REPORT DOCUMENTATION PAGE

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Dave Cobb, Jonathan Myers

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100 Technology Center Drive
Stoughton, MA 02072

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14. ABSTRACT

The Final Quality Control Plan for the Geochemical Evaluation of Metals in Groundwater at Ravenna Army Ammunition Plant, Ravenna, Ohio summarizes the quality control methods that will be used to support the geochemical evaluation of metals in groundwater. It was prepared in accordance with the requirements included in the contract award.

15. SUBJECT TERMS
Draft Quality Control Plan for the Geochemical Evaluation of Metals in Groundwater at Ravenna Army Ammunition Plant, Ravenna, Ohio

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			David Cobb
Unclassified	Unclassified	Unclassified	UL	28	19b. TELEPHONE NUMBER *(Include area code)* 617.589.5561

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3. DATES COVERED. Indicate the time during which the work was performed and the report was written, e.g., Jun 1997 - Jun 1998; 1-10 Jun 1996; May - Nov 1998; Nov 1998.

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14. ABSTRACT. A brief (approximately 200 words) factual summary of the most significant information.

15. SUBJECT TERMS. Key words or phrases identifying major concepts in the report.

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Final Quality Control Plan for the Geochemical Evaluation of Metals in Groundwater at Ravenna Army Ammunition Plant, Ravenna, Ohio
Version 1.0

Ravenna Army Ammunition Plant
Ravenna, Ohio

Contract No. W912QR-08-D-0013
Delivery Order 0006

Prepared for:

US Army Corps of Engineers ®
Louisville District
600 Martin Luther King, Jr. Place
Louisville, Kentucky 40202

Prepared by:

Shaw Environmental & Infrastructure, Inc.
100 Technology Center Drive
Stoughton, MA 02072

May 26, 2010

DOCUMENT DISTRIBUTION

Name/Organization	Number of Printed Copies	Number of Electronic Copies
RVAAP Facility Manager	2	2
USACE – Louisville District	3	3
USAEC Program Manager	0	1
Shaw Project Manager	3	3

RVAAP – Ravenna Army Ammunition Plant
USACE – U.S. Army Corps of Engineers – Louisville District
USAEC – U.S. Army Environmental Command

CONTRACTOR'S STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Shaw Environmental, Inc. has completed the *Final Quality Control Plan for the Geochemical Evaluation of Metals in Groundwater at Ravenna Army Ammunition Plant, Ravenna, Ohio*. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy, principles, and procedures, utilizing justified and valid assumptions, was verified. This included review of technical assumptions; methods, procedures and materials to be used; and whether the product meets customer's needs consistent with law and existing Corps policy.

Reviewed/Approved by:  Date: May 26, 2010

David Cobb
Project/Program Manager

Prepared/Approved by:  Date: May 26, 2010

Jonathan Myers, PhD.
Senior Environmental Engineer

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Acronyms and Abbreviations

COR	Contracting Officer's Representative
DO	Dissolved Oxygen
ITR	Independent Technical Review
Ohio EPA	Ohio Environmental Protection Agency
ORP	Oxidation-Reduction Potential
PDF	Portable Document Format
POC	Point of Contact
QA	Quality Assurance
QC	Quality Control
QCP	Quality Control Plan
RAB	Restoration Advisory Board
RVAAP	Ravenna Army Ammunition Plant
Shaw	Shaw Environmental & Infrastructure, Inc.
SOW	Scope of Work
TAL	Target Analyte List
USACE	U.S. Army Corps of Engineers
WP	Work Plan

1.0 Introduction

Under Contract No. W912QR-08-D-0013, Delivery Order 0006, the Louisville District U.S. Army Corps of Engineers (USACE) contracted Shaw Environmental & Infrastructure, Inc. (Shaw) to conduct a geochemical evaluation of metals in groundwater at the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio. The geochemical evaluation is necessary to determine if elevated concentrations of detected metals in groundwater are naturally occurring or chemicals of concern. This *Final Quality Control Plan for the Geochemical Evaluation of Metals in Groundwater at Ravenna Army Ammunition Plant, Ravenna, Ohio* (QCP) has been prepared as required by the Scope of Work (SOW), as well as to support the work required under the SOW.

1.1 Project Objective

The objective of this project is to characterize the naturally occurring background distributions of 23 elements in groundwater at RVAAP on a facility-wide basis. The site-specific geochemical and hydrogeological processes controlling the concentrations of elements in groundwater at the facility will also be identified. This information will be useful in future groundwater investigations for properly distinguishing between naturally occurring concentrations versus impact from contamination related to site activities. The approach is based on screening and evaluating Army-provided laboratory analytical results from previously conducted comprehensive site-wide groundwater sampling events involving at least 237 wells.

1.2 Document Organization

The balance of this document is organized as follows:

- Section 2.0 - Project Management
- Section 3.0 - Quality Control Plan
- Section 4.0 - Work Plan for Geochemical Evaluation
- Section 5.0 - Implementation of Work Plan
- Section 6.0 - Geochemical Evaluation Report
- Section 7.0 - Quality Assurance/Quality Control Review
- Section 8.0 - Project Schedule and Milestones
- Section 9.0 - Documentation of Project Records
- Section 10.0 - Project Close Out
- Section11.0 – References

2.0 Project Management

Shaw has assigned Mr. David Cobb as Project Manager for this project. Mr. Cobb is qualified to oversee all work described in the SOW and he will serve as the single point of contact (POC) and liaison for all work required. Mr. Cobb will be supported on this project by Dr. Jonathan Myers (Project Geologist) and Mr. Steven Jones (Quality Control Manager). Contact information for Shaw's key project personnel is listed below in **Table 2-1**.

Table 2-1
Shaw Key Project Personnel

Contact	Address	Phone	Email
David Cobb	100 Technology Center Drive Stoughton, MA 02072	Office: (617)589-5561 Mobile: (508) 667-3608	dave.cobb@shawgrp.com
Dr. Jonathan Myers	2440 Louisiana Blvd. NE, Suite 300 Albuquerque, NM 87110	Office: (505) 262-8726	jonathan.myers@shawgrp.com
Steven Jones	5050 Section Avenue Cincinnati, OH 45212	Office: (513) 782-4655	steven.s.jones@shawgrp.com

The following activities and deliverables will be performed in support of this project:

- Monthly progress reports
- Records of conversations
- Teleconference progress updates
- Meeting minutes documentation
- Public involvement / Restoration Advisory Board (RAB) meetings

The above activities will be conducted by Shaw to achieve project execution and maintain communication with the USACE. These activities are discussed in further detail below.

2.1 Monthly Progress Reports

Shaw will submit monthly written progress reports to the USACE POC for every month by the fifth (5th) day of the following month. The monthly reports will include an accurate and current account of all work completed and deliverables furnished to the RVAAP stake holders. With respect to this SOW, we anticipate each monthly progress report will consist of a paragraph or two of general project progress information and an updated schedule. The form of the report will

be consistent with the previous reports submitted by Shaw on other RVAAP projects and will include discussions on any quality control (QC) issues identified during the period of performance covered by the report. The monthly reports will be consistent with the requirements presented in the *Director's Final Findings and Orders, Ravenna Army Ammunition Plant (Ohio EPA, 2004).*

2.2 Records of Conversations

Shaw will prepare and maintain records of telephone conversations and significant verbal conversations conducted in support of this project. These records will be forwarded with monthly progress reports to the extent necessary.

2.3 Teleconference Progress Updates

Mr. Cobb currently attends biweekly teleconference progress meetings with RVAAP and USACE as part of his project management responsibilities under other RVAAP projects. The purpose of these meetings is to provide project status updates on ongoing RVAAP projects and discuss project execution and scheduling issues. A brief update on this project's status will be included as part of this call going forward.

2.4 Meeting Minutes Documentation

Shaw will take minutes at all meetings (with the exception of the biweekly scheduling calls hosted by RVAAP) held in support of this project. Meeting minutes will be typed and distributed to the USACE and respective POC within 7 calendar days following the meeting. To ensure accuracy, the meeting minutes will be submitted in draft format for review and comment by USACE (when applicable) before being issued as final.

2.5 Document Preparation

Reports will be submitted in electronic and printed format in accordance with the latest version of the *Ravenna Army Ammunition Plant Submission Format Guidelines* (Vista Sciences Corporation, 2009).

Final Reports will be provided in electronic format for posting to the Ravenna Environmental Information Management System. The final electronic document will be a text-searchable Adobe® Acrobat® Portable Document Format (PDF) file and will be accompanied by defined metadata for upload into the Army Repository of Environmental Documents. The final report will also be submitted on Compact Disc/Digital Versatile Disc in Microsoft® Word® and Microsoft® Excel®.

2.6 Public Involvement/Restoration Advisory Board Meetings

RVAAP has an active RAB. When requested by USACE, Shaw will present the findings of the geochemical evaluation during a RAB meeting selected by the Army. At present, Shaw is expected to only attend one RAB meeting under this contract. If requested, Shaw will also assist in the preparation for the RAB meeting by attending a pre planning meeting to go through Shaw's presentation to ensure the information included meets the expectations of the stakeholders.

3.0 Quality Control Plan

Shaw has prepared this QCP in accordance with requirements of ER 1110-1-12, *Engineering and Design - Quality Management* (USACE, .2006)

An independent technical review (ITR) of all deliverables will be performed to confirm the proper application of established guidance and regulations. A certification statement will be included with all products submitted to the Government under this project. The statement will be signed by the independent technical reviewer(s), stating that they have reviewed the applicable document or product and that all internal comments have been resolved, thus completing the product for release to the Government. Per the SOW, the QCP will be issued as Draft and Final for review and approval by the USACE only.

4.0 Work Plan for Geochemical Evaluation

Shaw will develop a work plan (WP) that outlines the techniques and methodologies that will be used in performing the geochemical evaluation. The WP will be based on the assumption that 237 facility wells will be sampled and analyzed for both filtered and unfiltered Target Analyte List (TAL) metals, and may include similar data obtained from the 6 newly installed deeper wells for evaluation. In addition, any field parameter data provided to Shaw (pH, temperature, dissolved oxygen [DO], Oxidation-Reduction Potential [ORP], turbidity, etc.) will also be reviewed.

Shaw will not be performing the well sampling services or laboratory analysis for this project. Field related activities will be conducted by others. Older, existing groundwater analytical data may be used for conducting the geochemical evaluation; however, the evaluation will focus on the newly acquired data (to be acquired in October 2009) for this study. Data provided to Shaw will be determined by USACE. Shaw will also not be responsible for validating any data provided by the Army. The Army will be responsible for validating all data provided for the geochemical evaluation before being delivered to Shaw.

The WP document will discuss how background concentrations for elements will be established. The WP will present the geochemical evaluation process, which includes the data screening process to be used in extracting background distributions from RVAAP's current groundwater analytical data, including the use of statistical methods, geochemical correlation and ratio plots. If an alternate form of study is anticipated for RVAAP to achieve the geochemical evaluation, then the WP will address the use of the alternate technology.

Shaw will submit a Preliminary Draft WP to the USACE within 30 days of contract award. Upon receipt of USACE comment responses, Shaw will submit a Draft WP for stakeholder review and approval. Shaw will submit the Final WP within 30 calendar days of receipt of Ohio EPA comments. Schedules specified by the Ohio EPA will take precedence over the USACE schedule. Army approval of the Final WP is achieved through the Contracting Officer Representative (COR).

5.0 Implementation of the Work Plan

Following the Final WP approval, Shaw will implement the WP. The Microsoft Access groundwater analytical database will be inspected by Shaw upon receipt to verify that the laboratory analytical results and field parameter data are complete. The laboratory data should include analyses of the 23-element target analyte list for filtered and unfiltered splits of each groundwater sample. Reporting limits, method detection limits, and QC flags should be included for each result. The field parameters present for each sample should include temperature, turbidity, specific conductivity, pH, DO, and ORP.

After the database has been determined by Shaw to be complete, the data will be converted from the database format to a cross-tabulation spreadsheet format to facilitate evaluation. In an effort to reduce human error and improve quality control, data will be manipulated in a manner that avoids hand-entry where ever possible. In the event that the data need to be hand entered, such entries will be checked by a person other than the enterer. Processes used to electronically manage blocks of data that do not change code, formula, mathematical, or query operations will be verified. Examples of these processes include the following:

- Importing or exporting data from one software program to another
- Cutting/pasting blocks of data
- Rearranging columns or rows of data

Data verification will focus upon the data management activities to ensure that data have not been changed or compromised and that the location of the data is as intended. Verification will ensure that information is not unexpectedly truncated, wrapped, or otherwise changed. The identification of potential problems in the process should be performed so that check points can be established. Depending upon the application, verification of a representative sample of the data may be performed.

Data evaluation will be aided by the use of industry-standard software, including Access, Excel, Statistica, ProUCL, and Crystal Ball for purposes of performing statistical tests (e.g., outlier identification, Wilcoxon rank sum tests, Kruskal Wallis tests); generation of probability, correlation, and ratio plots; and calculation of summary statistics. Verification of the software application results will be performed to ensure that the software is performing as expected. This check shall verify that the mathematics, codes, formulas, queries, and relational links used are correct and functioning as intended. This verification may be accomplished by a variety of methods to include the following:

- Comparison of inputs/outputs to a known data set

- Review of results from a dummy set of data
- Comparison of results to hand calculations
- Check of formulas or codes embedded in a spreadsheet
- Comparison of actual outputs to known outputs

Documentation of the original, signed verification records and their updates or revisions shall be retained in the project file.

The draft report will be reviewed by a qualified staff member to ensure that the conclusions are valid and logically follow from the available data. The assigned Reviewer shall have knowledge of the technical area being reviewed. The Reviewer shall examine the work products, then sign (or initial) and date those work products found to be satisfactory.

In the event that the data in question are part of the package provided to Shaw by USACE, Shaw will contact USACE to discuss possible corrective measures needed to address data quality issues.

6.0 Geochemical Evaluation Report

Shaw will prepare a written report documenting the geochemical evaluation of the groundwater data. At a minimum, the report will include the following information:

- Documentation of the techniques and methodologies used in the geochemical evaluation.
- Elemental correlation plots showing relationships between selected trace and major elements in the groundwater samples.
- Complete statistical descriptions of the distributions of background concentrations for each of the 23 elements. The fully screened background data will also be provided in electronic format.
- Discussion of the occurrences of inorganic contamination in the rejected samples. This discussion may be useful to form the basis for a petition to eliminate certain elements and/or wells from long-term monitoring programs or future remediation programs at the RVAAP if it can be demonstrated that some elements are not contaminants or if no contamination is present at some wells.
- A general discussion of possible site-specific remediation alternatives that may effectively remediate metals in groundwater at the facility.

The Preliminary Draft Report is due for submittal on or before 30 May 2010. Upon receipt of Army comment responses, Shaw will prepare and submit a Draft Report for stakeholder review and approval. Shaw will submit the Final Report within 30 calendar days of receipt of Ohio EPA comments. Schedules specified by the Ohio EPA will take precedence over the USACE schedule. USACE approval is achieved through the COR.

7.0 Quality Assurance/Quality Control Review

This section of the QCP summarizes the Shaw internal technical and external peer review. The Shaw quality assurance (QA) program provides controls for the formal verification (checking) of documents such as calculations and the presentation of information in the form of drawings, logs, and tables. Necessary approvals are also cited for quality-related documents; however, during the course of a project or proposal, verification of technical decisions and concepts (such as interpretation of data and evaluation of results) is required in order that the project or proposal can proceed on a sound conceptual basis. The review concept, or approach, may be needed for the following:

- During the project planning stage, have appropriate steps been implemented to satisfy the goals and objectives of the project?
- Are data of sufficient quality and properly interpreted so that conclusions can be justified and demonstrated?
- Are design parameters reasonable for the computations performed? What is the effect of variations of the assumptions upon the results?
- Do the results presented by Shaw in the form of a report, or other document, adequately represent the work performed and the conclusions reached? Do the results fulfill the objectives of the project?

The internal technical review process is used to verify these steps. Documents to be written during a project and indicated in the proposal will be subjected to peer review. The Shaw PM will complete a matrix of these documents on a delivery order basis and use it to obtain the required reviews.

A technical reviewer is selected based upon the following criteria:

- The reviewer must be independent of the project. The reviewer must be sufficiently informed regarding the project, but should not be making decisions that determine or affect the course of the project. The peer review process is an "outside" review of the project.
- The reviewer must be a person knowledgeable in the specific area of work, preferably a senior technical associate. Technical reviewers will be part of the Shaw organization.

At the conclusion of a technical peer review, the reviewer(s) will prepare written review comments and forward it to the PM; a copy of these review documents will also be placed in the project files. Technical review comments will be responded to in writing by the preparer of the

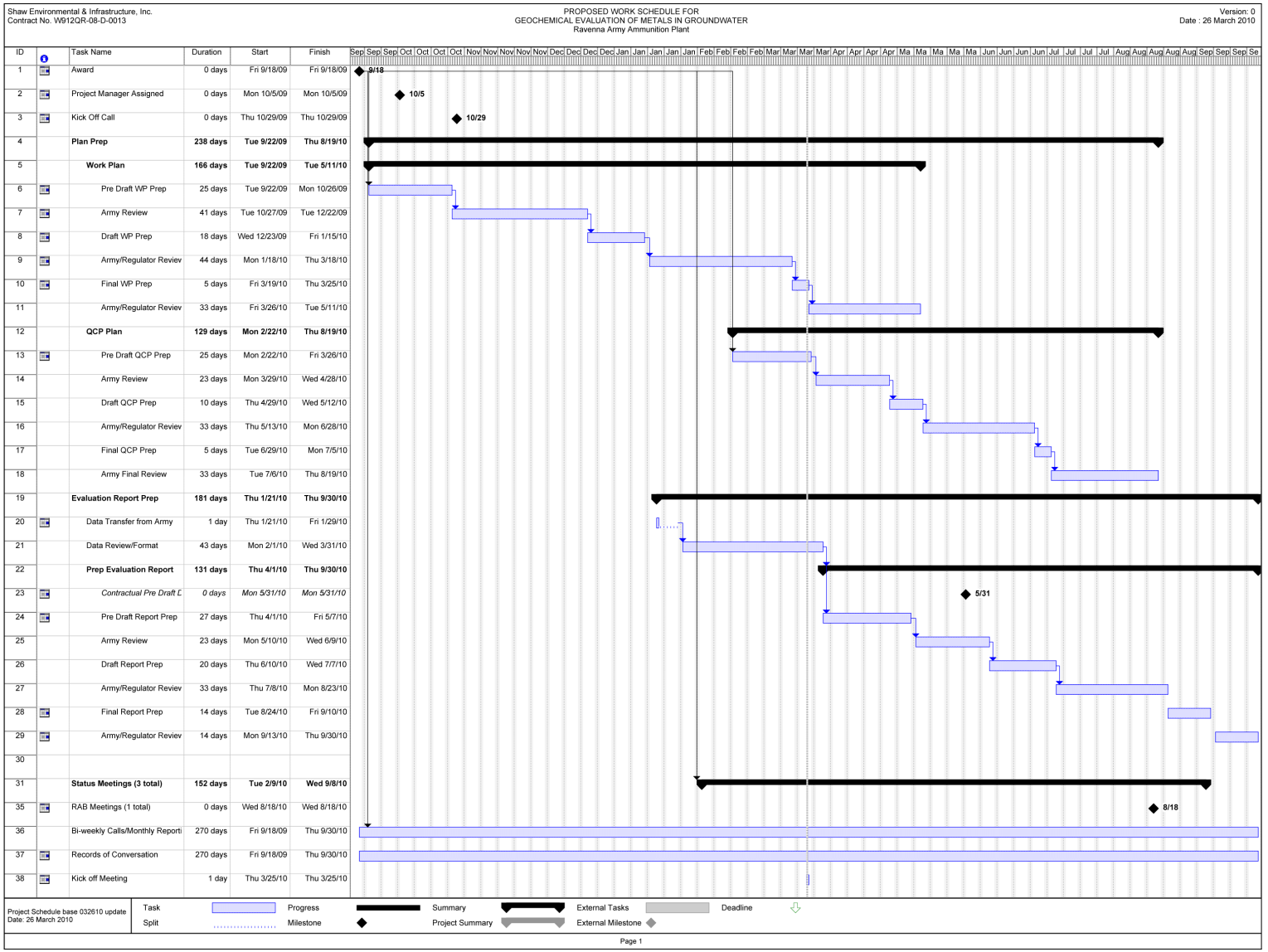
document, incorporated into the document as appropriate, and submitted with the document to the USACE.

External peer review will be performed on all draft project deliverables prior to issuance as final documents. It is anticipated that the external peer review will be performed, at a minimum, by the USACE. A formal response to peer review comments will be issued to all reviewing parties, documenting revisions made where appropriate to the draft deliverables; this does NOT apply to the Report of Finding prepared under this delivery order. All responses to the peer review comments will be coordinated with the USACE for their concurrence prior to incorporation. Final deliverables will be submitted after incorporating any pertinent comments that arise from peer review of the draft documents.

8.0 Project Schedule and Milestones

The project schedule and milestones are presented in **Figure 8-1**.

Figure 8-1
Project Schedule



9.0 Documentation of Project Records

The Shaw Project Records Clerk is responsible for maintaining control and retention for project-related records. Record control includes receipt from external and internal sources, transmittal, transfer to storage, and indication of record status. Retention includes receipt at storage areas, indexing and filing, storage and maintenance, and retrieval. Shaw will maintain the project repositories at its Randolph, Massachusetts office for all project records, including correspondence. Records will be controlled and retained, as appropriate, in the office central files or laboratory files. The Project Records Clerk will assign control numbers to all outgoing documents and is responsible for properly filing the controlled records (except for those related to accounting, purchasing, and drafting, which are retained in the respective department files). If requested, Shaw will provide the USACE Louisville District with a copy of all telephone memos, written correspondence, and meeting minutes regarding information related to the project within 10 days of the event required per the contract. Copies of all records will be retained by Shaw for a minimum of 7 years after the end of the contract period. In addition, project records deemed to be of importance by the USACE will be turned over to the USACE at the time of project close-out.

10.0 Project Close Out

At the completion of this evaluation, a project close-out meeting will be conducted. This will be at a time and place to be determined by Louisville District personnel, and may take the form of a teleconference. The purpose of this meeting will be to exchange feedback, discuss lessons learned, and conduct a final product verification.

11.0 Bibliography

Ohio Environmental Protection Agency (Ohio EPA), 2004, *Director's Final Findings and Orders, Ravenna Army Ammunition Plant*, June 10.

United States Army Corps of Engineers (USACE), 2006, *Engineering and Design - Quality Management*, ER 1110-1-12, September 30.

U.S. Environmental Protection Agency (EPA), 1997, *The Lognormal Distribution in Environmental Applications*, Technical Support Center Issue, EPA/600/R-97/006, December.

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Vista Sciences Corporation, 2009, *Ravenna Army Ammunition Plant Submission Format Guidelines*, Version 18.0, Ravenna, Ohio, December 21.