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Incineration of Low Level Radioactive Vegetation for Waste Volume Reduction

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INCINERATION OF LOW LEVEL RADIOACTIVE VEGETATION FOR WASTE VOLUME REDUCTION

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ABSTRACT

The purpose behind DOE's changing mission at the Savannah River Site (SRS) includes increasing activities for Waste Management and Environmental Restoration. At SRS there are a number of Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) locations that are contaminated with radioactive materials, support dense vegetation, and are targeted for remediation. Two such locations have been studied for non-time critical removal actions under the National Contingency Plan (NCP). Both of these sites support about 23 plant species. Surveys of the vegetation show that radiation emanates mainly from vines, shrubs, and trees and range from 20,000–200,000 disintegration / minute (d/m) beta gamma.

Planning for the removal and disposal of low-level radioactive vegetation was done with two principal goals: to process contaminated vegetation for optimum volume reduction and waste minimization; and for the protection of human health and environment. Four alternatives were identified as candidates for vegetation removal and disposal; chipping the vegetation and packing in carbon steel boxes (lined with synthetic commercial liners) and disposal at the Solid Waste Disposal Facility at SRS, composting the vegetation, burning the vegetation in the field, and incinerating the vegetation. One alternative, incineration, was considered a viable choice for waste volume reduction, safe handling, and the protection of the environment and human health. Advantages and disadvantages of all four alternatives have been evaluated.

For waste volume reduction and the ultimate disposal of radioactive vegetation, incineration is the preferred method. Advantages of incineration are that volume reduction is achieved and low-level radioactive waste is stabilized. For incineration and final disposal, vegetation will be chipped and packed in cardboard boxes and discharged to the rotary kiln of the incinerator. The slow rotation and long resident time in the kiln will ensure complete combustion of the vegetative material. The ash from the incinerator will be solidified with cement and rendered immobile. Solidified ash will control the potential contaminant pathways for the protection of human health and environment.

INTRODUCTION

At the Savannah River Site (SRS) there are a number of sites that have been contaminated with radioactive materials. Two such sites have been placed in the Resource Conservation and Recovery Act (RCRA) Facility Investigations/CERCLA Remedial Investigations (RFI/RI) Program. These sites are to be closed. The first part of closure implementation is to remove radioactive vegetation from the project sites.

The objective of this study was to develop planning strategies for radioactive vegetation removal, environmentally safe disposal, and to achieve maximum waste volume reduction. Three alternatives for vegetation removal and four options for vegetation processing were considered during the study. For this study, an analysis was performed on the type and volume of vegetation to be removed, level of radioactivity present in the vegetation, and options for vegetation removal and disposal.

LEVEL OF RADIOACTIVITY IN VEGETATION

The Health Protection Department (HP) at SRS has been periodically recording the rates and concentration of radioactivity in vegetation since the 1970's.[1] The range recorded by HP is contained in Table 1. A probe survey conducted on vegetation showed that the radiation levels ranged from 20,000–40,000 d/m beta/gamma and came mainly from vines and shrubs. Radiological survey observations made of a sweet gum tree showed a radiation level of 200,000 d/m beta/gamma, the trunk of a tree showed a radiation level of 40-60 mR/hr at 5 cm above the ground. The tree under observation was about 12–13 cm in diameter, and broken limbs from the tree showed a radiation level of 5 mR/hr.

Table I. Radionuclides Range pCi/g (dry) in Vegetation

Type of Vegetation	^{137}Cs	$^{89\ 90}Sr$
Vine Composite	10–310	5,600–128,600
Wood Composite	20–120	1,630–122,000
Broomsedge-Grass	6,750–8,190	2,430–25,240

TYPE OF VEGETATION

Both project sites support dense vegetation. About 23 types of trees, shrubs, and grasses were observed growing within the boundaries of the project sites.[2] Trees are of mixed heights and girth; many appear to have reached a height of about 12 m with a breast-height diameter of about 30–36 cm. Additionally, there are a number of young trees that have attained breast height The majority of shrubs are in the range of about 1–2 m in height.

VOLUME OF VEGETATION

The volume of fresh vegetation to be removed is presented in Table II. This table shows that the estimated vegetation to be ranges from 375-495 m^3.[2]

TABLE II. Volume of Vegetation to be Removed

Type of Vegetation	Range of Vegetation (m^3)
Trees (with roots)	195–240
Brush, vines, and grasses	180–255
Total	375–495

VEGETATION REMOVAL ACTIONS

According to the Federal Facility Agreement (FFA)[3], the two project sites under study must be assessed and remediated. Removal alternatives for these sites should be consistent with nine CERCLA-remedial evaluation criteria.[4] Closure options for these sites are to be environmentally sound. To establish a range of potential consequences and funding requirements for the chosen removal alternative of these two sites, the following three alternatives were examined for vegetation removal:

- no action (no removal of vegetation)
- cutting of vegetation and no removal
- cutting of all vegetation and removal

Alternative 1 - No Action

For this alternative, the vegetation at the project sites would not be cut or removed. The vegetation would continue to grow and multiply, and presumably continue to absorb radionuclides from the soil. Radioactive substances would continue to migrate along contaminant pathways to potential receptors. The potential impact to human health and the environment would continue unabated with the possible exposure of wildlife and the surrounding ecosystem from contaminated vegetation.

Exposure of radioactive vegetation to the public's health could occur as a result of transportation via several pathways. The potential contaminant pathways of concern are atmospheric, groundwater, surface water, and fugitive dry vegetative material. The potential contaminant exposure routes are ingestion, inhalation, and dermal contact. As a result of this alternative, the contaminant pathways and exposure routes would remain active and continue to cause adverse impacts on the environment.

Alternative 2 - Cutting of Vegetation and No Removal

This alternative involves cutting down the vegetation and leaving it on the ground. As a result, there will be no removal of the contaminated vegetation. This action will continue to impact the human health, the environment, and wildlife. Long-term remedial actions (close the site and construct a cap system) could be hindered because of interference from the large volume of dead vegetation lying on the ground. Contaminant pathways will remain active and unobstructed and that would cause the possible migration of radioactive substances off the site.

Dead vegetation lying at the ground, within the project boundaries, would biodegrade. As a result, biodegraded vegetation would reintroduce the radionuclides to the environment, either through wind erosion of vegetative materials or with surface water run-off (until the site is closed and a cover system installed). This could have a significant detrimental impact on the ecology of water bodies located in the near vicinity of the project sites.

The integrity and performance of the closure cap/cover system installed without removing vegetation could suffer adversely. Over a period of time, unremoved vegetation would undergo volume reduction due to biodegradation and could cause a serious threat to the performance of the cover system including localized subsidence, settlements, or complete failure of the cover system. Failure of the closure cover system would eventually reintroduce contamination to the environment.

Alternative 3 - Cutting of All Vegetation and Removal

This alternative processes the vegetation and removes it entirely from the project sites. This alternative will reduce and limit the likelihood of human and wildlife exposure to radioactive substances, as the contaminated medium would be physically removed, and alter and control the potential contaminated pathways. Removing the vegetation should also make the implementation of long-term remedial actions, cap construction, feasible.

PLANNING FOR VEGETATION REMOVAL, WASTE REDUCTION, AND DISPOSAL

The design analysis required consideration of each of the following removal and vegetation processing management practices; burying the removed vegetation at the Solid Waste Disposal Facility, open burning of vegetation, composting of vegetative mass, and incineration of vegetation.

Handling of Removed Radioactive Vegetation

Large trees, shrubs, small saplings, and other ground cover removed with the aid of mechanical equipment must be chipped and placed in 0.54 m cubed (21 inches cubed) cardboard boxes for incineration, and/or lined carbon steel boxes (2.8 m^3 volume [96 cu ft.]), for storage at the Solid Waste Disposal Facility. This practice will ensure safe storage and efficient handling of removed radioactive vegetation until its final destination for disposal is established.

Vegetation Processing for Waste Reduction and Disposal

The following four options were considered for processing radioactive contaminated vegetation for final disposal:

- *Disposal at the Solid Waste Disposal Facility*: Remove all chipped vegetation from the project sites in lined-carbon steel boxes (approximately 130–170 boxes) and transport them to the Solid Waste Disposal Facility at SRS. The disadvantage of this option is that considerable space will be required at the Solid Waste Disposal

Facility for the storage of about 130–170 boxes. Additionally, the vegetative mass over the period of time will decompose and reduce in volume, thus creating additional void space in boxes.

- *Composting the Vegetation*: Composting the vegetation from the project sites could be done under controlled conditions. However, the composted vegetation would not be suitable for soil amelioration as it will still be contaminated with radioactive substances, and subsequently contribute contamination to the environment. Therefore, composting at SRS is not recommended because of its foreseeable detrimental impacts to the environment.

- *Open Burning of the Vegetation*: Burning of radiological contaminated vegetation is unacceptable due to the high potential for an uncontrolled release of radioactive substances to the environment. Because of environmental consequences, this option for vegetation processing is not recommended.

- *Incineration of Vegetation*: Based on a cost analysis, it is still to be decided whether incineration of vegetation is done either at a commercially licensed incinerator or at the Consolidated Incineration Facility (CIF) at SRS. The CIF, located at SRS, is currently under construction with operations scheduled in February 1996. The facility is designed to treat mixed wastes containing both hazardous and radioactive contaminants. The actual waste streams designated for treatment using CIF are currently being evaluated under the National Environmental Policy Act (NEPA).[5] If the CIF is selected as the acceptable option for treatment of non-hazardous, low-level combustible waste, then the CIF can be used to treat radioactive vegetation. The advantages of incineration are a substantial reduction of vegetation volume, and better control of contaminant pathways leading to the environment.

Incineration Process: The chipped vegetation from the project area will be packed in 0.54 m cubed (21 inches cubed) disposal cardboard boxes. These boxes are discharged into the rotary kiln incinerator by a ram-feeder assembly. The kiln operating temperature ranges from 760–870° C. The slow rotation of the kiln promotes thorough combustion of the waste material. Ash drops from the discharge end of the kiln into a water-filled ash collection tank. This ash is scooped from the collection tank by a backhoe and dumped into a 55 gallons (208 l) drum until it is partially filled. Cement is then added and mixed with the ash to form a stabilized waste matrix to meet RCRA's Land Disposal Restriction (LDR) treatment standards.[6] Solidified ash drums (cured drums) are placed in onsite-concrete vaults for final disposal.

CONCLUSION

Three vegetation removal alternatives for these project sites were analyzed. The only feasible alternative for vegetation management was to remove all the vegetative growth from the project sites. The benefits of this alternative are that the contaminant pathways will be controlled and threats to human health and environment would be significantly reduced. Additionally, the implementation of this alternative will create conditions that are conducive to long-term integrity of the closure cap system as part of the final remedial action.

Four options for vegetation disposal processing from these two project sites were considered. Two options, open burning and composting were not recommended because they can pose serious risks to human health and the environment, and these two options will continue to contribute to the contaminant pathways. Analysis performed for volume reduction and controlling the contaminant pathways indicate that incineration of radioactive vegetation would be the best management option for waste volume reduction and safety of the public and environment. This option would control the potential contaminant pathways and protect human health and the environment. Additionally the final disposal of solidified ashes will require less space for burial as compared to disposal of chipped vegetation at the Solid Waste Disposal Facility. However, if the incinerator is not permitted to burn radioactive vegetation, then the second best option for vegetation disposal would be to place chipped vegetation in carbon-steel boxes and bury them at the Solid Waste Disposal Facility at SRS.

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