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Final Work Plan

Centredale Manor Shaker Study for Allendale and Lyman Mill Ponds

Centredale Manor Restoration Project Superfund Site North Providence, Rhode Island

Final Work Plan
Shaker Study for Allendale and Lyman Mill Ponds
Centredale Manor Restoration Project Superfund Site

Prepared for:

U.S. Army Corps of Engineers, New England District

December 15, 2004

Prepared by

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INTRODUCTION

This work plan is based on the scope of work provided by the U.S. Army Corps of Engineers (COE) dated October 15, 2004. This work will be performed under Task Order No. 01 for Contract No. DACW33-01-D-0004, *Centredale Manor Restoration Project Superfund Site*. Data collection will be conducted at the Centredale Manor Restoration Project (CMRP) site in North Providence, Rhode Island. Sediment cores will be collected from Allendale and Lyman Mill Ponds and analyzed onsite using a shaker device. The test results will be used to determine site-specific sediment erosion parameters. These site-specific parameters will be used to reduce uncertainty associated with the sediment stability analysis presented in the *Final Technical Memorandum, Sediment Stability Study* (November 2004). The shaker study will be conducted in accordance with the following documents:

> *Final Quality Assurance Project Plan Addendum, Interim Data Collection, Centredale Manor Restoration Project Site* (QAPP Addendum; September, 2002), as modified in the Errata Sheet (November, 2002).
>
> *Final Health and Safety Plan for the Human Health and Ecological Risk Assessment for the Centredale Manor Restoration Project Superfund Site* (HASP; May, 2002).

Shaker study data collection and analysis details are provided below.

SHAKER STUDY DATA COLLECTION

Laboratory flume experiments have determined the dependence of cohesive sediment resuspension on the applied shear stress and water content or time after deposition. Determining the site-specific resuspension properties of cohesive sediments, however, is accomplished using a portable device called a shaker (Tsai and Lick, 1986; Lick et al., 1995). The basic shaker consists of a cylindrical tube inside of which a horizontal grid oscillates vertically (Figure 1). The grid oscillates in the water and creates turbulence which penetrates down to the sediment-water interface and causes the sediment to resuspend. The turbulence and, hence, the amount of sediment resuspended is proportional to the frequency of the grid oscillation. It can be shown that the results from the shaker are a reasonably accurate estimate of sediment resuspension as a function of applied shear stress for a wide range of conditions (Lick et al., 1995).

Only a finite amount of material can be resuspended from a fine-grained, cohesive sediment bed that is exposed to a constant bottom shear stress. This phenomenon, referred to as bed armoring, has been observed and quantified in a number of laboratory (Parchure and Mehta, 1985; Tsai and Lick, 1987; Graham et al., 1992) and field studies (Hawley, 1991; Amos et al., 1992). The amount of fine-grained sediment resuspended from cohesive deposits is given by the Lick equation (Ziegler and Nisbet 1994):

$$\varepsilon = A \left(\tau / \tau_{cr} - 1 \right)^{n} \qquad (1)$$

where ε is resuspension potential (i.e., mass eroded per unit area); τ is bottom shear stress; and τ_{cr} is critical bottom shear stress. The site-specific parameters (i.e., A and n) in Equation (1) are determined from an analysis of the shaker data.

Sediment cores will be collected from 10 locations each in Allendale and Lyman Mill Ponds (Figures 2 and 3), and subjected to sediment erosion testing in the shaker. The core locations are distributed throughout each pond so as to capture any potential large-scale spatial variations in resuspension properties. Since detailed bed-type maps are not currently available for the two ponds, it is possible that some of the proposed shaker core locations have been placed in areas of noncohesive (sandy) sediment. The shaker is not designed to test sandy sediments. Thus, if a sandy bed is encountered at a coring location, then the field personnel will use best professional judgment to choose another location, which has a cohesive (muddy) bed, in the vicinity of the original core location. The actual location of each core will be determined and recorded using a hand-held Global Positioning System (GPS) device. The GPS unit will have a horizontal accuracy of 2-3 m; this level of accuracy is adequate for the study.

One shaker core will be collected at each location in the two ponds. Coring tubes that have a 5-inch diameter and are a minimum of 12-inches long will be used. These coring tubes are made of clear plexiglass and are reusable. The coring tubes are attached to a push-core apparatus equipped with a check valve. The cores are obtained by manually pushing the core tube into the sediment. After pushing the core into the sediment bed, the core must be retrieved gently enough such that the sediment-water interface is undisturbed. A rubber stopper will be placed in the bottom of the core tube prior to the point when the bottom of the core tube breaks the surface of the water to retain the sediment in the core tube. A minimum of approximately 4 inches of sediment should be in each core, and there must be a minimum of 4 inches of water in the core tube above the sediment. The sediment surface within the core should be as level as possible. The maximum acceptable deviation in surface height across the sediment is 0.5 inch. Cores that do not meet these criteria will be discarded, and a new sample will be collected until an acceptable core is obtained. Cores will be transported to the onsite shaker test areas near Allendale and Lyman Mill Dams, in an upright position, without disturbing the surficial sediment.

Each core will be tested in the shaker using this procedure:

1. On a data sheet (Attachment 1), record the core number, GPS coordinates of the core location, and the date of core collection.
2. Measure the sediment height at four equally-spaced locations around the core (i.e., every 90 degrees around the core). Calculate the average height of the sediment-water interface and record it on the data sheet for this core.
3. Remove water that is overlying the sediment in the core until the water depth is 3 inches above the average sediment height. Use a syringe to remove the water. Do this gently so that the sediment is undisturbed.
4. Collect a water sample for determining the initial total suspended solids (TSS) concentration in the core water by withdrawing 50 mL of water. Use a syringe to collect the water sample by placing the end of a piece of flexible tubing (attached to the tip of the syringe) in the center of the coring tube and about 1 cm below the water surface. Place the sample in the appropriate TSS sample bottle and label the bottle. Rinse the syringe and tubing with distilled water between uses.
5. Record a visual description of the sediment core on the data sheet.
6. Place the core in the shaker. Adjust the stroke of the oscillating grid so that the lower surface of the grid is 1 inch above the average sediment height when the grid is at the bottom of its stroke.
7. Run the shaker test using this sequence of effective shear stresses: 0.3, 0.5 and 0.9 Pa. The relationship between effective shear stress and shaker oscillation period and frequency is given in Table 1.

8. Run the shaker at 0.3 Pa (188 rpm) for 10 minutes. At the end of the 10-minute period, collect a 25 mL sample of water using the sampling tube and syringe. Place the sample in the appropriate TSS sample bottle and label the bottle. Rinse the syringe and tubing with distilled water.
9. Increase the shaker shear stress to 0.5 Pa (250 rpm) and run for 10 minutes. At the end of the 10-minute period, collect a 25 mL sample of water using the sampling tube and syringe. Place the sample in the appropriate TSS sample bottle and label the bottle. Rinse the syringe and tubing with distilled water.
10. Increase the shaker shear stress to 0.9 Pa (400 rpm) and run for 10 minutes. At the end of the 10-minute period, collect a 25 mL sample of water using the sampling tube and syringe. Place the sample in the appropriate TSS sample bottle and label the bottle. Rinse the syringe and tubing with distilled water.
11. After the shaker test is completed, discard the core water and sediment in the 55-gallon drum designated for investigation-derived waste (IDW). Clean the core tube and stopper with a scrub brush and water to remove all visible sediment prior to reuse. Discard used wash water in the 55-gallon drum.

Table 1. Relationship Between Shear Stress and Shaker Period/Frequency

Effective Shear Stress (Pa)	Shaker Oscillation Period (s)	Shaker Oscillation Frequency (rpm)
0.3	0.32	188
0.5	0.24	250
0.9	0.15	400

SAMPLE ANALYSIS

Each of the samples will be analyzed for TSS concentration by Northeast Analytical, Inc. (NEA), located in Schenectady, NY. NEA is certified by the New York State Department of Health (NYSDOH) and participates in the Environmental Laboratory Approval Program (ELAP) which is, in turn, a member of the National Environmental Laboratory Approval Council Program (NELAP). Proficiency samples for potable water, non- potable water, solid, and hazardous waste are analyzed on a quarterly basis within the ELAP/NELAP Program. NEA adheres to the strict QA/QC program outlined in the ELAP/NELAP manual. Northeast Analytical, Inc. uses methods of analysis that conform to protocols approved by NYSDOH ELAP/NELAP or when applicable, standard methods such as those published by EPA, ASTM, and NIOSH for analysis of samples.

Wastes from the project will be treated as routine laboratory waste, unless notified otherwise in writing from USEPA. A field duplicate sample will not be collected.

DATA ANALYSIS AND REPORTING

Data collected during the shaker tests, i.e., TSS concentration, are analyzed using the following approach. First, the TSS concentration (g/cm^3) is converted to resuspension potential (g/cm^2) by multiplying by the water depth (i.e., 7.6 cm or 3 inches). Next, resuspension potential (ε) is plotted versus effective shear stress (τ) on a log-log plot. A log-linear regression is performed on the correlation between $\log(\varepsilon)$ and $\log(\tau)$:

$$\log(\varepsilon) = n\log(\tau) + \log(A) \qquad (2)$$

to determine the site-specific parameters in the Lick equation, i.e., A and n. An example of this type of analysis for cohesive sediment collected within Watts Bar Reservoir on the Tennessee River is shown on Figure 4 (Ziegler and Nisbet 1995).

Shaker study test results will be included in the Sediment Stability Phase 2 letter report, which will briefly describe the methods and results of the sampling effort. The Sediment Stability Phase 2 letter report will include refined sediment stability analyses based on the site-specific values of A and n for Allendale and Lyman Mill Ponds.

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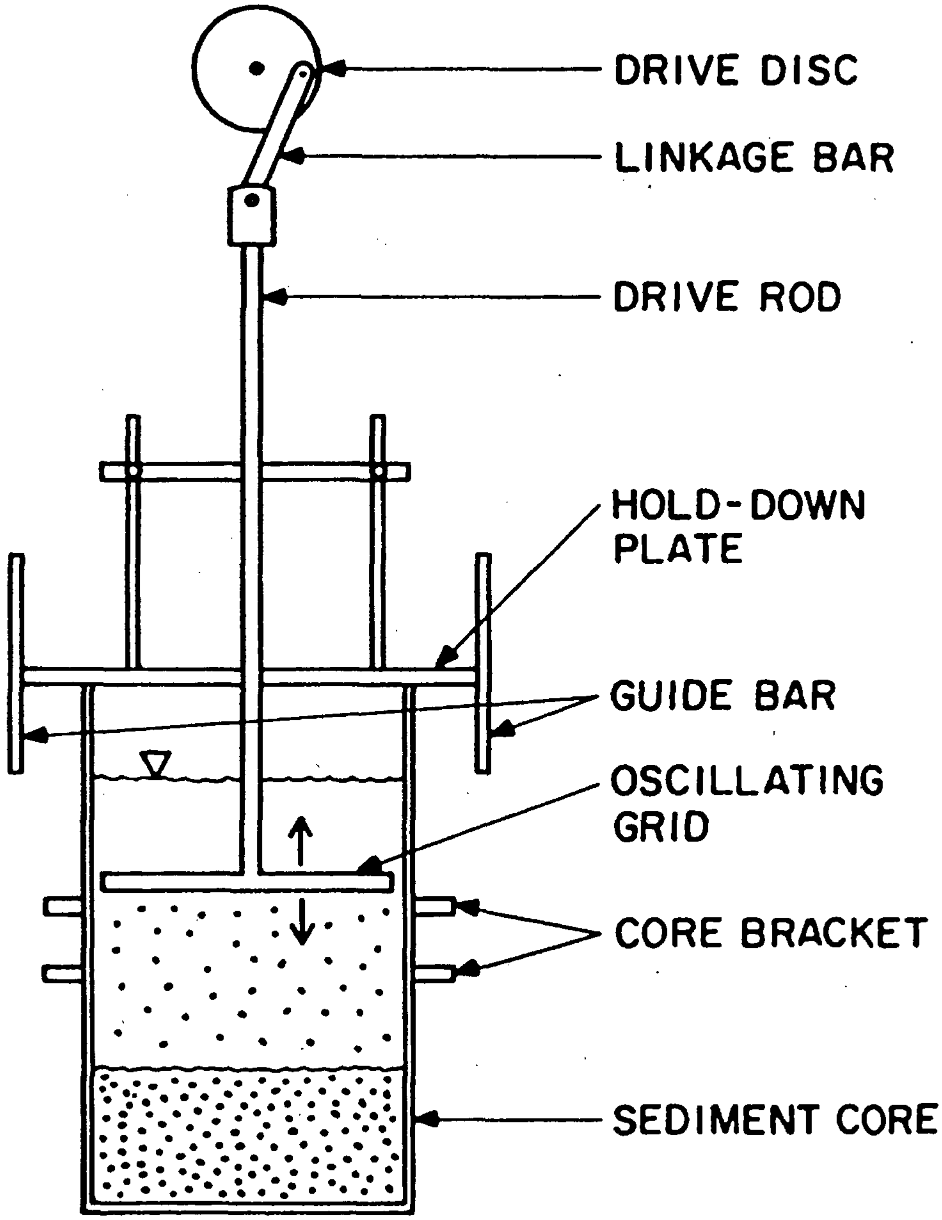
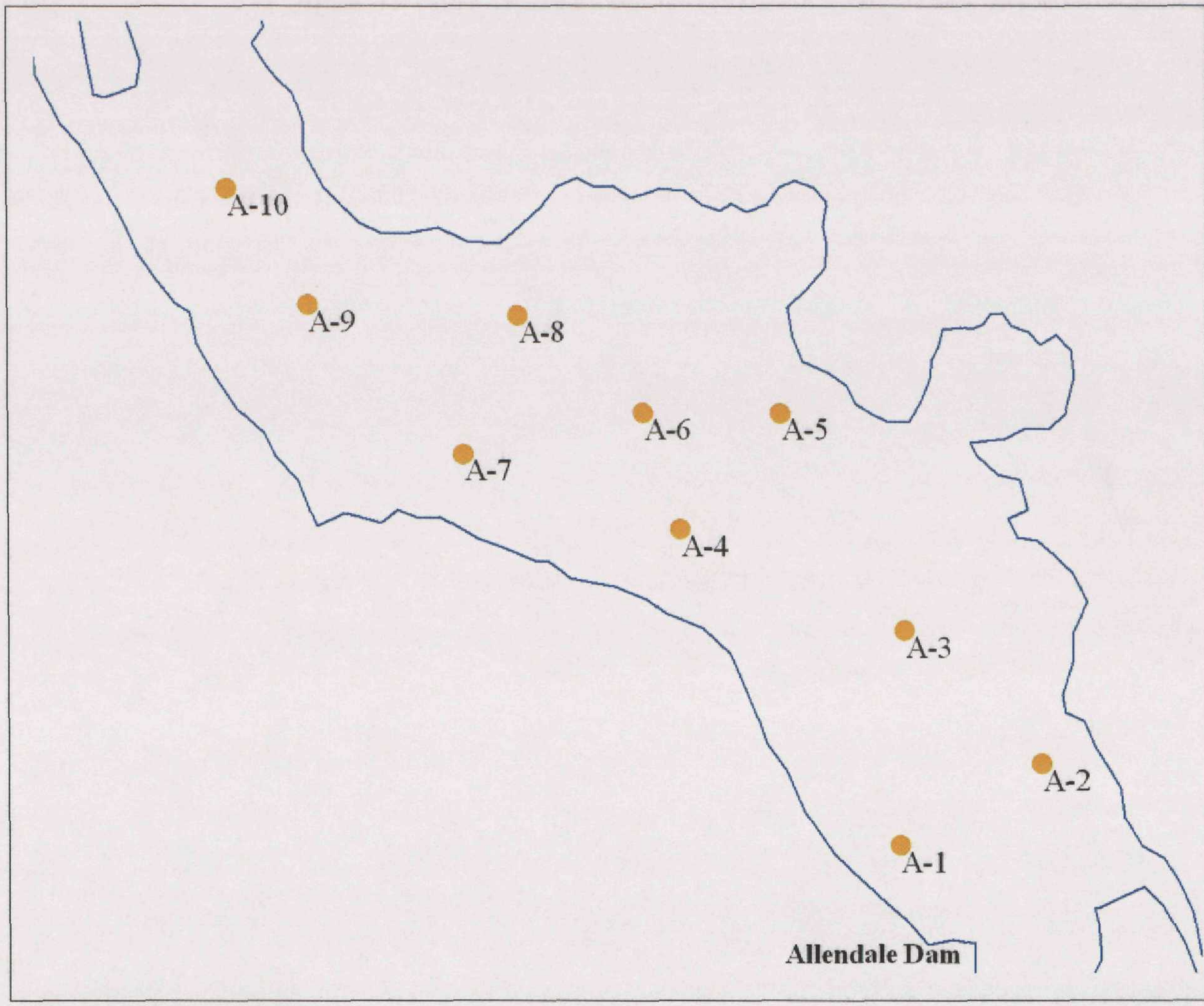


Figure 1. Schematic of the Shaker



Locator Map

Legend

1997 Shoreline

Shaker Core Locations

Figure 2. Locations of cores collected in Allendale Pond during shaker study.

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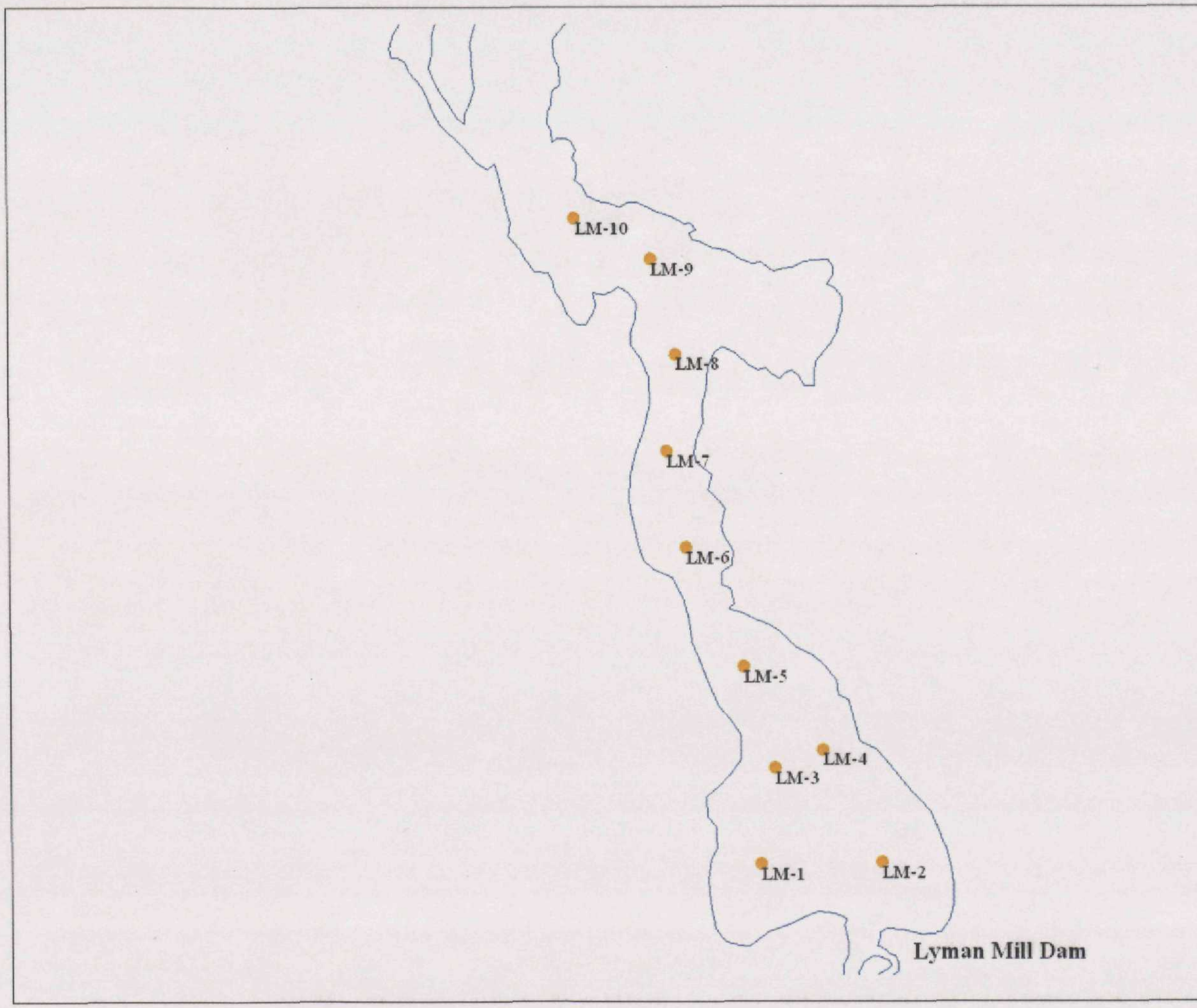
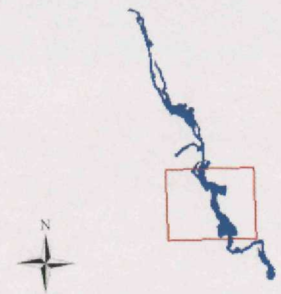


Locator Map



Legend

1997 Shoreline
Shaker Core Locations

Figure 3. Locations of cores collected in Lyman Mill Pond during shaker study.

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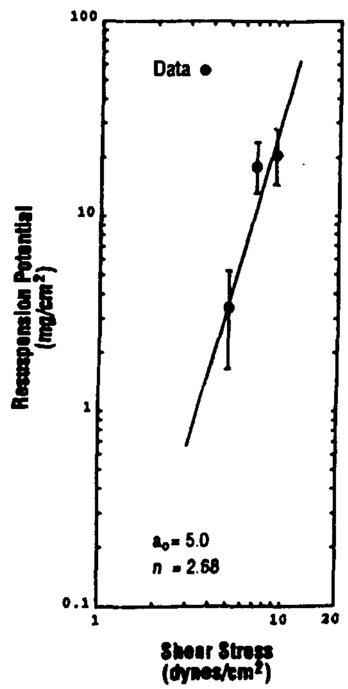

Figure 4. Analysis of Shaker Data from Watts Bar Reservoir on the Tennessee River (Ziegler and Nisbet, 1995)

ATTACHMENT 1

CENTREDALE MANOR SHAKER STUDY

CORE RECORD SHEET

Core Number _______

Date and Time of Core Collection ______________________________

GPS Coordinates of Core Location______________________________

Visual Description of Core

TSS Sample Numbers (as placed on bottle label)

Initial TSS sample ______________________

0.3 Pa TSS sample ______________________

0.5 Pa TSS sample ______________________

0.9 Pa TSS sample ______________________

Miscellaneous Notes About This Core