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ABSTRACT

WHITE OAK CREEK EMBAYMENT SEDIMENT RETENTION STRUCTURE: THE OAK RIDGE MODEL IN ACTION

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White Oak Creek is the major surface-water drainage through the Department of Energy (DOE) Oak Ridge National Laboratory (ORNL). Samples taken from the lower portion of the creek revealed high levels of Cesium-137, and lower levels of Cobalt-60 in near-surface sediment. Other contaminants present in the sediment included: lead, mercury, chromium, and PCBS. In October 1990, DOE, U.S. Environmental Protection Agency (EPA), and Tennessee Department of Environment and Conservation (TDEC) agreed to initiate a time-critical removal action in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to prevent transport of the contaminated sediments into the Clinch River system. This paper discusses the environmental, regulatory, design, and construction issues that were encountered in conducting the remediation work.

A major design constraint was to minimize the release of radioactively contaminated sediment during construction and over the 50 year design life of the structure. The other primary goal was to minimize the generation of wastes during construction The design proved to be challenging due to difficult environmental and design constraints, including very soft soils, the need to minimize disturbance to the sediments and construction-generated waste. The chosen alternative was a coffer cell structure to be constructed near the mouth of the creek. The structure is composed of rectangular cells with a reinforced concrete cap at the top to support a gabion flow-through structure. H-piles were driven inside the coffer cells to support the cap and tie the whole structure into the underlying shale. A relatively new technique in this country, jet grouting, was used to form a bottom seal in the structure and provide a means of tying the cell and H-piles together for load transfer purposes without disturbing the underlying sediment.

The environmental release and waste minimization goals of the project were all met, and the facility became operational one day before the required deadline of April 15, 1992.

White Oak Creek Embayment Sediment Retention Structure:
The Oak Ridge Model In Action

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White Oak Creek Embayment Sediment Retention Structure
The Oak Ridge Model In Action

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I. Introduction

The White Oak Creek Embayment (WOCE) Project is an excellent example of the application of the Oak Ridge model to solving an environmental remediation problem. A project team was created that represented a broad cross section of the engineering and scientific disciplines required to develop and implement the solution for the WOCE problem. The project team consisted of groups located in the Oak Ridge area, as well as groups with special expertise drawn from other areas of the country. While the following discussion is focused on the WOCE project, the approach utilized is representative of the approach that can generally be applied to other remediation projects. The remainder of the paper provides a description of the WOCE area and the need for the remediation project, the project team that was formed, and the sediment-retention structure design and construction.

White Oak Creek (WOC) is the primary surface water drainage for the Oak Ridge National Laboratory (ORNL) area. WOC originates north of Bethel Valley Road on the southern slope of Chestnut Ridge, 1.6 miles northeast of ORNL. WOC flows west through the main ORNL area, then turns southwest and joins Melton Branch before flowing into White Oak Lake (WOL). WOL is a small impoundment that has served as a settling basin for low-level radioactive effluents from ORNL since 1943. The WOL dam, located 0.6 miles above the confluence of WOC and the Clinch River, is the last controlled ORNL discharge point.

WOCE extends 0.6 miles downstream of the WOL dam to the confluence of WOC and the Clinch River at Clinch River Mile (CRM) 20.8 (Figure 1). WOCE sediments are intermittently inundated; the depth of water in the embayment is determined by the regulated summer and winter water levels of Watts Bar Reservoir and hydropower generation discharges from Melton Hill Dam, located on the Clinch River at CRM 23.1, 2.3 river miles upstream from the mouth of WOC.

* Managed by Martin Marietta Energy Systems, Inc., for the U. S. Department of Energy under contract DE-AC05-840R21400.

Sediment cores obtained in summer 1990 from the lower portion of WOCE revealed the presence of higher than expected levels of Cesium-137 activity in near-surface (upper 2–4-in.) sediments. Cesium-137 is a radioactive isotope historically produced in research-reactor operations at ORNL. Relatively high levels of mercury, chromium, lead, and Cobalt-60 were also observed in the WOCE sediment samples. Previous sediment samples obtained in 1979 and 1984 indicated that the contaminated sediment strata were located deeper in the sediment, ~ 1–2 ft below the sediment surface.

The results of the summer sediment sampling became available in late August 1990 and produced immediate concern because the WOCE sediments are uncontrolled; surface sediments, for example, can be eroded from the embayment and transported downstream into the Clinch River. An Occurrence Report was filed on September 7, and regulatory agencies were subsequently notified of the situation. On October 17, an agreement was reached among the Department of Energy (DOE), the Tennessee Department of Environment and Conservation (TDEC), and the Environmental Protection Agency Region IV (EPA-IV) that a time-critical removal action would be conducted to control the contaminated WOCE sediment and to prevent its transport downstream into the Clinch River. The time-critical removal action was to be conducted in accordance with the National Contingency Plan (40 CFR Part 300) and Sections 104 and 121 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

II. Project Team - The Oak Ridge Model In Action

The responsibilities and duties of all project participants are described in the following paragraphs.

The DOE Oak Ridge Field Office (DOE-OR) furnished overall project management including establishing and monitoring scope, cost, and schedule. DOE established the prime contracts required to accomplish the WOCE project including establishment of a new contractual arrangement with the U.S. Army Corps of Engineers (COE). DOE coordinated and directed the design, engineering, and construction services provided by the prime contractors and maintained surveillance and control of prime contracts. DOE also administered all contracts including specific approval of work assignments to participants; Title I, II, and III documents; and all work performed.

DOE-OR delegated the responsibility for the overall WOCE project integration to Martin Marietta Energy Systems, Inc. (MMES). The MMES Environmental Restoration Division (ERD) Off-Site Program (OSP) provided guidance and advice to DOE-OR on the conduct of the WOCE Project and ensured the preparation of project documentation for DOE-OR. ERD OSP conducted site characterization and environmental monitoring, and coordinated the activities of the WOCE project with other ERD activities and MMES projects and programs. The ERD OSP ensured that on-site support was provided to MK-Ferguson Oak Ridge Co. (MK-F) in health and safety, decontamination, and waste management activities and maintained the

WOCE project records and document control system. ERD OSP arranged for project readiness reviews. The ERD OSP Manager arranged for preparation of a review of regulations applicable to the WOCE project, which was prepared under subcontract by CDM Federal Programs.

Overall project integration, design review, construction support, and Title III engineering of the WOCE project was delegated to MMES Engineering. The responsibility included creating the project management plan, budget and schedule; recommending approval of all Title I and Title II documents; ensuring quality control of all construction activities assigned by DOE-OR; preparing safety and risk assessments and waste management plans; providing support to MK-F; preparing as-built drawings; and participating in readiness reviews. In addition Engineering established subcontracts with ERCE for the conduct of site geotechnical investigations and The University of Tennessee for hydological evaluations to support the design.

ORNL provided environmental, safety, health, and security support to the project. Health Physics technicians were provided by Radiation Protection and through subcontract to AFTREX. Oversight support was provided by Industrial Hygiene, Industrial Safety, and Environmental Compliance and Monitoring. Stream monitoring during critical construction operations and support for 90-day accumulation areas was provided by Environmental Compliance and Monitoring. Stream monitoring support and waste certification was provided by Environmental Sciences Division. Support to waste management activities was provided by Waste Operations. Guard forces were provided by ORNL security.

COE performed an alternatives analysis and conducted Title I and II design engineering including preparation of all final working drawings, specifications, and estimates. COE also provided Title III support to MMES Engineering and established a subcontract with Ground Services Engineering to provide design and field support during the jet grouting and rock anchor installation activities.

MK-F performed work as indicated in the drawings and specifications through direct hire and subcontract forces. A fixed price subcontract was established with the J. M. Foster Co. for installation of the coffer cell structure, concrete cap, gabions, and for general site construction support. A second fixed price subcontract was established with Haliburton/NUS (HNUS) for jet grouting and rock anchor installation (through HNUS subcontract to HydroGroup). MK-F provided on-site geotechnical testing services through a subcontract with Geotek. MK-F ensured that workers on the project met the required health and safety provisions of the project by providing a Site Health and Safety Officer through a subcontract with IT Corporation and through use of MK-F personnel. MK-F was responsible for the on-site packaging of waste and final site cleanup.

The Tennessee Valley Authority (TVA) provided technical review and assitance in controlling Clinch River water levels. EPA-IV and TDEC provided regulatory assistance.

III. Sediment Retention Structure Design and Construction

The first step in the implementation of the WOCE remediation was the establishment of the project team as described in the preceeding section. A critical initial focus of the team was obtaining the required National Environmental Policy Act approvals and development of a Functional Requirements Document, which outlined the performance requirements of the project. In addition, a geotechnical field investigation was conducted in mid-November 1990 by ERCE and COE to develop information to support evaluation and design activities. Due to the concern for mobilizing sediments, the sampling activities were limited to relatively nonintrusive bottom sediment and soil sampling. Rock cores were not obtained.

In December 1990 COE conducted an Alternatives Evaluation, which investigated 16 retention and in situ fixation approaches (including a no-action alternative) for stabilizing the WOCE sediments. Each of the alternatives was evaluated against CERCLA criteria. The alternative selected based on the evaluation was a coffer cell/rockfill structure.

Design of the coffer cell structure was initiated in December 1990 Figure 2 provides a cross section of the structure. The structure is composed of rectangular cells with a reinforced concrete cap at the top to support a gabion flow-through structure. H-piles were driven inside the coffer cells to support the cap and tie the whole structure into the underlying shale. A relatively new technique in this country, jet grouting, was used to form a bottom seal in the structure and provide a means of tying the cell and H-piles together for load transfer purposes without disturbing the underlying sediment.

Performance of site preparation activities by MK-F direct-hire forces coupled with a fast track bid and award process resulted in the start of coffer cell construction by J. M. Foster, Inc., in May 1991. Completion of the coffer cell wall across the embayment provided the initial sediment retention capability in July 1991 — nine months after the decision was made to implement the Time Critical Removal Action. Coffer cell structure construction was completed in September 1991. Following award of the jet grouting contract to HNUS, two field demonstrations were conducted in Duncan, Oklahoma, to test equipment and develop data on jet grouting parameters to be utilized at WOCE. HNUS began jet grouting at WOCE with a final trial field test that began in January 1992. Field production jet grouting was completed in March 1992. Through around the clock operations, the rock anchor installation was completed in early April. With careful sequencing, parallel construction efforts, an innovative rockfill structure construction approach developed by J. M. Foster, Inc., and cooperation by TVA in managing Clinch River levels, the coffer cell concrete cap construction and rockfill installation were completed on April 14, 1992.

IV. Summary

The U.S. Environmental Protection Agency and the DOE Environmental Restoration Program have emphasized the need for focused, streamlined approaches to achieving source control and risk reduction in environmental remediation projects. An integrated scientific and engineering project team conducted a time-critical CERCLA removal action to achieve control of contaminated sediments in the White Oak Creek Embayment at the Oak Ridge National Laboratory. A Critical factor contributing to the success of this effort was the immediate and continued involvement of an interagency working group (EPA-IV, TDEC, TVA, COE, and DOE) in the planning and execution of the project. Many of the project subtasks were conducted in parallel by cooperating parties to expedite project completion. The teamwork demonstrated by the federal and state agencies, the prime contractors, and the multiple subcontractors was essential for project success. The WOCE Project provides an excellent example of the application of the Oak Ridge Model to solving an environmental remediation problem.

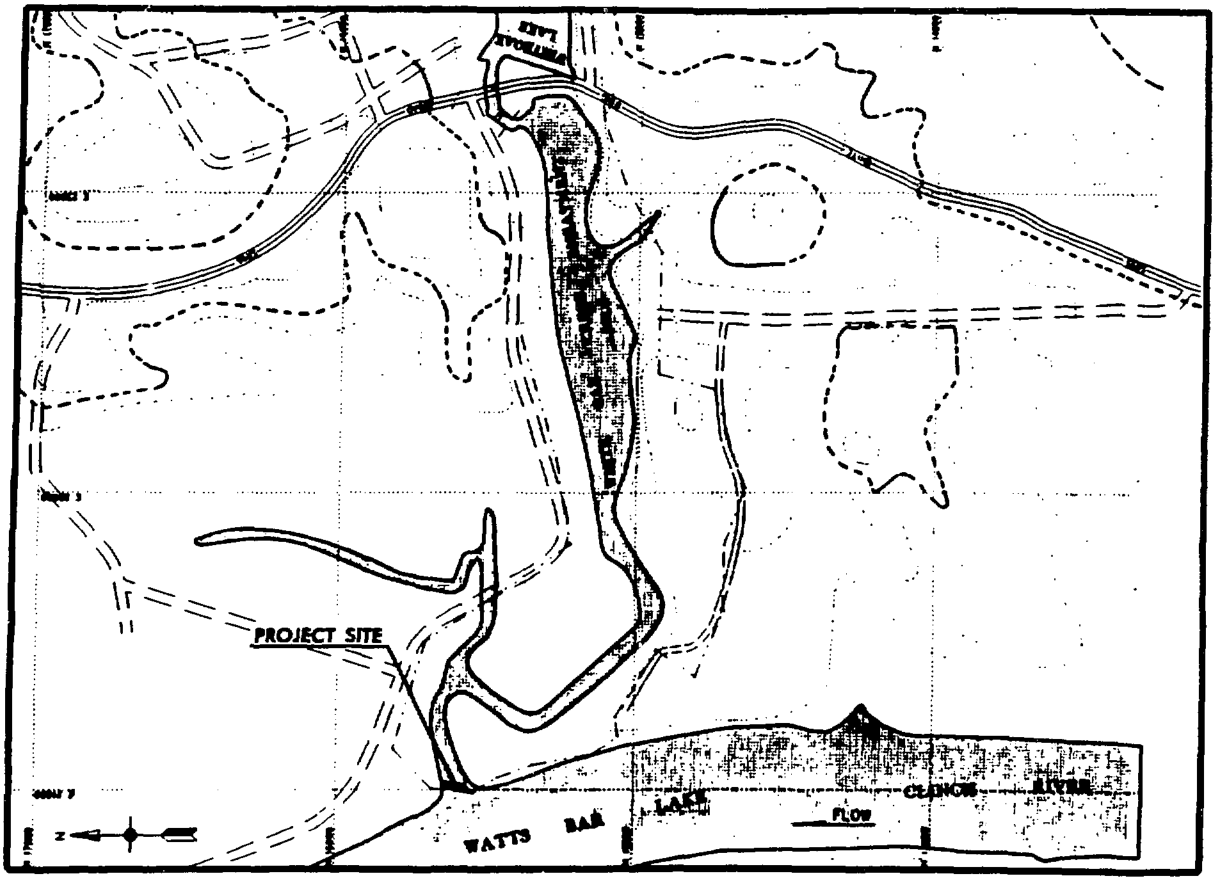

FIGURE 1
WHITE OAK CREEK EMBAYMENT SITE

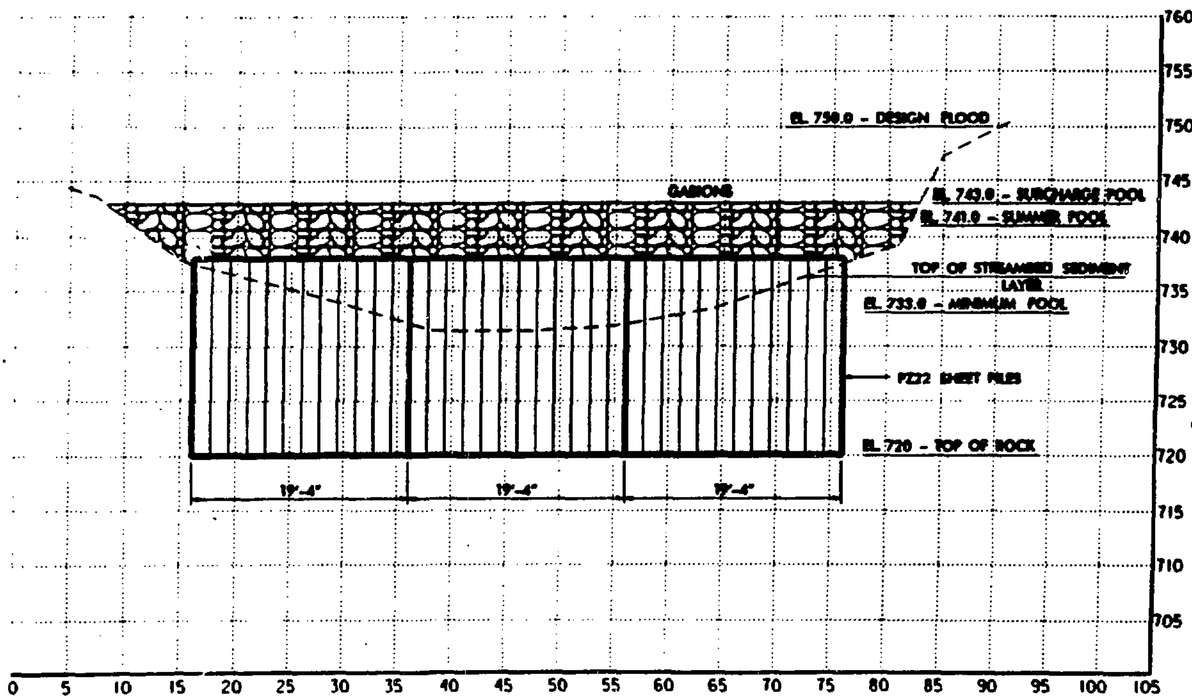

FIGURE 2

SECTION / ELEVATION

COFFERCELL / ROCKFILL STRUCTURE