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Innovative Uses of Compost
Composting of Soils Contaminated by Explosives

Introduction

Soil at more than 30 munitions sites across the United States is contaminated with explosives. The U.S. military has discovered that the composting process, and the use of finished (mature, cured) compost can effectively remediate munitions-contaminated soils. To incorporate such soil into the composting process, the soil is excavated and mixed with other feedstocks. The end-product is a contaminant-free soil, containing nutrient-rich humus that can enhance landscaping and horticultural applications. Composting costs considerably less than soil excavation and incineration, the traditional method used for these cleanups.

The Umatilla Army Depot in Hermiston, Oregon, has successfully used composting to convert 15,000 tons of contaminated soil into safe soil containing humus. By using composting instead of incineration, Umatilla saved approximately $2.6 million. Clean-up goals for Umatilla were established at concentrations of less than 30 milligrams per kilogram for 2,4,6-Trinitrotoluene (TNT) and Royal Demolition Explosives (RDX). The project exceeded these expectations by achieving nondetectable levels of explosives. Contaminant byproducts were either destroyed or permanently bound to soil or humus.

The success at Umatilla indicates that composting of explosive-contaminated soil is a cost-effective and environmentally sound clean-up method. Millions of dollars could be saved if the composting process were used rather than conventional incineration to clean up contaminated soils at these and other military operations in the United States. Other sites using composting for explosives include the U.S. Naval Submarine Base in Bangor, Washington; the Navy Surface Warfare Center in Crane, Indiana; and the Sierra Army Depot in Herlong, California.

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How Contamination Occurred at Umatilla

Over a 15-year period during the 1950s and 1960s, workers at Umatilla used water and steam to clean TNT, RDX, and other explosives out of decommissioned 500- and 750-pound bombs. In the process of cleaning these bombs, more than 80 million gallons of explosive-contaminated "pink water" (named for its characteristic color) were washed into two 10,000 square-foot lagoons. When the water evaporated, workers excavated and transported the residual solids to another area and burned them. While the use of evaporative ponds was the accepted wastewater disposal technique at the time, it caused an unforeseen problem. Contaminants seeped into the soil and the ground water underlying the evaporation lagoons. In 1987, Umatilla was put on the Superfund list for hazardous waste cleanup because of TNT and RDX levels of 4,800 parts per million.

How Composting of Explosive-Contaminated Soils Works

Through the process in which compost is made, naturally occurring micro-organisms break down the explosive contaminants in the soil. Using the contaminants as "food," the micro-organisms convert them into harmless substances consisting primarily of water, carbon dioxide, and salts. In addition to this food source, micro-organisms require nutrients, such as carbon, nitrogen, phosphorous, and potassium, in order to thrive, digest, and reproduce. To provide these nutrients in sufficient quantities, soil amendments, such as manure and potato waste, were added to the contaminated soil at Umatilla.

Before beginning work at Umatilla, extensive tests were performed to determine the best mixture of contaminated soil and soil amendments to be used in the composting process. Numerous factors influence what mix of these ingredients provides micro-organisms with the optimum environment in which to live. The most important factor is the carbon to nitrogen ratio. Other factors influencing the choice of soil amendments include moisture, pH, degradability, percentage of organic matter, and availability of specific soil amendments. The composting feedstocks used at Umatilla were 30 percent contaminated soil, 21 percent cattle manure, 18 percent sawdust, 18 percent alfalfa, 10 percent

Photo courtesy of Bioremediation Service, Inc.

Workers, using highly specialized mixing equipment, turn steaming windrows of soil amendments mixed with explosive-contaminated soil from the Umatilla Army Depot.

potato waste, and 3 percent chicken manure. In other geographical areas, substitutions may be made depending on the cost and availability of ingredients.

Large, temporary mobile buildings were constructed to control fumes and ensure optimum conditions for the composting process. The mixture of contaminated soil and soil amendments was placed into windrows. Workers, using highly specialized mixing equipment, turned these steaming piles three times daily to: (1) ensure that the compost received sufficient oxygen; (2) release trapped heat, water vapor, and gases; and (3) to break up clumps. Treatment time for a 2,700-cubic-yard batch of soil was 10 to 12 days.

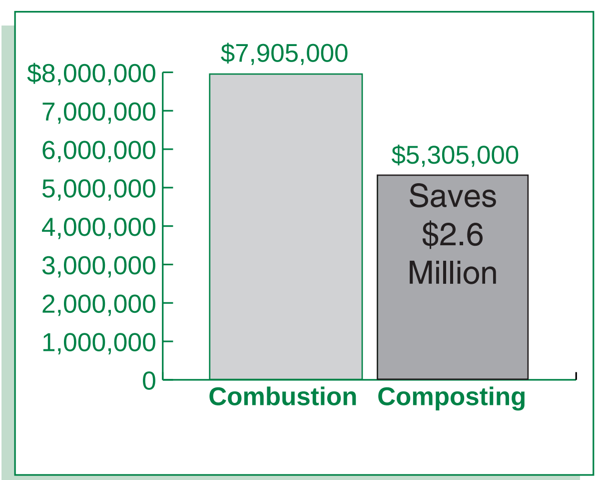
Benefits of Composting Explosive-Contaminated Soils

Composting of explosive-contaminated soils has significant economic and environmental benefits. At Umatilla, composting saved an estimated $2.6 million over incineration for cleanup of the entire site. Clean-up costs at Umatilla were estimated to be $527 per ton for combustion and $351 per ton for composting, resulting in a savings of $176 per ton.

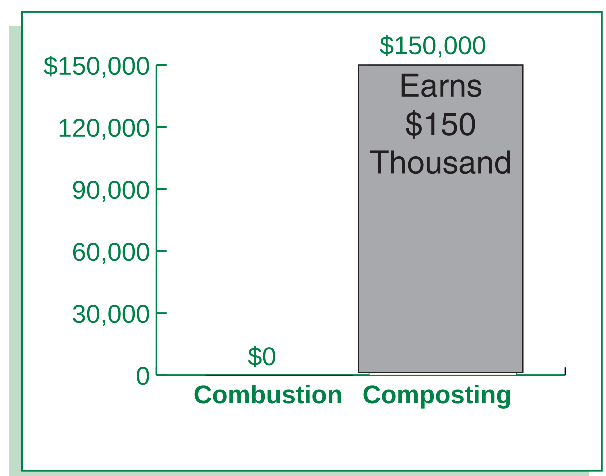
In addition, the end-product of the composting process, humus-rich soil, generally sells for at least $10 per ton, resulting in potential revenues of $150,000. Together, the savings ($2.6 million) and potential revenue ($150,000) from using the composting process to remediate explosive-contaminated soil could be $2.75 million. By contrast, the end-product of combustion has limited commercial value, and represents minimal potential revenue.

Combustion Versus Composting at Umatilla Army Depot

COST **Total Clean-up Cost for 15,000 Tons of Contaminated Soil***



BENEFIT **Value Added from Sale of 15,000 Tons of Treated Soil**



Savings and Revenue From Composting **$2,600,000 + $150,000 = $2,750,000**

** Based on information contained in "First Production-Level Bioremediation of Explosives-Contaminated Soil in the U. S." by David D. Emery and Patrick C. Faessler, Bioremediation Service, Inc.*

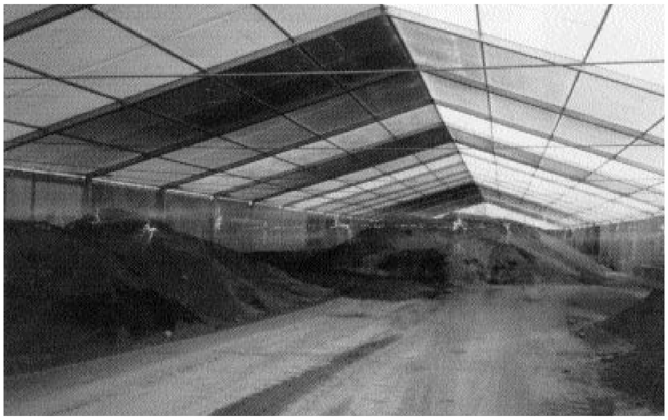


Photo courtesy of Bioremediation Service, Inc.

Large, temporary buildings controlled fumes and ensured optimum conditions for the composting of explosive-contaminated soil at the Umatilla Army Depot.

The U.S. Army Corps of Engineers has estimated that if composting were used to clean up the remaining U.S. munitions sites, $200 million could be saved.

While incinerators use large quantities of fossil fuel, a nonrenewable resource, only a small amount of fuel is needed for the machines that stir composting windrows. Incinerating soil at hazardous material disposal facilities results in ash that must be handled and disposed of as hazardous residue. By contrast, composting produces a nutrient-rich product comparable to an enriched top soil that can be used in landscaping and agricultural applications. In fact, tests on plants grown in remediated soil showed no toxic effects from the contaminants. This demonstrates that the contaminants are no longer present. According to Dr. Michael Cole, an expert in the degradation of organic contaminants in soil, composting, more than any other soil cleanup technique, results in an enriched soil end-product and restores the earth to a better condition than before it was contaminated.

References

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Williams, R.T., P.S. Zieganfuss, and W.E. Sisk. 1992. *Composting of explosives and propellant contaminated soils under thermophilic and mesophilic conditions. Journal of Industrial Microbiology*. 9:137-144.

For More Information

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