DEVELOPMENT OF A LONG-TERM MONITORING SYSTEM TO EVALUATE COVER SYSTEM PERFORMANCE

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ABSTRACT

Environmental remediation at the Fernald Environmental Management Project is nearing completion, but long-term technology needs continue to emerge at the site. Remote, real-time, autonomous monitoring technologies are needed to ensure the integrity of the site and its remedy systems once cleanup is complete. The Fernald Post Closure Stewardship Technology Project (PCSTP), through the work of the Integrating Stewardship Technology Team (ISTT), has selected technologies to address initial site needs. This paper will explore the monitoring requirements of the Fernald On-Site Disposal Facility (OSDF), the parameters selected as critical for comprehensive long-term monitoring of the facility, and the process by which technologies were chosen to monitor those parameters.

INTRODUCTION

The Fernald On-Site Disposal Facility is an engineered, above grade waste disposal facility being constructed to permanently store low-level radioactive waste at the Fernald Environmental Management Project (FEMP) located 29 km (18 mi) northwest of Cincinnati, Ohio. Long-term monitoring of OSDF is a priority of the Department of Energy, regulators, stakeholders, and the managing contractor for the site, Fluor Fernald, Inc. At FEMP, the Fernald Post Closure Stewardship Technology Project identifies, demonstrates, and implements technologies capable of monitoring the OSDF after site remediation is complete. The goal is to ensure that the OSDF is performing in accordance with the functional requirements and to provide an early warning for the need of potential corrective action. Specific PCSTP tasks include finding, developing, and implementing monitoring technologies; engineering integrated monitoring systems; preparing implementation plans that include frequency of monitoring, testing methods and maintenance; developing a long-term data collection and reporting system; and preparing cost estimates.

A team of experts, regulators, and stakeholders was formed in November 2000 to review drivers and long-term monitoring needs; to establish monitoring parameters for each monitoring need; and to develop, evaluate, and recommend technologies for each monitoring parameter, integrated monitoring system, data collection and reporting system, and long-term maintenance schedule. This team, which is the working arm of the PCSTP, is called the Integrating Stewardship Technology Team.

As the first focus of the team, the ISTT reviewed drivers for the long-term monitoring of the OSDF cover system, and monitoring needs for cover system performance. Four main drivers for long-term monitoring are regulatory requirements, OSDF design criteria, OSDF Post-Closure Care and Inspection Plan, and the Fernald Environmental Management Project Final Land Use Plan. Monitoring needs identified for final cover system performance are grouped into three areas: (i) ecological system associated with the vegetative cover and in the OSDF buffer area, (ii) physical changes in the cover system and buffer area, and (iii) effectiveness of institutional controls.

This paper and presentation cover processes used in the development of a long-term monitoring system for the OSDF cell 1 final cover system, selection of the monitoring parameters, and monitoring technologies for the selected parameters.

OSDF Design and Technology Needs

The 28 ha (70 ac) OSDF is engineered to contain 1.9 million m^3 (2.5 million yd^3) of low-level radioactive soil and construction debris (impacted material) from the remediation activities at the FEMP. The OSDF will have eight cells. As of November 2001, three cells have been constructed. The final cover system (cap) is being constructed at Cell 1. The other two cells are active and accepting impacted material.

A performance goal of the OSDF is to isolate impacted material from the environment for at least 200 years with continual effectiveness for up to 1000 years to the extent practicable and reasonably achievable. This performance goal will be achieved through internal hydrologic control, external hydrologic control, geotechnical stability, resistance to erosion, and resistance to biointrusion. These controls are incorporated into the engineering and construction of the OSDF multi-layer liner system and final cover system. A 1.5 m (5 ft) thick multi-layer liner system constructed within each cell consists of the following layers (from bottom to top): compacted clay liner, secondary geosynthetic clay liner, secondary geomembrane liner, geotextile cushion, leak detection system (LDS) drainage corridor with LDS sub-drain pipe, primary geosynthetic clay liner, primary geomembrane liner, geotextile cushion, leachate collection system (LCS) drainage corridor with LCS sub-drain pipe, and geotextile filter. Monitoring of leachate flow and quality are being conducted for LDS and LCS flows at the valve houses outside the limits of the multi-layer liner system for each cell.

After each cell is filled to capacity, a final cover system (cap), is installed. The cap is designed to: minimize infiltration into closed cells, promote drainage to minimize erosion and abrasion of the cover, and accommodate settling and subsidence to maintain the integrity of the cover. The hydraulic conductivity of the cap must be less than or equal to the hydraulic conductivity of the liner system or natural sub-soil present, with the intention of preventing the "bathtub effect" (i.e., accumulation of water within the impacted material). The final cover system is 2.67 m (8.75 ft) thick and consists of the following layers (from bottom to top): compacted clay cap, geosynthetic clay cap, geomembrane cap, geotextile cushion, cover drainage layer, biointrusion barrier with choking layer, granular filter, vegetative soil layer, topsoil, an erosion mat, and vegetation.

The process for developing a long-term monitoring system for the final cover system for Cell 1 began with formation of the ISTT in November 2000. During the ISTT's first meeting in November 2000, Fluor Fernald, Inc. presented the drivers and monitoring needs for the OSDF. The ISTT reviewed drivers and monitoring needs to establish monitoring parameters for each monitoring need. The ISTT participants held separate breakout sessions to identify and prioritize ecological and geomechanical monitoring parameters and institutional controls. The breakout sessions were also used to identify potential monitoring technologies associated with each parameter. During the ISTT's second meeting in January 2001, the team re-evaluated the parameters identified in November and narrowed the list to five critical parameters. The parameters, along with technologies selected by ISTT to measure them, are presented in Table I.

Table I. Monitored Parameters and Components of Monitoring System.

Monitored Component	Parameter Monitored	Monitoring Technology
Drainage layer	Pore water pressure in drainage layer	Submersible pressure transducers
Surface and internal cover grades, barrier layer (distortion)	Settlement (total and differential)	Topographic survey using settlement plates & rods, ground penetrating radar (GPR) targets
Status of Root Zone	Soil water content, soil water potential	Soil-water status nests including dielectric water content sensors and thermal dissipation potential sensors
Barrier layer (freezing)	Soil temperature above barrier layer	Thermocouples in thermal dissipation sensors
Cover system and buffer area	Overall condition of cover	Routine topographic survey Web cam Visual and/or remote sensing

Project Status

As of November 2001, procurement and installation plans have been developed for the soil-water status nests, GPR targets, settlement plates and rods, and submersible pressure transducer risers. Installation of these monitoring devices and equipment is currently underway, with the calibration and installation of the actual instruments scheduled to take place between November 2001 and January 2002. The Cell 1 monitoring system is expected to be fully operational by the Spring of 2002. Once the system is installed, data will be collected according to the following monitoring schedule stated in the Post Closure Care and Inspection Plan:

- Monthly – At completion of each cap for at least two years
- Quarterly – During remaining OSDF construction period and for additional three years
- Annually – Three years after completion of OSDF construction

Fernald's progress and accomplishments in stewardship planning and monitoring technology application establish the site as a pioneer within the DOE complex, which has thus far focused primarily on site closure and remediation. Long-term stewardship is becoming an increasingly important issue to DOE closure sites, many of which will soon face their own post-closure monitoring and maintenance challenges. Fernald's experience with the OSDF and monitoring technologies will benefit sites that have not yet begun planning for long-term stewardship, as well as those which are beginning to encounter similar challenges.