RESEARCH PAYS OFF

Minnesota Develops Method To Recycle Petroleum-Contaminated Soil

The Minnesota Department of Transportation (Mn/DOT) is currently upgrading fuel installations at truck stations throughout the state. As part of this project, approximately half of the department's 600 underground storage tanks have been removed.

Petroleum has leaked from the tanks, pipes, or dispensers at many of these old fuel installations. Consequently, petroleum-contaminated soil is often found during tank removal. The Minnesota Pollution Control Agency (MPCA) requires that this contaminated soil be treated.

Problem

Mn/DOT excavates thousands of cubic meters of petroleum-contaminated soil annually. The preferred method of soil treatment has historically been "landfarming" on state-owned property, which involves tilling the contaminated soil into the native soil where microorganisms degrade the petroleum hydrocarbons. This method of treatment typically costs approximately $16 per cubic meter ($12 per cubic yard) of contaminated soil. In recent years, landfarming has become increasingly difficult because of the lack of suitable Mn/DOT land parcels, public perception, and local government objectives.

An alternative remediation method is thermal treatment. This method is more expensive and may cost from $60 to $80 per cubic meter ($45 to $60 per cubic yard) of contaminated soil. Therefore the department can only afford thermal treatment of a small volume of soil each year.

Faced with the prospect of an increasing quantity of contaminated soil and few feasible treatment options, Mn/DOT investigated the use of bioremediation to treat petroleum-contaminated soil.

Solution

Mn/DOT developed an effective technique to bioremediate contaminated soils that is low cost, low technology, low maintenance, and totally contained. The process does not adversely affect the environment, but it does reduce treatment costs and future liability, thereby providing an effective means for soil treatment to all tank owners.

The bioremediation treatment process is similar to composting. Naturally occurring microorganisms found in organic matter consume petroleum hydrocarbons as a food source. The byproducts of the breakdown of hydrocarbons by this process are water vapor and carbon dioxide.

Application

In the bioremediation research effort initiated in the summer of 1991, Mn/DOT treated approximately 430 cubic meters (560 cubic yards) of petroleum-contaminated, medium-grained-sand soil excavated during the removal of nine underground storage tanks. Most of the contaminated soil was removed from the vicinity of diesel fuel and regular gasoline tanks; a small amount was removed from the vicinity of a waste oil tank. Laboratory analyses taken from the waste oil stockpile detected 56 parts per million (ppm) total petroleum hydrocarbons (TPH). Analyses of the fuel stockpile revealed a maximum concentration of 1300 ppm TPH.

The contaminated soil was mixed with animal manure and wood chips at a ratio of four parts soil to one part manure and one part wood chips. The mixed material was then set in windrows (long low ridges) in three lifts, each approximately two feet deep. The windrows also contained segments of drain tile between the lifts, which extended through the width of the pile (Figure 1). Finally, the treatment piles, called "biomounds," were covered with plastic sheeting. The sheeting was cut to allow the ends of the drain tile to be exposed to the atmosphere (Figure 2).

The manure provided a substantial population of microbes, which broke down the petroleum hydrocarbons. The manure also supplied a needed source of moisture for the microbes. The wood chips served as a bulking agent, reducing compaction within the pile.

The drain tile placed in the biomound allowed for passive air exchange between the biomound and the atmosphere. Because composting generates heat within the biomound, thermocouple wires were positioned in the pile to monitor interior temperature. This provided an indirect way to measure the microbial bioactivity.

Analysis of samples collected from the biomound after a treatment period of approximately 11 weeks detected petroleum hydrocarbon concentrations below the MPCA regulation threshold of 10 ppm TPH. After the successful completion of the initial research, Mn/DOT has continued evaluation of biomound treatment with the support of the Environmental Protection Agency. The goal is to develop biomound designs that further increase the treatment effectiveness.

Benefits

In addition to successfully treating the soil, the bioremediation treatment process developed by Mn/DOT proved to be affordable. The total cost of remediation was approximately $17 per cubic meter ($13 per cubic yard) of contaminated soil. This cost represents a substantial savings over thermal treatment, the most common soil remediation used in areas where landfarming is not possible. Since completion of the initial research project, the department has saved approximately $150,000 over alternative treatment costs. An added benefit is the end product of this process. Once composted, the soil has a higher organic value than it did initially. Mn/DOT proposes to use this material as a top-soil amendment.

This treatment process also has been positively received by government agencies and the public because the contaminated soil is contained during treatment, thus preventing runoff or leaching of contaminants. In summary, this process produces a beneficial end product (top-soil amendment) from two waste materials (animal manure and petroleum-contaminated soil) in an environmentally sound and cost-effective manner.

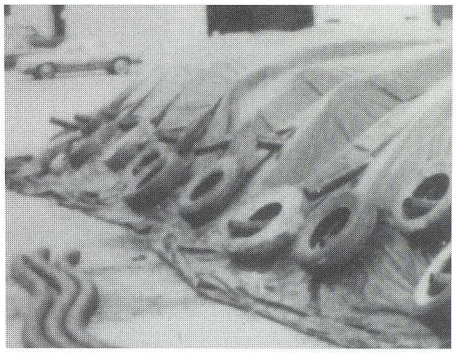

FIGURE 2 Constructed biomound with plastic sheeting.

The Minnesota method was used in North Carolina in 1994 to bioremediate petroleum-contaminated soil. Initial research findings indicated the cost of treating approximately 530 cubic meters (700 cubic yards) of soil to be $31 per cubic meter ($24 per cubic yard). These costs include labor, equipment, supplies, and laboratory testing of the soil. Estimated labor and equipment costs for future projects are substantially lower—approximately $21 per cubic meter ($16 per cubic yard). On the basis of the average purchase price for a composted soil similar to the bioremediated soil, the North Carolina Department of Transportation estimates that use of the bioremediated soil for roadside planting will result in a potential savings of $18 per cubic meter ($14 per cubic yard), an approximate 40 percent savings.

Biomound construction plans and a video are available from Mn/DOT. For further information, contact Brian Kamnikar, Environmental Engineer, Mn/DOT Oakdale Office, Mail Stop 620, 3485 Hadley Avenue North, Oakdale, Minnesota 55128-3307 (telephone 612-779-5091).

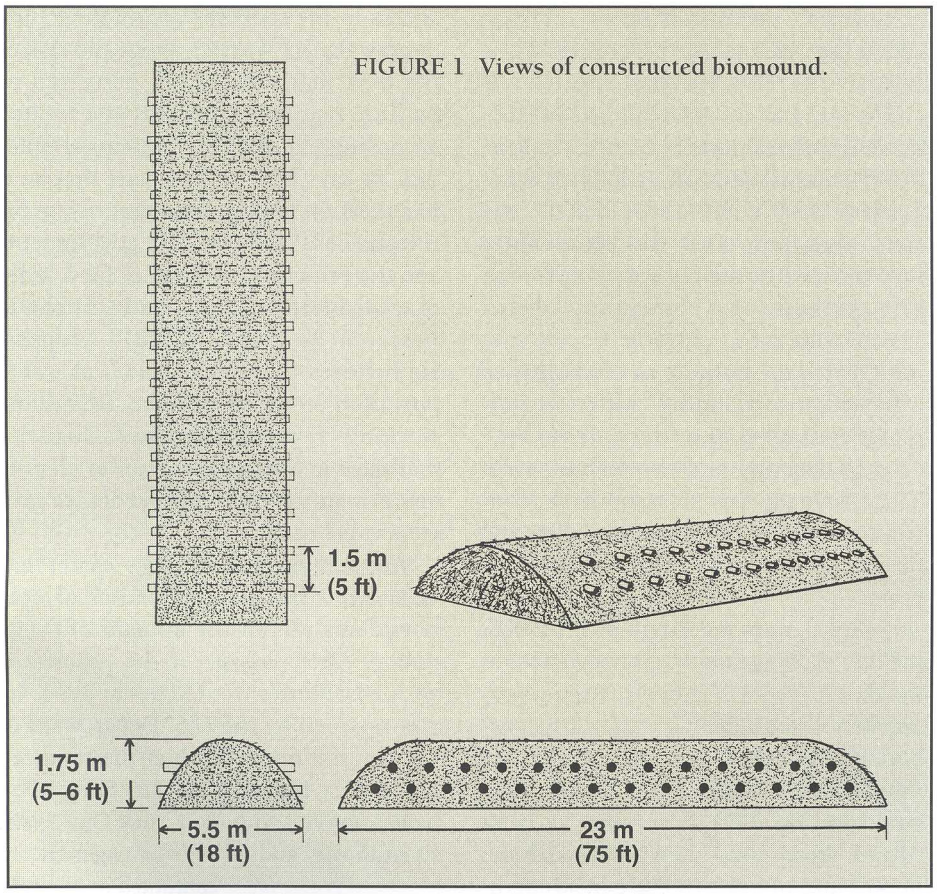

FIGURE 1 Views of constructed biomound.

Suggestions for "Research Pays Off" topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418 (telephone 202-334-2952).