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# Reducing Biosolids Disposal Costs Using Land Application in Forested Areas

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# DISCLAIMER

# REDUCING BIOSOLIDS DISPOSAL COSTS USING LAND APPLICATION IN FORESTED AREAS

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## Introduction

Switching biosolids land application from a reclamation site to a forested site significantly reduced the cost of biosolids disposal at the Savannah River Site. Previous beneficial reuse programs focused on reclamation of existing borrow pits. While extremely beneficial, this program became very costly due to the regulatory requirements for groundwater monitoring, soil monitoring and frequent biosolids analyses.

A new program was developed to reuse biosolids in forested areas where the biosolids could be used as a soil conditioner and fertilizer to enhance timber yield. The forested land application site was designed so that groundwater monitoring and soil monitoring could be eliminated while biosolids monitoring and site maintenance were minimized. Monitoring costs alone were reduced by 80%. Capital costs for site preparation were also significantly reduced since there was no longer a need for expensive groundwater monitoring wells.

## Background

The Savannah River Site (SRS) is a Department of Energy facility located near Aiken, South Carolina and is operated by Westinghouse Savannah River Company. A system of twenty (20) small package wastewater treatment plants is used to treat sanitary wastewater produced by the SRS employee population. SRS produces approximately 400,000 gallons of 1.5% solids biosolids per year. Although biosolids production is relatively small (just over 25 dry tons per year), the cost of biosolids disposal continued to outpace other operational costs.

Previously, SRS biosolids were used to reclaim former borrow pit sites. Borrow pits are areas where soil is removed for use elsewhere and is replaced with inert construction debris such as tree stumps, wooden formwork, rocks, etc. This debris is covered with a layer of soil, but is typically unable to sustain much plant life without the addition of needed nutrients.

Biosolids were applied to two former borrow pits which were permitted as land application sites through the South Carolina Department of Health and Environmental Control (SCDHEC) at a rate of 200 lbs. of nitrogen per acre. Conditions of the SCDHEC permit for land application at the borrow pits included installation of seven (7) groundwater monitoring wells, annual groundwater analysis, quarterly groundwater analysis, annual soil analysis at depths of 0-6", 6-12", and 12-18", and annual biosolids analyses from each of the twenty (20) package wastewater treatment plants along with an annual complete TCLP analysis on one sample composited from all twenty (20) plants (Table 1). Annual monitoring costs ($32,000) contributed over $1,000 per dry ton per year to the total biosolids disposal cost.

## Table 1

## Borrow Pit Land Application Monitoring Requirements

| Annual Soil Monitoring Parameters | Annual Groundwater Monitoring Parameters | Quarterly Groundwater Monitoring Parameters | Annual Biosolids Monitoring Parameters |
|---|---|---|---|
| Cation Exchange Capacity<br>pH<br>Total Organic Carbon<br>Total Kjeldahl Nitrogen<br>ammonia<br>nitrate<br>phosphate<br>sulfate<br>chloride<br>calcium<br>sodium<br>potassium<br>magnesium<br>iron<br>manganese<br>aluminum<br>zinc<br>copper<br>nickel<br>chromium<br>cadmium<br>silver | calcium<br>cadmium<br>copper<br>iron<br>potassium<br>magnesium<br>manganese<br>nickel<br>lead<br>orthophosphate | pH<br>specific conductance<br>nitrate-nitrite<br>Total Dissolved Solids<br>sodium<br>chloride | % Total Solids<br>% Volatile Solids<br>Total Nitrogen<br>ammonia<br>nitrate<br>pH<br>phosphorus<br>potassium<br>copper<br>silver<br>zinc<br>nickel<br>lead<br>cadmium<br>TCLP |

**Current Program**

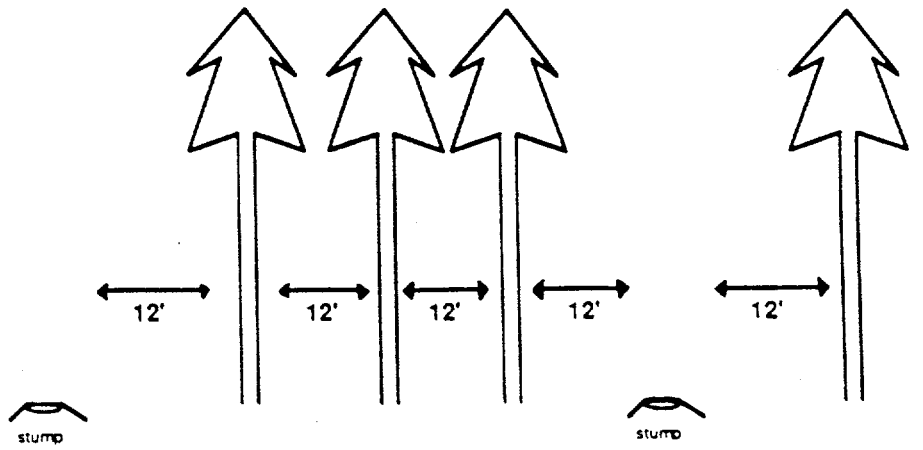
Although borrow pit reclamation using biosolids was successful, a new approach to biosolids reuse needed to be developed. This program was developed with the following objectives:

a) Current land application equipment must be adequate for new program with only minor upgrades.
b) Added nutrients should be removed from the soil by a crop in order to eliminate the need for groundwater and soil monitoring.
c) Crop harvesting should be kept to a minimum to control costs.
d) Crop growth should provide a benefit to SRS in either on-site use or off-site sales.

A forested land application site was chosen as the best candidate for continued reuse of biosolids with reduced capital and operation costs. It was determined that biosolids application at the forested site could be accomplished using the same liquid applicator truck used at the reclamation site. Instead of spraying biosolids on an open area, the applicator truck could travel down rows cleared through the forested area. A pathway cleared every 48' would allow truck access and ensure that the biosolids application was evenly distributed (Figure 1).

**Figure 1**

**Typical Forested Site Pathway**



Previous studies[1] at SRS showed that timber yield was enhanced when biosolids were applied as a fertilizer and soil conditioner to local pine forests. Pine forests would provide adequate uptake of nutrients while producing a salable crop which would require harvesting only every 40-50 years. As an added benefit, wastewater operators would not have to become "forestry experts" since the U.S. Forest Service managed all of the timber crops and sales at SRS.

The site of the new land application area was chosen based on the following factors:

1) Trees on the site were already established (8-20 years old) with a closed canopy. The closed canopy helps prevent airborne pollen, seeds, etc. from germinating and taking up the nutrients which are meant for the trees.
2) The depth to seasonally high groundwater was greater than 12 inches and there was no surface water on the site. This protects groundwater and surface water from possible nutrient/pollutant contamination.
3) Slope of the site was < 8% to ensure rainwater runoff would not carry nutrient/pollutants beyond site boundaries.
4) The site was easily accessible by roadway, yet public access was limited.

Once the land application site was chosen, biosolids application rates were calculated to ensure that nutrient levels were within the forest uptake rates and all applicable state and federal regulations. State and federal regulations were determined to be the limiting factor. SRS biosolids were very "clean" with regard to regulated pollutants so nitrogen was the constituent which determined all of the final loading rates (Table 2).

**Table 2**
**Forested Land Application Site Loading Rates**

| Parameter | Loading Rate (lbs/acre/yr) |
|---|---|
| Total Nitrogen | 78 |
| Total Inorg. N | <5.4 |
| Total Phosphorus | 5.6 |
| Total Potassium | <5.4 |
| Total Cadmium | <0.01 |
| Total Lead | <0.14 |
| Total Zinc | 1.4 |
| Total Nickel | <0.09 |
| Total Silver | 0.15 |
| Total Chromium | 0.05 |
| Total Copper | 1.04 |
| Total Cadmium | 0.01 |

The new site was permitted by SCDHEC, but permit requirements now included the requirements of 40 CFR Part 503 in addition to the SCDHEC requirements. Groundwater monitoring was eliminated once it was established that the depth to seasonally high water was greater than twelve(12) inches. Soil monitoring was performed initially as a part of the permit application process, but was not required on an ongoing basis. Biosolids monitoring frequency increased from annually to quarterly in order to meet new SCDHEC requirements, but the number of parameters analyzed decreased slightly (Table 3).

**Table 3**
**Forested Land Application Site Monitoring Requirements**

| Quarterly Biosolids Monitoring Parameters |
|---|
| Arsenic |
| Cadmium |
| Chromium |
| Copper |
| Lead |
| Mercury |
| Nickel |
| Selenium |
| Silver |
| Zinc |
| Total Potassium |
| Total Phosphorus |
| pH |
| Total Nitrogen |

**Reasoning**

Why does the regulatory climate seem so lax by comparison for forested land application? Forested land provides a crop to uptake nutrients applied by the sludge. Proper design and loading limitations ensure that nutrient applications do not exceed crop uptake rates. If nutrients are taken up by the crop, there is no need for groundwater monitoring. Likewise, routine soil monitoring is unnecessary once it is established that the soil is suitable for biosolids land application.

Also important is the fact that timber is a non-food chain crop. Continued close monitoring of metal concentrations, etc. is unnecessary due to the absence of a human health risk. Initial monitoring of soil levels along with routine biosolids monitoring are sufficient.

## Conclusion

Using forested land application of biosolids is a cost effective means of biosolids reuse. A reduction in monitoring costs from $32,000/year to $6,000/year (81%) at SRS showed that forested land application was a more cost effective alternative for biosolids disposal. Forested land provides a crop to uptake nutrients, however, unlike many crops, timber is only harvested every forty to fifty (40-50) years. Crops must be harvested to ensure that added nutrients do not contaminate groundwater sources. Timber crops provide an adequate uptake of nutrients without the high cost of annual harvesting. Additionally, timber crops are relatively abundant in certain regions (i.e. the southeastern U.S.).

## References

[1] Corey, Jack, M. W. Lowen, and C. E. Davis, "Sludge Land Application Program at the Savannah River Plant", 1985.

[2] Pal, Dhiraj and Michael Overcash, Design of Land Treatment Systems for Industrial Wastes - Theory and Practice, 1979

[3] Land Application of Sludge Guidance Manual, South Carolina Department of Health and Environmental Control, 1987.