Evaluation and Implementation of a Soil Blending Application

H. Honerlah
United States Army Corps of Engineers-Baltimore District
10 South Howard St. Baltimore, MD 21203-1715
USA

D.Sendra, A. Zafran
Shaw Environmental & Infrastructure
Colonie FUSRAP Site
Colonie, New York 12205
USA

ABSTRACT

With the Nuclear Regulatory Commission (NRC) issuing guidance on the "Use of Intentional Mixing of Contaminated Soil" (SECY-04-0035) dated 1 March 2004, an opportunity to blend higher level radiologically contaminated soils with that of lower activity from the Colonie Formerly Utilized Sites Remedial Action Program (FUSRAP) site became available. Shaw Environmental, under contract with United States Army Corps of Engineers (USACE) to remediate the Colonie site, was tasked to blend soils of higher radioactivity (> 6.29 Bq/g or 170 pCi/g) concentration with soils of lower radioactivity concentration (< 6.29 Bq/g or 170 pCi/g). A mass balance formula approach was used to determine the proper soil blending ratio. This blending process enabled soils to meet the Waste Acceptance Criteria (WAC) of a specific disposal facility. All blended waste streams were treated to stabilize lead, removing the hazardous waste code D008, and to meet appropriate Resource Conservation Recovery Act (RCRA) requirements and land disposal restrictions.

The initial blending on-site was conducted with a 2,485 m^3 (3,250 yd^3) stockpile of higher concentration soils being blended with lower concentration soils. The lower concentration soils were excavated, staged and sampled into 191 m^3 (250 yd^3) stockpiles. The ratio for this blending was based on the average radiological concentration of the large stockpile being blended and average concentrations of the individual 191 m^3 (250 yd^3) piles of lower radiological concentration using a mass balance approach. Once a new 191 m^3 (250 yd^3) stockpile was created with blended soils it was sampled to insure it met the WAC of Facility A. After the large stockpile had been successfully blended and additional in-situ soils of higher concentration were excavated, they were blended using a similar mass balance approach. For the newly excavated soils, each of the individual piles radiological concentrations was used to determine the specific blending ratio.

The blending process took place to lower the disposal costs for the project. By sending the soils to Facility A (RCRA part C permitted) vs. Facility B (Part 61 NRC licensed), a cost savings of

over 1.56 million dollars was realized. Prior to commencing the blending of soils, USACE coordinated discussions with appropriate state and federal governmental organizations.

INTRODUCTION

The former owner (National Lead) of the Colonie FUSRAP site operated from the late 1930's as an industrial facility. During these years, the facility carried out a number of processes using radioactive materials consisting primarily of depleted uranium (source material), but also of thorium (source material) and enriched uranium (special nuclear material). The Colonie site operated under several NRC licenses and an agreement state license. New York State officials closed the facility in 1984 due to unacceptable air emission releases from site operations. Congress authorized the Department of Energy (DOE) to remediate the property, and subsequently all radioactive material was transferred to the control of DOE under their Atomic Energy Act authorities. The investigations conducted on the site indicate that the primary radiological contaminant of concern (COC) is uranium in the form of depleted uranium, which is defined as source material in Title 10 - Code of Federal Regulations - Part 40. The site also has a characteristic Hazardous Waste (HW) (D008, Lead), which has contaminated an area greater than the radiological COC's. All contamination is primarily in the form of soil like material at various depths.

During the initial removal actions USACE and Shaw determined that a majority of the contaminated material excavated contained uranium that could be designated as an unimportant quantity of source material (less than 0.05% by weight) as defined in Title 10, Code of Federal Regulations, part 40.13(a). In January 2000, USACE gained concurrence from the NRC to transfer this material to a RCRA facility for disposal as long as individual doses were less than 1 millisievert (100 millirem) per year. To date, USACE and Shaw have disposed of an estimated 103,372 m3 of material as an unimportant quantity of source material at a RCRA disposal facility.

By 2005, the site removal actions segregated an estimated 2,300 m^3 as source material (uranium greater than 0.05% by weight) in an above ground stockpile. USACE reviewed NRC guidance "Use of Intentional Mixing of Contaminated Soil" (SECY-04-0035) dated 1 March 2004 and determined that the intentional mixing of materials to meet a disposal facilities WAC would be appropriate for material staged at the Colonie site. USACE communicated with the NRC and the NRC stated that the approach proposed for the Colonie site would be consistent with the current NRC guidance.

Shaw performed the soil blending operations at the Colonie FUSRAP site to reduce the average radiological activity of the soil allowing the material to meet the definition of an unimportant quantity of source material and the WAC for a RCRA disposal facility. This paper will discuss the methods used to determine the proper blending ratios, results of the blending, costs of the blending, cost savings and lessons for the project.

Site History

Industrial operations on-site began in approximately 1923 when the Embossing Company purchased a portion of the present day site to construct a facility to manufacture wood products and toys. In 1927, Magnus Metal Company, Inc. purchased the property and converted the facility to a brass foundry for manufacturing railroad components. Magnus Metal Company, Inc. cast the brass components in sand molds and manufactured brass bearing housings with surfaces of babbitt metal (an alloy of lead, copper and antimony).

In 1937, National Lead Industries (NL) purchased the facility and continued the brass foundry operations initiated by Magnus Metal Company, Inc. At some point before 1941, NL purchased an adjacent lot that contained a portion of Patroon Lake and began filling Patroon Lake with used casting sand, which contained high levels of lead and other materials. After World War II, the plant began casting aluminum parts and frames for aircraft. In 1958, the nuclear division of NL began producing items manufactured from uranium and thorium under a license issued by the Atomic Energy Commission (AEC). NL discontinued its brass foundry operations in 1960.

From 1958 through 1984, NL carried out a number of processes using radioactive materials consisting primarily of depleted uranium but also of thorium and enriched uranium. The majority of nuclear operations conducted at the plant were to reduce depleted uranium-tetrafluoride to depleted uranium metal, which was then fabricated into shielding components, ballast weights for airplanes, and armour piercing projectiles.

Other processes conducted at the plant included an electroplating operation for plating uranium with nickel and cadmium. NL letters indicate that under an AEC license, approximately 42 cubic meters (m^3) of graphite, slag, refractory, uranium oxide, insoluble oil, metal scrap, and combustible trash were buried in the former Patroon Lake area in 1961. Chemical wastes and packaged chemicals used at the site had included acids, bases, degreasing agents, carbon tetrachloride, benzene, polychlorinated biphenyls (PCBs), cyanide, and asbestos. The chemicals present on the Resource Conservation and Recovery Act (RCRA) Part A application permit were removed from the Colonie site as part of this facility's closure as a designated "interim RCRA storage facility." This closure was documented in the 1995 RCRA Closure Report certified by both the DOE and an independent New York State Professional Engineer.

New York State officials closed NL in 1984 at which time Congress authorized the DOE to remediate the property. In February 1984, the Secretary of Energy accepted an offer from NL to donate the land, buildings, and equipment to the DOE in order to help expedite the cleanup. In 1985 the DOE acquired a portion of the Niagara Mohawk (NiMo) property bordering the Colonie site and subsequently designated it as part of the Colonie site. The current Colonie site consists of approximately 11.2 acres.

From 1984 to 1988, remedial efforts were completed by the DOE for 53 of the 56 Vicinity Properties. From 1992 to 1996, the remaining NL Site buildings were demolished by DOE. In 1997 the FUSRAP program was moved by congress from the DOE to USACE. Various debris, waste materials and machinery associated with demolition of the main buildings were left on-site at the time USACE and their contractors initiated their remedial efforts.

USACE Removal Action Process

USACE established procedures to segregate the waste materials at the Colonie site. The first step in the segregation process involved developing a correlation in counts per minute (cpm), for a field instrument for detection of low energy radiation (FIDLER), to a Bq/g (pCi/g) concentration of depleted uranium in surface soils. This field instrument was used to guide the excavator during the removal action. As the material was removed from the excavation, it was placed into 191 m^3 (250 yd^3) stockpiles, sampled using a five point composite approach to allow for representative results, and analyzed by on-site gamma spectroscopy. USACE utilized this process to segregate the material based on the radiological activity to allow for disposal of the material as an unimportant quantity of source material and staging of source material for disposal at a Title 10 - Code of Federal Regulations - Part 61 facility.

Since the site was a foundry for many years, USACE was aware that a majority of the excavated soils at the Colonie FUSRAP site would be contaminated with metals and exhibit a Toxicity Characteristic Hazardous Waste Code D008 (as identified in Title 40 – Code of Federal Regulations – Part 261). This material was treated on site to remove the toxicity characteristic and thus rendered it non-hazardous per Title 40 – Code of Federal Regulation - Part 261. The waste segregated as source material and prepared for offsite disposal was defined as Low Level Radioactive Waste (LLRW), not "mixed waste" because it does not contain a hazardous waste component. All waste material prepared for disposal must comply with the applicable land disposal restrictions identified within Title 40 - Code of Federal Regulation - Part 268 which relate to notification and treatment requirements. The onsite treatment system involved several physical steps including transfer from the stockpile staging area to the treatment area, loading into a 51millimeter (2 inch) screener to remove debris, passing on conveyers through the treatment process, and transfer of material to the load out area for transportation.

Under the direction of the USACE, site remediation activities have included the following:

- Removal and disposition of building material and equipment
- Removal of building slabs, foundation, and asphalt pavement
- Excavation of landfilled materials in the former Patroon Lake
- Excavation of contaminated surface and subsurface soils
- Treatment of soils to stabilize Hazardous Waste Code D008.

Additional support activities included:

- Removal and replacement of a major stormwater drainage channel that bisected the landfill area associated with stream diversion to facilitate site remediation
- Dewatering well fields to lower the water table and allow for deep excavations
- Design and operation of a water treatment facility with State Pollution Discharge Elimination System monitoring and reporting requirements
- Perimeter air monitoring on a 24 hour – 7 days per week basis
- Relocation of power lines that transected the landfill area.

Through October 2006 USACE has achieved the following key accomplishments on the project:

- Excavation of 159,456 tons of contaminated wastes
- Off-site transportation of 166,140 metric tons
- On-site water treatment of 112,010,334 liters of storm water and groundwater

- Completed Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) certification for 24 survey units
- On site treatment of over 110,000 tons which were contaminated with metals
- Placed 121,027 m^3 of off-site backfill material into these completed units.

Fig. 1. Colonie FUSRAP site aerial photo

METHODOLOGY AND EXECUTION OF BLENDING

To blend the soils at the Colonie site it was determined that the best approach would be to use a mass balance approach. This was due to the fact that the site had large stockpiles of soils that had previously been excavated, sampled, segregated and stockpiled into elevated activity soils and lower activity soils. Using this mass balance approach, it was necessary to determine the weighted average of each stockpile since the larger stockpiles had multiple data points that each represented a different volume. In addition with the clean up process ongoing at the site, the potential for increasing the amount of higher activity and lower activity soils was likely, and therefore was included as part of the blending process. The blending of material with elevated activity (EA) and material with an unimportant quantity of source material (UQSM) is described in equation 1.

The goal of the blending operation was to determine the optimal amount of material required to meet the WAC of the disposal facility and meet the sampling requirements established onsite for one sample per 191 m^3. Shaw used a front end loader with a bucket scale to track the weights

used for blending each stockpile and an average soil density of 1.53 metric-ton/m3 for post blending sampling. Table I provides a summary of the material blended at the Colonie site. The material prepared for blending was placed into a new pile and blended utilizing an excavator. Once each new pile had been thoroughly mixed it was sampled to insure the activity of the pile met the WAC of the RCRA facility.

$$WAC^{Uranium\ 238}\,(EA_{ton} + UQSM_{ton}) = U^{238}{}_{EA}\,(EA_{ton}) + U^{238}{}_{UQSM}\,(UQSM_{ton}) \qquad \text{(eq.1)}$$

Where

$WAC^{Uranium\text{-}238}$	=	Disposal Facility Waste Acceptance Criteria for Uranium-238 (pCi/g)
$U^{238}{}_{EA}$	=	Average U^{238} concentration of material with elevated activity (where the average U^{238} concentration is greater than 0.05% by weight)(pCi/g)
$U^{238}{}_{UQSM}$	=	Average U^{238} concentration of material containing an unimportant quantity of source material (pCi/g)
EA_{ton}	=	Tons of material with elevated activity (where the average U^{238} concentration is greater than 0.05% by weight)
$UQSM_{ton}$	=	Tons of material containing an unimportant quantity of source material

Table I – Summary Results of Material Staged for Blending at the Colonie Site

	Minimum	Maximum	Weighted Average	Material Weight (Metric ton)
$U^{238}{}_{EA}$ (Bq/g)	8.51	28.27	12.71	5,225
$U^{238}{}_{UQSM}$ (Bq/g)	0.19	2.06	0.47	7,031
$U^{238}{}_{EA}$ (pCi/g)	230.00	764.00	343.40	5,225
$U^{238}{}_{UQSM}$ (pCi/g)	5.10	55.80	12.60	7,031

Summary Results of Blending

Approximately 40 new stockpiles were generated during the blending operations at the Colonie site. Calculations were completed based upon the weighted average of the material staged for blending to determine the most efficient blending ratios. The lowest blending ratio was determined to be 0.6 UQSM to 1 EA and the highest blending ratio was determined to be 3.8

UQSM to 1 EA. The average blending ratio was determined to be 1.6 UQSM to 1 EA. Table II reports the minimum, maximum, weighted average, and the calculated/estimated weighted average results of the blending operation at the Colonie site.

Table II – Summary Results from Blending

	Minimum	Maximum	Weighted Average	Calculated/Estimated Weighted Average
$U^{238}_{Blended}$ (Bq/g)	0.44	4.14	1.76	5.69
$U^{238}_{Blended}$ (pCi/g)	12.00	112.00	47.69	153.66

COST SAVINGS

The costs savings recognized to the project are based on the diffence between the two facilities disposal rates and the difference between transportation costs for the waste, minus the labor and equipment to conduct the blending evolution. Disposal costs used in the comparison are based on the USACE Kansas City Disposal Contract with the two facilities. Facility A uses a cost associated with the disposal of Low Activity Radioactive Material (LARM) at a RCRA facility and Facility B uses a cost associated with the disposal of Low Level Mixed Waste at a Part 61 NRC licensed facility (the Part 61 NRC facility requires placement of material treated to remove the characteristic hazardous waste code into the facilities mixed waste cell even though the material is no longer a mixed waste). Transportation costs were considered however, for the differences between the two facilities were negligible. This delta is $498.90 m3 at approximately 3,250 m^3 (4,250 yd^3) that was blended, this amounts to a savings of $1,621,425. The labor expended and equipment costs were tracked by Shaw Costs Control and Scheduler. Labor cost for this blending process was $47,000.00 and equipment (extra excavator) costs were approximately $15,000.00. This amounts to a cost savings of $1,559,425.

Table III – Cost Comparison Information

	Disposal (cost/m^3)	Transportation (cost/m^3)	Total (cost/m^3)
RCRA Facility	$94.08	$88.20	$182.28
LLRW/LLMW Part 61 Facility	$602.28	$78.90	$681.18

LESSONS LEARNED

- Continuous improvement of process – the project staff needs to be looking for ways to continuously improve project process as a means by which to increase efficiently and decrease project costs.

- Periodic review of processes and regulations – The project team needs to periodically review project processes. This review should be performed to reinforce that the best practices are being used on the project to achieve stated goals.

- The application of this new guidance and soil blending - Other FUSRAP sites (where applicable) have the opportunity to ship more contaminated material off sites at reduce costs while complying with all guidance and regulations.

CONCLUSION

The blending of material at the Colonie site afforded the project the opportunity to dispose of the higher activity material therefore reducing the radioactive source term onsite. The reduction in source term reduced the onsite dose rates associated with the stockpiled material with no significant increase in dose rate due to blending operations. The blending operations allowed the site to remove all material from the site in a shorter period of time due to the more efficient use of resources which were realized from the cost savings associated with the transportation and disposal of LARM waste.

It should be noted that the blending operations showed that the calculated weighted average values estimated for the blending resulted in actual values on average three times lower then that calculated. These results are specific to the Colonie site and may be due to numerous factors not limited to the following; 1) lack of homogeneity of the in-situ wastes at the Colonie site, 2) over excavation of the elevated waste material which typical results in unintentional blending of material, 3) treatment of material for the hazardous waste at the Colonie site resulting in unintentional blending of the radioactive source term, and 4) multiple handling and movements of material on site resulting in unintentional blending of the radioactive source term.

While post excavation blending may not be applicable to all sites due to regulatory issues, space constraints, or insufficient low activity material to blend, it certainly can provide significant cost savings and lessen the fiscal burden of a site cleanup.