FUSRAP DECISION MAKING AND LESSONS LEARNED

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ABSTRACT

The early days of the atomic weapons production program in the United States resulted in radiological contamination at numerous processing and disposal facilities. The federal government is addressing these legacy sites, and others included by Congress because of similar contamination conditions, under the Formerly Utilized Sites Remedial Action Program (FUSRAP). The U.S. Army Corps of Engineers (USACE) took responsibility for FUSRAP in 1997 and has focused its efforts on meeting remedial requirements for these sites. Shaw Environmental, Inc. (Shaw) is USACE's environmental remediation contractor at the following FUSRAP sites. USACE District responsibilities are also shown:

Ashland 1 and 2 – USACE Buffalo District
Colonie – USACE Baltimore District for Engineering, USACE New York District for Construction
Linde – USACE Buffalo District
Maywood – USACE Kansas City District for Engineering, New York District for Construction
St. Louis Downtown Site (SLDS) – USACE Kansas City District for Engineering, USACE St. Louis District for Construction.
St. Louis Airport Site (SLAPS) – USACE Kansas City District for Engineering, USACE St. Louis District for Construction.

This paper will present the processes by which remedial decisions were reached for each site, and key lessons learned during these processes.

INTRODUCTION

The ability to start, execute, and complete remedial activities at a FUSRAP site poses many challenges. As work processes are defined, decisions must be made regarding how the contamination will be identified, collected, managed, packaged, transported, and disposed. These decisions must reflect the best use of available funding while being considerate of external influences. Stakeholder input (including public perception and regulator influence) often has a profound impact on these decisions and shapes the character of each site.

Regulatory requirements guide how work processes are implemented. For example, some waste material is regulated with few options for disposal while other waste material has many disposal possibilities. Likewise, there are many packaging and transportation options depending on the characteristics of the waste material and the physical constraints of the site. Contamination remediation is also influenced by site conditions. Some sites are in rural settings with plenty of elbowroom while other sites are located in active industrial areas with severe logistical limitations. All successful FUSRAP site cleanups have demonstrated the ability to learn from the past and apply those lessons to refine existing work processes. Work process refinements are part of the Corps' commitment to continuous improvement.

SITE SUMMARIES

The St. Louis Downtown Site (SLDS)

The SLDS covers approximately two square miles in a heavily industrialized area north of downtown St. Louis, Missouri. The Manhattan Engineering District (MED), a predecessor of the U.S. Department of Energy (DOE), contracted Mallinckrodt, Inc (MI) during the early stages of atomic weapons development in the 1940s. The mission of MI's downtown St. Louis facility was to refine methods of concentrating uranium ore. Refinement consisted of acid digestion and ether extraction. Primary contaminant release pathways consisted of air borne (stack) and effluent sewer releases. Remedial actions are required under and around the former process buildings without disruption to existing plant operations. The site is production constrained due to limited access and cramped working areas. The SLDS project currently requires the remediation of 13 contaminated areas and the investigation of approximately 30 vicinity properties (VPs) to determine if remediation is required.

The St. Louis Airport Site (SLAPS)

SLAPS is approximately 17 miles northwest of downtown St. Louis, in the cities of Hazelwood and Berkeley and adjacent to the Lambert-St. Louis International Airport. The 11.3-hectare property is made up of three parcels currently owned by the City of St. Louis. SLAPS was originally acquired to store residues and scrap from uranium processing efforts in downtown St. Louis. Over time residues migrated from the site by air and water to nearby properties and a through a creek that drains the site. In 1966 and 1967, most of these residues were sold to various uranium reprocessing facilities and removed from SLAPS. The remaining on-site structures were razed and buried on the property. The DOE prepared and released a limited scope Engineering Evaluation/Cost Analysis (EE/CA) in 1997 to begin cleanup of the SLAPS property. DOE was the federal agency responsible for FUSRAP prior to USACE.

The Linde Air Products (LAP) Site

During the 1940s, portions of a property formerly owned by LAP in Tonawanda, New York housed operations for isolating uranium from ore. This work was executed under contract to the MED. Multiple separation processes including acid digestion resulted in elevated radionuclide levels in portions of the LAP property. Subsequent disposal and relocation of over 91,000 metric tonnes (t) of the process wastes resulted in elevated radionuclide levels at three nearby properties in the Town of Tonawanda: the Ashland 1 and 2 properties and the Seaway property. The former LAP property is currently owned by Praxair, Inc. and encompasses a 54.6-hectare complex housing office buildings, fabrication facilities, and approximately 1,400 employees. A multi-hectare VP east of the Praxair facility that includes railroad and power line corridors and private industrial property is also part of the Linde Site. Shaw began remediation activities following release of the site's Record of Decision (ROD) in March 2000. Building 14, a separate operable unit at the Linde site, received a ROD in 2002. Shaw completed the Building 14 demolition in 2004.

The Ashland Sites

The Ashland sites are located in the Town of Tonawanda, New York, just south of the Niagara River. From 1942 to 1946, the former Linde Air Products Division of Union Carbide performed uranium separation at its facility, also located in Tonawanda. The work was performed under contract to the MED. From 1944 to 1946, residual materials from the uranium separation process were transported to a 4-hectare site known then as the Haist property and subsequently designated Ashland 1. These materials consisted primarily of low-grade uranium ore tailings. Records indicate that approximately 7,260 t of residues were placed over roughly two-thirds of the property. In 1960, the property was transferred to Ashland Oil, which constructed a bermed area to serve as a secondary containment basin for two aboveground petroleum storage tanks. This construction operation involved excavation and removal of approximately 5,450 t of soil containing radioactive residuals and commingled MED-related inorganic constituents. The excavated soil was transported to the Ashland 2 site and the adjacent Seaway Industrial Park for disposal. The majority of the radioactive residuals and commingled inorganic constituents removed from the Ashland 1 site were deposited in a disposal area at the Ashland 2 site.

The Maywood Site

The Maywood site includes residential, municipal, and commercial properties in the boroughs of Maywood and Lodi, and the Township of Rochelle Park, all located in Bergen County, New Jersey. The primary contaminant at the site is thorium-232 (Th-232), which originated from extraction processes involving monazite sands by the former Maywood Chemical Works (MCW) between 1916 and 1959. Process wastes from the thorium extraction operations were generally stored in open piles and retention ponds on the MCW property. Some of the process wastes were removed and used as fill on nearby properties; additional waste migrated off the property via natural drainage associated with the former Lodi Brook. Placed on the National Priorities List in 1983, and subsequently assigned by Congress to the DOE in 1984, the FUSRAP Maywood site consists of 88 designated VPs. Sixty-four residential properties at the site have been remediated by the DOE and USACE. Shaw’s scope is to execute the cleanup of the remaining 24 industrial, commercial and government properties. A ROD for soils and buildings was executed in 2003; on a separate track, work is proceeding under CERCLA to identify a response action and secure a ROD for any groundwater contamination found to be associated with FUSRAP material.

The site's 24 VPs vary in size from under 1,000 square meters (m^2) to over 12 hectares. Cleanup of the 24 properties is complicated by several factors: the need to conduct remedial activities while minimizing impacts to ongoing business operations of property owners and tenants; intensive land development and traffic in the site’s densely populated metropolitan location; and waste proximity to surface water, storm drainage structures and wetlands.

The Colonie Site

The 4.5-hectare Colonie site is located on New York State Route 5 approximately five kilometers (km) north of downtown Albany. The site was formerly operated by National Lead Industries (NL) and was an active metals foundry long before the introduction of radiological materials (depleted uranium and Th-232) into the manufacturing process. In 1958, the nuclear division of NL began producing items manufactured from depleted uranium and thorium under a license issued by the Atomic Energy Commission. The plant handled enriched uranium from approximately 1960 to 1972. From 1966 to 1972, NL held several contracts to manufacture fuel from enriched uranium for experimental nuclear reactors. Operations were conducted at the plant to reduce depleted uranium-tetrafluoride to depleted uranium metal, which was then fabricated into shielding components, ballast weights, and projectiles. Contaminant releases from the site occurred through airborne dispersion of radioactive emissions and direct burial of waste, equipment, and drums into the former Lake area and under the building as it expanded. The site is bordered to the north and east by occupied residences and commercial establishments, including two restaurants. CSX and Amtrak rail lines are active along the southern property line. A drainage channel consisting of a combination of open channel flow and buried 1.2-m reinforced concrete culvert bisects the site. The site is also home to two sets of 45-KVA high voltage transmission lines feeding a main Town of Colonie electric substation.

PROJECT PLANNING AND DECISION MAKING PROCESS

Table I summarizes the characteristics that influence remedial decisions at each site described above.

Table I. Decision Influence Matrix

Influence	SLDS	SLAPS	Ashland	Linde	Maywood	Colonie
Waste Source	Acid digestion	Granular waste	Granular waste	Granular waste	Acid digestion	Electroplating
Cleanup Criteria	ROD	EE/CA	EE/CA	ROD	ROD	EE/CA
Excavation Method	Gross & Guided (Note 1)	Gross & Guided	Directly Guided (Note 2)	Gross & Guided	Gross & Guided	Directly Guided
Contamination Presence	Spot excavation	Contiguous excavation	Contiguous excavation	Contiguous excavation	Contiguous and spot excavation	Contiguous excavation
Site Location	Active industrial	Abandoned industrial	Active industrial	Active industrial, municipal utility, and commercial	Active industrial, commercial and residential	Abandoned industrial, residential, and commercial
Congestion	Cramped, space limited	Wide open	Space limited	Space limited	Space limited, urban traffic	Space limited
Waste Package	Gondola	Gondola	Intermodal	Intermodal	Gondola	Intermodal
General Waste Classification	11e2	11e2	11e2	11e2	11e2	Hazardous
Material Handling Restrictions	Daily covered stockpile	None	No daily stockpile	No daily stockpile	Covered stockpile, maximum volume limits	None

ROD - Record of Decision
EE/CA - Engineering Evaluation/Cost Analysis
Note 1 - Depending on the quantity and reliability of radiological data for a specific location being remediated, a gross vertical and/or horizontal excavation limit is established and remediated. When the gross remediation is at or near design limits, excavation support personnel using field survey instruments assume control of the excavation and "guide" the remainder of the remediation.
Note 2 – Where design excavation limits have been inferred, typically due to limited available radiological data, excavation support personnel using field survey instruments guide the remedial excavation.
11(e)2 - Refers to "byproduct material", originally defined in Section 11.e of the Atomic Energy Act of 1954 to read as follows: "…any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material. Section 11.e was amended by the Uranium Mill Tailings Control Act of 1978 to define "byproduct material" as follows: "…(1) any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material, and (2) the tailings or waste produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source material content.

Many factors influence how decisions are made during project planning. All sites are faced with a myriad of influences and requirements that must be considered prior to deciding how remediation will be planned and executed. Most FUSRAP sites, and all the sites considered in this paper, have had active investigation or remediation for over a decade. In some cases, the DOE had made commitments at these sites that are beyond the control of USACE or its contractor, and these commitments are honored. These commitments influence how site remediation would be performed and in effect can be viewed as policy decisions once remediation is underway. The most significant policy decisions are those between USACE, property owners, and federal and state regulators who approve the final remedy.

The physical nature of a site may be the most significant influence on decision-making. Several sites are located in open areas with sufficient room to consider many remedial process options, while other sites are located in confined areas with active industry or residential areas offering fewer options. All the FUSRAP sites considered here share a common remedial decision for offsite contaminant disposal or recycling. Material handling decisions are influenced by past commitments, the nature of the waste material, and the physical location of the site.

Lessons learned also have an important influence on remedial decisions, as positive or negative experiences inform approaches to current work. Capitalizing on lessons learned is a critical component for continuous improvement of existing work processes and avoiding repeat mistakes in future remedial process decisions. A discussion of specific influences on remedial decision-making follows.

Policy Decisions Regarding Excavated Material Reuse

In general, policy decisions are USACE-driven, comply with applicable regulations, rules, and laws, and may be constrained by funding. However, local stakeholders such as municipal officials and the general public can also influence policy.

The SLDS ROD provides for reuse of excavated material that does not exceed site cleanup goals. This material is used as deep fill (i.e., more than 1.8 m below grade). To date, more than 6,880 cubic meters (m^3) of material have been reused in this way. Some stakeholders have questioned this practice, but the savings from reduced transportation and disposal (T&D) and fill importation costs is an important policy consideration for USACE. USACE has learned it can act in accordance with the ROD without compromising legitimate stakeholder interests.

The FUSRAP Colonie Site has used approximately 1,340 m^3 of excavated material as backfill. The material was stripped overburden generated during the installation of a replacement 122-centimeter RCP for the unnamed tributary which flows through the site. The excavated material is stockpiled, sampled, and analyzed with an on-site High Purity germanium meter for radiological parameters and a Niton X-Ray Fluorescence unit for metals concentrations. When this process indicates that stockpiled material has concentrations below site cleanup criteria, the samples are sent to an off-site laboratory for confirmation. If the off-site laboratory data indicates compliance with site cleanup criteria, the data is formalized into a submission to USACE for concurrence to use the soil as backfill material. To date all soil deemed acceptable for backfill by USACE has been successfully placed below a depth of 2.7-m.

The USACE approved excavated material reuse after more than three years of remedial action at the Linde FUSRAP Site. Initially, all excavated material required off-site disposal by agreement reached with stakeholders during the Remedial Design approval process in 2000. All backfill was select limestone crusher run imported from quarries over 16 km away. Since that time, USACE has concurred with Shaw's suggestion that release and reuse of non-impacted material excavated from cleared areas was more cost effective than disposal and imported material backfill. This experience showed that a comprehensive technical and financial policy review can identify ways to improve technical approaches.

Schedule Decisions (Property Owner Cross Contamination Liability)

SLDS was the second FUSRAP site with a ROD when USACE started remediation in 1998. USACE was influenced by the desire to show progress, and rapid progress was made with the remediation of several VPs and three areas within the plant through 2003. USACE has yet to resolve a significant cross contamination issue with Mallinckrodt. Mallinckrodt continued to refine the same ore feedstock from which uranium was once extracted to extract columbium and tantalum metal. Mallinckrodt’s refinement process resulted in contamination that is indistinguishable from MED/AEC contamination. USACE is unwilling to remediate areas of suspected cross contamination until an agreement is reached regarding contamination liability. This policy appeared practical in 1998 because there was time to reach agreement. However, an agreement has not yet been reached, resulting in staffing planning challenges for the remaining remedial activities. The lesson learned suggests caution and sensitivity when assuming that complex negotiations will be resolved off the critical path. Resolution of the contamination liability issue is now on the project critical path.

At Colonie, USACE is responding to issues that have extended resources and are quickly becoming part of the critical path. The CSX VP Site Investigation was performed to gather supplemental information and further refine areas of concern. This effort identified a smaller area and volume requiring remediation. As a result, a revised EE/CA is being prepared to modify the original cleanup design from contiguous excavation to focused spot excavation, thereby saving time, resources, and funds. However, this effort is quickly becoming a critical path item with the site completion date approaching. In addition, USACE responded to a report issued by a local university professor who identified some depleted uranium in a reservoir downstream from the site. USACE subsequently provided funding and resources to perform a Site Investigation of Patroon Creek, Three Mile Reservoir and the unnamed tributary that traverses the site. This investigation yielded no data above site cleanup criteria in either Three Mile Reservoir or Patroon Creek, but did confirm an isolated spot of contamination previously identified by DOE just downgradient from the site. USACE has targeted this area for remediation concurrent with the CSX VP.

Preparation of project work plans for the Ashland 1 site was conducted concurrent with on-going site restoration and closeout documentation efforts for Ashland 2. Mobilization to the Ashland 1 site, including placement of infrastructure, was conducted prior to approval of the final project plans. Initially, it was anticipated that this process would promote efficiency and result in cost savings. However, this was not the case. In an effort to expedite the plan deliverables, the project team attempted to minimize the time allocation for plan preparation and thorough review. Completion of the Independent Technical Review process for the work plans that was required by the USACE was expedited to support schedule acceleration. As a result, plan review and comment resolution cycles consistently exceeded scheduled time allotments. Establishing realistic milestones and holding meetings with reviewers where responses were discussed and concurrences obtained eventually expedited the comment resolution process. In retrospect, it was recommended that periodic analyses of actual report preparation and review times be performed and that these timeframes be used as guidance for future scheduling and budgeting. The continued use of “resolution” meetings to streamline the plan review process was endorsed. Further recommendations included performance of risk and cost benefit analyses when any plan deviation is identified. Emphasis was placed on identifying potential impacts to related project activities where deviations are not immediately recognized.

Physical Nature of the Site Decision Influences

Equipment selection and material processes at SLDS were influenced by the cramped work setting and anticipated slow production rates. Rail track space is also limited with no suitable space for a material stockpile greater than 765 m^3. Material handling managers needed to assess the likelihood of excavation production exceeding the capacity to load out into gondola rail cars. The alternative to onsite load out was the use of intermodal rail cars (IMC) that, once loaded, could be delivered to a trans-load facility. Given that direct loading of gondola railcars is more cost effective than using IMCs, and an expectation that excavation interruptions due to insufficient load out capacity could be averted, a decision to direct load gondola rail cars was made. The lesson learned for SLDS is a positive one. Careful planning of site access, equipment procurement, material handling, and infrastructure location has served USACE well when the focus was on what is possible given the constraints rather than dwelling on the constraints themselves.

Cleanup Criteria

Primary contaminants of concern at SLDS include Uranium 238 (U-238), Thorium 230 (Th-230), and Radium 226 (R-226). The SLDS is located on a flood plain adjacent to the Mississippi River. The area has been steadily built up over several centuries with a wide range of fill materials. Challenges have surfaced at several excavations where Th-230 was the primary driver to meet cleanup criteria. Th-230 can be challenging to detect with hand held field instruments. This resulted in inefficient excavation, as several rounds of sampling and lab analysis were required to assess Th-230 concentrations. Lessons learned from this experience have caused SLDS to be more sensitive to the potential presence of Th-230, and site staff have developed a sampling strategy to delineate Th-230 proactively rather than reactively. Thus, the risk of construction crew down time while waiting for analytical results, at a cost of approximately $5,000 US per day, is reduced.

The FUSRAP Colonie Site remediation is being performed in accordance with a June 2001 Action Memorandum that revised the original September 1995 EE/CA for the site. The revision of the original EE/CA was deemed necessary due to uncertainties regarding the implementability of on-site waste consolidation, physical site constraints, and local community resistance to the remedy in the original EECA. The EECA called for moderate excavation, with the majority of soils being consolidated in an on-site landfill. An Action Memorandum changed the remedy to large-scale excavation and off-site disposal. The new cleanup criteria are for the most likely future use scenario (Urban Resident), allowing for a more beneficial reuse of the site. Under the Action Memorandum, the U-238 cleanup criteria remained at 35 picocuries per gram (pCi/g). The Th-232 value decreased from 15 pCi/g to 2.8 pCi/g. The lead standard dropped from 500 to 450 parts per million (ppm), but standards for copper and arsenic were introduced for the first time. Copper cleanup criteria were set at 1,912 ppm and arsenic at 7.4 ppm. Since the site operated as a metals foundry prior to and during U-238 and Th-232 processing, metals contaminants are generally deeper than the radiological constituents, which are driving the excavation to depth. As part of the Action Memorandum, a risk assessment was performed and concluded that radiological contamination should be removed regardless of depth, but that the excavation for metals should cease at a depth of approximately 5.8 meters. This change in the cleanup criteria was instituted two years after site remediation was initiated. While this change is positive from the public acceptance and beneficial reuse perspectives, it required revisiting the initial Final Status Survey (FSS) unit due to the additional metals and the lower cleanup criteria. USACE’s effective communication with Shaw during the preparation of the Action Memorandum limited this reexamination to a few FSS units.

The Ashland 2 project remediation of a 1.62-hectare site involved excavation and off-site shipment of 47,401 t of radioactively contaminated soil. Th-230 was the primary contaminant of concern at the site. Since available instrumentation used for in-situ soil screening could not accurately detect Th-230 at the cleanup concentration of 40 pCi/gm, surrogate measurements that relied on associated concentrations of R-226 were used. These surrogate measurements involved a correlation between in-situ gamma readings and laboratory analysis of the Th-230 concentrations in the soil. During the remediation work (approximately six months duration) this correlation was regularly checked to assure its validity. Various factors (such as the depth of contaminated soil below the in-situ survey point or the presence of contaminated soil in an excavation sidewall) were monitored to modify the correlation. By continually refining the correlation between in-situ gamma measurements and laboratory analysis of corresponding soil samples, excavation operations were successfully guided using field measurements. As a result, the post-remediation residual concentrations for radionuclides of concern were below ROD criteria and satisfied New York State Department of Environmental Conservation (NYSDEC) residential thresholds.

Preferential Pathways for Contaminant Migration

At the SLDS, active and historical utilities provide preferential pathways for contamination migration. These pathways are difficult to anticipate due to poor as-built information, thick building foundations, and an abundance of metallic fill material. Site operations have been brought to a stop several times as unknown utilities are found with contamination following within utility bedding materials. This typically results in excavations growing beyond design limits. Since SLDS is a cramped working environment, excavation growth usually requires different shoring and additional utility rerouting. Volume growth can result in delays as time is spent to plan a course of action and order materials.

At Colonie, USACE has worked extensively with NYSDEC with respect to the onsite culverts and sewer systems used by the active facility. USACE has performed video surveys of culverts and taken many direct and swipe samples from manholes and pipes to ensure that there is no exposure risk to members of the community or trained utility workers. USACE also performed a risk analysis for the offsite sewers that is currently under NYSDEC review. One of the main releases of contamination was through airborne emissions from the stack. Roof drains collected stormwater that came into contact with contamination that settled on the roof. During storm events the contaminated water from the roof was collected in downspouts that connected to the floor drains and discharged to either the local sewers or the creek that flows through the site. The drainage pipes under the building were not very well documented in the few available construction as-built drawings for the building. The utilities under the building were preferential pathways for contaminant migration. All utilities shown on as-built drawings are being documented as they are removed. Uncovered utilities not shown on the as-builts are being added to them to ensure that parts are not missed.

Lessons learned have caused the design engineers and operations staff to consider contingencies for remediation outside anticipated areas of excavation. Design documents are structured for flexibility to minimize down time due to changed conditions. The designs now reflect the existence of “unknowns” identified during FUSRAP excavations.

At Linde, the remedial action experience has caused a significant reconsideration of the site conceptual model for the location and volume of impacted material. The ROD was based on a remedial investigation (RI) report conclusion that contaminant locations and volume were dictated by two factors: direct placement of solid material during MED operations, and surface water mobilization and deposition. During Class 2 area surveys and subsequent remedial action, impacted material has been encountered in many new locations. A critical review of the site conceptual model showed that a key mechanism for contaminated material transport and deposition - post MED facility operations and site improvements - was underestimated. The LAP evolved into Praxair, Inc. over 60 years, and continuous site operations have caused impacted material to be redistributed, more than five times in some instances, during site improvements or O&M activities. This mechanical redistribution of onsite contaminants significantly increased the volume of contaminated material and located it in places never investigated during the RI, such as bedding for sewers, structural subgrade and backfill for building foundations, and borrow material for onsite transportation infrastructure. This lesson resulted in additional Class 2 areas at the Linde site and execution of multiple data collection requests for further site characterization. The ultimate impact is a more than 100 percent increase in the estimated volume of material to be removed from the Linde site.

Material Handling

The SLAPS remediation is a pure production process, and site planning and operations have been structured to leverage efficient work processes for excavation, material stockpiling, rail car load out, T&D and facilities development. SLAPS has always been funding constrained and considerable planning went into equipment selection and the volume balance between excavation and T&D based on anticipated funding. The result has worked better than anticipated where stockpiling is used as the balance point between the pace of excavation and T&D funding limitations. T&D funding is typically exhausted in the spring and excavation continues while a temporary stockpile is generated. Frequently, additional funding becomes available near the end of the fiscal year and T&D resumes accordingly. FUSRAP Colonie has similar operational constraints under its track lease with CSX that prohibits gondola loading. The track is active, and Shaw must operate derailers and coordinate track use with CSX.

Another aspect of material handling which is sometimes overlooked is backfill material delivery to a site. At Colonie, Shaw worked with the Town of Colonie to improve an adjacent parcel of property by extending a roadway to the site from a nearby industrial park. This avoided backfill haul truck traffic on a very busy main roadway and improved safety for pedestrians using a bus stop in front of the site as well as vehicles traveling the main roadway.

Two important material handling lessons have been gained at SLAPS and Colonie. First, continuous improvement of existing work processes is critical in expediting railcar loading, packaging, manifesting, and release tasks. Success in the early years of the project was defined as five to six railcars ready for release by the daily railroad cutoff time (usually 3:00 PM). The railroad cutoff time is now earlier in the afternoon, yet operations is routinely able to completely package 12 railcars (full spur) before lunch. These improvements are only possible through a dedicated site staff working safely and efficiently. Second, the ability to uncouple excavation progress from the load out process has been made possible by efficient management of stockpiled material. Operations went to considerable effort to develop a stockpile strategy that was safe and in compliance.

Contaminated Water Management

The SLAPS site is wide open and water management from excavations and stockpiles has been a challenge. This is mainly due to the presence of selenium, and is especially true in winter and spring due to storage capacity issues. For several years, application of contaminated water onto contaminated ground (evaporation and transpiration) and dust suppression were sufficient, and water treatment was not required. With most of the site now remediated, there is much less available space for ground application, and water treatment is required. A biotreatment system based on activated sludge has been developed for the removal of selenium from the water. Lessons learned highlight the value of ground application and dust suppression as an economical method for water management. Sewer release criteria and National Pollutant Discharge Elimination System permit requirements for SLAPS are not generous and the cost to treat water to release criteria is expensive. Ground application is inexpensive and if managed well can safely discharge several million gallons of water per year.

Remediation of the Ashland 1 site involved excavation and off-site shipment of 156,819 t of radiologically impacted soils over a three-year period. Excavators were used to load contaminated material into articulated dump trucks at the point of excavation. The articulated dump trucks transported the material to a stockpile where front-end loaders placed the material into IMCs for shipment by rail to a licensed disposal facility. Deviations from original work plans early in the project resulted in unforeseen impacts. The most readily accessible contamination was excavated and removed, resulting in an expansive hole covering approximately 4 hectares. Limited site drainage produced significant ponding and water backup. Water management became the primary operational challenge and impediment to progress. The eventual engineered solution involved design and installation of an automated pump station, which added time and cost to the project closeout. With the benefit of hindsight, the project team evaluated this situation during a Lessons Learned session. A full risk/benefit analysis was recommended when changes to the Scope of Work resulted in deviations from approved plans or operational approaches to a task. It was acknowledged that, in this case, unknowns associated with project funding and severe winter weather would have compromised the accuracy of the risk/benefit analysis.

Final Status Survey Process

FUSRAP projects abide by the Multiagency Radiation Survey and Site Investigation Manual [1] in conducting Final Status Surveys (FSS). However, the degree of pre-removal FSS work plan development and roles and responsibilities vary greatly among the projects. For example, at some sites the primary construction contractor performs FSS planning and execution, inclusive of radiological analyses. At others, independent USACE-contracted parties may conduct various tasks of the FSS.

At the St. Louis FUSRAP projects, the FSS process has been challenging due to the inherent difficulty in managing coordination, communication, data collection, data analysis, and decision-making tasks. Although the USACE is responsible for approving release of a remediated survey unit based on FSS results, both the construction contractor and a separately contracted USACE verification contractor each perform certain portions of the FSS process. A third USACE contractor oversees the construction contractor's FSS and pre-FSS removal activities. Lessons learned have resulted in refining FSS task timing and roles and responsibilities. However, some efficiencies remain unrealized, primarily due to the tedious nature of resolving field or construction constraints when nearing completion of removal work and entering initial FSS phases for a survey unit, and overall coordination among USACE, the construction contractor, and the FSS contractor.

At Linde, FSSs are streamlined in specific circumstances to limit field efforts in some units to less than four hours after exposure of the surface to be cleared. In order to expedite the FSS process to meet schedule demands, Shaw performs several steps in parallel with USACE and NYSDEC reviews. In time-sensitive cases such as sewer main replacement, entire excavation areas are pre-defined as needed to allow location of random systematic samples prior to excavation. This allows excavation, FSS activities, and construction/backfilling operations to occur concurrently. Strict radiological controls and construction safety boundaries are maintained between the excavation cut face, the area of the unit undergoing FSS walkovers and sampling, and the new construction. Upon concurrence with FSS survey and sampling results by the USACE and NYSDEC, USACE provides direction to proceed with backfill in the unit. In most cases, this direction is received prior to receipt of off-site laboratory analytical results. Thus, the team proceeds at risk. Without exception, the end result of this process has been that analytical results confirm a successful remediation and the task schedules are expedited. The lesson learned in this case is that FSS field activities and backfill authorizations can be completed in a single workday. This process has been executed many times at Linde, and there is momentum to accept the risks and use it more routinely in future units across the site.

At Maywood, FSS is normally implemented in fully remediated Class 1 survey units that range from 100 to 2,000 square meters in size. In consideration of the potential cost and risk implications for maintaining large open excavations that may be wholly or partially below the water table or adjacent to structures or active roadways, the project may elect a "quick release" approach to FSS and subsequent backfill. Quick Release FSS is triggered and performed in a stepwise process:

- Shaw initiates excavation of a designed survey unit and encounters conditions that may have potential safety or significant cost implications (e.g., stability of adjacent structures, erosion and sediment control issues, water management concerns, etc.)
- The Shaw Construction Manager communicates the safety or cost concerns to the USACE Field Representative and the Shaw Project Health Physicist (HP).
- The Shaw HP communicates the data quality and cost implications of performing a partial FSS of the survey unit in question. Typically, the cost implications (i.e., additional sampling, field survey efforts, and potential need for re-excavation) are acceptable when compared to the lost productivity of a field remediation team. The data quality implications require greater consideration. For example, the proximity of unremediated soils in an adjacent region of the survey unit can negatively affect the ability of the FSS Team to determine that there is a "uniform distribution of residual contamination" in the survey unit using gamma walkover survey data. Also, since only a portion of the systematic sampling is completed, the non-parametric statistical evaluations of soil concentration data cannot be performed. This calls for greater conservatism during the guided excavation process.
- The USACE Field Rep weighs the field concern against the cost and data quality implications to FSS and directs the Team accordingly.
- If quick release is selected, the area in question is prepared for FSS by establishing erosion and sediment controls and removing accumulated water.
- FSS activities (i.e., gamma walkover, systematic sampling, and bias sampling) are performed in the accessible portion of the survey unit.
- If the area is to be "immediately backfilled" because of a critical condition, the Shaw HP examines the gamma walkover for obvious problems and directs construction accordingly. If no anomalies are detected, the area is backfilled to the elevation needed to resolve the problematic condition.
- Otherwise, samples are submitted to the on-site New Jersey Department of Environmental Protection- (NJDEP) certified lab with a typical turnaround of 8-36 hours, depending on the number of samples and when they are submitted.
- The Shaw HP reviews all raw data (scans and sample results) with the USACE Field Rep for approval to backfill. If the data indicates that FSS data quality objectives have been met, the area is backfilled to the elevation needed to resolve the problematic condition.

Radiochemical Analyses

To support the anticipated long-term cleanup at the Maywood site, the USACE and Shaw performed a cost benefit evaluation for several configurations of on-site versus off-site laboratory scenarios. Cost assumptions were made for preconstruction site remediation and construction of an on-site laboratory, and for radioanalytical needs over the life of the project. It was concluded that complete on-site analysis was more beneficial and in the interest of the USACE, considering a minimum six-year performance period. Additionally, it was recommended that the laboratory capabilities include alpha and gamma spectroscopy and that NJDEP certification be obtained. The primary benefits of having an NJDEP-certified on-site laboratory include faster results and no additional costs for samples requiring fast turnaround times. These are significant benefits when costs for backfilling and excavation water management, particularly next to structures, are time-critical concerns. The cost benefit for the onsite laboratory increases with the numbers of samples, especially those requiring quicker turnaround times. The onsite radiochemical lab has supported project FSS analysis since receiving NJDEP certification and USACE Center for Expertise validation for gamma spectroscopy in early 2004; approvals for alpha spectroscopy were received in January 2005.

In addition to supporting project "production" efforts in removing contaminated soils, radioanalytical capabilities support essential wastewater treatment discharge compliance requirements. During batch treatment of excavation dewatering discharges in the Maywood project's winter construction period, the influence of urban roadway de-icing salts on the radiochemical analysis of treated effluent was observed to interfere with agency-required Minimum Detection Activity (MDA). As described elsewhere in this session, an alternative compliance methodology has been developed by the project and accepted by the permitting agency: where gross alpha (GA) or gross beta (GB) analytical results are less than or equal to the permit discharge limit, but the MDA exceeds the permit MDA limit, GA/GB concentrations and associated MDAs are derived from isotopic analysis to verify compliance.

CONCLUSION

Lessons learned at the FUSRAP sites discussed in this paper are numerous. These lessons are the result of local decisions made with the best information available at the time. The factors that influence these decisions evolve over time, and the ensuing lessons learned allow USACE and Shaw to benefit by improving existing work processes and avoiding pitfalls when starting new processes. Shaw is actively sharing the knowledge between the FUSRAP sites it is working on, and with similar projects in the company. This will result in project teams with a greater knowledge base and expanded awareness of options while planning or reacting to decision influences.

REFERENCE

1. "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)", NUREG-1575, Rev. 1; EPA 402-R-97-016, Rev. 1; DOE/EH-0624, Rev. 1 (August 2000)