	Term	Unit	Value	Reference
ABS	Absorption factor	-	User specified	
AF	Adherence factor	-	1.45	a, c
AT _c	Averaging time carcinogens	days	25550	
AT _n	Averaging time non-carcinogens	days	ED x 365	
BW _a	Body weight adult	kg	70	c
BW _c	Body weight child	kg	15	c
CF	Conversion factor	-	0.000001	-
CS	Chemical concentration in soil	mg/Kg-day	User specified	
CW	Chemical concentration in water	mg/L	User specified	
ED _c	Exposure duration child	years	6	c
ED _{total} ED	Exposure duration for carcinogen total or Residential	years	30	c
ED _o	Exposure duration occupational	years	25	c
EF	Exposure frequency residential	days	350	c
ET	Exposure Time General/Occupational Groundwater Surface Water - ingestion Surface water - dermal Air -inhalation	hrs/day	8.0 0.2 2.6 2.6 24.0	c, d
FI	Fraction ingested Residential Occupational	-	1.0 0.5	b
IRA _a	Inhalation rate air adult	m ³ /day	20	b
IRA _{adj}	Inhalation rate - air adjusted	-	11.66	
IRA _c	Inhalation rate child	m ³ /day	12	b
IRA _a	Inhalation rate adult	m ³ /day	20	b
IR	Ingestion rate food Fruit/veggies Fish	kg/day	0.28 0.122 0.054	c,d

IRS _a	Ingestion rate soil adult	mg/day	100	b
IRS _c	Ingestion rate soil child	mg/day	200	b
IRS _{adj}	Ingestion - soil adjusted	-	114.29	
IRS _c	Ingestion rate soil child	mg/day	200	b
IRW _a	Ingestion rate water adult	L/day	2	b
IRW _{adj}	Ingestion -water adjusted	L-y/kg-d	1.09	
IRW _c	Ingestion rate water child	L/day	1	b
K	Volatilization factor, water to air	-	0.5	
PC	Permeability constant	cm/hr	User specified	b
PEF	Particulate emission factor	kg/m ³	6.789926E08	f
SAW _c	Surface area child groundwater dermal surface water dermal	cm ²	7500	b,e
SAS _a SAS _c	Surface area soil occupational - adult child	cm ² /event	4500 1875	e
SAS _{adj}	Surface area soil adjusted	cm ² /event	2290	
SAW _a	Surface area for water contact adult	cm ²	820	b
SAW _{adj}	Surface area for water contact	cm ² /event	9200	
VF	Volatilization factor, soil to air	kg/m ³	User specified	-

References:

- Risk Assessment Guidance for Superfund, Volume I, EPA/540/1-89/002, December 1989.
- Region III values
- Exposure Factors handbook, EPA/600/8-89/043, July 1989
- Human health evaluation manual supplemental guidance, OSWER Directive 9285.6-03, March 25, 1991.
- Dermal exposure Assessment, Principles and Applications, Interim Report, EPA/600/8-91/011b, January 1992.
- Technical Background Document for Draft Soil Screening Level Guidance, Office of Solid Waste and Emergency Response, EPA/540/R-94/101, December 1994.

Attachment 2

Soil Background Development

FILE

2 April 1997
Reference: L0706.05.01

Mr. Arne Olsen
Alliant Techsystems
P. O. Box 1
Radford, Virginia 24141-0100



Re: Incinerator Spray Pond Closure,
Background Soil Sampling Results

Dear Arne:

The following represents the updated report for background soil sampling results for the Incinerator Spray Pond based on our 26 March 1997 telephone conversation.

Alliant Techsystems, Inc. (Alliant) is submitting background soil sampling results and revised critical values in support of closure of the Incinerator Spray Pond at the Radford Army Ammunition Plant in Radford, Virginia. These changes are being made in response to comments received from the Virginia Department of Environmental Quality (DEQ) on 26 March 1997. Changes include recalculation of the critical values for chromium, lead, mercury, nickel, and thallium using analytical values reported between the method detection limit and practical quantitation limit (PQL). It is noted that because the reported values are less than the laboratory PQL, the values may not be true or accurate values. Basing the critical values on these analytical results may lower cleanup levels. Secondly, the critical values were recalculated using 95% data coverage and 95% confidence level.

The background critical values are based on samples taken on 2 January 1996 and 5 December 1996. In accordance with Section 3.7.1 of the approved closure plan for the Incineratory Spray Pond, Alliant collected and analyzed six background soil samples for the constituents provided in Table 3-2A, "*Hazardous Constituents of Concern*." The following statistical operations were conducted on the data:

- Check for possible data outliers;
- Test assumptions of data normality;

- Check for adequate number of samples collected; and
- Calculation of background critical values.

Table 1 summarizes the analytical results and indicates the hazardous constituents of concern, Practical Quantitation Limit (PQL), units, and results. Table 2 provides the calculated soil background critical values. Analytical methods, statistical methods, and conclusions are discussed further below.

Data

Background soil sampling results with the Practical Quantitation Limits for the 2 January 1996 sampling events were submitted on 25 March 1996. As indicated in the 28 May 1996 and 28 October 1996 letters from DEQ to Ms. C. A. Jake, Alliant Techsystems, Inc., several analytical methods did not conform to Table 3-2 of the approved closure plan for the Incinerator Spray Pond, dated 24 August 1995. However, because most constituents were detected above the PQL, DEQ accepted the results for all the constituents in Table 3-2 with the exception of arsenic, di-n-butyl phthalate, diethyl phthalate, and resorcinol. Consequently, additional soil samples were collected and analyzed for these constituents on 5 December 1996. The analytical methods used were those identified in the updated Table 3-2A enclosed with DEQ's 28 October 1996 letter.

The analytical methods used for antimony, barium, chromium, lead, mercury, nickel, and thallium were not those identified in the approved closure plan. However, these constituents were detected at levels above the method detection limit for the methods used. Because the constituents were detected, DEQ indicated its approval of the methods in DEQ's 28 October 1996 letter to C.A. Jake, Alliant Techsystems.

Alliant resampled and re-analyzed for arsenic, di-n-butyl phthalate, diethyl phthalate, and resorcinol in December 1996 because of several concerns. First, the analytical method utilized in the first sampling event, SW-846 Method 8061, could not confirm the presence of diethyl phthalate because the ions in the clay soil matrix interfere with the laboratory instrumentation. Second, the recovery of several surrogates was not within acceptable ranges. Finally, the non-detected values for resorcinol and diethyl phthalate were based upon a Mass Spectral Library Search only. Although DEQ later approved the use of Method 8270B for these

**INCINERATOR SPRAY POND BACKGROUND SOIL RESULTS
BASIC RESULTS (CONDENSED)
FOR ALL DATES**

COMPANY: Alliant Techsystems Inc.

SITE: Incin. Spray Pond

PROGRAM: Closure

PROGRAM TYPE: Soil

DATA GROUP:

All Duplicates Used

PARAMETER	UNIT	SAMPLE NUMBER	SAMPLE DATE	RESULT	DETECTION LIMIT	COMMENT CODE
LOCATION III: Background						

RAAP LIST

2,4-DINITROTOLUENE	PPB	BG1	01/02/1996	Non-Detec	130.00000	
2,4-DINITROTOLUENE	PPB	BG2	01/02/1996	Non-Detec	130.00000	
2,4-DINITROTOLUENE	PPB	BG3	01/02/1996	Non-Detec	130.00000	
2,4-DINITROTOLUENE	PPB	BG4	01/02/1996	Non-Detec	130.00000	
2,4-DINITROTOLUENE	PPB	BG5	01/02/1996	Non-Detec	130.00000	
2,4-DINITROTOLUENE	PPB	BG6	01/02/1996	Non-Detec	130.00000	
2,6-DINITROTOLUENE	PPB	BG1	01/02/1996	Non-Detec	70.00000	
2,6-DINITROTOLUENE	PPB	BG2	01/02/1996	Non-Detec	70.00000	
2,6-DINITROTOLUENE	PPB	BG3	01/02/1996	Non-Detec	70.00000	
2,6-DINITROTOLUENE	PPB	BG4	01/02/1996	Non-Detec	70.00000	
2,6-DINITROTOLUENE	PPB	BG5	01/02/1996	Non-Detec	70.00000	
2,6-DINITROTOLUENE	PPB	BG6	01/02/1996	Non-Detec	70.00000	
ANTIMONY	PPM	BG1	01/02/1996	3.370	1.50000	
ANTIMONY	PPM	BG2	01/02/1996	3.250	1.50000	
ANTIMONY	PPM	BG3	01/02/1996	3.700	1.50000	
ANTIMONY	PPM	BG4	01/02/1996	5.480	1.50000	
ANTIMONY	PPM	BG5	01/02/1996	2.140	1.50000	
ANTIMONY	PPM	BG6	01/02/1996	4.200	1.50000	
ARSENIC	PPM	BG1	01/02/1996	2.250	1.25000	
ARSENIC	PPM	BG2	01/02/1996	3.880	1.25000	
ARSENIC	PPM	BG3	01/02/1996	2.900	1.25000	
ARSENIC	PPM	BG4	01/02/1996	2.070	1.25000	
ARSENIC	PPM	BG5	01/02/1996	1.910	1.25000	
ARSENIC	PPM	BG6	01/02/1996	1.760	1.25000	
BARIUM	PPM	BG1	01/02/1996	66.100	1.00000	
BARIUM	PPM	BG2	01/02/1996	82.300	1.00000	
BARIUM	PPM	BG3	01/02/1996	63.000	1.00000	

(continues)

**INCINERATOR SPRAY POND BACKGROUND SOIL RESULTS
BASIC RESULTS (CONDENSED)
FOR ALL DATES**

PARAMETER	UNIT	SAMPLE NUMBER	SAMPLE DATE	RESULT	DETECTION LIMIT	COMMENT CODE
BARIUM	PPM	BG4	01/02/1996	93.300	1.00000	
BARIUM	PPM	BG5	01/02/1996	91.500	1.00000	
BARIUM	PPM	BG6	01/02/1996	74.600	1.00000	
BERYLLIUM	PPM	BG1	01/02/1996	0.702	0.10000	
BERYLLIUM	PPM	BG2	01/02/1996	0.538	0.10000	
BERYLLIUM	PPM	BG3	01/02/1996	0.451	0.10000	
BERYLLIUM	PPM	BG4	01/02/1996	0.920	0.10000	
BERYLLIUM	PPM	BG5	01/02/1996	0.895	0.10000	
BERYLLIUM	PPM	BG6	01/02/1996	0.817	0.10000	
CADMIUM	PPM	BG1	01/02/1996	Non-Detec	0.05000	
CADMIUM	PPM	BG2	01/02/1996	Non-Detec	0.05000	
CADMIUM	PPM	BG3	01/02/1996	Non-Detec	0.05000	
CADMIUM	PPM	BG4	01/02/1996	0.058	0.05000	
CADMIUM	PPM	BG5	01/02/1996	0.054	0.05000	
CADMIUM	PPM	BG6	01/02/1996	0.053	0.05000	
CHROMIUM	PPM	BG1	01/02/1996	17.000	25.00000	
CHROMIUM	PPM	BG2	01/02/1996	16.000	25.00000	
CHROMIUM	PPM	BG3	01/02/1996	19.000	25.00000	
CHROMIUM	PPM	BG4	01/02/1996	23.500	25.00000	
CHROMIUM	PPM	BG5	01/02/1996	21.500	25.00000	
CHROMIUM	PPM	BG6	01/02/1996	21.500	25.00000	
DI-N-BUTYL PHTHALATE	PPB	BG1	01/02/1996	Non-Detec	330.00000	
DI-N-BUTYL PHTHALATE	PPB	BG2	01/02/1996	Non-Detec	330.00000	
DI-N-BUTYL PHTHALATE	PPB	BG3	01/02/1996	Non-Detec	330.00000	
DI-N-BUTYL PHTHALATE	PPB	BG4	01/02/1996	Non-Detec	330.00000	
DI-N-BUTYL PHTHALATE	PPB	BG5	01/02/1996	Non-Detec	330.00000	
DI-N-BUTYL PHTHALATE	PPB	BG6	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG1	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG2	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG3	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG4	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG5	01/02/1996	Non-Detec	330.00000	
DIETHYL PHTHALATE	PPB	BG6	01/02/1996	Non-Detec	330.00000	
LEAD	PPM	BG1	01/02/1996	11.000	50.00000	
LEAD	PPM	BG2	01/02/1996	10.000	50.00000	
LEAD	PPM	BG3	01/02/1996	13.000	50.00000	
LEAD	PPM	BG4	01/02/1996	14.500	50.00000	
LEAD	PPM	BG5	01/02/1996	11.500	50.00000	
LEAD	PPM	BG6	01/02/1996	14.500	50.00000	
MERCURY	PPM	BG1	01/02/1996	0.250	1.00000	
MERCURY	PPM	BG2	01/02/1996	0.250	1.00000	
MERCURY	PPM	BG3	01/02/1996	0.200	1.00000	
MERCURY	PPM	BG4	01/02/1996	0.150	1.00000	
MERCURY	PPM	BG5	01/02/1996	0.100	1.00000	
MERCURY	PPM	BG6	01/02/1996	0.250	1.00000	

(continues)

**INCINERATOR SPRAY POND BACKGROUND SOIL RESULTS
BASIC RESULTS (CONDENSED)
FOR ALL DATES**

PARAMETER	UNIT	SAMPLE NUMBER	SAMPLE DATE	RESULT	DETECTION LIMIT	COMMENT CODE
NICKEL	PPM	BG1	01/02/1996	5.400	7.50000	
NICKEL	PPM	BG2	01/02/1996	3.500	7.50000	
NICKEL	PPM	BG3	01/02/1996	4.700	7.50000	
NICKEL	PPM	BG4	01/02/1996	10.600	7.50000	
NICKEL	PPM	BG5	01/02/1996	11.500	7.50000	
NICKEL	PPM	BG6	01/02/1996	9.400	7.50000	
RESORCINOL	PPB	BG1	01/02/1996	Non-Detec	330.00000	
RESORCINOL	PPB	BG2	01/02/1996	Non-Detec	330.00000	
RESORCINOL	PPB	BG3	01/02/1996	Non-Detec	330.00000	
RESORCINOL	PPB	BG4	01/02/1996	Non-Detec	330.00000	
RESORCINOL	PPB	BG5	01/02/1996	Non-Detec	330.00000	
RESORCINOL	PPB	BG6	01/02/1996	Non-Detec	330.00000	
SILVER	PPM	BG1	01/02/1996	0.025	0.01000	
SILVER	PPM	BG2	01/02/1996	0.017	0.01000	
SILVER	PPM	BG3	01/02/1996	0.017	0.01000	
SILVER	PPM	BG4	01/02/1996	0.076	0.01000	
SILVER	PPM	BG5	01/02/1996	0.045	0.01000	
SILVER	PPM	BG6	01/02/1996	0.037	0.01000	
THALLIUM	PPM	BG1	01/02/1996	0.160	0.50000	
THALLIUM	PPM	BG2	01/02/1996	0.125	0.50000	
THALLIUM	PPM	BG3	01/02/1996	0.180	0.50000	
THALLIUM	PPM	BG4	01/02/1996	0.280	0.50000	
THALLIUM	PPM	BG5	01/02/1996	0.245	0.50000	
THALLIUM	PPM	BG6	01/02/1996	0.270	0.50000	

----- End of Report -----

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**Table 2: Critical Values
Incinerator Spray Pond Closure**

<u>Parameter</u>	<u>Upper Tolerance Limit (UTL)</u>	<u>Practical Quantitation Limit (PQL)</u>
2,4-Dinitrotoluene	130.0 ppb	130.0 ppb
2,6-Dinitrotoluene	70.0 ppb	70.0 ppb
Antimony	7.8 ppm	1.5 ppm
Arsenic	5.43 ppm	1.25 ppm
Barium	125.75 ppm	1.00 ppm
Beryllium	1.44 ppm	0.1 ppm
Cadmium	0.071 ppm	0.05 ppm
Chromium	30.55 ppm	25.0 ppm
Di-n-butyl phthalate	330.0 ppb	330.0 ppb
Diethyl phthalate	330.0 ppb	330.0 ppb
Lead	19.4 ppm	50.0 ppm
Mercury	0.44 ppm	1.0 ppm
Nickel	20.1 ppm	7.5 ppm
Resorcinol	330.0 ppb	330.0 ppb
Silver	0.12 ppm	0.01 ppm
Thallium	0.45 ppm	0.5 ppm

constituents, Alliant resample and reanalyze for these constituents on 5 December 1996.

SW-846 Method 6020 was utilized for analysis of arsenic. However, the laboratory Minimum Qualifying Limit (MQL) was 1.25 ppm versus 0.2 ppm identified in Table 3-2A. This discrepancy was due to the nature of the sample matrix and the digestion method used. Soils, especially clayey/silty soils, present special interference problems in laboratory analysis. The clay particles contain ionic charges and higher natural levels of metals which tend to interfere with the more sensitive laboratory equipment. Because arsenic was detected above the laboratory MQL, resampling will not be necessary.

Outliers

The data were checked for possible outliers using the Outlier Test, which follows ASTM Standard E178-75. The Monitor System, developed by Entech Systems, Inc., who also developed GRITSTAT, contains the same programs as GRITSTAT. These programs allow users to perform evaluations on more than one constituent at a time. The Outlier Test program is particularly useful for statistically detecting and verifying suspected outliers and locating possible data entry errors. It uses a standard t-test to compare the largest value from a sample set to the remaining values and then designates the possibility of this value being an outlier as "Yes" or "No." If the report indicates "Yes" for any parameter, it then lists the following information about it:

- The value of the possible outlier;
- Sampling location;
- Sample date; and
- Sample number.

No possible outliers were identified for any of the parameters. The test report is included with this letter as **Attachment A**.

Normality

The data were checked for normality using the Shapiro-Wilk Goodness-of-Fit Test. This program systematically designates the underlying distribution as normal, lognormal, or non-normal. If the data fails the test of normality, the program automatically takes the logs of the data and repeats the procedure. The Data Distribution program and report also computes:

- Sample size;
- Percentage of non-detects in each sample set;
- Coefficient of Kurtosis;
- Coefficient of skewness; and

- Coefficient of variation.

The report is included with this letter as **Attachment B**. As expected, the following compounds were not detected in any of the six samples and the data set is, therefore, non-normal:

2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-butyl phthalate
Diethyl phthalate
Resorcinol

The following compounds were detected above the method detection limit, but in some cases below the PQL, in all six samples and normally distributed:

Antimony
Arsenic
Barium
Beryllium
Chromium
Lead
Mercury
Nickel
Silver
Thallium

One compound, cadmium, was detected in 50% of the background samples. A non-normal distribution results when more than 50% of the samples are non-detects. In accordance with DEQ's *Guidance on Statistical Methods for Groundwater Data Analysis at a Solid Waste or Hazardous Waste Site*, Version 2.0 (10 August 1995), Alliant performed the recommended functions for data with more than 15% but less than or equal to 50% non-detected values.

The data set excluding non-detected values was checked for normality. As indicated in **Attachment B**, the detected only data for cadmium were normally distributed.

Appropriate Sample Numbers

A simple check to ensure that an appropriate number of samples were taken for analysis was completed for each parameter which had detected results. An appropriate number of samples could not be calculated for those parameters which had non-detected results.

The method is listed in Chapter 9, *Sampling Plan*, of SW-846, and summarized in Attachment C of this letter. Use of this alternate method was approved in a letter to J. J. Redder of Alliant Techsystems from C. L. Parker IV of DEQ dated 15 November 1995.

This method calculates an appropriate number of samples based on the variance as computed by the actual sample results. Then the calculated appropriate number of samples is compared to the actual number of sample measurements taken, which was six for each parameter, to ensure that an adequate number of background samples were taken. The calculated appropriate number of samples should be less than or equal to the actual number of samples taken.

Only barium, for which an appropriate number of 16 samples was calculated, did not pass this test. Alliant believes additional samples for barium are not necessary for the successful closure of this unit. barium is not a constituent of primary concern for closure of this unit; the mean concentration of barium in the samples is 78.5 mg/kg, or 28% of the naturally occurring mean concentration of 280 mg/kg for the eastern United States.

Critical Values

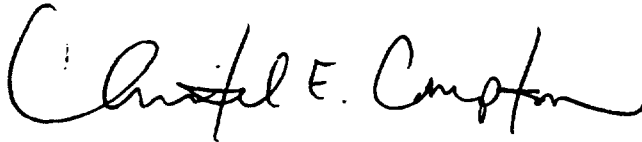
Based on the previous calculations and evaluations, Table 2 provides the calculated critical soil values for the Incinerator Spray Pond. In accordance with DEQ's guidance, an upper tolerance limit (UTL) was calculated for the data that were detected in all six background samples, using the Tolerance Limits method. A 95% level of coverage and a 95% confidence level were chosen. The calculated UTLs are listed in Attachment D.

For cadmium, which had 50% non-detect values and a normal distribution of detected-only values, Cohen's method of adjustment was used to calculate the mean, standard deviation, and UTL. The laboratory

PQL was used as the background value for those constituents with 100% non-detected values.

An electronic copy of this document has been enclosed with this report. If you have any questions regarding this letter or would like any additional information, please call me at (540) 776-3545.

Sincerely,



Christel E. Compton
Branch Manager

CC:db

enclosures: Table 1: Incinerator Spray Pond Analytical Results
Table 2: Critical Values
Attachments A-D

Attachment A
Outlier Test Report

BACKGROUND SOIL SAMPLES
OUTLIER TEST
FOR ALL DATES

COMPANY: Alliant Techsystems Inc.

SITE: Incin. Spray Pond

PROGRAM: Closure

PROGRAM TYPE: Soil

DATA GROUP:

All Duplicates Used
Significance Level (1 - alpha): 95%

Non-Detects = Detection Limit/2

LOCATION	POSSIBLE OUTLIER?	SAMPLE NUMBER	SAMPLE DATE	VALUE	SAMPLE SIZE	MEAN	CALCULATED T	TABULAR T
RAAP LIST								

PARAMETER: 2,4-DINITROTOLUENE

UNIT: PPM

Background

NO

PARAMETER: 2,6-DINITROTOLUENE

UNIT: PPM

Background

NO

PARAMETER: ANTIMONY

UNIT: PPM

Background

NO

PARAMETER: ARSENIC

UNIT: PPM

Background

NO

PARAMETER: BARIUM

UNIT: PPM

Background

NO

(continues)

BACKGROUND SOIL SAMPLES
OUTLIER TEST
FOR ALL DATES

LOCATION	POSSIBLE OUTLIER?	SAMPLE NUMBER	SAMPLE DATE	VALUE	SAMPLE SIZE	MEAN	CALCULATED T	TABULAR T
PARAMETER: BERYLLIUM							UNIT: PPM	
Background	NO							
PARAMETER: CADMIUM							UNIT: PPM	
Background	NO							
PARAMETER: CHROMIUM							UNIT: PPM	
Background	NO							
PARAMETER: DI-N-BUTYL PHTHALATE							UNIT: PPB	
Background	NO							
PARAMETER: DIETHYL PHTHALATE							UNIT: PPB	
Background	NO							
PARAMETER: LEAD							UNIT: PPM	
Background	NO							
PARAMETER: MERCURY							UNIT: PPM	
Background	NO							
PARAMETER: NICKEL							UNIT: PPM	
Background	NO							
PARAMETER: RESORCINOL							UNIT: PPB	
Background	NO							

(continues)

BACKGROUND SOIL SAMPLES
OUTLIER TEST
FOR ALL DATES

LOCATION	POSSIBLE OUTLIER?	SAMPLE NUMBER	SAMPLE DATE	VALUE	SAMPLE SIZE	MEAN	CALCULATED T	TABULAR T

PARAMETER: SILVER UNIT: PPM

Background

NO

PARAMETER: THALLIUM UNIT: PPM

Background

NO

----- End of Report -----

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Attachment B
Normality Test Report and
Descriptive Statistics

**BACKGROUND SOIL SAMPLES
DATA DISTRIBUTION
FOR ALL DATES**

COMPANY: Alliant Techsystems Inc.
SITE: Incin. Spray Pond
PROGRAM: Closure
PROGRAM TYPE: Soil
DATA GROUP:

All Duplicates Used
 Significance Level (1 - alpha): 95%

Non-Detects = Detection Limit/2

LOCATION ID	SAMPLE SIZE	# N-Ds	SHAPIRO-WILK DISTRIBUTION	CALCULATED W	TABULAR W	SKENNESS	KURTOSIS	COEFFICIENT OF VARIATION
RAAP LIST								
PARAMETER: 2,4-DINITROTOLUENE								UNIT: PPB
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00
PARAMETER: 2,6-DINITROTOLUENE								UNIT: PPB
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00
PARAMETER: ANTIMONY								UNIT: PPM
Background	6	0	Normal	0.9687	0.7880	0.25	1.77	0.30
PARAMETER: ARSENIC								UNIT: PPM
Background	6	0	Normal	0.8583	0.7880	0.77	1.81	0.33
PARAMETER: BARIUM								UNIT: PPM
Background	6	0	Normal	0.9173	0.7880	-0.01	1.00	0.16

(continues)

**BACKGROUND SOIL SAMPLES
DATA DISTRIBUTION
FOR ALL DATES**

LOCATION ID	SAMPLE SIZE	% N-De	SHAPIRO-WILK DISTRIBUTION	CALCULATED W	TABULAR W	SKENNESS	KURTOSIS	COEFFICIENT OF VARIATION
PARAMETER: BERYLLIUM								UNIT: PPM
Background	6	0	Normal	0.9127	0.7880	-0.27	1.08	0.27
PARAMETER: CADMIUM								UNIT: PPM
Background	6	50	Non-Normal	0.7243	0.7880	0.02	0.73	0.41
PARAMETER: CHROMIUM								UNIT: PPM
Background	6	0	Normal	0.9380	0.7880	-0.07	1.09	0.15
PARAMETER: DI-N-BUTYL PHTHALATE								UNIT: PPB
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00
PARAMETER: DIETHYL PHTHALATE								UNIT: PPB
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00
PARAMETER: LEAD								UNIT: PPM
Background	6	0	Normal	0.9068	0.7880	0.01	1.02	0.15
PARAMETER: MERCURY								UNIT: PPM
Background	6	0	Normal	0.8308	0.7880	-0.49	1.30	0.32
PARAMETER: NICKEL								UNIT: PPM
Background	6	0	Normal	0.8897	0.7880	0.01	0.88	0.45

(continues)

BACKGROUND SOIL SAMPLES
DATA DISTRIBUTION
FOR ALL DATES

LOCATION ID	SAMPLE SIZE	% N-Ds	SHAPIRO-WILK DISTRIBUTION	CALCULATED W	TABULAR W	SKEWNESS	KURTOSIS	COEFFICIENT OF VARIATION
PARAMETER: RESORCINOL UNIT: PPM								
Background	6	100	Non-Normal	0.0000	0.7880	0.00	0.00	0.00
PARAMETER: SILVER UNIT: PPM								
Background	6	0	Normal	0.8693	0.7880	0.71	1.84	0.56
PARAMETER: THALLIUM UNIT: PPM								
Background	6	0	Normal	0.9120	0.7880	-0.11	0.98	0.30

----- End of Report -----

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NORMALITY CHECK ON DETECTED VALUES - 50% NON-DETECT
DATA DISTRIBUTION
FOR ALL DATES

COMPANY: Alliant Techsystems Inc.

SITE: Incln. Spray Pond

PROGRAM: Closure

PROGRAM TYPE: Soil

DATA GROUP:

All Duplicates Used

Non-Detects Ignored

Significance Level (1 - alpha): 95%

LOCATION ID	SAMPLE SIZE	$\frac{1}{N-1}$	SHAPIRO-WILK DISTRIBUTION	CALCULATED W	TABULAR W	SKENNESS	KURTOSIS	COEFFICIENT OF VARIATION

RAAP LIST

PARAMETER: CADMIUM

UNIT: PPM

Background

3	0		Normal	0.8928	0.7670	0.32	0.67	0.04

----- End of Report -----

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**INCINERATOR SPRAY POND BACKGROUND SOIL RESULTS
DESCRIPTIVE STATISTICS
FOR ALL DATES**

COMPANY: Alliant Techsystems Inc.

SITE: Incin. Spray Pond

PROGRAM: Closure

PROGRAM TYPE: Soil

DATA GROUP:

All Duplicates Used

Non-Detects = Detection Limit/2

PARAMETER	SAMPLE								
UNIT	SIZE	N-Ds	MEAN	MEDIAN	STANDARD DEVIATION	VARIANCE	MINIMUM	MAXIMUM	
LOCATION ID: Background									
RAAP LIST									
ANTIMONY									
PPM	6	0	3.690	3.535	1.110	1.233	2.140	5.480	
ARSENIC									
PPM	6	0	2.462	2.160	0.800	0.640	1.760	3.880	
BARIUM									
PPM	6	0	78.467	78.450	12.741	162.339	63.000	93.300	
BERYLLIUM									
PPM	6	0	0.721	0.760	0.193	0.037	0.451	0.920	
CADMIUM									
PPM	6	50	0.040	> 49% N-D's	0.017	0.000	Non-Detect	0.058	
CHROMIUM									
PPM	6	0	19.750	20.250	2.911	8.475	16.000	23.500	
LEAD									
PPM	6	0	12.417	12.250	1.882	3.542	10.000	14.500	
MERCURY									
PPM	6	0	0.200	0.225	0.063	0.004	0.100	0.250	
NICKEL									
PPM	6	0	7.517	7.400	3.390	11.494	3.500	11.500	
SILVER									
PPM	6	0	0.036	0.031	0.022	0.001	0.017	0.076	
THALLIUM									
PPM	6	0	0.210	0.213	0.064	0.004	0.125	0.280	

----- End of Report -----

The Monitor System, TM

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Attachment C
Appropriate Number of Samples

ALLIANT TECHSYSTEMS, INC.
INCINERATOR SPRAY POND BACKGROUND SOIL SAMPLES
APPROPRIATE NUMBER OF SAMPLES CHECK
SW-846 CHAPTER 9 SAMPLING PLAN

Variance of Sample, s^2

$$s^2 = \frac{\sum X_i^2 - (\sum X_i)^2 / n}{n - 1} \quad \text{where } n = \text{number of sample measurements.}$$

Appropriate Number of Samples, n

$$n = \frac{t^2 s^2}{RT-X}$$

where RT = regulatory threshold,

X = sample mean, and

t = value based on the number of degrees of freedom (n-1)

The results for the following parameters were non-detect and, therefore, an appropriate number of samples could not be calculated:

2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-butyl phthalate
Diethyl phthalate
Resorcinol

Although many of the results for most of the following parameters were below the PQL, an appropriate number of samples was calculated using the laboratory detection limit.

Antimony =	2.7	Number of Actual Samples = 6
Arsenic =	0.0	
Barium =	16.4	
Beryllium =	0.1	
Cadmium =	0.0	
Chromium =	1.3	
Lead =	1.2	
Mercury =	0.0	
Nickel =	3.3	
Silver =	0.4	
Thallium =	0.0	

Attachment D
Critical Values

UPPER TOLERANCE LIMIT FOR 50% NON-DETECTS
TOLERANCE LIMITS
FOR ALL DATES

COMPANY: Alliant Techsystems Inc.
SITE: Incin. Spray Pond
PROGRAM: Closure
PROGRAM TYPE: Soil
DATA GROUP:

All Duplicates Used
Tolerance Coefficient (Y): 95%

Cohen's Method Used For Non-Detects
Level Of Coverage (P): 95%

LOCATION ID	SAMPLE SIZE	% NON- DETECT	MEAN	REGULATORY LIMIT	UPPER TOLERANCE LIMIT

RAAP LIST

PARAMETER: CADMIUM

UNIT: PPM

Background

6	50	0.050	0.000	0.071

----- End of Report -----

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UPPER TOLERANCE LIMITS FOR 100% DETECTED
TOLERANCE LIMITS
FOR ALL DATES

COMPANY: Alliant Techsystems Inc.

SITE: Incin. Spray Pond

PROGRAM: Closure

PROGRAM TYPE: Soil

DATA GROUP:

All Duplicates Used
Tolerance Coefficient (Y): 95%

Non-Detects = Detection Limit/2
Level Of Coverage (P): 95%

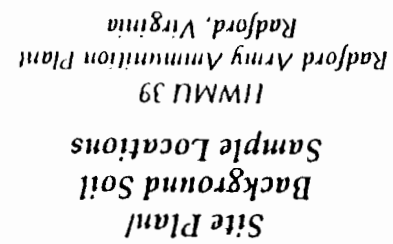
LOCATION ID	SAMPLE SIZE	% NON- DETECT	MEAN	REGULATORY LIMIT	UPPER TOLERANCE LIMIT
RAAP LIST					
PARAMETER: ANTIMONY					UNIT: PPM
Background	6	0	3.690	0.000	7.810
PARAMETER: ARSENIC					UNIT: PPM
Background	6	0	2.462	0.000	5.430
PARAMETER: BARIUM					UNIT: PPM
Background	6	0	78.467	0.000	125.749
PARAMETER: BERYLLIUM					UNIT: PPM
Background	6	0	0.721	0.000	1.436
PARAMETER: CHROMIUM					UNIT: PPM
Background	6	0	19.750	0.000	30.553

(continues)

UPPER TOLERANCE LIMITS FOR 100% DETECTED
TOLERANCE LIMITS
FOR ALL DATES

LOCATION ID	SAMPLE SIZE	% NON- DETECT	MEAN	REGULATORY LIMIT	UPPER TOLERANCE LIMIT
PARAMETER: LEAD					UNIT: PPM
Background	6	0	12.417	0.000	19.401
PARAMETER: MERCURY					UNIT: PPM
Background	6	0	0.200	0.000	0.435
PARAMETER: NICKEL					UNIT: PPM
Background	6	0	7.517	0.000	20.098
PARAMETER: SILVER					UNIT: PPM
Background	6	0	0.036	0.000	0.120
PARAMETER: THALLIUM					UNIT: PPM
Background	6	0	0.210	0.000	0.447

----- End of Report -----
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Sample Chain of Custody

W.O. Number: 176E4.07.01 Project Name: ZAAP-Site 39

Sampler: Z.M. Iler / Z. Estes

ERM T.R. Number	Date	Time	COMP	GRAB	Sample Location	Number of Containers	See Attached List						Remarks
025398	1-2-96	11:15		X	BG-1 (4.5')	1	X			96-000	61		* 2-week Turn Around
025399	1-2-96	11:30		X	BG-2 (4.5')	1	X			000	62		Send Results to:
025400	1-2-96	11:50		X	BG-3 (4.5')	1	X			000	63		Christel Ackerman
025401	1-2-96	12:15		X	BG-4 (4.5')	1	X			000	64		ERM, Inc.
025402	1-2-96	12:30		X	BG-5 (4.5')	1	X			000	65		(540) 776-3545
025403	1-2-96	12:55		X	BG-6 (4.5')	1	X			000	66		(540) 776-8530 (FAX)
025404	1-2-96	12:00		X	BGD-3 (4.5')	4	X			000	67		
025405	1-2-96	10:40		X	FIELD BLANK	6	X			000	68		Invoice Jerry Redder,
025406	1-2-96	13:10		X	EQUIP BLANK	6	X			000	69		ZAAP, directly
025448	12-19-95	12:00		X	TRIP BLANK	7	X			000	70		

Sample Relinquished	Date	Time	Sample Received by:	Date	Time	Reason for Transfer
K. J. Iler	1-3-96	10:50	James W. H. / Jerry P. White	1-3-96	10:50	Transferred to CNLC rep.
				1/3/96	1715	



**CENTRAL VIRGINIA
LABORATORIES & CONSULTANTS, INC.**

P.O. Box 10938 Lynchburg, Virginia 24506
OFFICE: 3109 Odd Fellows Road • (804) 847-2852 • 800-296-1470 • FAX (804) 847-2830

**Christel Ackerman
Environmental Resources Management, Inc.
3140 Chaparral Drive, Suite 201
Roanoke, Virginia 24018**

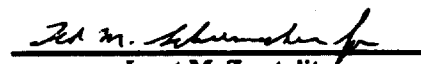
PROJECT NAME:		RAAP Site 39	RAAP Site 39	RAAP Site 39	RAAP Site 39
PROJECT NUMBER:		176E4.07.01	176E4.07.01	176E4.07.01	176E4.07.01
CUSTOMER ID:		BG - 1 (4.5')	BG - 2 (4.5')	BG - 3 (4.5')	BG - 4 (4.5')
CVLC ID:		96-00061	96-00062	96-00063	96-00064
COLLECTION DATE :	Grab:	01/02/96	01/02/96	01/02/96	01/02/96
COLLECTION TIME (hours):	Grab:	1115	1130	1150	1215
RELINQUISHED DATE:		01/03/96	01/03/96	01/03/96	01/03/96
RELINQUISHED TIME (hours):		1050	1050	1050	1050
RECEIVED DATE:		01/03/96	01/03/96	01/03/96	01/03/96
RECEIVED TIME (hours):		1715	1715	1715	1715

NG = Not Given

Comments:

The presence of Diethyl Phthalate detected by method SW 8061 in several of the samples was not confirmed by mass spectrometry. Therefore, Diethyl Phthalate for these samples was reported by SW-846 Method 8270.

Respectfully Submitted,


Janet M. Zwetolitz
Laboratory Director

January 16, 1996

Report Date

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

PROJECT NAME:		RAAP Site 39	RAAP Site 39	RAAP Site 39	RAAP Site 39
PROJECT NUMBER:		176E4.07.01	176E4.07.01	176E4.07.01	176E4.07.01
CUSTOMER ID:		BG - 5 (4.5')	BG - 6 (4.5')	BGD - 3 (4.5')	Field Blank
CVLC ID:		96-00065	96-00066	96-00067	96-00068
COLLECTION DATE :	Grab:	01/02/96	01/02/96	01/02/96	01/02/96
COLLECTION TIME (hours):	Grab:	1230	1255	1200	1040
RELINQUISHED DATE:		01/03/96	01/03/96	01/03/96	01/03/96
RELINQUISHED TIME (hours):		1050	1050	1050	1050
RECEIVED DATE:		01/03/96	01/03/96	01/03/96	01/03/96
RECEIVED TIME (hours):		1715	1715	1715	1715

NG = Not Given

Comments:

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

PROJECT NAME:		RAAP Site 39	RAAP Site 39
PROJECT NUMBER:		176E4.07.01	176E4.07.01
CUSTOMER ID:		Equip Blank	Trip Blank
CVLC ID:		96-00069	96-00070
COLLECTION DATE :	Grab:	01/02/96	12/19/95
COLLECTION TIME (hours):	Grab:	1310	1200
RELINQUISHED DATE:		01/03/96	01/03/96
RELINQUISHED TIME (hours):		1050	1050
RECEIVED DATE:		01/03/96	01/03/96
RECEIVED TIME (hours):		1715	1715

NG = Not Given

Comments:

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

			<u>BG - 1 (4.5')</u> <u>96-00061</u>	<u>BG - 2 (4.5')</u> <u>96-00062</u>	<u>BG - 3 (4.5')</u> <u>96-00063</u>	<u>BG - 4 (4.5')</u> <u>96-00064</u>
<u>INORGANIC COMPOUNDS</u>	<u>SW-846 Method</u>	<u>DL (MG/KG)</u>	<u>MG/KG</u>	<u>MG/KG</u>	<u>MG/KG</u>	<u>MG/KG</u>
Antimony, Total	7041	0.150	3.37	3.25	3.70	5.48
Arsenic, Total	7060	0.50	ND	ND ¹	ND	ND
Barium, Total	6010A	0.100	66.1	82.3	63.0	93.3
Beryllium, Total	6010A	0.0100	0.702	0.538	0.451	0.920
Cadmium, Total	7131	0.0050	ND	ND	ND	0.058
Chromium, Total	7190	2.50	17.0	16.0	19.0	23.5
Lead, Total	7420	5.0	11.0	10.0	13.0	14.5
Mercury, Total	7471	0.10	0.25	0.25	0.20	0.15
Nickel, Total	7520	0.750	5.40	3.50	4.70	10.6
Silver, Total	7761	0.0010	0.0255	0.0170	0.0170	0.0765
Thallium, Total	7841	0.050	0.160	0.125	0.180	0.280

ND = Not Detected

¹The spike recovery was not within the acceptable range. Therefore, the reported result is estimated.

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

INORGANIC COMPOUNDS	SW-846 Method	DL (MG/KG)	BG - 5 (4.5')	BG - 6 (4.5')	BGD - 3 (4.5')
			96-00065	96-00066	96-00067
			MG/KG	MG/KG	MG/KG
Antimony, Total	7041	0.150	2.14	4.20	3.40
Arsenic, Total	7060	0.50	ND	ND	ND
Barium, Total	6010A	0.100	91.5	74.6	58.5
Beryllium, Total	6010A	0.0100	0.895	0.817	0.521
Cadmium, Total	7131	0.0050	0.054	0.053	ND
Chromium, Total	7190	2.50	21.5	21.5	19.5
Lead, Total	7420	5.0	11.5	14.5	11.5
Mercury, Total	7471	0.10	0.10	0.25	0.10
Nickel, Total	7520	0.750	11.5	9.40	4.50
Silver, Total	7761	0.0010	0.0450	0.0370	0.0205
Thallium, Total	7841	0.050	0.245	0.270	0.185

ND = Not Detected

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

INORGANIC COMPOUNDS	SW-846 Method	DL (MG/L)	Field Blank	Equip Blank	Trip Blank
			96-00068	96-00069	96-00070
			MG/L	MG/L	MG/L
Antimony, Total	7041	0.003	ND	ND	ND
Arsenic, Total	7060	0.001	ND	ND	ND
Barium, Total	6010A	0.002	ND	ND	ND
Beryllium, Total	6010A	0.0002	ND	ND	ND
Cadmium, Total	7131	0.0001	ND	ND	ND
Chromium, Total	7191	0.001	ND	ND	ND
Lead, Total	7421	0.001	ND	ND	ND
Mercury, Total	7470	0.0002	0.0002	0.0002	0.0002
Nickel, Total	7520	0.015	ND	ND	ND
Silver, Total	7761	0.0002	ND	ND	ND
Thallium, Total	7841	0.001	ND	ND	ND

ND = Not Detected

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

		<u>BG - 1 (4.5')</u>	<u>BG - 2 (4.5')</u>	<u>BG - 3 (4.5')</u>	<u>BG - 4 (4.5')</u>
		<u>96-00061</u>	<u>96-00062</u>	<u>96-00063</u>	<u>96-00064</u>
<u>SW-846 METHOD 8061</u>	<u>DL(UG/KG)</u>	<u>UG/KG</u>	<u>UG/KG</u>	<u>UG/KG</u>	<u>UG/KG</u>
Di-n-butyl-phthalate	220	ND	ND	ND	ND
Diethyl phthalate	170	ND	ND	ND	ND

ND = Not Detected

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

<u>SW-846 METHOD 8061</u>	<u>DL(UG/KG)</u>	<u>BG - 5 (4.5')</u>	<u>BG - 6 (4.5')</u>	<u>BGD - 3 (4.5')</u>
		<u>96-00065</u>	<u>96-00066</u>	<u>96-00067</u>
		<u>UG/KG</u>	<u>UG/KG</u>	<u>UG/KG</u>
Di-n-butyl-phthalate	220	ND	ND	ND

ND = Not Detected

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

<u>SW-846 METHOD 8061</u>	<u>DL(UG/L)</u>	<u>Field Blank</u>	<u>Equip Blank</u>	<u>Trip Blank</u>
		96-00068	96-00069	96-00070
		<u>UG/L</u>	<u>UG/L</u>	<u>UG/L</u>
Di-n-butyl-phthalate	3.3	ND	ND	ND

ND = Not Detected

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

		<u>BG - 1 (4.5')</u>	<u>BG - 2 (4.5')</u>	<u>BG - 3 (4.5')</u>	<u>BG - 4 (4.5')</u>
		<u>96-00061</u>	<u>96-00062</u>	<u>96-00063</u>	<u>96-00064</u>
<u>SW-846 METHOD 8090</u>	<u>DL(UG/KG)</u>	<u>UG/KG¹</u>	<u>UG/KG¹</u>	<u>UG/KG</u>	<u>UG/KG¹</u>
2,4-Dinitrotoluene	13	ND	ND	ND	ND
2,6-Dinitrotoluene	7	ND	ND	ND	ND

ND = Not Detected

¹The recovery for each surrogate was not within the acceptable range. Therefore, the reported results are estimated.

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

		BG - 5 (4.5') 96-00065	BG - 6 (4.5') 96-00066	BGD - 3 (4.5') 96-00067
SW-846 METHOD 8090	DL(UG/KG)	UG/KG	UG/KG¹	UG/KG
2,4-Dinitrotoluene	13	ND	ND	ND
2,6-Dinitrotoluene	7	ND	ND	ND

ND = Not Detected

¹The recovery for each surrogate was not within the acceptable range. Therefore, the reported results are estimated.

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

SW-846 METHOD 8090	DL(UG/L)	Field Blank	Equip Blank	Trip Blank
		96-00068	96-00069	96-00070
		UG/L	UG/L	UG/L
2,4-Dinitrotoluene	0.2	ND	ND	ND
2,6-Dinitrotoluene	0.1	ND	ND	ND

ND = Not Detected

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

SW-846 METHOD 8270	DL(UG/KG)	BG - 1 (4.5')	BG - 2 (4.5')	BG - 3 (4.5')	BG - 4 (4.5')
		96-00061	96-00062	96-00063	96-00064
		UG/KG	UG/KG	UG/KG	UG/KG
Resorcinol ¹	330	ND	ND	ND	ND

ND = Not Detected

¹**Please Note: Values obtained above are based upon an NBS Mass Spectral Library Search only -
these values should be considered approximations.**

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

SW-846 METHOD 8270	DL(UG/KG)	BG - 5 (4.5')	BG - 6 (4.5')	BGD - 3 (4.5')
		96-00065	96-00066	96-00067
		UG/KG	UG/KG	UG/KG
Resorcinol ¹	330	ND	ND	ND
Diethyl phthalate	170	ND	ND	ND

ND = Not Detected

**¹Please Note: Values obtained above are based upon an NBS Mass Spectral Library Search only -
these values should be considered approximations.**

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

SW-846 METHOD 8270	DL(UG/L)	Field Blank	Equip Blank	Trip Blank
		96-00068	96-00069	96-00070
		UG/L	UG/L	UG/L
Resorcinol ¹	100	ND	ND	ND
Diethyl phthalate	2.5	ND ²	ND ²	<5.9 ²

ND = Not Detected

**¹Please Note: Values obtained above are based upon an NBS Mass Spectral Library Search only -
these values should be considered approximations.**

The recovery for each surrogate was not within the acceptable range. Therefore, the reported results are estimated.

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

SURROGATE COMPOUND	RECOVERY RANGE	BG - 1 (4.5')	BG - 2 (4.5')	BG - 3 (4.5')	BG - 4 (4.5')
		96-00061	96-00062	96-00063	96-00064
PERCENT RECOVERY (%)					
SW-846 Method 8061					
Diphenyl Phthalate	40 - 125	98	75	98	83
SW-846 Method 8090					
Dibutyl Chlorendate	40 - 125	24 ¹	37 ¹	40	38 ¹
SW-846 Method 8270					
Phenol-d6	24 - 113	127 ¹	77	84	70
2-Fluorophenol	25 - 121	90	70	74	67
2,4,6-Tribromophenol	19 - 122	77	74	61	59
Nitrobenzene-d5	23 - 118	30	62	61	68
2-Fluorobiphenyl	30 - 115	21 ¹	99	40	48
p-Terphenyl-d14	18 - 137	20	60	51	64

¹The recovery for each surrogate was not within the acceptable range. Therefore, the reported results are estimated.

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

		BG - 5 (4.5')	BG - 6 (4.5')	BGD - 3 (4.5')
		96-00065	96-00066	96-00067
<u>SURROGATE COMPOUND</u>	<u>RECOVERY RANGE</u>	<u>PERCENT RECOVERY (%)</u>		
SW-846 Method 8061				
Diphenyl Phthalate	40 - 125	88	103	102
SW-846 Method 8090				
Dibutyl Chlorendate	40 - 125	56	39 ¹	48
SW-846 Method 8270				
Phenol-d6	24 - 113	70	74	54
2-Fluorophenol	25 - 121	68	70	55
2,4,6-Tribromophenol	19 - 122	64	56	47
Nitrobenzene-d5	23 - 118	65	70	49
2-Fluorobiphenyl	30 - 115	46	48	35
p-Terphenyl-d14	18 - 137	65	53	52

CENTRAL VIRGINIA LABORATORIES AND CONSULTANTS, INC
Analytical Results

		Field Blank	Equip Blank	Trip Blank
		96-00068	96-00069	96-00070
<u>SURROGATE COMPOUND</u>	<u>RECOVERY RANGE</u>	<u>PERCENT RECOVERY (%)</u>		
SW-846 Method 8061				
Diphenyl Phthalate	40 - 125	81	55	101
SW-846 Method 8090				
Dibutyl Chlorendate	45 - 120	93	54	71
SW-846 Method 8270				
Phenol-d6	10 - 94	40	41	36
2-Fluorophenol	21 - 100	54	56	48
2,4,6-Tribromophenol	10 - 123	65	83	60
Nitrobenzene-d5	35 - 114	63	34 ¹	56
2-Fluorobiphenyl	43 - 116	42 ¹	22 ¹	40 ¹
p-Terphenyl-d14	33 - 133	47	30	46

¹The recovery for each surrogate was not within the acceptable range. Therefore, the reported results are estimated.

LEGEND

Spike Failure

The matrix spike sample analysis provides information about the effect of each sample matrix on the digestion and measurement methodology. Spike recoveries must be within specified limits. However, according to EPA Document No. EPA/540/R/94/082, **LABORATORY DATA VALIDATION FUNCTIONAL GUIDELINES FOR EVALUATING ORGANIC ANALYSES**, December, 1994 (Laboratory Functional Guidelines), if the sample result is outside the acceptable range, the results are reported as estimated.

Surrogate Failure

Laboratory performance on individual samples is established by means of spiking activities. All samples are spiked with surrogate compounds prior to sample preparation. The evaluation of the results of these surrogate spikes is not necessarily straightforward. The sample itself may produce effects due to such factors as interferences and high concentrations of analytes. Since the effects of the sample matrix are frequently outside the control of the laboratory and may present relatively unique problems, the review and validation of data based on specific sample results is frequently subjective and demands analytical experience and professional judgement.

Elevated Detection Limit

Often during analysis, an interferant or high concentration of a compound may create the need to dilute a sample. When the sample is diluted, the Method Detection Limit is elevated by the factor of the dilution.

Method Detection Limit

The Method Detection Limit is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero.

Attachment 3

Chains of Custody and Sample Results



NO. 53

4

ADDRESS: P.O. Box 1

CITY/STATE/ZIP: Radford, VA 24141

BILL TO: Same

CITY/STATE/ZIP: _____

CONTACT PERSON: Aine O'Shea

TELEPHONE/FAX: 540/639-8220

SITE ID & STATE: RAAP

PROJECT ID: Incin. Spray Pond Closure

SAMPLER: C. Compton, ERM

SAMPLE LOG AND ANALYSIS REQUEST		TURNAROUND TIME REQUIREMENTS		PRESERVATIVES	NOTE PRESERVATIVES →	PRESERVATIVE CODES																	
		REGULAR:	*RUSH:	0 No Preservative 1 Hydrochloric Acid 2 Nitric Acid 3 Sulfuric Acid 4 Sodium Thiosulfate 5 Sodium Hydroxide 6 Zinc Acetate 7 EDTA		0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7		
SAMPLE ID	NO. & TYPE OF CONTAINERS	SAMPLING DATE / TIME	MATRIX	SAMPLE COMP / GRAB	ANALYSES REQUESTED & METHOD																COMMENTS		
A1 12"	2/glass	8/19/97	Soil		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
A4 12"	2/glass				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
B2 12"	2/glass				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
C2 12"	2/glass				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
D2 12"	2/glass				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
D3 12"	2/glass				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
D3 12" Dupl.	2/glass				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
E1 12"	2/glass				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
~~E3 12" SC~~																							
E2 12"	2/glass				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Relinquished by: (Signature)		Date/Time	Received by: (Signature)		Date/Time	Relinquished by: (Signature)		Date/Time	Relinquished by: (Signature)		Date/Time	Relinquished by: (Signature)		Date/Time	Relinquished by: (Signature)		Date/Time	Relinquished by: (Signature)		Date/Time	Relinquished by: (Signature)		Date/Time
Special Requests:					Sample Condition: Good? Y N					Temperature Upon Arrival													
Shipment:	Hand-Del:	Courier:	UPS:	FedEx:	Shipment Date:					FAX Results: Y N													



**225 Industrial Park Rd.
P.O. Box 286, Beaver, WV 25813
Phone: 304-255-2500 or 800-999-0105
FAX: 304-255-2572**

NO. 53

CONTACT PERSON: Arne Olsen
TELEPHONE/FAX: 540/639-8220
SITE ID & STATE: RAAP
PROJECT ID: Incinerator Spray Pond Cause
SAMPLER: C. Compton, ERM

[illegible]

ALLIANT SAMPLE #: A1 12"
REIC SAMPLE #: 54113-1

DATE SAMPLED: 08-19-97
MATRIX: SOLID
MOISTURE: 18%

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
antimony	ND	mg/kg	7041	2.50	08-25-97/MS
arsenic	3.02	mg/kg	7060A	2.50	08-26-97/MS
barium	78.5	mg/kg	6010A	2.50	08-25-97/GM
beryllium	ND	mg/kg	6010A	0.63	08-25-97/GM
cadmium	0.030	mg/kg	7131A	0.025	08-26-97/MS
chromium	25.5	mg/kg	6010A	2.50	08-25-97/GM
lead	16.5	mg/kg	6010A	12.0	08-25-97/GM
mercury	ND	mg/kg	7470A	0.10	08-27-97/MS
nickel	13.5	mg/kg	6010A	2.50	08-25-97/GM
silver	ND	mg/kg	6010A	1.25	08-25-97/GM
thallium	0.16	mg/kg	7841	0.12	08-25-97/MS

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
2,4-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
2,6-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
diethylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
di-n-butylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
resorcinol	ND	mg/kg	8270B	0.200	08-26-97/WP

Surrogates	% Recovery
nitrobenzene-d5	34
2-fluorobiphenyl	30
p-terphenyl-d14	61

ND - None Detected at MQL
MQL - Minimum Quantifying Level

ALLIANT SAMPLE #: A4 12"
REIC SAMPLE #: 54113-2

DATE SAMPLED: 08-19-97
MATRIX: SOLID
MOISTURE: 22%

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
antimony	ND	mg/kg	7041	2.50	08-25-97/MS
arsenic	2.90	mg/kg	7080A	2.50	08-26-97/MS
barium	85.2	mg/kg	6010A	2.50	08-25-97/GM
beryllium	ND	mg/kg	6010A	0.63	08-25-97/GM
cadmium	0.030	mg/kg	7131A	0.025	08-26-97/MS
chromium	30.0	mg/kg	6010A	2.50	08-25-97/GM
lead	17.2	mg/kg	6010A	12.0	08-25-97/GM
mercury	ND	mg/kg	7470A	0.10	08-27-97/MS
nickel	15.3	mg/kg	6010A	2.50	08-25-97/GM
silver	ND	mg/kg	6010A	1.25	08-25-97/GM
thallium	0.14	mg/kg	7641	0.12	08-25-97/MS

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
2,4-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
2,6-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
diethylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
di-n-butylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
resorcinol	ND	mg/kg	8270B	0.200	08-26-97/WP

Surrogates	% Recovery
nitrobenzene-d5	29
2-fluorobiphenyl	30
p-terphenyl-d14	34

ND - None Detected at MQL
MQL - Minimum Quantifying Level

ALLIANT SAMPLE #: B2 12"
 REIC SAMPLE #: 54113-3

DATE SAMPLED: 08-19-97
 MATRIX: SOLID
 MOISTURE: 18%

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
antimony	ND	mg/kg	7041	2.50	08-25-97/MS
arsenic	3.62	mg/kg	7060A	2.50	08-26-97/MS
barium	83.8	mg/kg	6010A	2.50	08-25-97/GM
beryllium	ND	mg/kg	6010A	0.63	08-26-97/GM
cadmium	0.040	mg/kg	7131A	0.025	08-26-97/MS
chromium	28.2	mg/kg	6010A	2.50	08-26-97/GM
lead	19.1	mg/kg	6010A	12.0	08-25-97/GM
mercury	ND	mg/kg	7470A	0.10	08-27-97/MS
nickel	16.0	mg/kg	6010A	2.50	08-25-97/GM
silver	ND	mg/kg	6010A	1.25	08-25-97/GM
thallium	0.18	mg/kg	7841	0.12	08-25-97/MS

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
2,4-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
2,6-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
diethylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
di-n-butylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
resorcinol	ND	mg/kg	8270B	0.200	08-26-97/WP

Surrogates % Recovery

nitrobenzene-d5	33
2-fluorobiphenyl	30
p-terphenyl-d14	61

ND - None Detected at MQL
 MQL - Minimum Quantifying Level

ALLIANT SAMPLE #: C2 12"
REIC SAMPLE #: 54113-4

DATE SAMPLED: 08-19-97
MATRIX: SOLID
MOISTURE: 27%

TOTAL METALS ..

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
antimony	ND	mg/kg	7041	2.50	08-25-97/MS
arsenic	4.65	mg/kg	7060A	2.50	08-26-97/MS
barium	88.7	mg/kg	6010A	2.50	08-25-97/GM
beryllium	ND	mg/kg	6010A	0.63	08-25-97/GM
cadmium	0.045	mg/kg	7131A	0.025	08-26-97/MS
chromium	30.55 ppm 34.2	mg/kg	6010A	2.50	08-25-97/GM
lead	19 ppm 22.8	mg/kg	6010A	12.0	08-25-97/GM
mercury	ND	mg/kg	7470A	0.10	08-27-97/MS
nickel	14.8	mg/kg	6010A	2.50	08-25-97/GM
silver	ND	mg/kg	6010A	1.25	08-25-97/GM
thallium	0.21	mg/kg	7841	0.12	08-25-97/MS

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
2,4-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
2,6-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
diethylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
di-n-butylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
resorcinol	ND	mg/kg	8270B	0.200	08-26-97/WP

Surrogates % Recovery

nitrobenzene-d5	34
2-fluorobiphenyl	37
p-terphenyl-d14	64

ND - None Detected at MQL
MQL - Minimum Quantifying Level

ALLIANT SAMPLE #: D1 12"
REIC SAMPLE #: 54113-6

DATE SAMPLED: 08-19-97
MATRIX: SOLID
MOISTURE: 19%

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
antimony	ND	mg/kg	7041	2.50	08-25-97/MS
arsenic	ND	mg/kg	7060A	2.50	08-26-97/MS
barium	126 ppm	mg/kg	6010A	2.50	08-25-97/GM
beryllium	ND	mg/kg	6010A	0.63	08-25-97/GM
cadmium	0.042	mg/kg	7131A	0.025	08-26-97/MS
chromium	17.2	mg/kg	6010A	2.50	08-25-97/GM
lead	13.0	mg/kg	6010A	12.0	08-26-97/TJ
mercury	ND	mg/kg	7470A	0.10	08-27-97/MS
nickel	7.85	mg/kg	6010A	2.50	08-25-97/GM
silver	ND	mg/kg	6010A	1.25	08-25-97/GM
thallium	ND	mg/kg	7841	0.12	08-25-97/MS

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
2,4-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
2,6-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
diethylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
di-n-butylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
resorcinol	ND	mg/kg	8270B	0.200	08-26-97/WP

Surrogates	% Recovery
nitrobenzene-d5	35
2-fluorobiphenyl	41
p-terphenyl-d14	84

ND - None Detected at MQL
MQL - Minimum Quantifying Level

ALLIANT SAMPLE #: D3 12"
REIC SAMPLE #: 54113-6

DATE SAMPLED: 08-19-97
MATRIX: SOLID
MOISTURE: 15%

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
antimony	ND	mg/kg	7041	2.50	08-25-97/MS
arsenic	ND	mg/kg	7060A	2.50	08-26-97/MS
barium	41.2	mg/kg	6010A	2.50	08-26-97/GM
beryllium	ND	mg/kg	6010A	0.63	08-26-97/GM
cadmium	ND	mg/kg	7131A	0.025	08-26-97/MS
chromium	14.6	mg/kg	6010A	2.50	08-25-97/GM
lead	9.50	mg/kg	7421	0.25	08-26-97/TJ
mercury	ND	mg/kg	7470A	0.10	08-27-97/MS
nickel	6.62	mg/kg	6010A	2.50	08-25-97/GM
silver	ND	mg/kg	6010A	1.25	08-25-97/GM
thallium	ND	mg/kg	7841	0.12	08-25-97/MS

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
2,4-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
2,6-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
diethylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
di-n-butylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
resorcinol	ND	mg/kg	8270B	0.200	08-26-97/WP

Surrogates % Recovery

nitrobenzene-d5
2-fluorobiphenyl
p-terphenyl-d14

32
35
58

ND - None Detected at MQL
MQL - Minimum Quantifying Level

ALLIANT SAMPLE #: D3 12" DUPL.
 REIC SAMPLE #: 54113-7

DATE SAMPLED: 08-19-97
 MATRIX: SOLID
 MOISTURE: 17%

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
antimony	ND	mg/kg	7041	2.50	08-25-97/MS
arsenic	ND	mg/kg	7060A	2.50	08-26-97/MS
barium	46.2	mg/kg	6010A	2.50	08-25-97/GM
beryllium	ND	mg/kg	6010A	0.63	08-25-97/GM
cadmium	ND	mg/kg	7131A	0.025	08-26-97/MS
chromium	11.3	mg/kg	6010A	2.50	08-25-97/GM
lead	10.2	mg/kg	7421	0.25	08-26-97/TJ
mercury	ND	mg/kg	7470A	0.10	08-27-97/MS
nickel	5.08	mg/kg	6010A	2.50	08-25-97/GM
silver	ND	mg/kg	6010A	1.25	08-25-97/GM
thallium	ND	mg/kg	7841	0.12	08-25-97/MS

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
2,4-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
2,6-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
diethylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
di-n-butylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
resorcinol	ND	mg/kg	8270B	0.200	08-26-97/WP

Surrogates	% Recovery
nitrobenzene-d5	33
2-fluorobiphenyl	38
p-terphenyl-d14	60

ND - None Detected at MQL
 MQL - Minimum Quantifying Level

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Alliant Hercules, Inc.
Job #: 0897-54113

ALLIANT SAMPLE #: E1 12"
REIC SAMPLE #: 54113-8

DATE SAMPLED: 08-19-97
MATRIX: SOLID
MOISTURE: 22%

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
antimony	ND	mg/kg	7041	2.50	08-25-97/MS
arsenic	ND	mg/kg	7060A	2.50	08-26-97/MS
barium	126 ppm	mg/kg	6010A	2.50	08-25-97/GM
beryllium	ND	mg/kg	6010A	0.63	08-25-97/GM
cadmium	0.050	mg/kg	7131A	0.025	08-26-97/MS
chromium	25.4	mg/kg	6010A	2.50	08-25-97/GM
lead	19 ppm	mg/kg	6010A	12.0	08-26-97/TJ
mercury	ND	mg/kg	7470A	0.10	08-27-97/MS
nickel	14.9	mg/kg	6010A	2.50	08-25-97/GM
silver	ND	mg/kg	6010A	1.25	08-25-97/GM
thallium	0.12	mg/kg	7841	0.12	08-25-97/MS

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
2,4-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
2,6-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
diethylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
di-n-butylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
resorcinol	ND	mg/kg	8270B	0.200	08-26-97/WP

Surrogates	% Recovery
nitrobenzene-d5	35
2-fluorobiphenyl	43
p-terphenyl-d14	82

ND - None Detected at MQL
MQL - Minimum Quantifying Level

ALLIANT SAMPLE #: E2 12"
REIC SAMPLE #: 54113-9

DATE SAMPLED: 08-19-97
MATRIX: SOLID
MOISTURE: 18%

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
antimony	ND	mg/kg	7041	2.50	08-25-97/MS
arsenic	ND	mg/kg	7060A	2.50	08-26-97/MS
barium	36.2	mg/kg	6010A	2.50	08-25-97/GM
beryllium	ND	mg/kg	6010A	0.63	08-25-97/GM
cadmium	ND	mg/kg	7131A	0.025	08-26-97/MS
chromium	14.2	mg/kg	6010A	2.50	08-25-97/GM
lead	6.48	mg/kg	6010A	12.0	08-26-97/TJ
mercury	ND	mg/kg	7470A	0.10	08-27-97/MS
nickel	6.90	mg/kg	7421	0.25	08-25-97/GM
silver	ND	mg/kg	6010A	1.25	08-25-97/GM
thallium	ND	mg/kg	7841	0.12	08-25-97/MS

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
2,4-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
2,6-dinitrotoluene	ND	mg/kg	8270B	0.200	08-26-97/WP
diethylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
di-n-butylphthalate	ND	mg/kg	8270B	0.200	08-26-97/WP
resorcinol	ND	mg/kg	8270B	0.200	08-26-97/WP

Surrogates	% Recovery
nitrobenzene-d5	29
2-fluorobiphenyl	34
p-terphenyl-d14	62

ND - None Detected at MQL
MQL - Minimum Quantifying Level

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Alliant Hercules, Inc.
Job #: 0897-54113

ALLIANT SAMPLE #: EQUIPMENT BLANK DATE SAMPLED: 08-19-97
REIC SAMPLE #: 54113-10 MATRIX: LIQUID

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
antimony	ND	mg/l	7041	0.010	08-25-97/MS
arsenic	ND	mg/l	7080A	0.010	08-28-97/MS
barium	ND	mg/l	6010A	0.10	08-25-97/GM
beryllium	ND	mg/l	6010A	0.004	08-25-97/GM
cadmium	ND	mg/l	7131A	0.001	08-28-97/MS
chromium	ND	mg/l	7101	0.010	08-28-97/TJ
lead	ND	mg/l	7421	0.010	08-22-97/TJ
mercury	ND	mg/l	7470A	0.002	08-28-97/MS
nickel	ND	mg/l	6010A	0.10	08-25-97/GM
silver	ND	mg/l	6010A	0.050	08-25-97/GM
thallium	ND	mg/l	7841	0.005	08-25-97/MS

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
2,4-dinitrotoluene	ND	mg/l	8270B	0.010	08-28-97/WP
2,6-dinitrotoluene	ND	mg/l	8270B	0.010	08-28-97/WP
diethylphthalate	ND	mg/l	8270B	0.010	08-28-97/WP
di-n-butylphthalate	ND	mg/l	8270B	0.010	08-28-97/WP
resorcinol	ND	mg/l	8270B	0.010	08-28-97/WP

Surrogates

% Recovery

nitrobenzene-d5
2-fluorobiphenyl
p-terphenyl-d14

84
73
124

ND - None Detected at MQL
MQL - Minimum Quantifying Level

Page 12
Alliant Hercules, Inc.
Job #: 0897-54113

ALLIANT SAMPLE #: FIELD BLANK
REIC SAMPLE #: 54113-11

DATE SAMPLED: 08-19-97
MATRIX: LIQUID

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
antimony	ND	mg/l	7041	0.010	08-25-97/MS
arsenic	ND	mg/l	7060A	0.010	08-25-97/MS
barium	ND	mg/l	8010A	0.10	08-25-97/GM
beryllium	ND	mg/l	8010A	0.004	08-25-97/GM
cadmium	ND	mg/l	7131A	0.001	08-25-97/MS
chromium	ND	mg/l	7191	0.010	08-25-97/TJ
lead	ND	mg/l	7421	0.010	08-22-97/TJ
mercury	ND	mg/l	7470A	0.002	08-25-97/MS
nickel	ND	mg/l	8010A	0.10	08-25-97/GM
silver	ND	mg/l	8010A	0.050	08-25-97/GM
thallium	ND	mg/l	7841	0.005	08-25-97/MS

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
2,4-dinitrotoluene	ND	mg/l	8270B	0.010	08-26-97/WP
2,6-dinitrotoluene	ND	mg/l	8270B	0.010	08-26-97/WP
diethylphthalate	ND	mg/l	8270B	0.010	08-26-97/WP
di-n-butylphthalate	ND	mg/l	8270B	0.010	08-26-97/WP
resorcinol	ND	mg/l	8270B	0.010	08-26-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	79
2-fluorobiphenyl	76
p-terphenyl-d14	121

ND - None Detected at MQL
MQL - Minimum Quantifying Level

Page 13
Alliant Hercules, Inc.
Job #: 0897-54113

ALLIANT SAMPLE #: TRIP BLANK
REIC SAMPLE #: 54113-12

DATE SAMPLED: 08-19-97
MATRIX: LIQUID

TOTAL METALS-

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
antimony	ND	mg/l	7041	0.010	08-25-97/MS
arsenic	ND	mg/l	7060A	0.010	08-26-97/MS
barium	ND	mg/l	6010A	0.10	08-25-97/GM
beryllium	ND	mg/l	6010A	0.004	08-25-97/GM
cadmium	ND	mg/l	7131A	0.001	08-26-97/MS
chromium	ND	mg/l	7191	0.010	08-26-97/TJ
lead	ND	mg/l	7421	0.010	08-22-97/TJ
mercury	ND	mg/l	7470A	0.002	08-26-97/MS
nickel	ND	mg/l	6010A	0.10	08-25-97/GM
silver	ND	mg/l	6010A	0.050	08-25-97/GM
thallium	ND	mg/l	7841	0.005	08-25-97/MS

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	MQL	ANALYZED/BY
2,4-dinitrotoluene	ND	mg/l	8270B	0.010	08-26-97/WP
2,6-dinitrotoluene	ND	mg/l	8270B	0.010	08-26-97/WP
diethylphthalate	ND	mg/l	8270B	0.010	08-26-97/WP
di-n-butylphthalate	ND	mg/l	8270B	0.010	08-26-97/WP
resorcinol	ND	mg/l	8270B	0.010	08-26-97/WP

Surrogates	% Recovery
nitrobenzene-d5	81
2-fluorobiphenyl	70
p-terphenyl-d14	116

ND - None Detected at MQL
MQL - Minimum Quantifying Level

DATE 9-2-97

APPROVED

Ivan W. Leef
Ivan W. Leef

Janet M. Satterfield
Janet M. Satterfield



CLIENT: Alliant Techsystems Inc
ADDRESS: P.O. Box 1
CITY/STATE/ZIP: Radford, VA 24141
BILL TO: Same
CITY/STATE/ZIP:

CONTACT PERSON: Arne Olson
TELEPHONE/FAX: 540/639-8220
SITE ID & STATE: RAAP - Va
PROJECT ID: Train Spray Pond Closure
SAMPLER: C. Campbell, ERM

SAMPLE LOG AND ANALYSIS REQUEST		TURNAROUND TIME REQUIREMENTS		PRESERVATIVES	PRESERVATIVE CODES										COMMENTS
		REGULAR:	*RUSH:	NOTE PRESERVATIVES → 0 No Preservative 1 Hydrochloric Acid 2 Nitric Acid 3 Sulfuric Acid 4 Sodium Thiosulfate 5 Sodium Hydroxide 6 Zinc Acetate 7 EDTA											
SAMPLE ID	NO. & TYPE OF CONTAINERS	SAMPLING DATE / TIME	MATRIX	SAMPLE COMP / GRAB	ANALYTES REQUESTED & METHOD										
A1 18"	2/glass	9/17/10:00	Soil	Grab	X	X	X	X	X	X	X	X	X	X	
A1 24"		10:08			X	X	X	X	X	X	X	X	X	X	
A4 18"		10:12			X	X	X	X	X	X	X	X	X	X	
A4 24"		10:20			X	X	X	X	X	X	X	X	X	X	
B2 18"		10:45			X	X	X	X	X	X	X	X	X	X	
B2 24"		10:52			X	X	X	X	X	X	X	X	X	X	
C2 18"		11:15			X	X	X	X	X	X	X	X	X	X	
C2 24"		11:22			X	X	X	X	X	X	X	X	X	X	
D1 18"		12:35			X	X	X	X	X	X	X	X	X	X	
D1 24"		12:43			X	X	X	X	X	X	X	X	X	X	

Retiniquished by: (Signature) _____ Date/Time _____ Received by: (Signature) _____ Date/Time _____ Retiniquished by: (Signature) _____ Date/Time _____ Received by: (Signature) _____ Date/Time _____

Methods per DEA approved plan - A. Olsen Sample Condition: Good? Y N Temperature Upon Arrival °C

Hand-Del: Courier: UPS: FedEx: Shipment Date: FAX Results: Y N



REIC Laboratory
225 Industrial Park Rd.
P.O. Box 286, Beaver, WV 25813
Phone: 304-255-2500 or 800-999-0105
FAX: 304-255-2572

CHAIN OF CUSTODY RECORD NO. 55420

CLIENT: Alliant Techsystems Inc.
ADDRESS: P.O. Box 1
CITY/STATE/ZIP: Radford, VA 24141
BILL TO: Same
CITY/STATE/ZIP: _____

CONTACT PERSON: Arne Olsen
TELEPHONE/FAX: 540/639-8220
SITE ID & STATE: RRAP - Va.
PROJECT ID: Train Spray Pond Closure
SAMPLER: C. Compton, ERM

SAMPLE LOG AND ANALYSIS REQUEST		TURNAROUND TIME REQUIREMENTS		PRESERVATIVES		PRESERVATIVE CODES										COMMENTS						
		REGULAR: _____	*RUSH: _____	0 No Preservative	1 Hydrochloric Acid	2 Nitric Acid	3 Sulfuric Acid	4 Sodium Thiosulfate	5 Sodium Hydroxide	6 Zinc Acetate	7 EDTA	NOTE PRESERVATIVES →	ANALYTES REQUESTED & METHOD	24-Dinitrophenol	Dinitrophenol		Dinitrophenol	Benzoic	Chloroform	Lead	Nickel	Silver
SAMPLE ID	NO. & TYPE OF CONTAINERS	SAMPLING DATE / TIME	MATRIX	SAMPLE COMP / GRAB																		
D3 18"	2/glass	9/8/97 12:53	Soil	Grab	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
D3 24"		13:00			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
E1 18"		13:01			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
E1 24"		13:12			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
E2 18"		13:15			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
E2 24"		13:20			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
E1 18" Dupl.		13:22			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
E1 24" Dupl.		13:25			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
E2 18"		13:27			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
E2 24"		13:33			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Equip. Blank		13:35			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Field Blank		13:37			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
		13:39			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
		13:45			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
		13:48			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
		14:01	H ₂ O		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
		14:02			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
		14:08	H ₂ O		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
		14:10			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Special Requests: <u>Methods per DEQ approved plan - A. Olson</u>				Sample Condition: Good? Y N		Temperature Upon Arrival °C	
Shipment:	Hand-Del:	Courier:	UPS:	FedEx:	Shipment Date:	FAX Results: Y N	

**ALLIANT TECHSYSTEMS INC.
P O BOX 1
RADFORD VIRGINIA 24141**

**REIC JOB #: 0997-54714
SITE ID: RAAP - VA
PROJECT ID: INCIN. SPRAY POND CLOSURE
CUSTODY NO.: 53420 AND 53421**

**Prepared By:
REI Consultants, Inc.
P O Box 286
Beaver WV 26813**

**Phone: 304-266-2600
800-999-0106
Fax: 304-266-2672**

ALLIANT SAMPLE #: A1 18"
REIC SAMPLE #: 54714-1

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 20%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	80

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	30
2-fluorobiphenyl	38
p-terphenyl-d14	43

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	3100	ug/kg	7060A	200	09-23-97/TJ
barium	94800	ug/kg	6010A	1000	09-16-97/MS
beryllium	800	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	25700	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	13700	ug/kg	6010A	7500	09-18-97/MS
silver	48	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: A1 24"
REIC SAMPLE #: 54714-2

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 19%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	88

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	33
2-fluorobiphenyl	40
p-terphenyl-d14	47

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2560	ug/kg	7060A	200	09-23-97/TJ
barium	116000	ug/kg	6010A	1000	09-16-97/MS
beryllium	800	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	31300	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	20100	ug/kg	6010A	7500	09-18-97/MS
silver	30	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: A4 18"
REIC SAMPLE #: 54714-3

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 17%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	104

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	26
2-fluorobiphenyl	34
p-terphenyl-d14	40

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2990	ug/kg	7060A	200	09-23-97/TJ
barium	101000	ug/kg	6010A	1000	09-16-97/MS
beryllium	780	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	38400	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	20700	ug/kg	6010A	7500	09-18-97/MS
silver	50	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: A4 24"
REIC SAMPLE #: 54714-4

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 19%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	94

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	26
2-fluorobiphenyl	34
p-terphenyl-d14	39

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2400	ug/kg	7060A	200	09-23-97/TJ
barium	101000	ug/kg	6010A	1000	09-16-97/MS
beryllium	720	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	32600	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	17600	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: B2 18"
REIC SAMPLE #: 54714-5

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 18%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	88

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	29
2-fluorobiphenyl	37
p-terphenyl-d14	42

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2610	ug/kg	7060A	200	09-23-97/TJ
barium	89600	ug/kg	6010A	1000	09-16-97/MS
beryllium	750	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	34300	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	16800	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: B2 24"
REIC SAMPLE #: 54714-6

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 19%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	100

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	26
2-fluorobiphenyl	32
p-terphenyl-d14	38

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2450	ug/kg	7060A	200	09-23-97/TJ
barium	88100	ug/kg	6010A	1000	09-16-97/MS
beryllium	820	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	29700	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	17400	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: C2 18"
REIC SAMPLE #: 54714-7

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 23%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	94

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	27
2-fluorobiphenyl	32
p-terphenyl-d14	41

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	4580	ug/kg	7060A	200	09-23-97/TJ
barium	123000	ug/kg	6010A	1000	09-16-97/MS
beryllium	880	ug/kg	6010A	100	09-18-97/MS
cadmium	50	ug/kg	7131A	50	09-17-97/TJ
chromium	37900	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	20800	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: C2 24"
REIC SAMPLE #: 54714-8

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 20%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	89

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	29
2-fluorobiphenyl	30
p-terphenyl-d14	41

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	3410	ug/kg	7060A	200	09-23-97/TJ
barium	102000	ug/kg	6010A	1000	09-16-97/MS
beryllium	800	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	37500	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	19400	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: D1 18"
REIC SAMPLE #: 54714-9

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 20%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	96

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	25
2-fluorobiphenyl	32
p-terphenyl-d14	38

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2330	ug/kg	7060A	200	09-23-97/TJ
barium	103000	ug/kg	6010A	1000	09-16-97/MS
beryllium	650	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	31200	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	11600	ug/kg	6010A	7500	09-18-97/MS
silver	40	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: D1 24"
REIC SAMPLE #: 54714-10

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 25%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	86

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-21-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-21-97/WP
resorcinol	ND	ug/kg	8270B	330	09-21-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	50
2-fluorobiphenyl	38
p-terphenyl-d14	61

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	6460	ug/kg	7060A	200	09-23-97/TJ
barium	98200	ug/kg	6010A	1000	09-16-97/MS
beryllium	1280	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	34300	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	11600	ug/kg	6010A	7500	09-18-97/MS
silver	25	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: D3 18"
REIC SAMPLE #: 54714-11

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 21%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-24-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-24-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	84

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	27
2-fluorobiphenyl	31
p-terphenyl-d14	53

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	3050	ug/kg	7060A	200	09-23-97/TJ
barium	126000	ug/kg	6010A	1000	09-16-97/MS
beryllium	900	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	39000	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	19100	ug/kg	6010A	7500	09-18-97/MS
silver	45	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: D3 24"
REIC SAMPLE #: 54714-12

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 21%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	90

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	24
2-fluorobiphenyl	33
p-terphenyl-d14	56

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	3500	ug/kg	7060A	200	09-23-97/TJ
barium	112000	ug/kg	6010A	1000	09-16-97/MS
beryllium	1000	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	38500	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	16700	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: E1 18"
REIC SAMPLE #: 54714-13

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 19%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	114

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	27
2-fluorobiphenyl	34
p-terphenyl-d14	52

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	1740	ug/kg	7060A	200	09-23-97/TJ
barium	211000	ug/kg	6010A	1000	09-16-97/MS
beryllium	1000	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	29800	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	17500	ug/kg	6010A	7500	09-18-97/MS
silver	68	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: E1 24"
REIC SAMPLE #: 54714-14

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 22%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	100

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	26
2-fluorobiphenyl	32
p-terphenyl-d14	49

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	1680	ug/kg	7060A	200	09-23-97/TJ
barium	199000	ug/kg	6010A	1000	09-16-97/MS
beryllium	1020	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	25100	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	15.3	ug/kg	6010A	7500	09-18-97/MS
silver	25	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: E1 18" DUP.
REIC SAMPLE #: 54714-15

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 20%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

Surrogate	% Recovery
tetrachloro-m-xylene	100

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

Surrogates	% Recovery
nitrobenzene-d5	28
2-fluorobiphenyl	39
p-terphenyl-d14	57

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	1860	ug/kg	7060A	200	09-23-97/TJ
barium	113000	ug/kg	6010A	1000	09-16-97/MS
beryllium	1520	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	26100	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	12700	ug/kg	6010A	7500	09-18-97/MS
silver	30	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: E1 24" DUP.
REIC SAMPLE #: 54714-16

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 21%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	114

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-20-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-20-97/WP
resorcinol	ND	ug/kg	8270B	330	09-20-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	27
2-fluorobiphenyl	34
p-terphenyl-d14	56

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	2940	ug/kg	7060A	200	09-23-97/TJ
barium	110000	ug/kg	6010A	1000	09-16-97/MS
beryllium	650	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	28300	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	12800	ug/kg	6010A	7500	09-18-97/MS
silver	30	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: E2 18"
REIC SAMPLE #: 54714-17

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 19%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	86

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-21-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-21-97/WP
resorcinol	ND	ug/kg	8270B	330	09-21-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	25
2-fluorobiphenyl	41
p-terphenyl-d14	53

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	3690	ug/kg	7060A	200	09-23-97/TJ
barium	100000	ug/kg	6010A	1000	09-16-97/MS
beryllium	820	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	36200	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	20600	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: E2 24"
REIC SAMPLE #: 54714-18

DATE SAMPLED: 09-08-97
MATRIX: SOLID
MOISTURE: 20%

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/kg	8090	130	09-25-97/JA
2,6-dinitrotoluene	ND	ug/kg	8090	70	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	88

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/kg	8270B	330	09-21-97/WP
di-n-butyl phthalate	ND	ug/kg	8270B	330	09-21-97/WP
resorcinol	ND	ug/kg	8270B	330	09-21-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	35
2-fluorobiphenyl	30
p-terphenyl-d14	56

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/kg	7041	1000	09-16-97/TJ
arsenic	4390	ug/kg	7060A	200	09-23-97/TJ
barium	85400	ug/kg	6010A	1000	09-16-97/MS
beryllium	820	ug/kg	6010A	100	09-18-97/MS
cadmium	ND	ug/kg	7131A	50	09-17-97/TJ
chromium	31500	ug/kg	6010A	25000	09-16-97/MS
lead	ND	ug/kg	6010A	50000	09-16-97/MS
mercury	ND	ug/kg	7471	200	09-17-97/TJ
nickel	16700	ug/kg	6010A	7500	09-18-97/MS
silver	ND	ug/kg	7761	*25	09-17-97/GM
thallium	ND	ug/kg	7841	500	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: EQUIP. BLANK
REIC SAMPLE #: 54714-19

DATE SAMPLED: 09-08-97
MATRIX: LIQUID

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/l	8090	25	09-25-97/JA
2,6-dinitrotoluene	ND	ug/l	8090	15	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	78

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/l	8270B	25	09-21-97/WP
di-n-butyl phthalate	ND	ug/l	8270B	25	09-21-97/WP
resorcinol	ND	ug/l	8270B	25	09-21-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	48
2-fluorobiphenyl	64
p-terphenyl-d14	71

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/l	7041	10	09-16-97/TJ
arsenic	ND	ug/l	7060A	10	09-23-97/TJ
barium	ND	ug/l	6010A	100	09-16-97/MS
beryllium	ND	ug/l	6010A	4	09-18-97/MS
cadmium	ND	ug/l	7131A	1	09-17-97/TJ
chromium	ND	ug/l	7191	10	09-25-97/KC
lead	ND	ug/l	7421	10	09-24-97/KC
mercury	ND	ug/l	7470A	1	09-17-97/TJ
nickel	ND	ug/l	6010A	100	09-18-97/MS
silver	ND	ug/l	7761	5	09-17-97/GM
thallium	ND	ug/l	7841	5	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: FIELD BLANK
REIC SAMPLE #: 54714-20

DATE SAMPLED: 09-08-97
MATRIX: LIQUID

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/l	8090	25	09-25-97/JA
2,6-dinitrotoluene	ND	ug/l	8090	15	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	82

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/l	8270B	25	09-21-97/WP
di-n-butyl phthalate	ND	ug/l	8270B	25	09-21-97/WP
resorcinol	ND	ug/l	8270B	25	09-21-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	50
2-fluorobiphenyl	66
p-terphenyl-d14	67

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/l	7041	10	09-16-97/TJ
arsenic	ND	ug/l	7060A	10	09-23-97/TJ
barium	ND	ug/l	6010A	100	09-16-97/MS
beryllium	ND	ug/l	6010A	4	09-18-97/MS
cadmium	ND	ug/l	7131A	1	09-17-97/TJ
chromium	ND	ug/l	7191	10	09-25-97/KC
lead	ND	ug/l	7421	10	09-24-97/KC
mercury	ND	ug/l	7470A	1	09-17-97/TJ
nickel	ND	ug/l	6010A	100	09-18-97/MS
silver	ND	ug/l	7761	5	09-17-97/GM
thallium	ND	ug/l	7841	5	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

ALLIANT SAMPLE #: TRIP BLANK MATRIX: LIQUID
REIC SAMPLE #: 54714-21

SEMIVOLATILE ORGANIC COMPOUNDS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
2,4-dinitrotoluene	ND	ug/l	8090	25	09-25-97/JA
2,6-dinitrotoluene	ND	ug/l	8090	15	09-25-97/JA

<u>Surrogate</u>	<u>% Recovery</u>
tetrachloro-m-xylene	74

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
diethylphthalate	ND	ug/l	8270B	25	09-21-97/WP
di-n-butyl phthalate	ND	ug/l	8270B	25	09-21-97/WP
resorcinol	ND	ug/l	8270B	25	09-21-97/WP

<u>Surrogates</u>	<u>% Recovery</u>
nitrobenzene-d5	46
2-fluorobiphenyl	61
p-terphenyl-d14	34

TOTAL METALS

PARAMETER	RESULT	UNIT	METHOD	PQL	ANALYZED/BY
antimony	ND	ug/l	7041	10	09-16-97/TJ
arsenic	ND	ug/l	7060A	10	09-23-97/TJ
barium	ND	ug/l	6010A	100	09-16-97/MS
beryllium	ND	ug/l	6010A	4	09-18-97/MS
cadmium	ND	ug/l	7131A	1	09-17-97/TJ
chromium	ND	ug/l	7191	10	09-25-97/KC
lead	ND	ug/l	7421	10	09-24-97/KC
mercury	ND	ug/l	7470A	1	09-17-97/TJ
nickel	ND	ug/l	6010A	100	09-18-97/MS
silver	ND	ug/l	7761	5	09-17-97/GM
thallium	ND	ug/l	7841	5	09-17-97/TJ

ND - None Detected at PQL
PQL - Practical Quantitation Limit
* - Silver reported to Method Detection Limit

DATE 9-26-97

APPROVED Joseph Robertson
For Janet M. Satterfield

Ivan W. Leef
Ivan W. Leef

Attachment 4

Risk Tables for Exposure Pathways

**On-site Residential Exposure - Carcinogen
Inhalation of COPCs from Soil Particles
Radford Army Ammunition Plant
Radford, Virginia**

Equations: Intake (mg/kg-day) =
$$\frac{PEF \times IRA_{adj} \times ET \times EF}{AT_c}$$

Risk = Intake x Slope Factor (SF-Chemical Specific)

Hazard Quotient = Intake/Reference Dose (RfD-Chemical Specific)

Variable Abbreviation	Variable	REAMS Default Value	User Defined Value
PEF	Particulate Emission Factor in Air (kg/m3)	1.47E-09	
IRA _{adj}	Inhalation Rate (unitless)	11.66	
ET	Exposure Time (hours/day)	24	
EF	Exposure Frequency (days/year)	350	
AT _c	Averaging Time (period over which exposure is averaged - days)	25,550	

**On-site Resident Exposure - Carcinogen
Ingestion of COPCs in On-site Soils
Radford Army Ammunition Plant
Radford, Virginia**

Equations: Intake (mg/kg-day) =
$$\frac{CS \times IRS_{adj} \times CF \times FI \times EF}{AT_c}$$

Risk = Intake x Slope Factor (SF-Chemical Specific)

Hazard Quotient = Intake / Reference Dose (RfD-Chemical Specific)

Variable Abbreviation	Variable	REAMS Default Value	User Defined Value
CS	Chemical Concentration in Soil (mg/Kg)	~	Chemical Specific*
IRS _{adj}	Ingestion Rate (unitless)	114.29	
CF	Conversion Factor (1.0E-06 kg/mg)	0.000001	
FI	Fraction Ingested from Contaminated Source Residential (unitless)	1.0	
EF	Exposure Frequency (days/year)	350	
AT _c	Averaging Time (period over which exposure is averaged - days)	25,550	

Notes:

* Maximum Detected Concentration

Res-Ingest Soil.

**On-site Resident Exposure - Carcinogen
Dermal Contact with COPCs in Soil
Radford Army Ammunition Plant
Radford, Virginia**

Equations: Absorbed Dose (mg/kg-day) = $\frac{CS \times CF \times SAS_{adj} \times AF \times ABS \times EF}{AT_c}$

Risk = Intake x Slope Factor (SF-Chemical Specific)

Hazard Quotient = Intake / Reference Dose (RfD-Chemical Specific)

Variable Abbreviation	Variable	REAMS Default Value	User Defined Value
CS	Chemical Concentration in Soil (mg/Kg)	~	Chemical Specific*
CF	Volumetric Conversion Factor for Soil (1.0E-06 kg/mg)	0.000001	
SAS _{adj}	Skin Surface Area Available for Contact (cm2/event)	2,290	
AF	Soil Adherence Factor (mg/cm2)	~	1.45 (Given)
ABS	Chemical-specific Absorption Factor (unitless)	~	Chemical Specific**
EF	Exposure Frequency (days/year)	350	
AT _c	Averaging Time (period over which exposure is averaged - days)	25,550	

Notes:

* Maximum Soil Concentration

** Value from "Assessing Dermal Exposure From Soil" (USEPA, 1995)

On-site Residential (Adult) Exposure - Non-carcinogen
Inhalation of COPCs from Soil Particles
Radford Army Ammunition Plant
Radford, Virginia

Equations: Intake (mg/kg-day) =
$$\frac{PEF \times IRA_a \times ET \times EF \times ED}{BW_a \times AT_n}$$

Risk = Intake x Slope Factor (SF-Chemical Specific)

Hazard Quotient = Intake/Reference Dose (RfD-Chemical Specific)

Variable Abbreviation	Variable	REAMS Default Value	User Defined Value
PEF	Particulate Emission Factor in Air (kg/m3)	1.47E-09	
IRA _a	Inhalation Rate (m3/hour)	0.833	
ET	Exposure Time (hours/day)	24	
EF	Exposure Frequency (days/year)	350	
ED	Exposure Duration (years)	30	
BW _a	Adult Body Weight (kg)	70	
AT _n	Averaging Time (period over which exposure is averaged - days)	10,950	

On-site Residential (Child) Exposure - Non-carcinogen
Inhalation of COPCs from Soil Particles
Radford Army Ammunition Plant
Radford, Virginia

Equations: Intake (mg/kg-day) =
$$\frac{\text{PEF} \times \text{IRA}_c \times \text{ET} \times \text{EF} \times \text{ED}}{\text{BW}_c \times \text{AT}_n}$$

Risk = Intake x Slope Factor (SF-Chemical Specific)

Hazard Quotient = Intake/Reference Dose (RfD-Chemical Specific)

Variable Abbreviation	Variable	REAMS Default Value	User Defined Value
PEF	Particulate Emission Factor in Air (kg/m3)	1.47E-09	
IRA _c	Inhalation Rate (m3/hour)	0.5	
ET	Exposure Time (hours/day)	24	
EF	Exposure Frequency (days/year)	350	
ED	Exposure Duration (years)	6	
BW _c	Child Body Weight (kg)	15	
AT _n	Averaging Time (period over which exposure is averaged - days)	2,190	

**On-site Resident (Adult) Exposure - Non-carcinogen
Ingestion of COPCs in On-site Soils
Radford Army Ammunition Plant
Radford, Virginia**

Equations: Intake (mg/kg-day) =
$$\frac{CS \times IRS_a \times CF \times FI \times EF \times ED_a}{BW_a \times AT_n}$$

Risk = Intake x Slope Factor (SF-Chemical Specific)

Hazard Quotient = Intake / Reference Dose (RfD-Chemical Specific)

Variable Abbreviation	Variable	REAMS Default Value	User Defined Value
CS	Chemical Concentration in Soil (mg/Kg)	~	Chemical Specific*
IRS _a	Ingestion Rate - Adult (mg/soil/day)	100	
CF	Conversion Factor (1.0E-06 kg/mg)	0.000001	
FI	Fraction Ingested from Contaminated Source Residential (unitless)	1.0	
EF	Exposure Frequency (days/year)	350	
ED _a	Exposure Duration (years)	30	
BW _a	Adult Body Weight (kg)	70	
AT _n	Averaging Time (period over which exposure is averaged - days)	10,950	

Notes:

- Maximum Detected Concentration

Res-Ingest Soil.

**On-site Resident (Child) Exposure - Non-carcinogen
Ingestion of COPCs in On-site Soils
Radford Army Ammunition Plant
Radford, Virginia**

Equations: Intake (mg/kg-day) =
$$\frac{CS \times IRS_c \times CF \times FI \times EF \times ED_c}{BW_c \times AT_c}$$

Risk = Intake x Slope Factor (SF-Chemical Specific)

Hazard Quotient = Intake / Reference Dose (RfD-Chemical Specific)

Variable Abbreviation	Variable	REAMS Default Value	User Defined Value
CS	Chemical Concentration in Soil (mg/Kg)	~	Chemical Specific*
IRS _c	Ingestion Rate - Child (mg/soil/day)	200	
CF	Conversion Factor (1.0E-06 kg/mg)	0.000001	
FI	Fraction Ingested from Contaminated Source Residential (unitless)	1.0	
EF	Exposure Frequency (days/year)	350	
ED _c	Exposure Duration (years)	6	
BW _c	Child Body Weight (kg)	15	
AT _n	Averaging Time (period over which exposure is averaged - days)	2,190	

Notes:

- Maximum Detected Concentration

Res-Ingest Soil.

**On-site Resident (Adult) Exposure - Non-carcinogen
Dermal Contact with COPCs in Soils
Radford Army Ammunition Plant
Radford, Virginia**

Equations: Absorbed Dose (mg/kg-day) =
$$\frac{CS \times CF \times SA_a \times AF \times ABS \times EF \times ED_a}{BW_a \times AT_n}$$

Risk = Intake x Slope Factor (SF-Chemical Specific)

Hazard Quotient = Intake / Reference Dose (RfD-Chemical Specific)

Variable Abbreviation	Variable	REAMS Default Value	User Defined Value
CS	Chemical Concentration in Soils (mg/Kg)	~	Chemical Specific*
CF	Volumetric Conversion Factor for Soil (1.0E-06 kg/mg)	0.000001	
SA _a	Skin Surface Area Available for Contact (Adult - cm2/event)	~	4,860 (Given)
AF	Soil Adherence Factor (mg/cm2)	~	1.45 (Given)
ABS	Chemical-specific Absorption Factor (unitless)	~	Chemical Specific**
EF	Exposure Frequency (days/year)	350	
ED _a	Exposure Duration (years)	30	
BW _a	Adult Body Weight (kg)	70	
AT _n	Averaging Time (period over which exposure is averaged - days)	10,950	

Notes:

* Maximum Soil Concentration

** Value from "Assessing Dermal Exposure From Soil" (USEPA, 1995)

**On-site Resident (Child) Exposure - Non-carcinogen
Dermal Contact with COPCs in Soils
Radford Army Ammunition Plant
Radford, Virginia**

Equations: Absorbed Dose (mg/kg-day) =
$$\frac{CS \times CF \times SA_c \times AF \times ABS \times EF \times ED_c}{BW_c \times AT_n}$$

Risk = Intake x Slope Factor (SF-Chemical Specific)

Hazard Quotient = Intake / Reference Dose (RfD-Chemical Specific)

Variable Abbreviation	Variable	REAMS Default Value	User Defined Value
CS	Chemical Concentration in Soil (mg/Kg)	~	Chemical Specific*
CF	Volumetric Conversion Factor for Soil (1.0E-06 kg/mg)	0.000001	
SA _c	Skin Surface Area Available for Contact (Child - cm2/event)	1,875	
AF	Soil Adherence Factor (mg/cm2)	~	1.45 (Given)
ABS	Chemical-specific Absorption Factor (unitless)	~	Chemical Specific**
EF	Exposure Frequency (days/year)	350	
ED _c	Exposure Duration (years)	6	
BW _c	Adult Body Weight (kg)	15	
AT _n	Averaging Time (period over which exposure is averaged - days)	2,190	

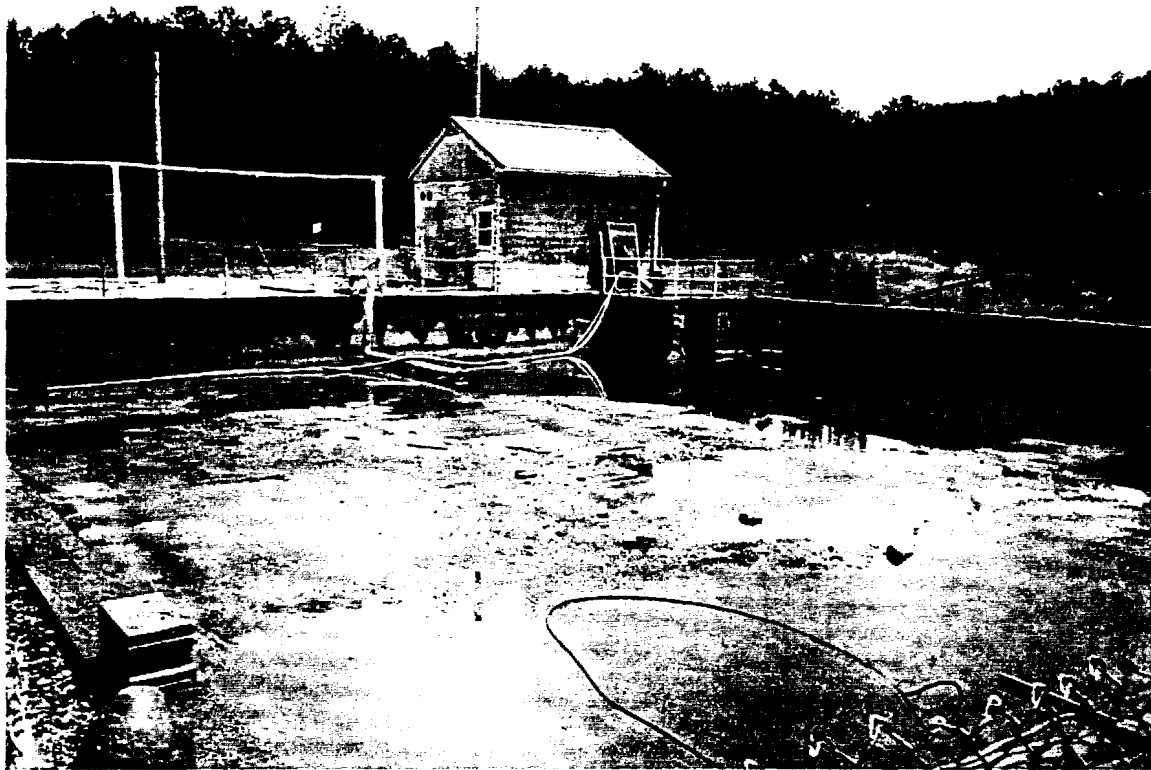
Notes:

* Maximum Soil Concentration

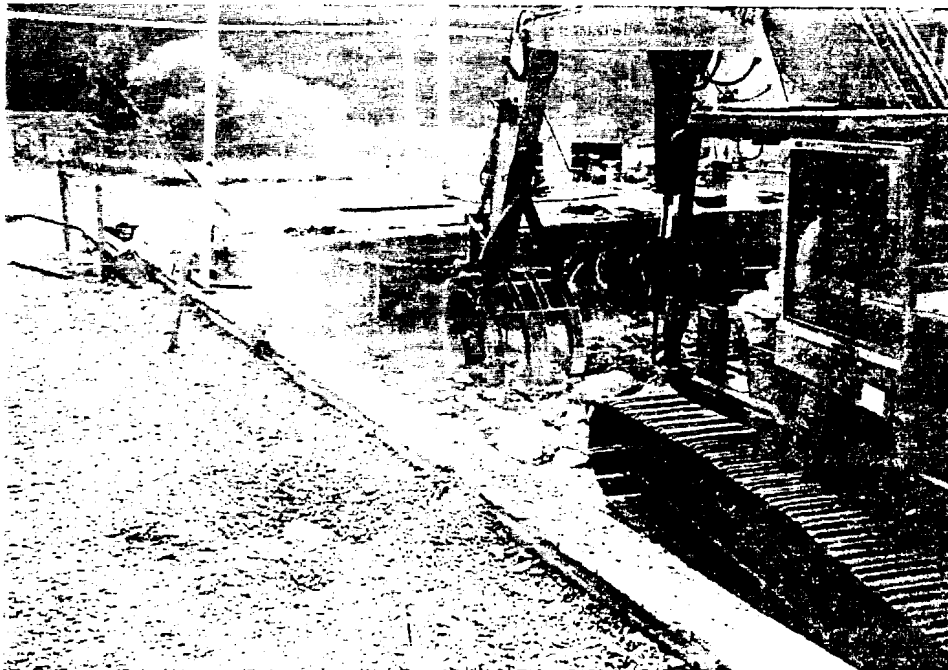
** Value from "Assessing Dermal Exposure From Soil" (USEPA, 1995)

Attachment 5

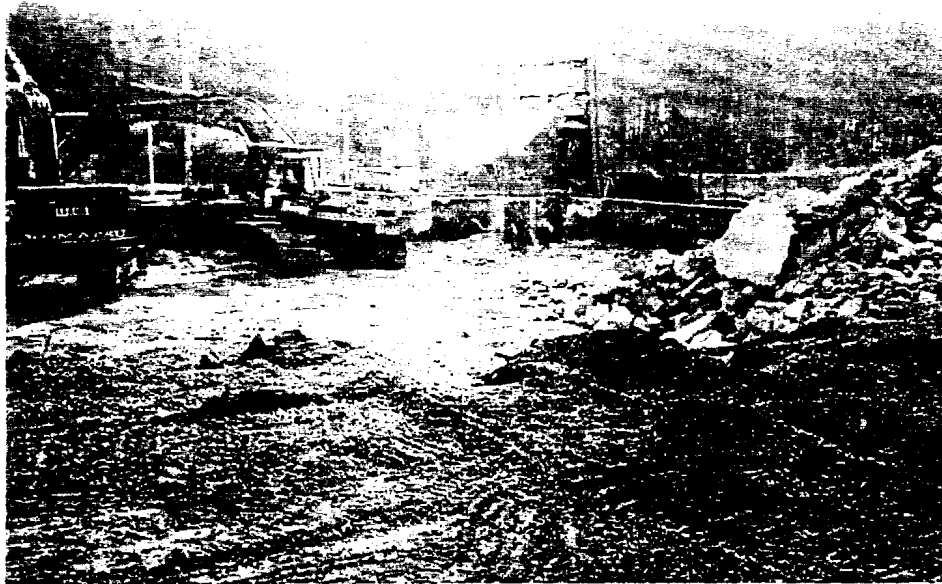
Photographs



Photograph 1: Incinerator Spray Pond (ISP) with metal piping removed.



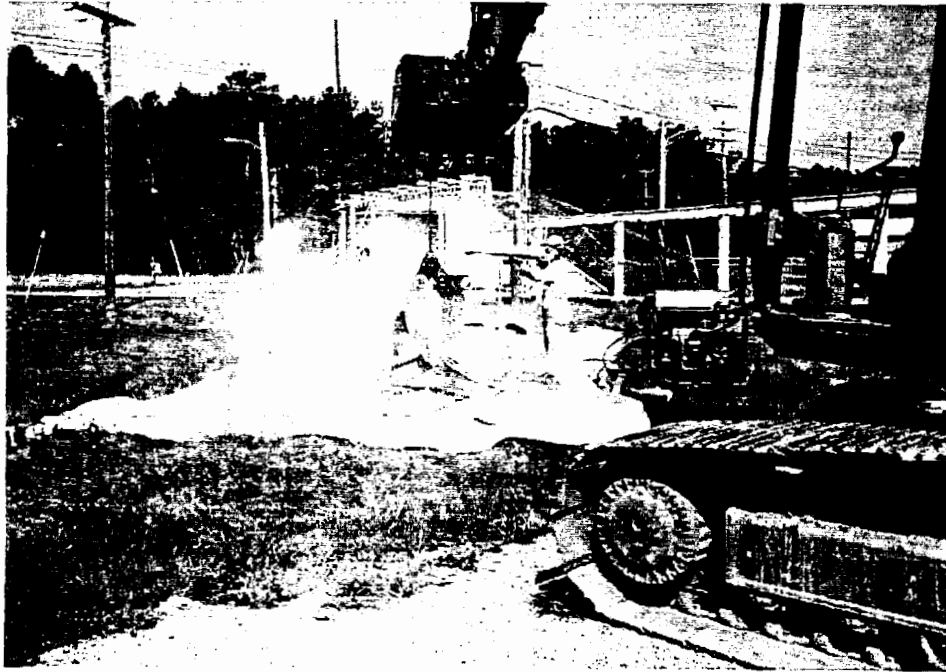
Photograph 2: Removal of the concrete base of the ISP.



Photograph 3: Concrete removal from the ISP.



Photograph 4: ISP following concrete demolition and removal. Notice the red flags designating grid sample locations.



Photograph 5: Decontamination or excavation equipment.



Photograph 6: Additional excavation of approximately 18 inches of soil from the bottom of the original ISP excavation.



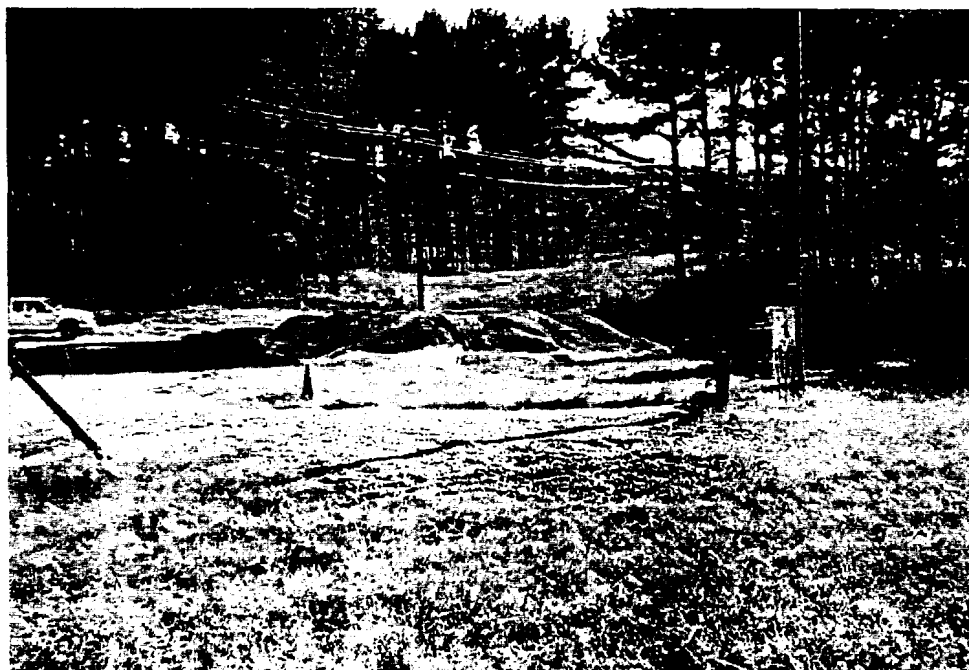
Photograph 7: Continued excavation of approximately 18 inches of soil from the ISP.



Photograph 8: ISP following the completion of excavation activities.



Photograph 9: Staging excavated material on plastic.



Photograph 10: Covering excavated soil at staging area with plastic