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Project Summary

Spreading Lagooned Sewage Sludge on Farmland: A Case History

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This report describes a case history on the use of anaerobically digested (stabilized) sewage sludge on agricultural land. Although this project involved a single application of sludge to soils, it revealed much about equipment, procedures, and regulatory agency requirements.

The case history describes the disposal of approximately 420,000 m^3 (111 million gal) of stabilized sludge and other materials that had been stored in holding lagoons at the Belmont, Indiana, Wastewater Treatment Plant, which is owned and operated by the Department of Public Works of the Consolidated City of Indianapolis, Indiana. The stabilized sludge and other materials were removed to enable the construction of new wastewater treatment facilities on portions of the Belmont site previously occupied by the sludge lagoons. The major portion of the sludge (265,000 m^3) was disposed of by application to privately owned cropland in adjacent Boone County, Indiana.

Cadmium (Cd) and polychlorinated biphenyl (PCB) contents of the sludge were the major constraints in determining the sludge application rates to the cropland. Frequent analyses of the sludge solids were needed to identify the appropriate rates. Landowners consigned about 5,000 ha (13,000 acres) for a single sludge application, after which corn and soybeans were grown. An effective public relations program minimized public resistance and secured the cooperation of area residents.

Analyses revealed no measurable increases in the Cd and PCB contents of the grain after the single sludge application. Techniques were developed for removing, transporting, and applying lagooned sludges and for administering and monitoring such a program.

This Project Summary was developed by EPA's Municipal Environmental Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Disposal of sludge produced during municipal wastewater treatment is a severe problem. To select a disposal method, an agency must consider numerous factors, including costs, protection of the public health, pollution of air, water, and land, public acceptance, and resource conservation and recovery. Land application of stabilized sewage sludge has become a viable sludge disposal option. Benefits of this method result from the use of sludge as a low-analysis fertilizer and soil conditioner.

When the city of Indianapolis, Indiana, was required to construct advanced wastewater treatment facilities at the existing Belmont Wastewater Treatment Plant, they determined that the most cost effective site for these new treatment facilities was the 10 sludge lagoons containing 420,000 m^3 (111 million gal) of digested sewage sludge for up to 50 years. Of the 420,000 m^3 of sludge originally contemplated for disposal by land spreading, 265,000 m^3 was actually spread on land and the remainder disposed of in a landfill. The site preparation contract was awarded to a contractor who chose to dispose of the lagooned sludge by applying it to privately owned agricultural cropland in adjacent Boone County, Indiana.

Procedures

The project consisted of the following major tasks: (1) obtaining approval from regulatory agencies; (2) obtaining cooperation of landowners and farmers; (3) removing, transporting, and applying the lagooned sludge to soil; and (4) monitoring the impact on crops.

Undefined state and Federal regulations hampered initiation of the project. To determine appropriate rates for sludge application on cropland, extensive analyses were conducted of the sludge stored in the lagoons. As expected, the sludge solids content was extremely variable, ranging from u1% near the surface to u30% at a 5-m depth. The Cd and PCB contents of the sludge were major constraints in determining sludge application rates to cropland. The Cd concentrations ranged from 122 to 241 mg/kg (with an average of 179). Sludge application rates were initially based on 1.1 kg Cd/ha and later increased to 2.1 kg/ha. The maximum amounts of lead (Pb), zinc (Zn), nickel (Ni), and copper (Cu) applied were less than 26, 48, 22, and 2.6 kg/ha, respectively. Corn and soybeans were the crops grown after a single soil application of the sludge.

The subcontractor responsible for the sludge application developed an effective public relations program involving demonstration plots, radio and newspaper advertising, and written materials. Landowners consigned about 5,000 ha (13,000 acres) for sludge application. The subcontractor collected the soil samples, provided soil and sludge analysis data, and applied limestone when the soil pH was below 6.5.

The sewage sludge was resuspended in each lagoon, pumped into semi-trailer tankers, trucked to Boone County, and either applied immediately or placed in temporary storage lagoons. A variety of equipment was used to surface apply or inject the sludge into soil. Adverse weather conditions reduced the time available for sludge application and thereby delayed project completion by several years.

Discussion

Sludge Disposal Procedures

A high rate of sludge handling was achieved by using procedures and equipment developed in similar bulk material handling industries. A cable-controlled, pontoon-mounted device was used to homogenize and move the sludge in the lagoons to a pump station for transfer to a truck loading station. Four large semi-trailer tankers could be loaded in 5 min at the bulk-fuel-oil type loading facility.

Each tanker truck transported 29.5 m^3 of sludge over 80 km (50 miles) to an adjacent county where it was again transferred to a field-spreading vehicle or to an interim sludge-holding lagoon. A variety of spreading equipment was used over the 4-year sludge speading period. The contractor initially used low-speed, agricultural-type equipment. This equipment was unable to maintain high rates of sludge application on a round-the-clock basis. The heavier, faster, construction-grade spreading units used in the last 2 years of the project demonstrated the availability of equipment for large-scale land application of sludge projects. Summarized specifications for this type of equipment are included in the report.

Public Relations

Even though a technically sound sludge application program might be designed, public opposition could prevent the program from being initiated. The contractor therefore realized that an effective public relations program was essential to insure acceptance of sludge utilization in the county where sludge was to be spread. Two sectors of the public were addressed by the public relations program: The farmers who were to receive the sludge, and their neighbors. The farmers needed to be convinced of the economic benefit of using sludge, which in their experience was an unknown soil amendment when compared with conventional fertilizers. The neighbors of the farmers were sensitive about the dumping of urban wastes in rural communities, and their concerns included odors, pathogens, and groundwater pollution.

The contractor addressed the public relations problem with a broad approach that included: (a) establishing good media relations, (b) holding group meetings, (c) carrying out test plot demonstrations, (d) having a motion picture of the project prepared for local viewing, and (e) gaining the active support of agronomy experts.

Retention of a Consulting Agronomist

The city identified a need for a person with special expertise in the field of sludge disposal on agricultural land. In addition to providing technical assistance, this consultant provided additional project credibility with both the general public and the regulatory agencies. At the request of the city, the consulting agronomist prepared an evaluation of the agronomic implications of the land application of sludge for this project. He concluded that the project was well designed and incorporated the latest concepts for land application of sludge. The consulting agronomist supported the Indiana State Board of Health (ISBH) requirements for continuous monitoring of the sludge removal and spreading operations. He continued to be associated with the project in a consulting role and was involved in designing a program for sampling and analyzing the corn and soybean crops raised on sludge-treated fields.

Crop Monitoring

The state regulatory agency required that samples of corn and soybean grain be collected and analyzed the first year after sludge applications. Random samples of grain were collected by hand harvesting in September of each year. Samples were collected from both the sludge-treated fields and adjacent fields not treated with sludge. Because the same varieties of corn and soybeans were not necessarily grown in adjacent fields, the comparisons of Cd and PCB concentrations in crops grown on sludge-treated and non-sludge-treated areas (Table 1) may reflect the influence of both crop variety and sludge application. All crop samples were obtained during the first cropping season after sludge application. In 1978, some corn grain samples showed slightly increased concentrations of Cd. No Cd or PCB's were present at detectable levels in any subsequent samples of corn and soybean grain.

Table 1. Concentrations of Cadmium and PCB's in Corn and Soybean Grain Grown on Sludge-Treated and Untreated Soils in Boone County, Indiana (µg/kg)

		PCB in Grain		Cd in Grain	
Year	Crop	Sludge-Treated	Untreated	Sludge-Treated	Untreated
1978	Corn (9)[a]	<1	<1	100	<20
	Soybeans (6)	<1	1	60	<50
1979	Corn (9)	<1	<1	<50	<50
1980	Corn (12)	<1	<1	<50	<50

[a] *The numbers in parentheses indicate the total number of samples analyzed.*

Conclusions

This project demonstrates that a metropolitan treatment plant can remove and apply to croplands a large volume of liquid stabilized sewage sludge that has been stored in lagoons. The project involved transportation of the sludge by semi-trailer tankers and either surface or subsurface application to cropland with conventional equipment. The sludge was applied on privately owned land in an adjacent rural county through a cooperative agreement between the farmers and contractor.

The planning and conduct of a land application project requires expertise in many technical and sociological disciplines. Critical areas identified during this project include materials handling and transport, public relations, sludge application equipment, soil and crop production, soil and groundwater monitoring, sludge application and crop production scheduling, experience in relating to farmers and their problems, obtaining regulatory approvals, and establishing the mechanism for flow of project data and information.

Adverse weather conditions caused delays in applying sludge to farmland, and the growth of row crops (corn and soybeans) minimized the number of days that sludge could be applied to soils. Coordination of crop production and sludge utilization programs is difficult because of uncertainties caused by adverse weather conditions.

A public relations program must be started very early in a project to obtain the support of the agricultural community. Both the benefits and problems must be presented to all interested parties. The project developed numerous procedures for monitoring sludge application rates and for maintaining a wide variety of records. The equipment initially chosen for applying sludge did not perform as anticipated. Alternative equipment was selected later that could withstand continuous use. All equipment should be evaluated onsite before purchase.

A single application of sewage sludge at a rate ranging from 1.12 to 2.1 kg Cd/ha caused no measurable increases in the Cd content of corn and soybean grain. Plant uptake of PCB's was also not detectable.

If at all possible, offsite storage of sludge in either temporary or permanent lagoons should be avoided. A far preferable procedure is to locate storage lagoons near the treatment plant and then transport the sludge just before it is to be applied to cropland. The two temporary storage lagoons near the sludge spreading site resulted in the only negative public response to the land application project.

This project demonstrates that a large metropolitan sanitary district can transport and apply sludge to cropland in a neighboring rural area without widespread public resistance. To accomplish this goal, it is essential to involve local agricultural leaders, develop an effective and honest public relations program, use aesthetically acceptable methods for sludge application, and develop sludge application procedures compatible with prevailing farming practices.

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***Gerald Stern** is the EPA Project Officer (see below).*
The complete report, entitled "Spreading Lagooned Sewage Sludge on Farmland: A Case History," (Order No. PB 82-181 082; Cost: $12.00, subject to change) will be available only from:
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