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Area Completion Strategies at Savannah River Site: Characterization for Closure and Beyond

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INTRODUCTION

During the first four decades of its 56 year existence, the Savannah River Site (SRS) was a key supplier of nuclear material for national defense. During the 1990s, the site's primary missions became waste site closure, environmental restoration, and deactivation and decommissioning (D&D) of remnant cold war apparatus.

Since 1989, with the approval of State and Federal regulatory agencies and with the participation of interested stakeholders, SRS has implemented a final remedy for a majority of the more than 500 individual waste sites at the former nuclear materials complex. These waste sites range from small, inert rubble pits to large, heavy industrial areas and radioactive waste disposal grounds. The closure and final remediation of these waste sites mark significant progress toward achieving SRS's overarching goal of reducing or eliminating future environmental damage and human health threats.

However, larger challenges remain. For example, what are appropriate and achievable end-states for decommissioned nuclear facilities? What environmental and human health risks are associated with these end-states?

To answer these questions within the strictures of smaller budgets and accelerated schedules, SRS is implementing an "area completion" strategy that:

- unites several discrete waste units into one conceptual model,
- integrates historically disparate environmental characterization and D&D activities
- reduces the number of required regulatory documents,
- and, in some cases, compresses schedules for achieving a stakeholder-approved end-state.

BACKGROUND AND HISTORY OF SRS

In 1950, the Atomic Energy Commission established the Savannah River Plant near Aiken, SC, for the production of nuclear materials for national defense. Now known as the Savannah River Site (SRS) and operated by the Department of Energy (DOE), the site occupies more than 300 square miles of land in the upper Atlantic coastal plain along the Savannah River.

From its inception in 1950 through the 1980s, the site operated redundant chemical separations facilities and several reactors for the production of tritium and plutonium, as well as coal-fired power stations and multiple areas for waste management and disposal. During the 1980s, the site became increasingly regulated by a growing body of environmental legislation; in 1989, the entire SRS was included as a "Superfund" waste site on the United States Environmental Protection Agency's (US EPA's) National Priority List.

With the end of the Cold War in 1991, SRS's primary mission evolved from nuclear defense to environmental cleanup and restoration. To integrate Federal and State mandated environmental compliance efforts, SRS and its two main regulatory agencies – the US EPA and the South Carolina Department of Health and Environmental Control (SCDHEC) – established a Federal Facility Agreement (FFA) in 1993[1]. The FFA marries the requirements of the two main regulations governing SRS (the Resource Conservation and Recovery Act [RCRA] and the Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA]) and enumerates how the 500+ individual waste sites at SRS are governed by these regulations.

Since 1989, SRS has characterized and implemented final remedies for more than 330 of these individual waste sites. The range of environmental remediation strategies implemented thus far is broad. For some sites that pose no human health or ecological threat, no actions were required other than assessment. Many waste units, however, posed significant threats and have been addressed by a wide spectrum of remedies. At sites with shallow or surficial contamination, soils and sediments have been excavated, stabilized in place with cementitous grout, covered with low permeability materials, or consolidated with other waste sites and remediated. For groundwater and vadose zone contamination, SRS has implemented and in many cases improved remedial approaches ranging from passive (for example, monitored natural attenuation, phytoremediation, and chemical adjustment) to active (barrier walls, pH modification, air stripping, and pump and treat).

Building on these successes, SRS, SCDHEC, and the US EPA signed an Accelerated Cleanup Agreement in 2003. The various components of this agreement include a Comprehensive Cleanup Plan[2], an Area Completion Strategy[3], and an End State Vision document that establish a final long-range strategy for both waste sites <u>and</u> inactive (D&D) facilities at SRS.

AREA COMPLETION STRATEGY

The concepts of "area completion" are simple yet key for cleaning up waste sites and for determining the appropriate strategy and end-state for inactive facilities, many of which are slated for various D&D activities. The area completion approach shares many aspects with the traditional approach to addressing discrete RCRA/CERCLA waste sites.

- Assess the problem.
- Identify data needs.
- Collect and evaluate data.
- Implement remedial solution(s).

The principles of area completion are less a departure from this approach and more a refinement and evolution.

- Assess problems on an <u>area-wide</u> basis, covering an often large geographic extent.
- Identify data needed to characterize environmental media (soil, groundwater, etc.) <u>and</u> to assess any remnant of D&D activities (concrete slabs, contaminated structures, etc.).
- Plan and collect a <u>robust</u> dataset with fewer field excursions and laboratory iterations.
- Evaluate data within the bounds of <u>future land use</u>.
- Implement remedial solution(s), using a phased approach where necessary.

SRS is implementing an area completion strategy for several of the 14 heavy industrial or nuclear use areas that exist at the site, including:

• **D Area** – a powerhouse and associated coal pile, ash basin, and rubble pit. Area closure strategy included removal of 35 buildings and installation of a 25-acre closure cap. Land use controls prohibit residential use[4].

• **TNX Area** – a 66-acre site of former pilot-scale test facilities and the first industrial area completed using the area closure concepts. Area closure activities (completed in 36 months) integrated eight discrete FFA waste units, removed 28 buildings and 2,000 cubic yards of contaminated soil, and installed a 10-acre geosynthetic cap. Land use controls prohibit residential use and maintain permanent inaccessibility[4]. The area closure approach was completed 48 months earlier than originally scheduled and saved approximately $13M versus the traditional approach to characterization and remediation.

• **M Area** – a reactor fuel and target fabrication area, where the area completion strategy combined six waste units, removed 47 facilities, and identified discrete areas requiring different remedial solutions, including no further action, early action (treatment), and consolidation with other waste units for eventual remediation.

• **P Area** – the first reactor area to be evaluated using the area closure approach. The 100-acre P-Area Operable Unit includes the hardened reactor building and associated ancillary structures, five FFA waste units not yet evaluated, and five areas of potential groundwater contamination. For the purposes of characterization, these 11 entities were variously divided or combined into five "investigative units." Over a two-year period, environmental media (soil, soil gas, groundwater, ash, etc.) in each investigative unit were sampled at multiple (160) locations. Samples were analyzed for targeted but comprehensive suites of contaminants and the results screened against applicable benchmarks for human health risk, ecological toxicity, and contaminant migration.

Using a future industrial land use scenario as a baseline for human health and ecological risk assessment, preliminary results indicate several problem areas for remediation or further investigation.

- There are two discrete areas where volatile organics solvents, which were used as industrial degreasers, are predicted to leach from soil to groundwater at unacceptable concentrations.
- Man-made radioactivity exists in the shallow soil and gravel along a section of railway that previously served reactor operations.
- At two surface water outfalls, additional data are needed to confirm previous results or to define the true vertical extent of radioactive contamination in soil.
- In the ash basin that received coal ash from the powerhouse, the concentrations of metals (and associated naturally occurring radionuclides) exceed acceptable thresholds.
- Along the now inactive process sewer line, previously used to convey effluent within P Area, there is no evidence of rupture or leakage; however, the interior surfaces of the sewer pipes are likely contaminated and contaminated sediment may still exist inside the sewer pipe.

For each of these areas of concern, a range of likely responses and alternatives is being considered using standard elements of the RCRA/CERCLA process combined into an expedited remedial schedule.

For the reactor building and some ancillary structures, regulators and stakeholders have agreed that the future industrial land use of P Area allows an *in situ* decommissioning, as opposed to deconstruction and *ex situ* disposal of large volumes of contaminated waste[4]. Given this land use scenario, the reactor building and some ancillary structures may serve a continuing purpose, and efforts are underway to evaluate their possible reuse for long-term storage or disposal of waste generated by ongoing cleanup activities.

RESULTS/LESSONS LEARNED

The area completion approaches being implemented at SRS reflect an evolution of the traditional RCRA/ CERCLA remedial process. Area completion strategies:

• group waste units and/or D&D facilities together for characterization, remediation, and possible reuse;

• identify data needs and integrate data collection activities for D&D, characterization, and remediation;

• identify problems that require action and match areas of concern with appropriate likely responses based on anticipated land use and end-states;

• streamline the regulatory process and reduce the number of required regulatory documents;

• and accelerate remedial and D&D decisions and reduce project costs versus the traditional "piecemeal" approach.

These strategies are achieving faster, more responsible, and less expensive solutions to managing the Cold War legacy while assuring protection of human and ecological receptors and future industrial workers.

REFERENCES

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